REPORT

OF THE

THIRTY-FOURTH MEETING

OF THE

BRITISH ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE;

HELD AT

BATH IN SEPTEMBER 1864.

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OBJECTS.

The Association contemplates no interference with the ground occupied by other institutions. Its objects are,—To give a stronger impulse and a more systematic direction to scientific inquiry,—to promote the intercourse of those who cultivate Science in different parts of the British Empire, with one another, and with foreign philosophers,—to obtain a more general attention to the objects of Science, and a removal of any disadvantages of a public kind which impede its progress.

RULES.

ADMISSION OF MEMBERS AND ASSOCIATES.

All persons who have attended the first Meeting shall be entitled to become Members of the Association, upon subscribing an obligation to conform to its Rules.

The Fellows and Members of Chartered Literary and Philosophical Societies publishing Transactions, in the British Empire, shall be entitled, in like manner, to become Members of the Association.

The Officers and Members of the Councils, or Managing Committees, of Philosophical Institutions, shall be entitled, in like manner, to become Members of the Association.

All Members of a Philosophical Institution recommended by its Council or Managing Committee, shall be entitled, in like manner, to become Members of the Association.

Persons not belonging to such Institutions shall be elected by the General Committee or Council, to become Life Members of the Association, Annual Subscribers, or Associates for the year, subject to the approval of a General Meeting.

COMPOSITIONS, SUBSCRIPTIONS, AND PRIVILEGES.

Life Members shall pay, on admission, the sum of Ten Pounds. They shall receive *gratuitously* the Reports of the Association which may be published after the date of such payment. They are eligible to all the offices of the Association.

Annual Subscribers shall pay, on admission, the sum of Two Pounds, and in each following year the sum of One Pound. They shall receive *gratuitously* the Reports of the Association for the year of their admission and for the years in which they continue to pay *without intermission* their Annual Subscription. By omitting to pay this Subscription in any particular year, Members of this class (Annual Subscribers) *lose for that and all future years* the privilege of receiving the volumes of the Association *gratis*: but they may resume their Membership and other privileges at any subsequent Meeting of the Association, paying on each such occasion the sum of One Pound. They are eligible to all the Offices of the Association.

Associates for the year shall pay on admission the sum of One Pound. They shall not receive *gratuitously* the Reports of the Association, nor be eligible to serve on Committees, or to hold any office.

The Association consists of the following classes:—

1. Life Members admitted from 1831 to 1845 inclusive, who have paid on admission Five Pounds as a composition.

2. Life Members who in 1846, or in subsequent years, have paid on admission Ten Pounds as a composition.

3. Annual Members admitted from 1831 to 1839 inclusive, subject to the payment of One Pound annually. [May resume their Membership after intermission of Annual Payment.]

4. Annual Members admitted in any year since 1839, subject to the payment of Two Pounds for the first year, and One Pound in each following year. [May resume their Membership after intermission of Annual Payment.]

5. Associates for the year, subject to the payment of One Pound.

6. Corresponding Members nominated by the Council.

And the Members and Associates will be entitled to receive the annual volume of Reports, *gratis*, or to *purchase* it at reduced (or Members') price, according to the following specification, viz.:—

1. *Gratis.*—Old Life Members who have paid Five Pounds as a composition for Annual Payments, and previous to 1845 a further sum of Two Pounds as a Book Subscription, or, since 1845, a further sum of Five Pounds.

New Life Members who have paid Ten Pounds as a composition.

Annual Members who have not intermitted their Annual Subscription.

2. *At reduced or Members' Prices,* viz. two-thirds of the Publication Price.—Old Life Members who have paid Five Pounds as a composition for Annual Payments, but no further sum as a Book Subscription.

Annual Members who have intermitted their Annual Subscription.

Associates for the year. [Privilege confined to the volume for that year only.]

3. Members may purchase (for the purpose of completing their sets) any of the first seventeen volumes of Transactions of the Association, *and of which more than* 100 *copies remain*, at one-third of the Publication Price. Application to be made (by letter) to Messrs. Taylor & Francis, Red Lion Court, Fleet St., London.

Subscriptions shall be received by the Treasurer or Secretaries.

MEETINGS.

The Association shall meet annually, for one week, or longer. The place of each Meeting shall be appointed by the General Committee at the previous Meeting; and the Arrangements for it shall be entrusted to the Officers of the Association.

GENERAL COMMITTEE.

The General Committee shall sit during the week of the Meeting, or longer, to transact the business of the Association. It shall consist of the following persons:—

1. Presidents and Officers for the present and preceding years, with authors of Reports in the Transactions of the Association.

2. Members who have communicated any Paper to a Philosophical Society, which has been printed in its Transactions, and which relates to such subjects as are taken into consideration at the Sectional Meetings of the Association.

3. Office-bearers for the time being, or Delegates, altogether not exceeding three in number, from any Philosophical Society publishing Transactions.

4. Office-bearers for the time being, or Delegates, not exceeding three, from Philosophical Institutions established in the place of Meeting, or in any place where the Association has formerly met.

5. Foreigners and other individuals whose assistance is desired, and who are specially nominated in writing for the Meeting of the year by the President and General Secretaries.

6. The Presidents, Vice-Presidents, and Secretaries of the Sections are *ex-officio* members of the General Committee for the time being.

SECTIONAL COMMITTEES.

The General Committee shall appoint, at each Meeting, Committees, consisting severally of the Members most conversant with the several branches of Science, to advise together for the advancement thereof.

The Committees shall report what subjects of investigation they would particularly recommend to be prosecuted during the ensuing year, and brought under consideration at the next Meeting.

The Committees shall recommend Reports on the state and progress of particular Sciences, to be drawn up from time to time by competent persons, for the information of the Annual Meetings.

COMMITTEE OF RECOMMENDATIONS.

The General Committee shall appoint at each Meeting a Committee, which shall receive and consider the Recommendations of the Sectional Committees, and report to the General Committee the measures which they would advise to be adopted for the advancement of Science.

All Recommendations of Grants of Money, Requests for Special Researches, and Reports on Scientific Subjects, shall be submitted to the Committee of Recommendations, and not taken into consideration by the General Committee, unless previously recommended by the Committee of Recommendations.

LOCAL COMMITTEES.

Local Committees shall be formed by the Officers of the Association to assist in making arrangements for the Meetings.

Local Committees shall have the power of adding to their numbers those Members of the Association whose assistance they may desire.

OFFICERS.

A President, two or more Vice-Presidents, one or more Secretaries, and a Treasurer, shall be annually appointed by the General Committee.

COUNCIL.

In the intervals of the Meetings, the affairs of the Association shall be managed by a Council appointed by the General Committee. The Council may also assemble for the despatch of business during the week of the Meeting.

PAPERS AND COMMUNICATIONS.

The Author of any paper or communication shall be at liberty to reserve his right of property therein.

ACCOUNTS.

The Accounts of the Association shall be audited annually, by Auditors appointed by the Meeting.

Table showing the Places and Times of Meeting of the British Association, with Presidents, Vice-Presidents, and Local Secretaries, from its Commencement.

PRESIDENTS.	VICE-PRESIDENTS.	LOCAL SECRETARIES.
The EARL FITZWILLIAM, D.C.L., F.R.S., F.G.S., &c. YORK, September 27, 1831.	Rev. W. Vernon Harcourt, M.A., F.R.S., F.G.S.	William Gray, jun., F.G.S. Professor Phillips, M.A., F.R.S., F.G.S.
The REV. W. BUCKLAND, D.D., F.R.S., F.G.S., &c. OXFORD, June 19, 1832.	Sir David Brewster, F.R.S. L. & E., &c. Rev. W. Whewell, F.R.S., Pres. Geol. Soc.	Professor Daubeny, M.D., F.R.S., &c. Rev. Professor Powell, M.A., F.R.S., &c.
The REV. ADAM SEDGWICK, M.A., V.P.R.S., V.P.G.S. CAMBRIDGE, June 25, 1833.	G. B. Airy, F.R.S., Astronomer Royal, &c. John Dalton, D.C.L., F.R.S.	Rev. Professor Henslow, M.A., F.L.S., F.G.S. Rev. W. Whewell, F.R.S.
SIR T. MACDOUGALL BRISBANE, K.C.B., D.C.L., F.R.S. L. & E. EDINBURGH, September 8, 1834.	Sir David Brewster, F.R.S., &c. Rev. T. R. Robinson, D.D.	Professor Forbes, F.R.S. L. & E., &c. Sir John Robinson, Sec. R.S.E.
The REV. PROVOST LLOYD, LL.D. DUBLIN, August 10, 1835.	Viscount Oxmantown, F.R.S., F.R.A.S. Rev. W. Whewell, F.R.S., &c.	Sir W. R. Hamilton, Astron. Royal of Ireland, &c. Rev. Professor Lloyd, F.R.S.
The MARQUIS OF LANSDOWNE, D.C.L., F.R.S., &c. BRISTOL, August 22, 1836.	The Marquis of Northampton, F.R.S. Rev. W. D. Conybeare, F.R.S., F.G.S. J. C. Prichard, M.D., F.R.S.	Professor Daubeny, M.D., F.R.S., &c. V. F. Hovenden, Esq.
The EARL OF BURLINGTON, F.R.S., F.G.S., Chancellor of the University of London LIVERPOOL, September 11, 1837.	The Bishop of Norwich, P.L.S., F.G.S. John Dalton, D.C.L., F.R.S. Sir Philip de Grey Egerton, Bart., F.R.S., F.G.S. Rev. W. Whewell, F.R.S.	Professor Traill, M.D. Wm. Wallace Currie, Esq. Joseph N. Walker, Pres. Royal Institution, Liverpool.
The DUKE OF NORTHUMBERLAND, F.R.S., F.G.S., &c. NEWCASTLE-ON-TYNE, August 20, 1838.	The Bishop of Durham, F.R.S., F.S.A. The Rev. W. Vernon Harcourt, F.R.S., &c. Prideaux John Selby, Esq., F.R.S.E.	John Adamson, F.L.S., &c. Wm. Hutton, F.G.S. Professor Johnston, M.A., F.R.S.
The REV. W. VERNON HARCOURT, M.A., F.R.S., &c. BIRMINGHAM, August 26, 1839.	Marquis of Northampton. Earl of Dartmouth. The Rev. T. R. Robinson, D.D. John Corrie, Esq., F.R.S. Very Rev. Principal Macfarlane	George Barker, Esq., F.R.S. Peyton Blakiston, M.D. Joseph Hodgson, Esq., F.R.S. Follett Osler, Esq.
The MARQUIS OF BREADALBANE, F.R.S. GLASGOW, September 17, 1840.	Major-General Lord Greenock, F.R.S.E. Sir David Brewster, F.R.S. Sir T. M. Brisbane, Bart., F.R.S. The Earl of Mount Edgecumbe.	Andrew Liddell, Esq. Rev. J. P. Nicol, LL.D. John Strang, Esq.
The REV. PROFESSOR WHEWELL, F.R.S., &c. PLYMOUTH, July 29, 1841.	The Earl of Morley. Lord Eliot, M.P. Sir C. Lemon, Bart. Sir D. T. Acland, Bart.	W. Snow Harris, Esq., F.R.S. Col. Hamilton Smith, F.L.S. Robert Were Fox, Esq. Richard Taylor, jun., Esq.
The LORD FRANCIS EGERTON, F.G.S. MANCHESTER, June 23, 1842.	John Dalton, D.C.L., F.R.S. Hon. and Rev. W. Herbert, F.L.S., &c. Rev. A. Sedgwick, M.A., F.R.S. W. C. Henry, M.D., F.R.S. Sir Benjamin Heywood, Bart.	Peter Clare, Esq., F.R.A.S. W. Fleming, M.D. James Heywood, Esq., F.R.S.
The EARL OF ROSSE, F.R.S. CORK, August 17, 1843.	Earl of Listowel. Viscount Adare Sir W. R. Hamilton, Pres.R.I.A. Rev. T. R. Robinson, D.D.	Professor John Stevelly, M.A. Rev. Jos. Carson, F.T.C. Dublin. William Keleher, Esq. Wm. Clear, Esq.
The REV. G. PEACOCK, D.D. (Dean of Ely), F.R.S. YORK, September 26, 1844.	Earl Fitzwilliam, F.R.S. Viscount Morpeth, F.G.S. The Hon. John Stuart Wortley, M.P. Sir David Brewster, K.H., F.R.S. Michael Faraday, Esq., D.C.L., F.R.S. Rev. W. V. Harcourt, F.R.S.	William Hatfeild, Esq., F.G.S. Thomas Meynell, Esq., F.L.S. Rev. W. Scoresby, LL.D., F.R.S. William West, Esq.

SIR JOHN F. W. HERSCHEL, Bart., F.R.S., &c. CAMBRIDGE, June 19, 1845.	The Earl of Hardwicke. The Bishop of Norwich Rev. J. Graham, D.D. Rev. G. Ainslie, D.D. G. B. Airy, Esq., M.A., D.C.L., F.R.S. The Rev. Professor Sedgwick, M.A., F.R.S.	William Hopkins, Esq., M.A., F.R.S. Professor Ansted, M.A., F.R.S.
SIR RODERICK IMPEY MURCHISON, G.C.St.S., F.R.S. SOUTHAMPTON, September 10, 1846.	The Marquis of Winchester. The Earl of Yarborough, D.C.L. Lord Ashburton, D.C.L. Viscount Palmerston, M.P. Right Hon. Charles Shaw Lefevre, M.P. Sir George T. Staunton, Bart., M.P., D.C.L., F.R.S. The Lord Bishop of Oxford, F.R.S. Professor Owen, M.D., F.R.S. Professor Powell, F.R.S.	Henry Clark, M.D. T. H. C. Moody, Esq.
SIR ROBERT HARRY INGLIS, Bart., D.C.L., F.R.S., M.P. for the University of Oxford. OXFORD, June 23, 1847.	The Earl of Rosse, F.R.S. The Lord Bishop of Oxford, F.R.S. The Vice-Chancellor of the University Thomas G. Bucknall Estcourt, Esq., D.C.L., M.P. for the University of Oxford. Very Rev. the Dean of Westminster, D.D., F.R.S. Professor Daubeny, M.D., F.R.S. The Rev. Prof. Powell, M.A., F.R.S.	Rev. Robert Walker, M.A., F.R.S. H. Wentworth Acland, Esq., B.M.
The MARQUIS OF NORTHAMPTON, President of the Royal Society, &c. SWANSEA, August 9, 1848.	The Marquis of Bute, K.T. Viscount Adare, F.R.S. Sir H. T. DelaBeche, F.R.S., Pres. G.S. The Very Rev. the Dean of Llandaff, F.R.S. Lewis W. Dillwyn, Esq., F.R.S. W. R. Grove, Esq., F.R.S. J. H. Vivian, Esq., M.P., F.R.S. The Lord Bishop of St. David's.	Matthew Moggridge, Esq. D. Nicol, M.D.
The REV. T. R. ROBINSON, D.D., M.R.I.A., F.R.A.S. BIRMINGHAM, September 12, 1849.	The Earl of Harrowby. The Lord Wrottesley, F.R.S. Right Hon. Sir Robert Peel, Bart., M.P., D.C.L., F.R.S. Charles Darwin, Esq., M.A., F.R.S., Sec. G.S. Professor Faraday, D.C.L., F.R.S. Sir David Brewster, K.H., LL.D., F.R.S. Rev. Prof. Willis, M.A., F.R.S.	Captain Tindal, R.N. William Wills, Esq. Bell Fletcher, Esq., M.D. James Chance, Esq.
SIR DAVID BREWSTER, K.H., LL.D., F.R.S. L. & E., Principal of the United College of St. Salvator and St. Leonard, St. Andrews. EDINBURGH, July 21, 1850.	Right Hon. the Lord Provost of Edinburgh The Earl of Cathcart, K.C.B., F.R.S.E. The Earl of Rosebery, K.T., D.C.L., F.R.S. Right Hon. David Boyle (Lord Justice-General), F.R.S.E. General Sir Thomas M. Brisbane, Bart., D.C.L., F.R.S., Pres. R.S.E. Very Rev. John Lee, D.D., V.P.R.S.E., Principal of the University of Edinburgh. Professor W. P. Alison, M.D., V.P.R.S.E. Professor J. D. Forbes, F.R.S., Sec. R.S.E.	Rev. Professor Kelland, M.A., F.R.S.L. & E. Professor Balfour, M.D., F.R.S.E., F.L.S. James Tod, Esq., F.R.S.E.
GEORGE BIDDELL AIRY, Esq., D.C.L., F.R.S., Astronomer Royal. IPSWICH, July 2, 1851.	The Lord Rendlesham, M.P. The Lord Bishop of Norwich Rev. Professor Sedgwick, M.A., F.R.S. Rev. Professor Henslow, M.A., F.L.S. Sir John P. Boileau, Bart., F.R.S. Sir William F. F. Middleton, Bart. J. C. Cobbold, Esq., M.P. T. B. Western, Esq.	Charles May, Esq., F.R.A.S. Dillwyn Sims, Esq. George Arthur Biddell, Esq. George Ransome, Esq., F.L.S.
COLONEL EDWARD SABINE, Royal Artillery, Treas. & V.P. of the Royal Society. BELFAST, September 1, 1852.	The Earl of Enniskillen, D.C.L., F.R.S. The Earl of Rosse, M.R.I.A., Pres. R.S. Sir Henry T. DelaBeche, F.R.S. Rev. Edward Hincks, D.D., M.R.I.A. Rev. P. S. Henry, D.D., Pres. Queen's College, Belfast Rev. T. R. Robinson, D.D., Pres. R.I.A., F.R.A.S. Professor G. G. Stokes, F.R.S. Professor Stevelly, LL.D.	W. J. C. Allen, Esq. William M'Gee, M.D. Professor W. P. Wilson.

PRESIDENTS.	VICE-PRESIDENTS.	LOCAL SECRETARIES.
WILLIAM HOPKINS, Esq., M.A., V.P.R.S., F.G.S., & Pres. Camb. Phil. Society HULL, September 7, 1853.	The Earl of Carlisle, F.R.S. Lord Londesborough, F.R.S. Professor Faraday, D.C.L., F.R.S. Rev. Prof. Sedgwick, M.A., F.R.S. Charles Frost, Esq., F.S.A., Pres. of the Hull Lit. and Philos. Society William Spence, Esq., F.R.S. Lieut.-Col. Sykes, F.R.S. Professor Wheatstone, F.R.S.	Henry Cooper, M.D., V.P. Hull. Lit. & Phil. Society. Bethel Jacobs, Esq., Pres. Hull Mechanics' Inst.
The EARL OF HARROWBY, F.R.S. LIVERPOOL, September 20, 1854.	The Lord Wrottesley, M.A., F.R.S., F.R.A.S. Sir Philip de Malpas Grey Egerton, Bart., M.P., F.R.S., F.G.S. Professor Owen, M.D., LL.D., F.R.S., F.L.S., F.G.S. Rev. Professor Whewell, D.D., F.R.S., Hon. M.R.I.A., F.G.S., Master of Trinity College, Cambridge William Lassell, Esq., F.R.S.L. & E., F.R.A.S. Joseph Brooks Yates, F.S.A., F.R.G.S.	Joseph Dickinson, M.D., F.R.S. Thomas Inman, M.D.
The DUKE OF ARGYLL, F.R.S., F.G.S. GLASGOW, September 12, 1855.	The Very Rev. Principal Macfarlane, D.D. Sir William Jardine, Bart., F.R.S.E. Sir Charles Lyell, M.A., LL.D., F.R.S. James Smith, Esq., F.R.S. L. & E. Walter Crum, Esq., F.R.S. Thomas Graham, Esq., M.A., F.R.S., Master of the Royal Mint Professor William Thomson, M.A., F.R.S.	John Strang, LL.D. Professor Thomas Anderson, M.D. William Gourlie, Esq.
CHARLES G. B. DAUBENY, M.D., LL.D., F.R.S., Professor of Botany in the University of Oxford CHELTENHAM, August 6, 1856.	The Earl of Ducie, F.R.S., F.G.S. The Lord Bishop of Gloucester and Bristol Sir Roderick I. Murchison, G.C.St.S., D.C.L., F.R.S. Thomas Barwick Lloyd Baker, Esq. The Rev. Francis Close, M.A.	Capt. Robinson, R.A. Richard Beamish, Esq., F.R.S. John West Hugall, Esq.
The REV. HUMPHREY LLOYD, D.D., D.C.L., F.R.S. L. & E., V.P.R.I.A. DUBLIN, August 26, 1857.	The Right Honourable the Lord Mayor of Dublin The Provost of Trinity College, Dublin The Marquis of Kildare. Lord Talbot de Malahide The Lord Chancellor of Ireland The Lord Chief Baron, Dublin Sir William R. Hamilton, LL.D., F.R.A.S., Astronomer Royal of Ireland Lieut.-Colonel Larcom, R.E., LL.D., F.R.S. Richard Griffith, Esq., LL.D., M.R.I.A., F.R.S.E., F.G.S.	Lundy E. Foote, Esq. Rev. Professor Jellett, F.T.C.D. W. Neilson Hancock, LL.D.
RICHARD OWEN, M.D., D.C.L., V.P.R.S., F.L.S., F.G.S., Superintendent of the Natural History Departments of the British Museum LEEDS, September 22, 1858.	The Lord Monteagle, F.R.S. The Lord Viscount Goderich, M.P., F.R.G.S. The Right Hon. M. T. Baines, M.A., M.P. Sir Philip de Malpas Grey Egerton, Bart., M.P., F.R.S., F.G.S. The Rev. W. Whewell, D.D., F.R.S., Hon. M.R.I.A., F.G.S., F.R.A.S., Master of Trinity College, Cambridge James Garth Marshall, Esq., M.A., F.G.S. R. Monckton Milnes, Esq., D.C.L., M.P., F.R.G.S.	Rev. Thomas Hincks, B.A. W. Sykes Ward, Esq., F.C.S. Thomas Wilson, Esq., M.A.
HIS ROYAL HIGHNESS THE PRINCE CONSORT ABERDEEN, September 14, 1859.	The Duke of Richmond, K.G., F.R.S. The Earl of Aberdeen, LL.D., K.G., K.T., F.R.S. The Lord Provost of the City of Aberdeen Sir John F. W. Herschel, Bart., M.A., D.C.L., F.R.S. Sir David Brewster, K.H., D.C.L., F.R.S. Sir Roderick I. Murchison, G.C.St.S., D.C.L., F.R.S. The Rev. W. V. Harcourt, M.A., F.R.S. The Rev. T. R. Robinson, D.D., F.R.S. A. Thomson, Esq., LL.D., F.R.S., Convener of the County of Aberdeen	Professor J. Nicol, F.R.S.E., F.G.S. Professor Fuller, M.A. John F. White, Esq.

The LORD WROTTESLEY, M.A., V.P.R.S., F.R.A.S. OXFORD, June 27, 1860.	The Earl of Derby, K.G., P.C., D.C.L., Chancellor of the Univ. of Oxford The Rev. F. Jeune, D.C.L., Vice-Chancellor of the University of Oxford The Duke of Marlborough, D.C.L., F.G.S., Lord Lieutenant of Oxfordshire The Earl of Rosse, K.P., M.A., F.R.S., F.R.A.S. The Lord Bishop of Oxford, D.D., F.R.S. The Very Rev. H. G. Liddell, D.D., Dean of Christ Church, Oxford Professor Daubeny, M.D., LL.D., F.R.S., F.L.S., F.G.S. Professor Acland, M.D., F.R.S. Professor Donkin, M.A., F.R.S., F.R.A.S.	George Rolleston, M.D., F.L.S. H. J. S. Smith, Esq., M.A., F.C.S. George Griffith, Esq., M.A., F.C.S.
WILLIAM FAIRBAIRN, Esq., LL.D., C.E., F.R.S. MANCHESTER, September 4, 1861.	The Earl of Ellesmere, F.R.G.S. The Lord Stanley, M.P., D.C.L., F.R.G.S. The Lord Bishop of Manchester, D.D., F.R.S., F.G.S. Sir Philip de M. Grey Egerton, Bart., M.P., F.R.S., F.G.S. Sir Benjamin Heywood, Bart., F.R.S. Thomas Bazley, Esq., M.P. James Aspinall Turner, Esq., M.P. James Prescott Joule, Esq., LL.D., F.R.S., Pres. Lit. & Phil. Soc. Manchester Professor E. Hodgkinson, F.R.S., M.R.I.A., M.I.C.E. Joseph Whitworth, Esq., F.R.S., M.I.C.E.	R. D. Darbishire, Esq., B.A., F.G.S. Alfred Neild, Esq. Arthur Ransome, M.A., Esq. Professor H. E. Roscoe, B.A.
The REV. R. WILLIS, M.A., F.R.S., Jacksonian Professor of Natural and Experimental Philosophy in the University of Cambridge CAMBRIDGE, October 1, 1862.	The Rev. the Vice-Chancellor of the University of Cambridge The Very Rev. Harvey Goodwin, D.D., Dean of Ely. The Rev. W. Whewell, D.D., F.R.S., Master of Trinity College, Cambridge The Rev. Professor Sedgwick, M.A., D.C.L., F.R.S. Rev. J. Challis, M.A., F.R.S. G. B. Airy, Esq., M.A., D.C.L., F.R.S., Astronomer Royal Professor G. G. Stokes, M.A., D.C.L., Sec. R.S. Professor J. C. Adams, M.A., D.C.L., F.R.S., Pres. C.P.S.	Professor C. C. Babington, M.A., F.R.S., F.L.S. Professor G. D. Liveing, M.A. The Rev. N. M. Ferrers, M.A.
SIR W. ARMSTRONG, C.B., LL.D., F.R.S. NEWCASTLE-ON-TYNE, August 26, 1863.	Sir Walter C. Trevelyan, Bart., M.A. Sir Charles Lyell, LL.D., D.C.L., F.R.S., F.G.S. Hugh Taylor, Esq., Chairman of the Coal Trade Isaac Lowthian Bell, Esq., Mayor of Newcastle. Nicholas Wood, Esq., President of the Northern Institute of Mining Engineers Rev. Temple Chevallier, B.D., F.R.A.S. William Fairbairn, Esq., LL.D., F.R.S.	A. Noble, Esq. Augustus H. Hunt, Esq. R. C. Clapham, Esq.
SIR CHARLES LYELL, Bart., M.A., D.C.L., F.R.S. BATH, September 14, 1864.	The Right Hon. the Earl of Cork and Orrery, Lord Lieutenant of Somersetshire The Most Noble the Marquis of Bath The Right Hon. Earl Nelson The Lord Portman The Very Reverend the Dean of Hereford The Venerable the Archdeacon of Bath W. Tite, Esq., M.P., F.R.S., F.G.S., F.S.A. A. E. Way, Esq., M.P. Francis H. Dickinson, Esq. W. Sanders, Esq. F.R.S., F.G.S.	C. Moore, Esq., F.G.S. C. E. Davis, Esq. The Rev. H. H. Winwood, M.A.
JOHN PHILLIPS, Esq., M.A., LL.D., F.R.S., F.G.S., Professor of Geology in the University of Oxford BIRMINGHAM, September 6, 1865.	The Right Hon. the Earl of Lichfield, Lord-Lieutenant of Staffordshire. The Right Hon. the Earl of Dudley The Right Hon. Lord Leigh, Lord-Lieutenant of Warwickshire The Right Hon. Lord Lyttelton, Lord-Lieutenant of Worcestershire The Right Hon. Lord Wrottesley, M.A., D.C.L., F.R.S., F.R.A.S. The Right Reverend the Lord Bishop of Worcester The Right Hon. C. B. Adderley, M.P. William Scholefield, Esq., M.P. | F. Osler, Esq., F.R.S. J. T. Chance, Esq. | The Rev. Charles Evans, M.A.	William Mathews, Esq., jun., F.G.S. John Henry Chamberlain, Esq. The Rev. G. D. Boyle, M.A.

THE GENERAL TREASURER'S ACCOUNT from August 26, 1863 (commencement of NEWCASTLE MEETING) to September 14, 1864 (BATH).

RECEIPTS.

	£	s.	d.
To Balance brought on from last Account	317	0	4
Received Life Compositions at Newcastle and since	448	0	0
,, Annual Subscriptions, ditto ditto	707	0	0
,, Associates' Tickets, ditto ditto	1706	0	0
,, Ladies' Tickets, ditto ditto	1007	0	0
,, Dividends on Stock	248	1	11
,, Sale of Publications—viz.			
Reports Catalogues of Stars, &c.	61	8	8
Legacy from the late Beriah Botfield of Ludlow	10	10	0
	£4505	0	11

PAYMENTS.

				£	s.	d.
By paid Expenses of Newcastle Meeting, Sundry Printing, Binding, Advertising, and Incidental Petty Expenses by the General Treasurer and Local Treasurers				261	18	5
Paid for Printing, Engraving, and Binding Report of 32nd Meeting (Cambridge)				707	2	11
For Printing, &c., Index to Reports 1831 to 1860				143	16	6
For Salaries, 12 months				350	0	0
For Purchase of £1500 3 per cent. Consols				1387	10	0
On account of Grants made at Newcastle Meeting, viz.—						
For Maintaining Establishment of Kew Observatory	£600	0	0			
Coal-fossils Committee	20	0	0			
Vertical Atmospheric Movements Committee	20	0	0			
Dredging Shetland Committee	75	0	0			
Dredging Northumberland Committee	25	0	0			
Balloon Committee	200	0	0			
Carbon under pressure Committee	10	0	0			
Standards of Electrical Resistance	100	0	0			
Analysis of Rocks	10	0	0			
Hydroida Report	10	0	0			
Askham's Gift	50	0	0			
Nitrite of Amyle Committee	10	0	0			
Nomenclature Committee	5	0	0			
Rain-Gauges	19	15	8			
Cast-Iron Investigation	20	0	0			
Tidal Observations in the Humber	50	0	0			
Spectral Rays Committee	45	0	0			
Luminous Meteors Committee	20	0	0			
				1289	15	8
				4140	3	6
Balance at London and Westminster Bank	£358	19	7			
,, in hands of General Treasurer	5	17	10			
				364	17	5
				£4505	0	11

II. Table showing the Names of Members of the British Association who have served on the Council in former years.

Aberdeen, Earl of, LL.D., K.G., K.T., F.R.S. (deceased).
Acland, Sir T. D., Bart., M.A., D.C.L., F.R.S.
Acland, Professor H. W., M.D., F.R.S.
Adams, Prof. J. Couch, M.A., D.C.L., F.R.S.
Adamson, John, Esq., F.L.S.
Ainslie, Rev. Gilbert, D.D., Master of Pembroke Hall, Cambridge.
Airy, G. B., M.A., D.C.L., F.R.S., Astr. Royal.
Alison, Professor W. P., M.D., F.R.S.E. (decd).
Allen, W. J. C., Esq.
Anderson, Prof. Thomas, M.D.
Ansted, Professor D. T., M.A., F.R.S.
Argyll, G. Douglas, Duke of, F.R.S. L. & E.
Armstrong, Sir W. G., F.R.S.
Arnott, Neil, M.D., F.R.S.
Ashburton, William Bingham, Lord, D.C.L.
Atkinson, Rt. Hon. R., late Lord Mayor of Dublin.
Babbage, Charles, Esq., M.A., F.R.S.
Babington, Professor C. C., M.A., F.R.S.
Baily, Francis, Esq., F.R.S. (deceased).
Baines, Rt. Hon. M. T., M.A., M.P. (decd).
Baker, Thomas Barwick Lloyd, Esq.
Balfour, Professor John H., M.D., F.R.S.
Barker, George, Esq., F.R.S. (deceased).
Bath, The Most Noble the Marquis of.
Bath, The Venerable the Archdeacon of.
Beamish, Richard, Esq., F.R.S.
Beechey, Rear-Admiral, F.R.S. (deceased).
Bell, Isaac Lowthian, Esq.
Bell, Professor Thomas, V.P.L.S., F.R.S.
Bengough, George, Esq.
Bentham, George, Esq., Pres.L.S.
Biddell, George Arthur, Esq.
Bigge, Charles, Esq.
Blakiston, Peyton, M.D., F.R.S.
Boileau, Sir John P., Bart., F.R.S.
Boyle, Right Hon. D., Lord Justice-General (deceased).
Brady, The Rt. Hon. Maziere, M.R.I.A., Lord Chancellor of Ireland.
Brand, William, Esq.
Breadalbane, John, Marquis of, K.T., F.R.S. (deceased).
Brewster, Sir David, K.H., D.C.L., LL.D., F.R.S. L. & E., Principal of the University of Edinburgh.
Brisbane, General Sir Thomas M., Bart., K.C.B., G.C.H., D.C.L., F.R.S. (decd).
Brodie, Sir B. C., Bart., D.C.L., P.R.S. (deceased).
Brooke, Charles, B.A., F.R.S.
Brown, Robert, D.C.L., F.R.S. (deceased).
Brunel, Sir M. I., F.R.S. (deceased).
Buckland, Very Rev. William, D.D., F.R.S., Dean of Westminster (deceased).
Bute, John, Marquis of, K.T. (deceased).
Carlisle, G. W. Fred., Earl of, F.R.S. (decd).
Carson, Rev. Joseph, F.T.C.D.
Cathcart, Lt.-Gen., Earl of, K.C.B., F.R.S.E. (deceased).
Challis, Rev. J., M.A., F.R.S.
Chalmers, Rev. T., D.D. (deceased).
Chance, James, Esq.
Chester, John Graham, D.D., Lord Bishop of (deceased).
Chevallier, Rev. Temple, B.D., F.R.A.S.
Christie, Professor S. H., M.A., F.R.S.
Clapham, R. C., Esq.
Clare, Peter, Esq., F.R.A.S. (deceased).
Clark, Rev. Prof., M.D., F.R.S. (Cambridge.)
Clark, Henry, M.D.
Clark, G. T., Esq.
Clear, William, Esq. (deceased).
Clerke, Major S., K.H., R.E., F.R.S. (decd).
Clift, William, Esq., F.R.S. (deceased).
Close, Very Rev. F., M.A., Dean of Carlisle.
Cobbold, John Chevalier, Esq., M.P.
Colquhoun, J. C., Esq., M.P. (deceased).
Conybeare, Very Rev. W. D., Dean of Llandaff (deceased).
Cooper, Sir Henry, M.D.
Cork and Orrery, The Rt. Hon. the Earl of, Lord-Lieutenant of Somersetshire.
Corrie, John, Esq., F.R.S. (deceased).
Crum, Walter, Esq., F.R.S.
Currie, William Wallace, Esq. (deceased).
Dalton, John, D.C.L., F.R.S. (deceased).
Daniell, Professor J. F., F.R.S. (deceased).
Darbishire, R. D., Esq., B.A., F.G.S.
Dartmouth, William, Earl of, D.C.L., F.R.S.
Darwin, Charles, Esq., M.A., F.R.S.
Daubeny, Prof. C. G. B., M.D., LL.D., F.R.S.
DelaBeche, Sir H. T., C.B., F.R.S., Director-Gen. Geol. Surv. United Kingdom (decd).
De la Rue, Warren, Ph.D., F.R.S.
Derby, Earl of, D.C.L., Chancellor of the University of Oxford.
Devonshire, W., Duke of, M.A., D.C.L., F.R.S.
Dickinson, Francis H., Esq.
Dickinson, Joseph, M.D., F.R.S.
Dillwyn, Lewis W., Esq., F.R.S. (deceased).
Donkin, Professor W. F., M.A., F.R.S.
Drinkwater, J. E., Esq. (deceased).
Ducie, The Earl of, F.R.S.
Dunraven, The Earl of, F.R.S.
Egerton, Sir P. de M. Grey, Bart., M.P., F.R.S.
Eliot, Lord, M.P.
Ellesmere, Francis, Earl of, F.G.S. (decd).
Enniskillen, William, Earl of, D.C.L., F.R.S.
Estcourt, T. G. B., D.C.L. (deceased).
Fairbairn, William, LL.D., C.E., F.R.S.
Faraday, Professor, D.C.L., F.R.S.
Ferrers, Rev. N. M., M.A.
FitzRoy, Rear-Admiral, F.R.S. (deceased).
Fitzwilliam, The Earl, D.C.L., F.R.S. (decd).
Fleming, W., M.D.
Fletcher, Bell, M.D.
Foote, Lundy E., Esq.
Forbes, Charles, Esq. (deceased).
Forbes, Prof. Edward, F.R.S. (deceased).
Forbes, Prof. J. D., LL.D., F.R.S., Sec. R.S.E. Principal of University of St. Andrews.
Fox, Robert Were, Esq., F.R.S.
Frost, Charles, F.S.A.
Fuller, Professor, M.A.
Galton, Francis, F.R.S., F.G.S.

Gassiot, John P., Esq., F.R.S.
Gilbert, Davies, D.C.L., F.R.S. (deceased).
Gladstone, J. H., Ph.D., F.R.S.
Goodwin, The Very Rev. H., D.D., Dean of Ely.
Gourlie, William, Esq. (deceased).
Graham, T., M.A., D.C.L., F.R.S., Master of the Mint.
Gray, John E., Esq., Ph.D., F.R.S.
Gray, Jonathan, Esq. (deceased).
Gray, William, Esq., F.G.S.
Green, Prof. Joseph Henry, D.C.L., F.R.S. (deceased).
Greenough, G. B., Esq., F.R.S. (deceased).
Griffith, George, M.A., F.C.S.
Griffith, Sir R. Griffith, Bt., LL.D., M.R.I.A.
Grove, W. R., Esq., M.A., F.R.S.
Hallam, Henry, Esq., M.A., F.R.S. (dec[d]).
Hamilton, W. J., Esq., F.R.S., Sec. G.S.
Hamilton, Sir Wm. R., LL.D., Astronomer Royal of Ireland, M.R.I.A., F.R.A.S.
Hancock, W. Neilson, LL.D.
Harcourt, Rev. Wm. Vernon, M.A., F.R.S.
Hardwicke, Charles Philip, Earl of, F.R.S.
Harford, J. S., D.C.L., F.R.S.
Harris, Sir W. Snow, F.R.S.
Harrowby, The Earl of, F.R.S.
Hatfeild, William, Esq., F.G.S. (deceased).
Henry, W. C., M.D., F.R.S.
Henry, Rev. P. S., D.D., President of Queen's College, Belfast.
Henslow, Rev. Professor, M.A., F.L.S. (dec[d]).
Herbert, Hon. and Very Rev. Wm., LL.D., F.L.S., Dean of Manchester (dec[d]).
Hereford, The Very Rev. the Dean of.
Herschel, Sir John F.W., Bart., M.A., D.C.L., F.R.S.
Heywood, Sir Benjamin, Bart., F.R.S.
Heywood, James, Esq., F.R.S.
Hill, Rev. Edward, M.A., F.G.S.
Hincks, Rev. Edward, D.D., M.R.I.A.
Hincks, Rev. Thomas, B.A.
Hinds, S., D.D., late Lord Bishop of Norwich (deceased).
Hodgkin, Thomas, M.D.
Hodgkinson, Professor Eaton, F.R.S. (dec[d]).
Hodgson, Joseph, Esq., F.R.S.
Hogg, John, Esq., M.A., F.L.S.
Hooker, Sir William J., LL.D., F.R.S.
Hope, Rev. F. W., M.A., F.R.S.
Hopkins, William, Esq., M.A., LL.D., F.R.S.
Horner, Leonard, Esq., F.R.S. (deceased).
Houghton, Lord, D.C.L.
Hovenden, V. F., Esq., M.A.
Hugall, J. W., Esq.
Hunt, Aug. H., Esq., B.A., Ph.D.
Hutton, Robert, Esq., F.G.S.
Hutton, William, Esq., F.G.S. (deceased).
Ibbetson, Capt. L. L. Boscawen, K.R.E., F.G.S.
Inglis, Sir R. H., Bart., D.C.L., M.P. (dec[d]).
Inman, Thomas, M.D.
Jacobs, Bethel, Esq.
Jameson, Professor R., F.R.S. (deceased).
Jardine, Sir William, Bart., F.R.S.E.
Jeffreys, John Gwyn, Esq., F.R.S.
Jellett, Rev. Professor.
Jenyns, Rev. Leonard, F.L.S.
Jerrard, H. B., Esq.
Jeune, The Right Rev. F., D.C.L.
Johnston, Right Hon. William, late Lord Provost of Edinburgh.
Johnston, Prof. J. F. W., M.A., F.R.S. (dec[d]).
Keleher, William, Esq. (deceased).
Kelland, Rev. Prof. P., M.A., F.R.S. L. & E.
Kildare, The Marquis of.
Lankester, Edwin, M.D., F.R.S.
Lansdowne, Hen., Marquis of, D.C.L., F.R.S.
Larcom, Major, R.E., LL.D., F.R.S.
Lardner, Rev. Dr. (deceased).
Lassell, William, Esq., F.R.S. L. & E.
Latham, R. G., M.D., F.R.S.
Lee, Very Rev. John, D.D., F.R.S.E., Principal of the University of Edinburgh (deceased).
Lee, Robert, M.D., F.R.S.
Lefevre, Right Hon. Charles Shaw, late Speaker of the House of Commons.
Lemon, Sir Charles, Bart., F.R.S.
Liddell, Andrew, Esq. (deceased).
Liddell, Very Rev. H. G., D.D., Dean of Christ Church, Oxford.
Lindley, Professor John, Ph.D., F.R.S.
Listowel, The Earl of.
Liveing, Prof. G. D., M.A., F.C.S.
Lloyd, Rev. B., D.D., Provost of Trin. Coll., Dublin (deceased).
Lloyd, Rev. H., D.D., D.C.L., F.R.S. L. & E., M.R.I.A.
Londesborough, Lord, F.R.S. (deceased).
Lubbock, Sir John W., Bart., M.A., F.R.S. (deceased).
Luby, Rev. Thomas,
Lyell, Sir Charles, Bart., M.A., LL.D., D.C.L., F.R.S.
MacCullagh, Prof., D.C.L., M.R.I.A. (dec[d]).
MacDonnell, Rev. R., D.D., M.R.I.A., Provost of Trinity College, Dublin.
Macfarlane, The Very Rev. Principal. (dec[d]).
MacGee, William, M.D.
MacLeay, William Sharp, Esq., F.L.S.
MacNeill, Professor Sir John, F.R.S.
Malahide, The Lord Talbot de.
Malcolm, Vice-Ad. Sir Charles, K.C.B. (dec[d]).
Maltby, Edward, D.D., F.R.S., late Lord Bishop of Durham (deceased).
Manchester, J. P. Lee, D.D., Lord Bishop of.
Marlborough, Duke of, D.C.L.
Marshall, J. G., Esq., M.A., F.G.S.
May, Charles, Esq., F.R.A.S. (deceased).
Meynell, Thomas, Esq., F.L.S.
Middleton, Sir William F. F., Bart.
Miller, Prof. W. A., M.D., Treas. & V.P.R.S.
Miller, Professor W. H., M.A., For. Sec. R.S.
Moggridge, Matthew, Esq.
Moillet, J. D., Esq. (deceased).
Monteagle, Lord, F.R.S.
Moody, J. Sadleir, Esq.
Moody, T. F., Esq.
Moody, T. H. C., Esq.
Morley, The Earl of.
Moseley, Rev. Henry, M.A., F.R.S.
Mount-Edgecumbe, Ernest Augustus, Earl of.
Murchison, Sir Roderick I., G.C. St.S., D.C.L., LL.D., F.R.S.

Neild, Alfred, Esq.
Neill, Patrick, M.D., F.R.S.E.
Nelson, The Rt. Hon. Earl
Nicol, D., M.D.
Nicol, Professor J., F.R.S.E., F.G.S.
Nicol, Rev. J. P., LL.D.
Noble, Capt. A., R.A.
Northampton, Spencer Joshua Alwyne, Marquis of, V.P.R.S. (deceased).
Northumberland, Hugh, Duke of, K.G., M.A., F.R.S. (deceased).
Ormerod, G. W., Esq., M.A., F.G.S.
Orpen, Thomas Herbert, M.D. (deceased).
Orpen, John H., LL.D.
Osler, Follett, Esq., F.R.S.
Owen, Prof., M.D., D.C.L., LL.D., F.R.S.
Oxford, Samuel Wilberforce, D.D., Lord Bishop of, F.R.S., F.G.S.
Palmerston, Visc., K.G., G.C.B., M.P., F.R.S.
Peacock, Very Rev. G., D.D., Dean of Ely, F.R.S. (deceased).
Peel, Rt. Hon. Sir R., Bart., M.P., D.C.L. (dec[d]).
Pendarves, E. W., Esq., F.R.S. (deceased).
Phillips, Professor John, M.A., LL.D., F.R.S.
Phillips, Rev. G., B.D., President of Queen's College, Cambridge.
Pigott, The Rt. Hon. D. R., M.R.I.A., Lord Chief Baron of the Exchequer in Ireland.
Porter, G. R., Esq. (deceased).
Portlock, Major-General, R.E., LL.D., F.R.S. (deceased).
Portman, The Lord.
Powell, Rev. Professor, M.A., F.R.S. (dec[d]).
Price, Rev. Professor, M.A., F.R.S.
Prichard, J. C., M.D., F.R.S. (deceased).
Ramsay, Professor William, M.A.
Ransome, George, Esq., F.L.S.
Reid, Maj.-Gen. Sir W., K.C.B., R.E., F.R.S. (deceased).
Rendlesham, Rt. Hon. Lord, M.P.
Rennie, George, Esq., F.R.S.
Rennie, Sir John, F.R.S.
Richardson, Sir John, C.B., M.D., LL.D., F.R.S. (deceased).
Richmond, Duke of, K.G., F.R.S. (dec[d]).
Ripon, Earl of, F.R.G.S.
Ritchie, Rev. Prof., LL.D., F.R.S. (dec[d]).
Robinson, Capt., R.A.
Robinson, Rev. J., D.D.
Robinson, Rev. T. R., D.D., F.R.S., F.R.A.S.
Robison, Sir John, Sec.R.S.Edin. (deceased).
Roche, James, Esq.
Roget, Peter Mark, M.D., F.R.S.
Rolleston, Professor, M.D., F.R.S.
Ronalds, Francis, F.R.S. (deceased).
Roscoe, Professor H. E., B.A., F.R.S.
Rosebery, The Earl of, K.T., D.C.L., F.R.S.
Ross, Rear-Admiral Sir J. C., R.N., D.C.L., F.R.S. (deceased).
Rosse, Wm., Earl of, M.A., F.R.S., M.R.I.A.
Royle, Prof. John F., M.D., F.R.S. (dec[d]).
Russell, James, Esq. (deceased).
Russell, J. Scott, Esq., F.R.S.
Sabine, Major-General Edward, R.A., D.C.L., LL.D., President of the Royal Society.
Sanders, William, Esq., F.R.S., F.G.S.
Scoresby, Rev. W., D.D., F.R.S. (deceased).
Sedgwick, Rev. Prof., M.A., D.C.L., F.R.S.
Selby, Prideaux John, Esq., F.R.S.E.
Sharpey, Professor, M.D., Sec.R.S.
Sims, Dillwyn, Esq.
Smith, Lieut.-Col. C. Hamilton, F.R.S. (dec[d]).
Smith, Prof. H. J. S., M.A., F.R.S.
Smith, James, F.R.S. L. & E.
Spence, William, Esq., F.R.S. (deceased).
Spottiswoode, W., M.A., F.R.S.
Stanley, Edward, D.D., F.R.S., late Lord Bishop of Norwich (deceased).
Staunton, Sir G. T., Bt., M.P., D.C.L., F.R.S.
St. David's, C. Thirlwall, D.D., Lord Bishop of.
Stevelly, Professor John, LL.D.
Stokes, Professor G. G., M.A., D.C.L., Sec.R.S.
Strang, John, Esq., LL.D.
Strickland, Hugh E., Esq., F.R.S. (deceased).
Sykes, Colonel W. H., M.P., F.R.S.
Symonds, B. P., D.D., Warden of Wadham College, Oxford.
Talbot, W. H. Fox, Esq., M.A., F.R.S.
Tayler, Rev. John James, B.A.
Taylor, Hugh, Esq.
Taylor, John, Esq., F.R.S. (deceased).
Taylor, Richard, Esq., F.G.S.
Thompson, William, Esq., F.L.S. (deceased).
Thomson, A., Esq.
Thomson, Professor William, M.A., F.R.S.
Tindal, Captain, R.N. (deceased).
Tite, William, Esq., M.P., F.R.S.
Tod, James, Esq., F.R.S.E.
Tooke, Thomas, F.R.S. (deceased).
Traill, J. S., M.D. (deceased).
Trevelyan, Sir W. C., Bart.
Turner, Edward, M.D., F.R.S. (deceased).
Turner, Samuel, Esq., F.R.S., F.G.S. (dec[d]).
Turner, Rev. W.
Tyndall, Professor John, F.R.S.
Vigors, N. A., D.C.L., F.L.S. (deceased).
Vivian, J. H., M.P., F.R.S. (deceased).
Walker, James, Esq., F.R.S.
Walker, Joseph N., Esq., F.G.S.
Walker, Rev. Professor Robert, M.A., F.R.S.
Warburton, Henry, Esq., M.A., F.R.S. (dec[d]).
Ward, W. Sykes, Esq., F.C.S.
Washington, Captain, R.N., F.R.S.
Way, A. E., Esq., M.P.
Webster, Thomas, M.A., F.R.S.
West, William, Esq., F.R.S. (deceased).
Western, Thomas Burch, Esq.
Wharncliffe, John Stuart, Lord, F.R.S. (dec[d]).
Wheatstone, Professor Charles, F.R.S.
Whewell, Rev. William, D.D., F.R.S., Master of Trinity College, Cambridge.
White, John F., Esq.
Williams, Prof. Charles J. B., M.D., F.R.S.
Willis, Rev. Professor Robert, M.A., F.R.S.
Wills, William, Esq., F.G.S. (deceased).
Wilson, Thomas, Esq., M.A.
Wilson, Prof. W. P.
Winchester, John, Marquis of.
Wood, Nicholas, Esq.
Woollcombe, Henry, Esq., F.S.A. (deceased).
Wrottesley, John, Lord, M.A., D.C.L., F.R.S.
Yarborough, The Earl of, D.C.L.
Yarrell, William, Esq., F.L.S. (deceased).
Yates, James, Esq., M.A., F.R.S.
Yates, J. B., Esq., F.S.A., F.R.G.S. (dec[d]).

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Report of the Council of the British Association, presented to the General Committee, Wednesday, September 14, 1864.

1. The Council have received the Report of the Kew Committee for the past year, which will be laid before the General Committee on Monday.

2. The Report of the Parliamentary Committee has been received, and the Council recommend the adoption of this Report by the General Committee.

3. The Council have added to the list of Corresponding Members the names of the following Foreign Men of Science, who have been present at Meetings of the Association:—

Dr. Torell, Dr. Buys Ballot, M. Des Cloizeaux, and Prof. Adolph Steen.

4. The Council have received invitations to hold the next Meeting of the Association at Birmingham, and another to hold it at Nottingham. An invitation has also been received from Dundee for the year 1867.

Report of the Kew Committee of the British Association for the Advancement of Science for 1863–1864.

The Committee of the Kew Observatory submit to the Association the following statement of their proceedings during the past year:—

A set of Self-recording Magnetographs, of the same pattern as those at Kew, have been ordered by the Italian Government for Professor Donati of Florence; these have been completed by Adie of London, and despatched to their destination.

General Sabine has received letters from Mr. Meldrum, Director of the Mauritius Observatory, and from Mr. Ellery, Director of that at Melbourne, from which there seems to be a good prospect that at no distant date Self-recording Magnetographs may be in operation in these localities. This would be a result of very great scientific importance, since there are as yet none of these instruments established in the southern hemisphere.

The Committee have lost with regret the valuable services of Mr. Chambers, who left the Observatory about the middle of November last for an appointment in India. His place as Magnetical Assistant has been supplied by Mr. George Whipple, who has given much satisfaction in his new office.

The sum of £50 has been received from the Government Grant Fund of the Royal Society for the purpose of obtaining printed copies of magnetic curves. This has been spent in procuring photolithographic copies of a number of the most interesting traces simultaneously produced by the Magnetographs at Kew and Lisbon. These have been published by the Kew and Lisbon Observatories, and distributed to scientific men likely to take an interest in the subject.

A Unifilar and Dip Circle have been verified at Kew and forwarded to the Lisbon Observatory, and a Self-recording Electrometer, on Professor W. Thomson's principle, has also been despatched to that institution.

Two Unifilars and two Dip Circles have likewise been ordered by Colonel Walker, Director of the Trigonometrical Survey of India, and they are at present in the hands of the opticians.

The usual monthly absolute determinations of the magnetic elements continue to be made at Kew, and the Self-recording Magnetographs are in constant operation as heretofore, under the superintendence of Mr. Whipple, Magnetical Assistant.

Advantage has again been taken of these automatic records of the earth's magnetism by the Committee engaged in the preparation of electrical standards, who have found it desirable, for some of their experiments, to ascertain the contemporaneous readings of the Declination Magnetograph.

The following papers having reference to Kew Observatory have been communicated to the Royal Society by Major-General Sabine, President of that body:—

1. Results of hourly Observations of the Magnetic Declination made by Sir Francis Leopold M^cClintock, R.N., and the Officers of the Yacht 'Fox,' at Port Kennedy in the Arctic Sea, in the Winter of 1858–59; and a Comparison of these Results with those obtained by Captain Maguire, R.N. and the Officers of H.M.S. 'Plover,' in 1852, 1853, and 1854, at Point Barrow.

2. A Comparison of the most notable Disturbances of the Magnetic Declination in 1858 and 1859 at Kew and Nertschinsk; preceded by a brief Retrospective View of the Progress of the Investigation into the Laws and Causes of the Magnetic Disturbances.

A Table of the Mean Declination of the Magnet in each Decade from January 1858 to December 1863, derived from the Observations made at the Magnetic Observatory at Lisbon, has been drawn up by Senhor da Silveira, Director of that Observatory.

This Table exhibits the semiannual inequality to which that element is subject at Lisbon, and which is of the same nature as that derived from the Kew photographs by General Sabine.

Mr. Stewart, Superintendent of the Kew Observatory, in conjunction with Senhor Capello of the Lisbon Observatory, has communicated to the Royal Society a paper, entitled "Results of a Comparison of certain Traces produced simultaneously by the Self-recording Magnetographs at Kew and at Lisbon, especially of those which record the Magnetic Disturbance of July 15, 1863."

Mr. Stewart has likewise communicated to the same Society two short papers, one "On the Sudden Squalls of 30th October and 21st November 1863," and another, entitled "Remarks on Sun-Spots." He has also communicated to the Royal Society of Edinburgh a paper on "Sun-Spots, and their Connexion with Planetary Configurations."

Mr. A. H. Burgess, M.A., being desirous to obtain magnetical instruction, is at present visiting the Observatory for the purpose of acquainting himself with our method of observation.

The Meteorological work of the Observatory is now performed by Mr. Thomas Baker, who likewise takes charge of the photographic department connected with the self-recording instruments, and executes both offices very satisfactorily.

During the past year 97 Barometers
" " " 389 Thermometers

have been verified, and five Standard Thermometers have been supplied to men of science and opticians. A set of weights, a standard scale, and a measure of capacity have likewise been verified. The Self-recording Barograph continues in constant operation. Through an ingenious suggestion of Mr. Beckley traces in duplicate have been obtained, and one of these has been regularly forwarded to Admiral FitzRoy.

The Self-recording Electrometer of Professor W. Thomson has continued in constant operation until the beginning of August, when it was sent to the optician for repairs.

The arrangements at the Observatory for testing Sextants remain as before.

During the past year eight Sextants, two Quadrants, and one Transit-instrument have been verified.

The sun-spots continue to be observed, after the method of Hofrath Schwabe, of Dessau.

The Kew Heliograph in charge of Mr. De la Rue has been continuously worked by a qualified assistant, under the immediate supervision of Mr. Beckley, who has proved of much service to the Committee in this as well as in other matters. During the past year 175 negatives have been taken, and four sets of positives have been printed from each, one of which has been presented to the Royal Society. The negatives are being reduced under the superintendence of Mr. De la Rue, and by means of an instrument of his construction. Mr. B. Loewy, formerly assistant in the Flagstaff Observatory, Melbourne, has been engaged in this reduction, which he is executing very satisfactorily at Kew.

Mr. De la Rue is also having an arrangement made, by means of which the proportion of the sun's disk obscured by spots may be conveniently measured.

At Mr. De la Rue's request Mr. Loewy is now examining all pictures preserved at Kew, with reference to distribution of faculæ and general appearance, and it seems that, out of more than 500 groups hitherto examined, about 250 show a nearly equal distribution of faculous matter round the penumbra, while of the rest more than 200 have the faculæ decidedly, either entirely or mostly, on the left side. After concluding the examination, which will extend over more than 1000 spots, Mr. Loewy will submit the result to Mr. De la Rue.

The Spectroscope belonging to the Chairman has been supplemented with a set of eleven sulphuret-of-carbon prisms, made by Mr. Browning, and giving the very great angular separation of more than 3′ between the two lines D. The Chairman has communicated a short description of these prisms, and of the appearance of the two lines obtained by this arrangement, to the Royal Society.

That portion of the spectrum between D and E is now being mapped, and all the measurements have already been made. The results obtained show that the position of any line can be determined with very great accuracy. Mr. Loewy has been the principal observer, and he seems well qualified for the work.

Preliminary arrangements have been made, under the superintendence of Professor Stokes, for experiments on the retardation of the pendulum in different gases.

At the request of the Secretary of State for India, received through the Royal Society, arrangements have been made for the preparation of apparatus to be used for the vibration of pendulums *in vacuo* at the different stations of the Trigonometrical Survey in India; and the request has also been made that the officer who may conduct this experimental investigation should receive instructions at this Observatory.

The instrument constructed by Mr. Broun for the purpose of estimating the magnetic dip by means of soft iron remains at present at the Observatory.

The balance of the £40 granted by the British Association in 1861, for an additional photographic assistant, has been expended under the superintendence of Mr. De la Rue, along with further sums which have been defrayed by Royal Society grants received by that gentleman.

The Superintendent has likewise received grants from the Royal Society for special experiments to be made at Kew, and when these are completed an account will be rendered to that Society. It will thus be seen that other experiments and observations of a nature to further science are made at Kew besides those which form the constant work of the Observatory, and of these the Spectroscope measurements at present in progress may be mentioned as an example; it will also be noticed that the British Association do not bear the expense of these experiments, but this is defrayed by those who bring them before the Committee.

From the financial statement which accompanies this Report, it will be seen that the adverse balance of last year has been considerably reduced, but there is still a balance against this Observatory amounting to £45 17*s.* 9*d.* The Committee recommend that a sum of £600 should be granted for the expenditure of the current year.

A correspondence, which is appended to this Report, has taken place between the Astronomer Royal and the Chairman, relative to a paragraph contained in the Report of the former to the Visitors of the Royal Observatory.

The Astronomer Royal has further suggested that certain experiments should be made in this Observatory:—

1st. For the purpose of investigating the discordances which he has found in his observations of the dipping-needle.

2nd. For the purpose of investigating the displacements which occur in the trace of his vertical-force photograph.

3rd. On the temperature corrections of the force of a magnet made by heating it in hot air instead of by hot water.

The Committee, for the reasons contained in the letter of the Superintendent (No. VII. Correspondence), considerd that it was not advisable to undertake the experiments suggested by the Astronomer Royal, as one of these would necessarily involve the displacement of the Kew vertical-force magnetograph, while the others refer to points which, in the opinion of the Committee, have been already decided by previous observations and experiments.

J. P. Gassiot, *Chairman.*

Kew Observatory,
26th August, 1864.

Correspondence*.

I.

Kew Observatory, Richmond, 27th June, 1864.

My dear Sir,—The attention of the Kew Committee has been drawn to the following paragraph in your Report to the Visitors of the Royal Observatory:—

"I consider it certain that the small probable errors which have been attributed to ordinary needles are a pure delusion. I know no instrumental determination in which, without any breach of faith, the wish for uniformity of results will be so certainly followed by uniformity of results as in the determination of dip."

It having been suggested that the preceding paragraph may possibly be considered to refer to other observations than those made at Greenwich, I am requested by the Committee to inquire whether it is intended in any measure to refer to dip-observations made at this Observatory, and published in the publications of the Royal Society; the object of the Committee being

* A copy of this correspondence was forwarded to the Astronomer Royal on 26th August.

that, in the interest of Magnetical Science, the precise value of dip-observations made in this Observatory should be definitely ascertained.

Believe me, my dear Sir,

Yours very truly,

To G. B. Airy, Esq., F.R.S., (Signed) J. P. Gassiot,

Astronomer Royal, Observatory, Greenwich. *Chairman.*

II.

Royal Observatory, Greenwich, S.E., 28th June, 1864.

My dear Sir,—I have to acknowledge the receipt of your letter of 27th inst., in which you state that the attention of the Kew Committee has been drawn to a paragraph in my Report to the Visitors of the Royal Observatory, wherein I express my opinion on the inaccuracy of the small probable errors which have been attributed to ordinary dipping-needles; and in which you further remark that the cited paragraph may be considered to refer to other observations than those made at Greenwich, and therefore, on the part of the Kew Observatory Committee, you inquire whether the paragraph in question is intended in any measure to refer to dip-observations made at the Kew Observatory, and published in the publications of the Royal Society; the object of the Committee being that, in the interest of Magnetical Science, the precise value of dip-observations made in the Kew Observatory should be definitely ascertained.

It gives me great pleasure to enter fully upon any matter to which you may invite my attention, and particularly so when the object is such as is characterized in the last paragraph of your letter.

The inquiries in your letter are in fact two:—

First. Whether the paragraph of my Report refers to other observations than those made at Greenwich?

To this I reply that it necessarily refers to other observations. I have never succeeded in producing the agreement of results which is implied by the smallness of the probable errors, except by unfair selection among the discordant primary elements of observation on which the result is founded. I have stated this repeatedly in my Reports to the Board of Visitors (the whole series of which, I believe, are lodged in the Kew Observatory), and I have in one at least particularly remarked that the discordance still exists with the very fine instrument now in use at the Royal Observatory.

Second. Whether the paragraph of my Report is intended in any measure to apply to dip-observations made at the Kew Observatory, and published in the publications of the Royal Society?

To this I reply that it is intended so to apply, inasmuch as the degree of accuracy, to which I do not give my assent as real or well founded, is claimed for the dip-observations made at the Kew Observatory. In support of my statement of that claim, I will refer to a pamphlet by General Sabine, which I am unwilling further to describe, but which, as I am aware, has been forced on your attention and on that of the other members of the Committee of Recommendations of the British Association. In it will be found the following sentences:—"The probable error of a *single observation of the dip* with reliable instruments of easy procurement is known to be $\pm$ 1'·5. It has been shown to be so by a series of 282 observations made at Kew, employing 12 circles and 24 needles, all of the pattern which has been in use at Kew for several years past. The observations were made by seven different observers: the results are published in the 'Proceedings of the Royal Society,' March 1861, from entries in the Kew Observatory books, not a single observation having been omitted. The probable error $\pm 1'.5$ may be regarded as including *constant* errors, considering the number of different circles and needles which were employed, as well as the peculiarities of different observers, of whom there were seven." (The italics are General Sabine's.) These are the probable errors which I cannot accept as accurate.

It may not be superfluous to add that I have conversed with several foreign observers (one of whom has very lately quitted me), and that all have found discordances comparable to those which I have myself observed. I have therefore no novelty to claim, except the suggestion (made by me some years ago) of instability in the position of the magnetic axis, and the construction (within little more than a year) of an instrument whose results appear to support that suggestion.

I should be much gratified if the powers of the Kew Observatory could be devoted to the examination of this and analogous instrumental difficulties. These experimental inquiries are not well suited to the system of the establishment over which I preside. And, speaking as a member of the British Association, I think that the Kew Observatory would be better employed in that way than in the course which now absorbs so much of its strength. It was originally intended, and in my opinion wisely intended, for the verification and improvement of instruments, and not for continuous observations. If the examination which I propose should be taken up, I shall be happy to cooperate, by repetition of observations (as my opportunities might serve), and by communication of my results.

I am, my dear Sir,
Yours very truly,
J. P. Gassiot, Esq., (Signed) G. B. Airy.
Chairman of the Kew Observatory Committee.

III.

Clapham Common, June 30, 1864.

My dear Sir,—I have to acknowledge receipt of yours of 28th inst., wherein you state that the paragraph in your recent report "was intended to apply to the dip-observations made at Kew, and published in the publications of the Royal Society, inasmuch as the degree of accuracy, to which you do not give your assent as real or well founded, is claimed for these observations."

I have forwarded your letter to Mr. Stewart, the director of the Observatory, under whose immediate directions the observations were made, and I hope you will find that the explanation he will offer will satisfy you as to the entire truthfulness of the results he obtained, and to the reliability that should be placed thereon.

I have always understood, that to the continued magnetical observations which have been made at Kew Observatory has been mainly due the establishment of so many magnetical observatories abroad; it would, however, ill become me to offer to you any opinion as to their value, although I cannot but regret that they do not appear to have met your approval.

I am sure it would afford Mr. Stewart, as well as the Members of the Committee, much pleasure to follow out any experimental inquiries which you may at any time suggest.

Believe me, my dear Sir,
Yours most truly,
To G. B. Airy, Esq., (Signed) J. P. Gassiot.
Astronomer Royal, Greenwich.

IV.

Kew Observatory, Richmond, July 4th, 1864*.

My dear Sir,—I have perused Mr. Airy's letter to you, in which he states that the passage in his Report to the Board of Visitors, about which you wrote to him as Chairman of the Kew Committee, was intended to refer to the dip-observations made at the Kew Observatory, and published in the publications of the Royal Society. I have likewise perused your reply, and now, in accordance with your request, I shall describe the mode of dip-observation at Kew, in order that you may see that Mr. Airy's remark is inapplicable to our determinations.

But before doing so it may be well to state that the list of dip-observations recorded in the publication to which Mr. Airy refers *is* a faithful and complete catalogue of those which have been made at this Observatory. My connexion with the publication referred to is therefore this: I look upon it simply as an authorized and compendious catalogue of the dip-observations which have been made at Kew; and regarding the method in which these have been discussed in the publications of the Royal Society as not falling within the scope of my reply, I shall confine myself to the question of mental bias, and endeavour to show you that our dip-observations are quite free from any such source of error.

In the first place, the circles used at Kew are all of the same pattern; this being one which combines the united experience of several eminent magneticians, and which they were several years in bringing to perfection. The circles and needles are all likewise made by the same optician (Mr. Henry Barrow), who has devoted very great pains to the construction of these instruments. I mention this latter circumstance, because in this observation it is absolutely essential to have a needle constructed with the greatest care. Before commencing the observation, the fine hard axle of the needle is gently inserted into a piece of soft cork, in order that it may be thoroughly cleansed, and the agate knife-edges upon which it is to rest are likewise rubbed with cork The needle itself has been previously magnetized by being rubbed ten times on each side from centre to pole by a pair of bar magnets. After the plane of the magnetic meridian has been determined in the usual way, the circle is placed in this plane, and the needle is observed in the four following positions:—

I.	Face of needle to face of instrument	....Face of instrument	East.
II.	" " "	.... " "	West.
III.	Face of needle reversed	.... " "	West.
IV.	" "	.... " "	East.

The poles of the needle are then reversed by ten strokes of the bar magnets on each side, and the same set of observations is repeated, the mean of the whole eight positions giving the dip.

Both extremities of the needle are in each case successively viewed by microscopes attached to an arm, which also carries the verniers by means of which the position is read. Before making an observation, the needle is gently raised from its support and lowered again by means of a lifter twice or thrice, after which its position is noted. I ought likewise to remark that in magnetizing the needle it is always placed in a wooden frame in such a manner that the magnets are obliged to pass symmetrically over it.

In this process it appears to me that the only possible effect a mental

* This letter, although written on July 4th, was not sent to Mr. Airy until it had been approved of by the Committee at their meeting on August 26th.

bias can be imagined to have is to induce the observer to continue lifting the needle before reading, until it has come into what he considers the proper position; but even this is totally precluded by the method of observation, for the vernier is not read, and the observer does not know the position of his needle until it is at rest and the lifting process at an end. Besides, if the observer did know the position of his needle it would avail him little; for while the *mean* of the *eight* positions is nearly the same for different instruments, yet the reading of any one position of the needle may be, and usually is, very different from the true or finally deduced dip.

From all this it will be seen how little scope there is in the dip-observations for the operation of mental bias; but the observers who are supposed to have worked our instruments with an unconscious predetermination to produce certain results must have had still more formidable difficulties than even these to contend with. For, in order that mental bias should have operated in the case under discussion, the preconceived idea of uniformity with which the observer approached the instrument must have varied in such a measure from season to season and from year to year as to produce in the results obtained an annual variation, as well as a secular change, and these of such a nature as to conform with the results of other observatories. Mr. Airy must acknowledge that the uniformity to which he alludes, and the wish for which he supposes has created a mental bias, is that which remains after the annual and secular variations have been allowed for.

Next, with regard to observers; we have frequently at Kew gentlemen connected with foreign observatories, who come to receive a magnetical equipment. Their desire is to obtain the best possible instruments, but at the same time they view those presented to them with a very critical eye. One of these was Dr. Bergsma, who spent nearly a month in thoroughly examining the dip-circle and in suggesting refinements, but who went away convinced of its accuracy. Senhor da Souza of Coimbra, and Senhor Capello of Lisbon, have likewise made dip-observations at Kew, and with the same object, namely, to satisfy themselves by their own practical experience as to the best dip-circle with which to furnish their respective observatories.

I shall only allude to one observer more, who, though he only made a single observation, has frequently expressed his wish to make a series, but has hitherto been prevented by his numerous engagements. I speak of Mr. Glaisher, of Greenwich Observatory, who, on 21st October last, obtained with Circle No. 40 a dip of 68° 12′·2, while with Circle No. 33 Mr. Chambers on 19th and 20th October obtained 68° 12′·3.

I have thus endeavoured to show that in the Kew dip-observations there is absolutely no opportunity for mental bias to act, and that even if there were, many of our observers are not likely to have been the subjects of such an influence.

In thus fulfilling your request, it is within my province to notice the second part of Mr. Airy's letter only in as far as this is connected with the subject of discussion. You will, therefore, perhaps permit me to refer you to the following paragraph of his letter, which I shall now quote:—"I have therefore no novelty to claim, except the suggestion (made by me some years ago) of instability in the position of the magnetic axis, and the construction (within little more than a year) of an instrument whose results appear to support that suggestion. I should be much gratified if the powers of the Kew Observatory could be devoted to the examination of this and analogous instrumental difficulties. These experimental inquiries are not well suited to the system of the establishment over which I preside. And, speaking as a member of the British Association, I think that the Kew Observatory would be better employed in that way than in the course which now absorbs so much of its strength. It was originally intended, and in my opinion wisely intended, for the verification and improvement of instruments, and not for continuous observations. If the examination which I propose should be taken up, I should be happy to cooperate, by repetition of observations (as my opportunities might serve), and by communication of my results."

These words, while they imply a request which has been courteously acknowledged by you in your reply, appear also to convey the idea that the Kew Observatory has left the burden of an experimental inquiry regarding dip-circles to the Greenwich establishment, which is not well suited to undertake such a task.

I think that, whatever opinion be entertained regarding the functions of the Kew Observatory, it may be shown that it has fulfilled its duties as respects the dip-circle. I give you the following short sketch of our connexion as an observatory with this problem.

The Kew Committee, being desirous to promote the construction and employment of improved magnetical instruments, procured a dip-circle which was too little known, but which they had reason to think was a good practical instrument. In making monthly determinations of the dip with this instrument at Kew, and in bringing these before the notice of men of science, the Committee have given the most convincing experimental proof which it was in their power to afford of the excellence of this instrument, and they have the satisfaction to think that their work has not been in vain, for the directors of many foreign observatories have supplied themselves with these circles, and as many as could do it have personally inspected them at Kew. Mr. Airy appears to have adopted a different course; as far as I am aware, he has not yet honoured us with a visit to Kew, in order to inspect our dip-circle and become personally acquainted with our method of observation. On the other hand, he has instituted experiments of his own, but has not succeeded in producing a good instrument, and the results which he has thus obtained have induced him to believe that the Kew determinations (although made with a different instrument, which is also handled in a somewhat different manner) are not correct.

The Kew Committee have combated this conclusion, and are not shaken in their belief that they have obtained a nearly perfect dip-circle. They may be right or wrong in this opinion; but while they retain it they cannot surely be justly reproached with having left to the Greenwich Observatory the burden of an experimental inquiry which they can only regard as superfluous and self-imposed.

I remain, my dear Sir,
Yours very truly,
(Signed) B. Stewart.

To J. P. Gassiot, Esq., F.R.S.,
Chairman of the Kew Committee.

V.

Royal Observatory, Greenwich, July 11, 1864*.

My dear Sir,—You were so good as to hold out to me the expectation that probably the Kew Observatory Committee might be able to assist this observatory in some important examinations of discordances in the results of magnetic observations, which have given me great anxiety and trouble. To bring this matter more distinctly to a point I will indicate three subjects,

* At the date of this letter Mr. Airy had not received a copy of Mr. Stewart's letter of July 4th.

of which two have been before me for several years, and the third has lately come before me with great force.

1st. You are in some measure aware of the discordances which I have found in observations of the dipping-needle, made with the smallest conceivable change in the circumstances of bearing, or even (as in some experiments which I have lately transmitted to Prof. Stokes) without lifting the needle at all. I am sure the Kew Observatory would do well in thoroughly investigating this matter by experiment.

2nd. I have been troubled for many years with small displacements in the trace of the vertical-force photograph. I should be glad to have these investigated at the Kew Observatory; but it will be necessary for this purpose to modify the adjustments of the vertical-force instrument at Kew, which at present is incompetent to exhibit such displacements, and masks all that may ever have occurred.

3rd. I should be very glad indeed to have a set of experiments on the temperature corrections of the force of a magnet, made by heating it in hot air instead of by hot water. My own experiments leave us in most distressing doubts.

It will give me great pleasure to cooperate as far as possible with the Kew Committee in these matters; any record of our experiments and any apparatus that we can possibly spare will be at their command.

I am, my dear Sir,
Yours very truly,
(Signed) G. B. Airy.

To J. P. Gassiot, Esq.,
Chairman of the Kew Observatory Committee.

VI.

Clapham Common, July 13, 1864.

My dear Sir,—I have your letter of the 11th, suggesting certain experiments in relation to magnetic instruments, which I will lay before the Kew Committee at its next meeting.

I have in the mean time forwarded your letter to Mr. Stewart, the Director of Kew Observatory, who will, I am confident, give it his best attention.

I remain, yours truly,
(Signed) J. P. Gassiot.

To G. B. Airy, Esq., Astronomer Royal.

VII.

Kew Observatory, July 30, 1864.

My dear Sir,—I have perused Mr. Airy's letter, addressed to yourself as Chairman of the Kew Committee, in which he suggests that certain experiments should be made at the Kew Observatory, and I now reply to your request that I should report concerning this letter for the information of the Committee.

From the correspondence which has passed between Mr. Airy and yourself, I have little difficulty in finding the proper basis for this report; the question resolves itself into the following:—Is it expedient in the interest of magnetical science that the Committee should undertake these experiments?

If the suggestions of Mr. Airy refer to points which have not been settled, the Committee are surely indebted to him for bringing these before them; but if, on the other hand, it be the opinion of the Committee that these points have already been discussed and finally disposed of, Mr. Airy cannot blame them if they decline making the experiments which he suggests.

I will take these requests in succession.

1. His first relates to dip experiments and observations. About twenty-five years ago, a few magneticians, including General Sabine and the late Sir J. C. Ross, who were zealous for the advance of magnetical science, set themselves to work to improve the dip-circle. In this problem they had the advantage of the cooperation of the late Mr. Robinson, an excellent mechanician, who had also the subject very much at heart, and whose attention was especially directed to the *axle* of the needle with remarkable success. On his premature death, his process was continued by Mr. H. Barrow. Other improvements were afterwards made, and the Kew Observatory having in the mean time been established, that institution was not slow to recognize the practical excellence of this circle, and the Committee felt themselves able to recommend its general adoption. In order to justify their preference, they instituted a series of monthly observations, the result of which, in their opinion, as well as in that of very many scientific men, has been to demonstrate the practical goodness of this instrument. Not fewer than forty-two of these instruments have been made by Mr. Barrow, and these are, for the most part, in use in different parts of the globe. Many directors of foreign observatories who were previously acquainted with other dip-circles, suspecting these to be inferior to that at Kew, have repaired to our observatory for the purpose of convincing themselves by their own experience that the performance of the Kew circle was not exaggerated. I believe that, without exception, they have been satisfied with our results; but I need not dwell on this topic, as I have already in a previous letter endeavoured to show that our observations are quite trustworthy.

It was the wish of General Sabine, who had taken such an active part in dip-observations, as well as in the construction of the new circle, to exhibit in a scientific manner the probable error of a complete observation of the dip with any Kew instrument; and for this purpose he requested me to furnish him with a complete list of the results obtained at Kew since 1857, omitting none.

These observations were printed in the publications of the Royal Society, and I may be admitted to express my belief that, in the method of reduction employed, the observations were combined in the manner most approved by physicists. I may likewise mention that the probable error therein obtained, small as it is, must not be regarded as wholly due to instrumental inaccuracy, but in part at least to the occurrence of disturbances during some of the observations, a source of error which cannot be avoided. If Mr. Airy will refer to the results of the Kew observations in the Philosophical Transactions for 1863, art. 12, he will see an example of the advantage of employing an inclinometer with the small probable error of that of Kew, in problems of much theoretical importance.

It would thus appear that the Kew Committee have already obtained an almost perfect dip-circle, so that it is not easy to conceive what advantage is to be derived from the experiments proposed by Mr. Airy, especially since, in order to obtain the result which he desires, he has only to become personally acquainted with the working of our instrument, as has been done by those scientific men who have already visited Kew for this purpose.

2. Mr. Airy states,—"I have been troubled for many years with small displacements in the trace of the vertical-force photograph. I should be glad to have these investigated at the Kew Observatory; but it will be necessary for this purpose to modify the adjustments of the vertical-force instrument at Kew, which at present is incompetent to exhibit such displacements, and masks all that may ever have occurred."

I shall take this request in connexion with the following paragraph from Mr. Airy's last Report to the Board of Visitors of Greenwich Observatory:—

"The vertical-force magnetometer still exhibits sometimes the dislocations in the photographic trace. There is no evidence, I believe, that these dislocations do not exist in the curves of every vertical-force instrument, for they are always accompanied with vibration; and no vertical-force instrument, I believe, except that of Greenwich, gives a trace strong enough to exhibit vibrations, and the dislocations, therefore, with any other instrument would appear merely as interruptions of the trace, and would not attract much attention"*.

Before discussing Mr. Airy's request, I shall endeavour to show that our vertical-force instrument is free from objection. In the first place I am able to state, from having examined our vertical-force curves in conjunction with my assistant, that when cause of disturbance takes place the vibrations of our needle *are* impressed upon the photographic paper. Whenever a change takes place in the direction of the forces acting upon a freely suspended magnet, the impulse is followed, and the magnet, after an interval, which may be longer or shorter according to its time of vibration, assumes the new direction. If the changes of force succeed each other more rapidly than will admit of the magnet becoming stationary between their occurrence, it does not cease to vibrate until the intervals between the changes become long enough to permit it to do so†. This state of vibration *is* quite perceptible in the photographic records at Kew; but when the time of vibration is so small as in the Kew instrument, where it is seven seconds only, the *mean* place corresponding to a desired instant is almost always obtainable from the trace. It may suffice that in the six months from July 1 to December 31, 1863 (the records of which are now under reduction), and in which there should be 4416 equidistant hourly positions, there are only five wanting by reason of failures from *all causes whatever*. In one of these the disturbance was so excessive that the trace ran off the recording paper; in the other four the vibrations corresponding to the fluctuations in the directions of the disturbing force were too rapid to permit the trace to be sufficiently distinct for measurement. Should it be hereafter desirable to investigate more particularly the phenomena of the changes thus rapidly succeeding each other, a shorter, not a longer, magnet than the one in use at Kew would be required, having a shorter time of vibration than seven seconds; but in the mean time, and for the present wants of science, there is, I think, every reason to believe that Mr. Welsh exercised a sound judgment in determining the dimensions, shape, and weight of the Kew vertical-force magnet. The self-recording instruments at Kew are now in the seventh year of their performance, and the curves of each magnetograph, including those of the vertical force, have been carefully examined preparatory to reducing them, with the view of eliminating everything of the nature of displacements, whether due to instrumental defects or to the approach of magnetic matter. The curves of the vertical force under this very severe scrutiny have proved themselves as perfect as those of the other magnetometers, that is to say, they are practically faultless as far as one can judge by this means.

General Sabine has kindly undertaken the reduction of the traces afforded by our magnetographs, and finds that the vertical-force magnet is capable

* As far as I am aware, Mr. Airy has not seen any original negative from our vertical-force magnetograph.

† It has already been recognized by Gauss as a law, that no magnet can correctly record those changes of which the period is not considerably more than that of its own vibration.

of being applied in conjunction with the horizontal force to several important problems in which the theoretical bearings of the variations of the dip and total force are concerned, which will be shown as soon as the reductions, already far advanced, are completed; meanwhile instruments of the same pattern have been ordered by the directors of several foreign observatories, who have themselves personally examined the Kew instruments and the records of their performance, and have expressed their intention of working in concert with Kew.

The displacements and dislocations which have occasioned Mr. Airy so much trouble for several years past in the Greenwich vertical-force instruments are obviously due to a cause or causes very different from that which has been noticed above. From his own description of them, we learn that the results in one sheet cannot be compared with those in another, and that in 1859 the vertical-force magnet exhibited for the daily magnetic curve a form approaching much more nearly to a straight line than it had usually given. The imperfection of such an instrument is sufficiently manifest, and it would not be difficult, perhaps, to assign its probable cause or causes; but as it is no longer designed to be used by Mr. Airy himself, I submit that it would be inexpedient to employ the time of the observatory in investigating how much the defect of an instrument which is given up by its employer may be due to one cause and how much to another. The Kew instrument has no such defect; in other words, it is, to use Mr. Airy's expression, "incompetent to exhibit the displacements" (or dislocations) which take place in the Greenwich instrument.

Again, in order to investigate these dislocations experimentally, it would be necessary that the Committee should dismount our present instrument and mount one similar to that which Mr. Airy has discarded, if not that very magnet itself, and Mr. Airy in his request intimates that some such change would be necessary. To dismount an instrument so usefully employed as that at Kew, and with the performance of which for the purposes for which it was devised we have reason to be fully satisfied, for the chance of constructing one of a different form, which might probably not give us equal satisfaction, would seem to be a species of treason to the branch of science which we are endeavouring to advance, as well as to ourselves, and to those who have provided themselves with similar instruments to work in concert with us.

3. Mr. Airy's third request is that we should make experiments in order to determine if there be any difference in the temperature correction as derived when the magnet employed is placed in hot and cold air instead of in water, as is usually the case.

Let me first of all direct your attention to the principle on which the Kew Committee have proceeded for several years past in reference to the subject of temperature corrections. This principle has been *to avoid, as far as possible, the occasion for such corrections*, and the Committee will be glad to learn that Mr. Airy has latterly expressed his intention of adopting the same principle. At the Kew Observatory the variation of temperature to which the magnetographs are exposed is only half a degree Fahr. in twenty-four hours. In like manner, in the instrument for absolute determinations, by making the deflections and vibrations sufficiently near to one another in point of time, the correction for temperature is reduced to a minimum.

But in *former* days a number of experiments *were* made on the temperature correction, some with the purpose of proving that magnetic changes are not caused by the varying temperature of the air, and others which exactly correspond to the point referred to by Mr. Airy, and these lead to the belief that temperature corrections determined by hot and cold water experiments are almost identical with those determined by hot and cold air.

I find that at Toronto the temperature change of the vertical-force magnet found by comparing together days of different natural temperature was ·00011 for 1° Fahr., while the same determined by hot and cold water experiments was ·00009. At Makerstoun, also, the temperature correction of the balance magnet, as determined by hot and cold days, was ·000079, while that determined by hot and cold water experiments was ·000073.

These agreements are very near, and the first had induced General Sabine to remark that the hot and cold water method was sufficiently correct; while the same conclusion was also arrived at by Mr. Broun of Makerstoun, and, as far as I am aware, has been generally received.

It is impossible for me, after such evidence that both methods give very nearly the same corrections, to doubt that Mr. Airy's *very great difference* must have been occasioned by error of experiment.

As a principle, Mr. Airy will, I think, allow that in such an experiment it is better to have the hot and cold air filling a whole room than filling only a copper box; while at the same time it may be extremely difficult to indicate the precise source of error in his arrangement. I do not think that the Kew Committee are called upon to undertake this task, especially since (as has been shown) the comparison of corrections derived from heated air and heated water *has* already received due attention, the result of which has been to set that matter at rest in the minds of other magneticians; and also since the temperature corrections which will be hereafter required at Greenwich will not be of such magnitude as heretofore, and therefore are not likely to occasion Mr. Airy the same distressing doubts as those spoken of by him.

I remain, my dear Sir,
Yours very truly,
(Signed) B. STEWART.

J. P. Gassiot, Esq.,
Chairman of the Kew Committee.

The two following letters, although of later date than the Kew Report, have been attached to this correspondence by order of the Council.

VIII.

Royal Observatory, Greenwich, S.E., 1864, October 19th.

MY DEAR SIR,—I have to thank you for your kindness in transmitting for my inspection the Kew Vertical-Force Photograms for the months of June, July, and August 1863. They shall be returned by hand at an early opportunity. I have examined them with much interest, and take leave to communicate to you the following remarks on them.

1. The curves are traced more strongly than those which I had previously seen. I think this change a great improvement.

2. The sheets are very neat, uniform, and distinct—more uniform than the Greenwich sheets have been to the end of 1863, but, I think, not more uniform than the Greenwich sheets are now. This change in the Greenwich sheets, I believe, is to be attributed entirely to our gain of nearly uniform temperature, every part of our chemical process being the same as formerly.

3. The small perturbations are recorded with great delicacy—more clearly than in the former Greenwich sheets (though I believe that nearly all can be traced in our curves), but not more clearly than in our new sheets. I make the latter statement from examination of the general character of both, as I have not been able to compare corresponding sheets.

4. The vibrations of the magnet are not well shown. The largest are those of June $9^d\ 2^h\ 10^m$ (some doubt about this), June $20^d\ 14^h\ 17^m$, and July $30^d\ 0^h\ 8^m$; all these are really small, yet they are exhibited very feebly. It seems probable that a larger vibration would leave no visible trace.

5. I conclude from this that very violent and rapid changes of magnetism could not be shown.

6. In this respect the process used at Greenwich (fully detailed in the "Magnetical and Meteorological Results," 1862), which appears to be more sensitive to rapid movements, seems preferable to that used at Kew. I do not propose to make any change for our magnetic instruments; although for our exposed thermometers, in which the changes are not sudden, is yet under consideration whether a process like that of Kew should be introduced.

7. I find upon close inspection that the Kew curves are not free from dislocations; these are, however, smaller than those of the Greenwich curves. A few of them have caught the attention of the Kew observer, and are indicated by dots of red ink. Among these, I think, are June $17^d\ 23^h\ 50^m$, and June $19^d\ 22^h\ 40^m$. But there are many others (all small), as June $23^d\ 23^h\ 40^m$, June $29^d\ 23^h\ 0^m$, July $1^d\ 21^h\ 30^m$, July $3^d\ 22^h\ 50^m$, $23^h\ 30^m$, $23^h\ 35^m$, &c. &c.; July $13^d\ 5^h\ 0^m$ (which I note as occurring at a different hour of the day), &c. These are unimportant as affecting the readings of the curves, but not unimportant as affecting the possible explanation.

8. The comparison of the readings at Greenwich and at Kew, on days when the dislocations at Greenwich are sensible, entirely supports the view which I have entertained for many years, that the dislocations are transient phenomena, in no wise affecting the zero-measurement, and whose effects can by judicious attention be entirely remedied.

I am, my dear Sir,
Yours very truly,
(Signed) G. B. AIRY.

John P. Gassiot, Esq.,
Chairman of the Kew Committee.

IX.

Royal Observatory, Greenwich, S.E., 1864, November 15th.

MY DEAR SIR,—You are aware, perhaps, that Mr. Glaisher has visited the Kew Observatory, and that Mr. B. Stewart and Mr. Whipple have visited this Observatory, and that two of the Kew Dip instruments have been transported backwards and forwards; and that observations have been made with them by all the gentlemen whom I have mentioned, at Greenwich and at Kew; and that during these operations I have myself carefully examined the principal parts of the instruments, though I have not made any complete observations with them. The result of these operations is as follows:—

1. As far as depends on the mechanical construction, of the instruments including the needles, the workmanship of the instruments (I am not now speaking of the extent of applicability but of the workmanship of the important parts) is very good, of the same class as ours; I think ours better in some respects, but they may be considered as the same class.

2. As regards the results of observations, those made with the Kew instruments are consistent to a degree which I never saw before. And in the experiment which, as made with our needles, has perplexed me most, namely, that of rotating the instrument in azimuth without touching or lifting the needles, and remarking the change in their indications, the Kew needles appear to be nearly or entirely free from such change.

Accounts of the Kew Committee of the British Association from August 26, 1863 to September 14, 1864.

RECEIPTS.

	£	s.	d.	£	s.	d.
Received from the General Treasurer				600	0	0
,, (Donation)				100	0	0
,, for the verification of Instruments from the Board of Trade	11	14	0			
,, from the Admiralty	12	0	0			
,, from Opticians	19	18	0			
,, for Barograph Curves sent to the Meteorologic Office, London	26	2	10			
,, from the Russian Government for the verification of Magnetographs sent to St. Petersburg	30	0	0			
,, for the construction of standard Thermometers	3	6	0			
				103	0	10
Balance				45	17	9
				£848	18	7

PAYMENTS.

	£	s.	d.	£	s.	d.
Balance from last account				189	11	0
Salaries, &c.:—						
To B. Stewart, four quarters, ending 1st October, 1864	200	0	0			
Ditto, allowed for petty travelling expenses	10	0	0			
C. Chambers, until departure	12	10	0			
G. Whipple, four quarters, ending 18th September, 1864	75	0	0			
T. Baker, four quarters, ending 29th September, 1864	50	0	0			
R. Beckley, 55 weeks, ending 12th September, 1864, at 40*s.* per week	110	0	0			
F. Page, 26 weeks, ending 4th April, 1864, at 8*s.* per week	10	8	0			
Ditto, 23 weeks, ending 12th September, 1864, at 10*s.* per week	11	10	0			
				479	8	0
Apparatus, Materials, Tools, &c.				23	17	4
Ironmonger, Carpenter, and Mason				23	5	9
Printing, Stationery, Books, and Postage				29	10	11
Coals and Gas				49	13	9
House Expenses, Chandlery, &c.				25	6	8
Porterage and petty expenses				17	5	2
Rent of Land to 10th October, 1864				11	0	0
				£848	18	7

I have examined the above account and compared it with the vouchers presented to me.

	£	s.	d.	£	s.	d.
The excess of Expenditure over Income for preceding years, as stated in the Report of 12th August, 1863, amounted to				£189	11	0
The Expenditure for the present year				659	7	7
				848	18	7
The Receipts amount to	£703	0	10			
A Donation from the Chairman	100	0	0	803	0	10
Leaving a balance of				£ 45	17	9

R. HUTTON.

26th August, 1864.

The results for Dip obtainable with the Kew Dip instruments are undoubtedly more consistent and more certain than I had supposed them to be.

In considering the possible cause of this difference in the phenomena of the two sets of needles, I am led to the strong belief that it is not in any way mechanical. The mechanical structure and treatment is the same. I am inclined to suppose that it depends on the original quality and the subsequent tempering of the steel. I am not aware that the Kew Committee have published anything on this point.

I am, my dear Sir,
Yours very truly,
(Signed) G. B. Airy.

John P. Gassiot, Esq.,
Chairman of the Kew Committee.

Report of the Parliamentary Committee to the Meeting of the British Association at Bath, September 1864.

The Parliamentary Committee have the honour to report as follows:—

The Dukes of Devonshire and Argyll, the Earls of Harrowby and Enniskillen, and Sir John Pakington, have vacated their seats, but your Committee recommend their re-election.

Your Committee recommend that the Vacancy in the House of Commons' List be supplied by the election of Mr. Goschen.

Your Committee suggest that they should be permitted to propose for Election Members of either House of Parliament, in addition to the thirteen Members now constituting their Committee, whenever such addition may appear desirable.

These additional Members might be considered as Supernumerary, and any Vacancy in the Supernumerary List supplied, or not, as may be thought expedient, when the Vacancy occurs.

Your Committee also recommend that a Resolution, passed at Liverpool in 1854, be rescinded, and the following substituted:—

"That any Member of the Parliamentary Committee, who shall not attend any one of four consecutive Meetings of that Committee, shall be considered as having resigned, but shall be eligible for re-election."

No subject was referred to your Committee at Newcastle, but several of its Members have supported, or signified their intention to support, the valuable suggestion of the Royal Commissioners, that the study of Natural Science should be introduced into certain Public Schools, and likewise the Bill for legalizing the use of the Metric System of Weights and Measures.

In thus acting, the Committee conceive that they are properly fulfilling the important duty imposed upon them of "Watching over the interests of Science."

Wrottesley, *Chairman.*

17th August, 1864.

Recommendations adopted by the General Committee at the Bath Meeting in September 1864.

[When Committees are appointed, the Member first named is regarded as the Secretary, except there is a specific nomination.]

Involving Grants of Money.

That the sum of £600 be placed at the disposal of the Council for maintaining the Establishment of the Kew Observatory.

That Mr. J. Glaisher, Lord Rosse, The Rev. T. W. Webb, Mr. W. R. Birt, Dr. Lee, Mr. J. N. Lockyer, Mr. W. R. Dawes, Sir J. Herschel, Bart., Professor Phillips, Mr. J. Nasmyth, Mr. Warren De la Rue, and Mr. H. S. Ellis be a Committee (with power to add to their number) for the purpose of preparing forms for registering the various craters and visible objects on the Moon's surface, and for constructing an outline map of four times the scale of that of Beer and Mädler according to the plan proposed by Mr. Birt, and also for conducting an extensive correspondence with philosophers on the subject. That Mr. J. Glaisher be the Chairman of the Committee, and Mr. W. R. Birt be the Secretary; and that the sum of £35 be placed at their disposal for the purpose.

That the Committee on Luminous Meteors and Aërolites, consisting of Mr. Glaisher, Mr. R. P. Greg, Mr. E. W. Brayley, and Mr. Alexander Herschel be reappointed; that Mr. Herschel be the Secretary, and that the sum of £40 be placed at their disposal for the purpose.

That the Committee on Electrical Standards, consisting of Professor Williamson, Professor Wheatstone, Professor W. Thomson, Professor Miller, Dr. A. Matthiessen, Mr. Fleeming Jenkin, Sir Charles Bright, Professor Maxwell, Mr. C. W. Siemens, Mr. Balfour Stewart, Dr. Joule, and Mr. C. F. Varley, be reappointed; that Mr. Fleeming Jenkin be the Secretary, and that the sum of £100 be placed at their disposal for the purpose.

That the Balloon Committee, consisting of Colonel Sykes, Professor Airy, Lord Wrottesley, Sir David Brewster, Sir J. Herschel, Bart., Dr. Lloyd, Admiral FitzRoy, Dr. Lee, Dr. Robinson, Mr. Gassiot, Mr. Fairbairn, Dr. Tyndall, Dr. W. A. Miller, and Mr. Glaisher, be reappointed for the purpose of winter observations, night observations, electrical observations, if possible, and making experiments in months and seasons in which no observation has yet been made; that Mr. Glaisher be the Secretary, and that the sum of £150 be placed at their disposal for the purpose.

That Mr. G. J. Symons be requested to report on the Rainfall of the British Isles during the years 1863 and 1864, and also to have constructed and to transmit Rain-gauges to districts where observations are not at present made. The Gauges to be sent within the British Isles, and the instruments to be recalled should the observations not be satisfactorily made; and that the sum of £30 be placed at his disposal for the purpose.

That Dr. Robinson, Professor Wheatstone, Dr. Gladstone, and Professor Hennessy be a Committee (with power to add to their number) for the purpose of making experiments on the Transmission of Sound under Water; and that the sum of £30 be placed at their disposal for the purpose.

That Dr. Matthiessen, Mr. Noad, and Dr. D. Price be a Committee for the purpose of investigating the Chemical Constitution of Cast Iron; and that the sum of £30 be placed at their disposal for the purpose.

That M. Alphonse Gages be requested to continue his examination of the Mechanical Structure of Rocks and Artifical Formation of Minerals; and that the sum of £20 be placed at his disposal for the purpose.

That Mr. A. R. Catton be requested to complete his Examination and Analysis of Organic Acids formed synthetically; and that the sum o f£20 be placed at his disposal for the purpose.

That Prof. A. W. Williamson be requested to undertake the analysis of the gases evolved from the Bath Waters, and to make arrangements for their systematic collection; and that the sum of £20 be placed at his disposal for the purpose.

That Professor Wanklyn be requested to make experiments and report upon the difference between the two sets of Hexylic Compounds; and that the sum of £20 be placed at his disposal for the purpose.

That Professor Phillips, The Earl of Enniskillen, and Mr. C. Spence Bate be a Committee for the purpose of assisting Mr. H. Woodward in Researches on Eurypterus and other fossil Crustacea; and that the sum of £50 be placed at their disposal for the purpose.

That Sir R. I. Murchison, Sir P. Grey Egerton, Bart., and Professor Phillips be a Committee for the purpose of promoting researches in the Ossiferous Caves of Gibraltar, under the direction of Dr. Falconer and Professor Busk; and that the sum of £150 be placed at their disposal for the purpose.

That Dr. Falconer, Professor Busk, and Captain Spratt, R.N. be a Committee for the purpose of promoting researches in the Ossiferous Caves of Malta, under the direction of Dr. Adam; and that the sum of £30 be placed at their disposal for the purpose.

That Sir C. Lyell, Bart., Professor Phillips, Mr. John Lubbock, Mr. John Evans, Mr. E. Vivian, and Mr. William Pengelly be a Committee for the purpose of promoting researches on special points not yet sufficiently explored in Kent's Hole, Torquay, provided satisfactory arrangements can be made for the final disposition of the specimens; that Mr. W. Pengelly be the Secretary, and that the sum of £100 be placed at their disposal for the purpose.

That Mr. J. W. Salter, Mr. Robert Lightfoot, Mr. Vicary, and Mr. J. E. Lee be a Committee for the purpose of assisting Mr. Hicks in further excavations in the Lingula Flags at St. David's, the results to be communicated to the next Meeting of the Association; and that the sum of £10 be placed at their disposal for the purpose.

That Sir William Jardine, Bart., Dr. P. L. Sclater, Mr. H. T. Stainton, Mr. A. R. Wallace, Mr. C. Spence Bate, Mr. J. Gwyn Jeffreys, Dr. J. E. Gray, Dr. P. P. Carpenter, Mr. A. Newton, Professor C. C. Babington, Dr. J. D. Hooker, Professor T. H. Huxley, Dr. Francis, Professor Balfour, Professor Allman, Mr. A. H. Halliday, Mr. T. V. Wollaston, and Mr. G. Bentham be reappointed as a Committee to consider the question of Zoological Nomenclature; and that the sum of £10 be placed at their disposal for that purpose.

That Mr. J. Gwyn Jeffreys, Rev. W. Gregor, Mr. R. Dawson, Rev. J. Yuill, Dr. Grieve, and Professor Thomas Bell be a Committee for the purpose of dredging the Coasts of Aberdeenshire; and that the sum of £25 be placed at their disposal for the purpose.

That Mr. J. Gwyn Jeffreys, Mr. R. McAndrew, Mr. John Leckenby, Mr. C. Spence Bate, Mr. E. Waller, Rev. A. M. Norman, and Mr. H. K. Jordan be a Committee for the purpose of dredging the Coasts of the Channel Islands; and that the sum of £50 be placed at their disposal for the purpose.

That Dr. E. Perceval Wright, Professor Babington, Professor Harvey (Dublin), Mr. H. C. Watson, Dr. D. Moore (Dublin), and Mr. A. G. Moore be a Committee for the purpose of investigating the distribution of the Irish Flora; and that the sum of £25 be placed at their disposal for the purpose.

That Professor Allman and Dr. E. P. Wright be a Committee for the purpose of concluding and supplementing a Report on the Hydroida; and that the sum of £13 be placed at their disposal for the purpose.

That the sum of £3 9*s*. 0*d*. be granted to Dr. P. P. Carpenter for the purpose of defraying the expenses incurred by him (over and above a sum of £10 granted in 1863) in preparing his Report on American Mollusca.

That Mr. J. Gwyn Jeffreys, The Rev. Thomas Hincks, Mr. C. Spence Bate, Mr. J. Couch, Mr. Charles Stuart, Mr. J. B. Rowe, and Mr. J. Ralfs be a Committee for investigating the marine Fauna and Flora of the southern coasts of Cornwall and Devon; and that the sum of £25 be placed at their disposal for the purpose.

That Dr. B. W. Richardson be requested to continue his researches on the Physiological Action of some Amyl Compounds; and that the sum of £20 be placed at his disposal for the purpose.

That Dr. J. E. Gray, Mr. McAndrew, Mr. C. Spence Bate, and Mr. Frank Buckland be a Committee for the purpose of examining and reporting on the breeding of Oysters, and with special reference to the possibility of renewing old beds, and introducing other kinds of oysters; and that the sum of £25 be placed at their disposal for the purpose.

That Mr. John Lubbock, Mr. John Crawfurd, and Sir Roderick I. Murchison be a Committee for the purpose of aiding the Researches of Mr. George Busk on Typical Crania; and that the sum of £50, granted last year but not drawn, be placed at their disposal for the purpose.

That the Committee, consisting of Lord Wrottesley, The Right Hon. C. B. Adderley, M.P., Sir William Armstrong, The Astronomer Royal, Samuel Brown, W. Ewart, M.P., T. Graham, Sir John Hay, Bart., Professor Hennessy, James Heywood, Dr. Lee, Dr. Leone Levi, Professor A. W. Miller, Professor Rankine, Rev. Dr. Robinson, Colonel Sykes, M.P., W. Tite, M.P., Professor W. A. Williamson, and Frederick Purdy (with power to add to their number), be reappointed to report on the best means of providing for a uniformity of weights and measures with reference to the interests of science; and that the sum of £20 be placed at their disposal.

That the Committee for the purpose of experimenting on the difference between the resistance of floating bodies moving along the surface of water and similar bodies moving under water, consisting of Professor Rankine, Mr. James R. Napier, and Mr. Scott Russell, be reappointed, with the addition of Mr. W. Froude; and that the sum of £100, granted last year and not drawn, be placed at their disposal for the purpose.

That a sum of £6 8*s*., excess of expenditure by the Committee on the Tides of the Humber and Ouse beyond the grant of £50, be paid to Mr. J. Oldham.

That Mr. J. Hawkshaw, Mr. J. F. Bateman, Mr. J. Oldham, Mr. W. Parks, Mr. J. Scott Russell, Mr. Thomas Webster, Mr. C. Vignoles, Sir J. Rennie, and Mr. G. P. Bidder, jun., be a Committee for the purpose of arranging and analyzing the Tidal operations which have already been made on the coasts and estuaries of Great Britain, and making such further observations and investigations as the Committee may deem desirable for recording and exhibiting Tidal phenomena; and that the sum of £200 be placed at their disposal for that purpose.

That the Patent Law Committee be reappointed, and that it consist of the following Members:—Mr. Thomas Webster, Sir W. G. Armstrong, Mr. J. F.

Bateman, Mr. W. Fairbairn, Mr. John Hawkshaw, Mr. J. Scott Russell, and Mr. John Bethell (with power to add to their number); and that the grant of £30, previously made and not drawn, be renewed.

Applications for Reports and Researches not involving Grants of Money.

That Mr. Fleeming Jenkin be requested to continue his Report on Thermo-Electrical Phenomena.

That the Committee on Fog Signals, consisting of Dr. Robinson, Professor Wheatstone, and Dr. Gladstone, be reappointed (with power to add to their number), and requested to continue their labours.

That Mr. Hirst be requested to report on certain new developments of Geometrical Methods.

That Professor Stokes be requested to continue his Report on the present state of Physical Optics.

That Professor Griffith and Dr. Akin be requested to continue their Report on the Transmutation of Spectral Rays.

That Dr. Paul be requested to draw up a Report upon the application of Chemistry to Geology.

That Dr. Baker Edwards be requested to make experiments, and report upon the alkaloidal principles of Calabar Beans.

That Mr. J. Gwyn Jeffreys, Dr. J. E. Gray, Mr. R. McAndrew, Dr. Collingwood, Mr. C. Spence Bate, Rev. A. M. Norman, Dr. E. P. Wright, and Rev. Thomas Hincks be a Committee for the purpose of acting as a General Dredging Committee.

That the Committee on Scientific Evidence in Courts of Law, consisting of The Rev. W. V. Harcourt, Professor Williamson, The Right Hon. J. Napier, Mr. W. Tite, M.P., Professor Christison, Mr. James Heywood, Mr. J. F. Bateman, Mr. Thomas Webster, Sir Benjamin Brodie, Bart., and Prof. W. A. Miller (with power to add to their number), be reappointed; and that Prof. Williamson be the Secretary.

That the Gun-cotton Committee, consisting of Mr. W. Fairbairn, Mr. Joseph Whitworth, Mr. James Nasmyth, Mr. J. Scott Russell, Mr. John Anderson, Sir William G. Armstrong, Dr. Gladstone, Professor W. A. Miller, Dr. Frankland, and Mr. Abel, be reappointed and requested to continue their Report.

That Mr. F. J. Spencer not having been able to complete his report "On the different modes of estimating nominal horse-power of Marine Engines, with a view of securing the adoption of one uniform system," be requested to continue his labours, and to report at the next Meeting of the Association.

Involving Applications to Governments or Institutions.

That Major-General Sabine, Sir John Herschel, Bart., Mr. J. P. Gassiot, and Sir Roderick I. Murchison be a Committee for the purpose of communicating to the Russian Government the opinion of the British Association, that the establishment of magnetical observations on the Kew System at the Observatory of Tiflis, by Professor Moritz of that place, would largely conduce to the furtherance of magnetical science.

That General Sabine be requested to afford Mr. Neumayer the advice he desires as to the best form of publication of the magnetical observations of the Melbourne Observatory.

That the Parliamentary Committee be requested to press on the Government the expediency of instituting a series of experiments on Fog Signals.

That Sir Roderick I. Murchison, Admiral R. Collinson, and Mr. A. G. Findlay be a Committee for the purpose of forwarding a request to Her Majesty's Government that, as far as is compatible with the exigencies of Her Majesty's Navy and the discipline of the ships, they should be furnished with apparatus (as used in Her Majesty's Ship 'Bulldog') to ascertain the depth of the ocean, and to obtain specimens of the bottom on all convenient occasions, the particulars to be forwarded to the Hydrographic Department, and the specimens to be sent to the Geological Museum.

That Sir Roderick I. Murchison, The Lord Alfred Churchill, M.P., Mr. Galton, and Mr. Spottiswoode be a Committee for the purpose of requesting the Foreign Office to grant to Captain Richard Burton six months' leave to explore the sources of the Niger before proceeding to his new post.

Communications to be printed entire among the Reports.

That the Addresses of the Presidents of the Sections be printed in the Transactions.

That the Report of the Committee on Tidal Observations on the Humber, Trent, and Ouse, with Tables and Diagrams, be published *in extenso* in the Transactions.

That Mr. W. Fairbairn's paper "On some of the Mechanical Properties of the Atlantic Telegraph Cable" be printed at length in the Report.

Synopsis of Grants of Money appropriated to Scientific Purposes by the General Committee at the Bath Meeting in September 1864. *The names of the Members who would be entitled to call on the General Treasurer for the respective Grants are prefixed.*

Kew Observatory.

	£	s.	d.
Maintaining the Establishment of Kew Observatory	600	0	0

Mathematics and Physics.

Glaisher, Mr.—Preparation of Forms for Observation of Moon's Surface	35	0	0
Glaisher, Mr.—Luminous Meteors and Aërolites	40	0	0
Williamson, Prof.—Electrical Standards	100	0	0
Sykes, Col.—Balloon Committee	150	0	0
Symons, Mr.—Rain-gauges	30	0	0
Robinson, Dr.—Transmission of Sound	30	0	0

Chemistry.

Matthiessen, Dr.—Chemical Constitution of Cast Iron (renewed)	30	0	0
Gages, M.—Mechanical Structure of Rocks	20	0	0
Catton, Mr.—Analysis of Organic Acids	20	0	0
Williamson, Prof.—Analysis of Gases of Bath Waters	20	0	0
Wanklyn, Prof.—Hexylic Compounds	20	0	0

Geology.

	£	s.	d.
Phillips, Prof.—Fossil Crustacea	50	0	0
Murchison, Sir R.—Bone Caves of Gibraltar	150	0	0
Falconer, Dr.—Fossil Remains in Malta	30	0	0
Lyell, Sir C.—Excavations in Kent's Hole	100	0	0
Salter, Mr. J.—Lingula Flags at St. David's	10	0	0

Zoology and Botany.

Gray, Dr. J. E.—Breeding of Oysters	25	0	0
Jardine, Sir W.—Zoological Nomenclature (renewed)	10	0	0
Jeffreys, Mr.—Dredging Coast of Aberdeenshire	25	0	0
Jeffreys, Mr.—Dredging Coast of Channel Islands	50	0	0
Wright, Dr. E. P.—Irish Flora	25	0	0
Allman, Prof.—Hydroida	13	0	0
Carpenter, Dr. P. P.—Report on American Mollusca	3	9	0
Jeffreys, Mr.—Marine Fauna and Flora	25	0	0
Richardson, Dr. B. W.—Physiological Action of some Amyl Compounds	20	0	0

Geography and Ethnology.

Lubbock, Mr.—Typical Crania (renewed)	50	0	0

Statistics and Economic Science.

Wrottesley, Lord.—Metrical Committee	20	0	0

Mechanics.

Russell, Scott, Mr.—Resistance of Bodies in Water (renewed)	100	0	0
Oldham, Mr.—Tides of Humber	6	8	0
Hawkshaw, Mr.—Tidal Observations on British Coasts	200	0	0
Webster, Mr.—Patent Laws (renewed)	30	0	0
Total	2037	17	0

General Statement of Sums which have been paid on Account of Grants for Scientific Purposes.

	£	s.	d.
1834.			
Tide Discussions	20	0	0
1835.			
Tide Discussions	62	0	0
British Fossil Ichthyology	105	0	0
	£167	0	0
1836.			
Tide Discussions	163	0	0
British Fossil Ichthyology	105	0	0
Thermometric Observations, &c.	50	0	0
Experiments on long-continued Heat	17	1	0
Rain-Gauges	9	13	0
Refraction Experiments	15	0	0
Lunar Nutation	60	0	0
Thermometers	15	6	0
	£434	14	0
1837.			
Tide Discussions	284	1	0
Chemical Constants	24	13	6
Lunar Nutation	70	0	0
Observations on Waves	100	12	0
Tides at Bristol	150	0	0
Meteorology and Subterranean Temperature	89	5	0
Vitrification Experiments	150	0	0
Heart Experiments	8	4	6
Barometric Observations	30	0	0
Barometers	11	18	6
	£918	14	6
1838.			
Tide Discussions	29	0	0
British Fossil Fishes	100	0	0
Meteorological Observations and Anemometer (construction)	100	0	0
Cast Iron (Strength of)	60	0	0
Animal and Vegetable Substances (Preservation of)	19	1	10
Railway Constants	41	12	10
Bristol Tides	50	0	0
Growth of Plants	75	0	0
Mud in Rivers	3	6	6
Education Committee	50	0	0
Heart Experiments	5	3	0
Land and Sea Level	267	8	7
Subterranean Temperature	8	6	0
Steam-vessels	100	0	0
Meteorological Committee	31	9	5
Thermometers	16	4	0
	£956	12	2
1839.			
Fossil Ichthyology	110	0	0
Meteorological Observations at Plymouth	63	10	0
Mechanism of Waves	144	2	0
Bristol Tides	35	18	6
Meteorology and Subterranean Temperature	21	11	0
Vitrification Experiments	9	4	7
Cast Iron Experiments	100	0	0
Railway Constants	28	7	2
Land and Sea Level	274	1	4
Steam-vessels' Engines	100	0	0
Stars in Histoire Céleste	331	18	6
Stars in Lacaille	11	0	0
Stars in R.A.S. Catalogue	6	16	6
Animal Secretions	10	10	0
Steam-engines in Cornwall	50	0	0
Atmospheric Air	16	1	0
Cast and Wrought Iron	40	0	0
Heat on Organic Bodies	3	0	0
Gases on Solar Spectrum	22	0	0
Hourly Meteorological Observations, Inverness and Kingussie	49	7	8
Fossil Reptiles	118	2	9
Mining Statistics	50	0	0
	£1595	11	0
1840.			
Bristol Tides	100	0	0
Subterranean Temperature	13	13	6
Heart Experiments	18	19	0
Lungs Experiments	8	13	0
Tide Discussions	50	0	0
Land and Sea Level	6	11	1
Stars (Histoire Céleste)	242	10	0
Stars (Lacaille)	4	15	0
Stars (Catalogue)	264	0	0
Atmospheric Air	15	15	0
Water on Iron	10	0	0
Heat on Organic Bodies	7	0	0
Meteorological Observations	52	17	6
Foreign Scientific Memoirs	112	1	6
Working Population	100	0	0
School Statistics	50	0	0
Forms of Vessels	184	7	0
Chemical and Electrical Phenomena	40	0	0
Meteorological Observations at Plymouth	80	0	0
Magnetical Observations	185	13	9
	£1546	16	4
1841.			
Observations on Waves	30	0	0
Meteorology and Subterranean Temperature	8	8	0
Actinometers	10	0	0
Earthquake Shocks	17	7	0
Acrid Poisons	6	0	0
Veins and Absorbents	3	0	0
Mud in Rivers	5	0	0
Marine Zoology	15	12	8
Skeleton Maps	20	0	0
Mountain Barometers	6	18	6
Stars (Histoire Céleste)	185	0	0

	£	s.	d.
Stars (Lacaille)	79	5	0
Stars (Nomenclature of)	17	19	6
Stars (Catalogue of)	40	0	0
Water on Iron	50	0	0
Meteorological Observations at Inverness	20	0	0
Meteorological Observations (reduction of)	25	0	0
Fossil Reptiles	50	0	0
Foreign Memoirs	62	0	0
Railway Sections	38	1	6
Forms of Vessels	193	12	0
Meteorological Observations at Plymouth	55	0	0
Magnetical Observations	61	18	8
Fishes of the Old Red Sandstone	100	0	0
Tides at Leith	50	0	0
Anemometer at Edinburgh	69	1	10
Tabulating Observations	9	6	3
Races of Men	5	0	0
Radiate Animals	2	0	0
	£1235	10	11

1842.

	£	s.	d.
Dynamometric Instruments	113	11	2
Anoplura Britanniæ	52	12	0
Tides at Bristol	59	8	0
Gases on Light	30	14	7
Chronometers	26	17	6
Marine Zoology	1	5	0
British Fossil Mammalia	100	0	0
Statistics of Education	20	0	0
Marine Steam-vessels' Engines	28	0	0
Stars (Histoire Céleste)	59	0	0
Stars (Brit. Assoc. Cat. of)	110	0	0
Railway Sections	161	10	0
British Belemnites	50	0	0
Fossil Reptiles (publication of Report)	210	0	0
Forms of Vessels	180	0	0
Galvanic Experiments on Rocks	5	8	6
Meteorological Experiments at Plymouth	68	0	0
Constant Indicator and Dynamometric Instruments	90	0	0
Force of Wind	10	0	0
Light on Growth of Seeds	8	0	0
Vital Statistics	50	0	0
Vegetative Power of Seeds	8	1	11
Questions on Human Race	7	9	0
	£1449	17	8

1843.

	£	s.	d.
Revision of the Nomenclature of Stars	2	0	0
Reduction of Stars, British Association Catalogue	25	0	0
Anomalous Tides, Frith of Forth	120	0	0
Hourly Meteorological Observations at Kingussie and Inverness	77	12	8
Meteorological Observations at Plymouth	55	0	0
Whewell's Meteorological Anemometer at Plymouth	10	0	0
Meteorological Observations, Osler's Anemometer at Plymouth	20	0	0
Reduction of Meteorological Observations	30	0	0
Meteorological Instruments and Gratuities	39	6	0
Construction of Anemometer at Inverness	56	12	2
Magnetic Cooperation	10	8	10
Meteorological Recorder for Kew Observatory	50	0	0
Action of Gases on Light	18	16	1
Establishment at Kew Observatory, Wages, Repairs, Furniture and Sundries	133	4	7
Experiments by Captive Balloons	81	8	0
Oxidation of the Rails of Railways	20	0	0
Publication of Report on Fossil Reptiles	40	0	0
Coloured Drawings of Railway Sections	147	18	3
Registration of Earthquake Shocks	30	0	0
Report on Zoological Nomenclature	10	0	0
Uncovering Lower Red Sandstone near Manchester	4	4	6
Vegetative Power of Seeds	5	3	8
Marine Testacea (Habits of)	10	0	0
Marine Zoology	10	0	0
Marine Zoology	2	14	11
Preparation of Report on British Fossil Mammalia	100	0	0
Physiological Operations of Medicinal Agents	20	0	0
Vital Statistics	36	5	8
Additional Experiments on the Forms of Vessels	70	0	0
Additional Experiments on the Forms of Vessels	100	0	0
Reduction of Experiments on the Forms of Vessels	100	0	0
Morin's Instrument and Constant Indicator	69	14	10
Experiments on the Strength of Materials	60	0	0
	£1565	10	2

1844.

	£	s.	d.
Meteorological Observations at Kingussie and Inverness	12	0	0
Completing Observations at Plymouth	35	0	0
Magnetic and Meteorological Cooperation	25	8	4
Publication of the British Association Catalogue of Stars	35	0	0
Observations on Tides on the East coast of Scotland	100	0	0
Revision of the Nomenclature of Stars 1842	2	9	6
Maintaining the Establishment in Kew Observatory	117	17	3
Instruments for Kew Observatory	56	7	3

	£	s.	d.
Influence of Light on Plants......	10	0	0
Subterraneous Temperature in Ireland	5	0	0
Coloured Drawings of Railway Sections	15	17	6
Investigation of Fossil Fishes of the Lower Tertiary Strata ...	100	0	0
Registering the Shocks of Earthquakes 1842	23	11	10
Structure of Fossil Shells	20	0	0
Radiata and Mollusca of the Ægean and Red Seas 1842	100	0	0
Geographical Distributions of Marine Zoology...........1842	0	10	0
Marine Zoology of Devon and Cornwall	10	0	0
Marine Zoology of Corfu	10	0	0
Experiments on the Vitality of Seeds	9	0	3
Experiments on the Vitality of Seeds 1842	8	7	3
Exotic Anoplura	15	0	0
Strength of Materials	100	0	0
Completing Experiments on the Forms of Ships	100	0	0
Inquiries into Asphyxia	10	0	0
Investigations on the Internal Constitution of Metals	50	0	0
Constant Indicator and Morin's Instrument, 1842	10	3	6
	£981	12	8

1845.

	£	s.	d.
Publication of the British Association Catalogue of Stars	351	14	6
Meteorological Observations at Inverness	30	18	11
Magnetic and Meteorological Co-operation	16	16	8
Meteorological Instruments at Edinburgh........................	18	11	9
Reduction of Anemometrical Observations at Plymouth	25	0	0
Electrical Experiments at Kew Observatory	43	17	8
Maintaining the Establishment in Kew Observatory	149	15	0
For Kreil's Barometrograph	25	0	0
Gases from Iron Furnaces	50	0	0
The Actinograph	15	0	0
Microscopic Structure of Shells...	20	0	0
Exotic Anoplura 1843	10	0	0
Vitality of Seeds...............1843	2	0	7
Vitality of Seeds...............1844	7	0	0
Marine Zoology of Cornwall......	10	0	0
Physiological Action of Medicines	20	0	0
Statistics of Sickness and Mortality in York	20	0	0
Earthquake Shocks 1843	15	14	8
	£830	9	9

1846.

	£	s.	d.
British Association Catalogue of Stars 1844	211	15	0
Fossil Fishes of the London Clay	100	0	0
Computation of the Gaussian Constants for 1839..............	50	0	0
Maintaining the Establishment at Kew Observatory	146	16	7
Strength of Materials...............	60	0	0
Researches in Asphyxia............	6	16	2
Examination of Fossil Shells......	10	0	0
Vitality of Seeds 1844	2	15	10
Vitality of Seeds 1845	7	12	3
Marine Zoology of Cornwall......	10	0	0
Marine Zoology of Britain	10	0	0
Exotic Anoplura 1844	25	0	0
Expenses attending Anemometers	11	7	6
Anemometers' Repairs	2	3	6
Atmospheric Waves	3	3	3
Captive Balloons 1844	8	19	3
Varieties of the Human Race 1844	7	6	3
Statistics of Sickness and Mortality in York	12	0	0
	£685	16	0

1847.

	£	s.	d.
Computation of the Gaussian Constants for 1839	50	0	0
Habits of Marine Animals	10	0	0
Physiological Action of Medicines	20	0	0
Marine Zoology of Cornwall ...	10	0	0
Atmospheric Waves	6	9	3
Vitality of Seeds	4	7	7
Maintaining the Establishment at Kew Observatory	107	8	6
	£208	5	4

1848.

	£	s.	d.
Maintaining the Establishment at Kew Observatory	171	15	11
Atmospheric Waves	3	10	9
Vitality of Seeds	9	15	0
Completion of Catalogues of Stars	70	0	0
On Colouring Matters	5	0	0
On Growth of Plants...............	15	0	0
	£275	1	8

1849.

	£	s.	d.
Electrical Observations at Kew Observatory	50	0	0
Maintaining Establishment at ditto	76	2	5
Vitality of Seeds	5	8	1
On Growth of Plants...............	5	0	0
Registration of Periodical Phenomena	10	0	0
Bill on account of Anemometrical Observations	13	9	0
	£159	19	6

1850.

	£	s.	d.
Maintaining the Establishment at Kew Observatory	255	18	0
Transit of Earthquake Waves ...	50	0	0

	£	s.	d.
Periodical Phenomena	15	0	0
Meteorological Instrument, Azores	25	0	0
	£345	18	0

1851.

	£	s.	d.
Maintaining the Establishment at Kew Observatory (includes part of grant in 1849)	309	2	2
Theory of Heat	20	1	1
Periodical Phenomena of Animals and Plants	5	0	0
Vitality of Seeds	5	6	4
Influence of Solar Radiation......	30	0	0
Ethnological Inquiries	12	0	0
Researches on Annelida	10	0	0
	£391	9	7

1852.

	£	s.	d.
Maintaining the Establishment at Kew Observatory (including balance of grant for 1850) ...	233	17	8
Experiments on the Conduction of Heat	5	2	9
Influence of Solar Radiations ...	20	0	0
Geological Map of Ireland	15	0	0
Researches on the British Annelida................................	10	0	0
Vitality of Seeds	10	6	2
Strength of Boiler Plates	10	0	0
	£304	6	7

1853.

	£	s.	d.
Maintaining the Establishment at Kew Observatory	165	0	0
Experiments on the Influence of Solar Radiation...................	15	0	0
Researches on the British Annelida................................	10	0	0
Dredging on the East Coast of Scotland..............................	10	0	0
Ethnological Queries	5	0	0
	£205	0	0

1854.

	£	s.	d.
Maintaining the Establishment at Kew Observatory (including balance of former grant)	330	15	4
Investigations on Flax	11	0	0
Effects of Temperature on Wrought Iron	10	0	0
Registration of Periodical Phenomena	10	0	0
British Annelida	10	0	0
Vitality of Seeds	5	2	3
Conduction of Heat	4	2	0
	£380	19	7

1855.

	£	s.	d.
Maintaining the Establishment at Kew Observatory	425	0	0
Earthquake Movements	10	0	0
Physical Aspect of the Moon......	11	8	5
Vitality of Seeds	10	7	11
Map of the World..................	15	0	0
Ethnological Queries	5	0	0
Dredging near Belfast	4	0	0
	£480	16	4

1856.

	£	s.	d.
Maintaining the Establishment at Kew Observatory:— 1854......£ 75 0 0; 1855......£500 0 0	575	0	0
Strickland's Ornithological Synonyms	100	0	0
Dredging and Dredging Forms...	9	13	9
Chemical Action of Light	20	0	0
Strength of Iron Plates	10	0	0
Registration of Periodical Phenomena	10	0	0
Propagation of Salmon	10	0	0
	£734	13	9

1857.

	£	s.	d.
Maintaining the Establishment at Kew Observatory	350	0	0
Earthquake Wave Experiments..	40	0	0
Dredging near Belfast	10	0	0
Dredging on the West Coast of Scotland..........................	10	0	0
Investigations into the Mollusca of California	10	0	0
Experiments on Flax	5	0	0
Natural History of Madagascar..	20	0	0
Researches on British Annelida	25	0	0
Report on Natural Products imported into Liverpool	10	0	0
Artificial Propagation of Salmon	10	0	0
Temperature of Mines	7	8	0
Thermometers for Subterranean Observations	5	7	4
Life-Boats	5	0	0
	£507	15	4

1858.

	£	s.	d.
Maintaining the Establishment at Kew Observatory	500	0	0
Earthquake Wave Experiments..	25	0	0
Dredging on the West Coast of Scotland	10	0	0
Dredging near Dublin	5	0	0
Vitality of Seeds	5	5	0
Dredging near Belfast	18	13	2
Report on the British Annelida...	25	0	0
Experiments on the production of Heat by Motion in Fluids ...	20	0	0
Report on the Natural Products imported into Scotland	10	0	0
	£618	18	2

1859.

	£	s.	d.
Maintaining the Establishment at Kew Observatory	500	0	0
Dredging near Dublin	15	0	0
Osteology of Birds..................	50	0	0
Irish Tunicata	5	0	0
Manure Experiments	20	0	0
British Medusidæ	5	0	0
Dredging Committee...............	5	0	0
Steam-vessels' Performance	5	0	0
Marine Fauna of South and West of Ireland	10	0	0
Photographic Chemistry	10	0	0
Lanarkshire Fossils	20	0	1
Balloon Ascents.....................	39	11	0
	£684	11	1

1860.	£	s.	d.
Maintaining the Establishment of Kew Observatory	500	0	0
Dredging near Belfast	16	6	0
Dredging in Dublin Bay	15	0	0
Inquiry into the Performance of Steam-vessels	124	0	0
Explorations in the Yellow Sandstone of Dura Den	20	0	0
Chemico-mechanical Analysis of Rocks and Minerals	25	0	0
Researches on the Growth of Plants	10	0	0
Researches on the Solubility of Salts	30	0	0
Researches on the Constituents of Manures	25	0	0
Balance of Captive Balloon Accounts	1	13	6
	£1241	7	0

1861.	£	s.	d.
Maintaining the Establishment of Kew Observatory	500	0	0
Earthquake Experiments	25	0	0
Dredging North and East Coasts of Scotland	23	0	0
Dredging Committee:— 1860 ...... £50 0 0; 1861 ...... £22 0 0	72	0	0
Excavations at Dura Den	20	0	0
Solubility of Salts	20	0	0
Steam-vessel Performance	150	0	0
Fossils of Lesmahago	15	0	0
Explorations at Uriconium	20	0	0
Chemical Alloys	20	0	0
Classified Index to the Transactions	100	0	0
Dredging in the Mersey and Dee	5	0	0
Dip Circle	30	0	0
Photoheliographic Observations	50	0	0
Prison Diet	20	0	0
Gauging of Water	10	0	0
Alpine Ascents	6	5	1
Constituents of Manures	25	0	0
	£1111	5	10

1862.	£	s.	d.
Maintaining the Establishment of Kew Observatory	500	0	0
Patent Laws	21	6	0
Mollusca of N.-W. America	10	0	0
Natural History by Mercantile Marine	5	0	0
Tidal Observations	25	0	0
Photoheliometer at Kew	40	0	0
Photographic Pictures of the Sun	150	0	0
Rocks of Donegal	25	0	0
Dredging Durham and Northumberland	25	0	0
Connexion of Storms	20	0	0
Dredging North-East Coast of Scotland	6	9	6
Ravages of Teredo	3	11	0
Standards of Electrical Resistance	50	0	0
Railway Accidents	10	0	0
Balloon Committee	200	0	0
Dredging Dublin Bay	10	0	0
Dredging the Mersey	5	0	0
Prison Diet	20	0	0
Gauging of Water	12	10	0
Steamships' Performance	150	0	0
Thermo-Electric Currents	5	0	0
	£1293	16	6

1863.	£	s.	d.
Maintaining the Establishment of Kew Observatory	600	0	0
Balloon Committee deficiency	70	0	0
Balloon Ascents (other expenses)	25	0	0
Entozoa	25	0	0
Coal Fossils	20	0	0
Herrings	20	0	0
Granites of Donegal	5	0	0
Prison Diet	20	0	0
Vertical Atmospheric Movements	13	0	0
Dredging Shetland	50	0	0
Dredging North-east coast of Scotland	25	0	0
Dredging Northumberland and Durham	17	3	10
Dredging Committee superintendence	10	0	0
Steamship Performance	100	0	0
Balloon Committee	200	0	0
Carbon under pressure	10	0	0
Volcanic Temperature	100	0	0
Bromide of Ammonium	8	0	0
Electrical Standards	100	0	0
—— Construction and distribution	40	0	0
Luminous Meteors	17	0	0
Kew Additional Buildings for Photoheliograph	100	0	0
Thermo-Electricity	15	0	0
Analysis of Rocks	8	0	0
Hydroids	10	0	0
	£1608	3	10

1864.	£	s.	d.
Maintaining the Establishment of Kew Observatory	600	0	0
Coal Fossils	20	0	0
Vertical Atmospheric Movements	20	0	0
Dredging Shetland	75	0	0
Dredging Northumberland	25	0	0
Baloon Committee	200	0	0
Carbon under pressure	10	0	0
Standards of Electric Resistance	100	0	0
Analysis of Rocks	10	0	0
Hydroida	10	0	0
Askham's Gift	50	0	0
Nitrite of Amyle	10	0	0
Nomenclature Committee	5	0	0
Rain-Gauges	19	15	8
Cast Iron Investigation	20	0	0
Tidal Observations in the Humber	50	0	0
Spectral Rays	45	0	0
Luminous Meteors	20	0	0
	£1289	15	8

Extracts from Resolutions of the General Committee.

Committees and individuals, to whom grants of money for scientific purposes have been entrusted, are required to present to each following meeting of the Association a Report of the progress which has been made; with a statement of the sums which have been expended, and the balance which remains disposable on each grant.

Grants of pecuniary aid for scientific purposes from the funds of the Association expire at the ensuing meeting, unless it shall appear by a Report that the Recommendations have been acted on, or a continuation of them be ordered by the General Committee.

In each Committee, the Member first named is the person entitled to call on the Treasurer, William Spottiswoode, Esq., 59 Grosvenor Place, London, S.W., for such portion of the sum granted as may from time to time be required.

In grants of money to Committees, the Association does not contemplate the payment of personal expenses to the members.

In all cases where additional grants of money are made for the continuation of Researches at the cost of the Association, the sum named shall be deemed to include, as a part of the amount, the specified balance which may remain unpaid on the former grant for the same object.

General Meetings.

On Wednesday Evening, September 14, at 8 P.M., in the Theatre, Sir W. G. Armstrong, LL.D., F.R.S., resigned the office of President to Sir Charles Lyell, M.A., D.C.L., LL.D., F.R.S., F.G.S., who took the Chair, and delivered an Address, for which see page lx.

On Thursday Evening, September 15, at 8 P.M., a Soirée took place in the Assembly Rooms.

On Friday Evening, September 16, at 8.30 P.M., in the Town Hall, Professor Roscoe delivered a Discourse on the Chemical Action of Light.

On Monday Evening, September 19, at 8 P.M., in the Theatre, Dr. Livingstone delivered a Lecture on his recent travels in Central Africa.

On Tuesday Evening, September 20, at 8 P.M., a Soirée took place in the Assembly Room.

On Wednesday, September 21, at 3 P.M., the concluding General Meeting took place, when the Proceedings of the General Committee, and the Grants of Money for Scientific purposes, were explained to the Members.

The Meeting was then adjourned to Birmingham*.

* The Meeting is appointed to take place on Wednesday, September 6, 1865.

ADDRESS

BY

SIR CHARLES LYELL, Bart., LL.D., D.C.L., F.R.S., &c.

Gentlemen of the British Association,—The place where we have been invited this year to hold our Thirty-fourth Meeting is one of no ordinary interest to the cultivators of physical science. It might have been selected by my fellow-labourers in geology as a central point of observation, from which, by short excursions to the east and west, they might examine those rocks which constitute, on the one side, the more modern, and on the other the more ancient records of the past, while around them and at their feet lie monuments of the middle period of the earth's history. But there are other sites in England which might successfully compete with Bath as good surveying stations for the geologist. What renders Bath a peculiar point of attraction to the student of natural phenomena is its thermal and mineral waters, to the sanatory powers of which the city has owed its origin and celebrity. The great volume and high temperature of these waters render them not only unique in our island, but perhaps without a parallel in the rest of Europe, when we duly take into account their distance from the nearest region of violent earthquakes or of active or extinct volcanos. The spot where they issue, as we learn from the researches of the historian and antiquary, was lonely and desert when the Romans first landed in this island, but in a few years it was converted into one of the chief cities of the newly conquered province. On the site of the hot springs was a large morass from which clouds of white vapour rose into the air; and there first was the spacious bath-room built, in a highly ornamental style of architecture, and decorated with columns, pilasters, and tessellated pavements. By its side was erected a splendid temple dedicated to Minerva, of which some statues and altars with their inscriptions, and ornate pillars are still to be seen in the Museum of this place. To these edifices the quarters of the garrison, and in the course of time the dwellings of new settlers, were added; and they were all encircled by a massive wall, the solid foundations of which still remain.

A dense mass of soil and rubbish, from 10 to 20 feet thick, now separates the level on which the present city stands from the level of the ancient Aquæ Solis of the Romans. Digging through this mass of heterogeneous materials, coins and coffins of the Saxon period have been found; and lower down, beginning at the depth of from 12 to 15 feet from the surface, coins have been disinterred of Imperial Rome, bearing dates from the reign of Claudius to that of Maximus in the fifth century. Beneath the whole are occasionally seen tessellated pavements still retaining their bright colours, one of which, on the site of the Mineral-water Hospital, is still carefully preserved, affording us an opportunity of gauging the difference of level of ancient and modern Bath.

On the slopes and summits of the picturesque hills in the neighbourhood rose many a Roman villa, to trace the boundaries of which, and to bring to light the treasures of art concealed in them, are tasks which have of late years amply rewarded the researches of Mr. Scarth and other learned antiquaries. No wonder that on this favoured spot we should meet with so many memorials of former greatness, when we reflect on the length of time during which the imperial troops and rich colonists of a highly civilized people sojourned here, having held undisturbed possession of the country for as many years as have elapsed from the first discovery of America to our own times.

One of our former Presidents, Dr. Daubeny, has remarked that nearly all the most celebrated hot springs of Europe, such as those of Aix-la-Chapelle, Baden-Baden, Naples, Auvergne, and the Pyrenees, have not declined in temperature since the days of the Romans; for many of them still retain as great a heat as is tolerable to the human body, and yet when employed by the ancients they do not seem to have required to be first cooled down by artificial means. This uniformity of temperature, maintained in some places for more than 2000 years, together with the constancy in the volume of the water, which never varies with the seasons, as in ordinary springs, the identity also of the mineral ingredients which, century after century, are held by each spring in solution, are striking facts, and they tempt us irresistibly to speculate on the deep subterranean sources both of the heat and mineral matter. How long has this uniformity prevailed? Are the springs really ancient in reference to the earth's history, or, like the course of the present rivers and the actual shape of our hills and valleys, are they only of high antiquity when contrasted with the brief space of human annals? May they not be like Vesuvius and Etna, which, although they have been adding to their flanks, in the course of the last 2000 years many a stream of lava and shower of ashes, were still mountains very much the same as they now are in height and dimensions from the earliest times to which we can trace back their existence? Yet although their foundations are tens of thousands of years old, they were laid at an era when the Mediterranean was already inhabited by the same species of marine shells as those with which it is now peopled; so that these volcanos must be regarded as things of yesterday in the geological calendar.

Notwithstanding the general persistency in character of mineral waters and hot springs ever since they were first known to us, we find on inquiry that some few of them, even in historical times, have been subject to great changes. These have happened during earthquakes which have been violent enough to disturb the subterranean drainage and alter the shape of the fissures up which the waters ascend. Thus during the great earthquake at Lisbon in 1755, the temperature of the spring called La Source de la Reine at Bagnères de Luchon, in the Pyrenees, was suddenly raised as much as 75° F., or changed from a cold spring to one of 122° F., a heat which it has since retained. It is also recorded that the hot springs at Bagnères de Bigorre, in the same mountain-chain, became suddenly cold during a great earthquake which, in 1660, threw down several houses in that town.

It has been ascertained that the hot springs of the Pyrenees, the Alps, and many other regions are situated in lines along which the rocks have been rent, and usually where they have been displaced or "faulted." Similar dislocations in the solid crust of the earth are generally supposed to have determined the spots where active and extinct volcanos have burst forth; for several of these often affect a linear arrangement, their position seeming to have been determined by great lines of fissure. Another connecting link between the volcano and the hot spring is recognizable in the great abundance of hot springs in regions where volcanic eruptions still occur from time to time. It is also in the same districts that the waters occasionally attain the boiling-temperature, while some of the associated stufas emit steam considerably above the boiling-point. But in proportion as we recede from the great centres of igneous activity, we find the thermal waters decreasing in frequency and in their average heat, while at the same time they are most conspicuous in those territories where, as in Central France or the Eifel in Germany, there are cones and craters still so perfect in their form, and streams of lava bearing such a relation to the depth and shape of the existing valleys, as to indicate that the internal fires have become dormant in comparatively recent times. If there be exceptions to this rule, it is where hot springs are met with in parts of the Alps and Pyrenees which have been violently convulsed by modern earthquakes.

To pursue still further our comparison between the hot spring and the volcano, we may regard the water of the spring as representing those vast clouds of aqueous vapour which are copiously evolved for days, sometimes for weeks, in succession from craters during an eruption. But we shall perhaps be asked whether, when we contrast the work done by the two agents in question, there is not a marked failure of analogy in one respect—namely a want, in the case of the hot spring, of power to raise from great depths in the earth voluminous masses of solid matter corresponding to the heaps of scoriæ and streams of lava which the volcano pours out on the surface. To one who urges such an objection it may be said that the quantity of solid as well as gaseous matter transferred by springs from the interior of the earth to its surface is far more considerable than is commonly imagined. The thermal waters of Bath are far from being conspicuous among European hot springs for the quantity of mineral matter contained in them in proportion to the water which acts as a solvent; yet Professor Ramsay has calculated that if the sulphates of lime and of soda, and the chlorides of sodium and magnesium, and the other mineral ingredients which they contain, were solidified, they would form in one year a square column 9 feet in diameter, and no less than 140 feet in height. All this matter is now quietly conveyed by a stream of limpid water, in an invisible form, to the Avon, and by the Avon to the sea; but if, instead of being thus removed, it were deposited around the orifice of eruption, like the siliceous layers which encrust the circular basin of an Icelandic geyser, we should soon see a considerable cone built up, with a crater in the middle; and if the action of the spring were intermittent, so that ten or twenty years should elapse between the periods when solid matter was emitted, or (say) an interval of three centuries, as in the case of Vesuvius between 1306 and 1631, the discharge would be on so grand a scale as to afford no mean object of comparison with the intermittent outpourings of a volcano.

Dr. Daubeny, after devoting a month to the analysis of the Bath waters in 1833, ascertained that the daily evolution of nitrogen gas amounted to no less than 250 cubic feet in volume. This gas, he remarks, is not only characteristic of hot springs, but is largely disengaged from volcanic craters during eruptions. In both cases he suggests that the nitrogen may be derived from atmospheric air, which is always dissolved in rain-water, and which, when this water penetrates the earth's crust, must be carried down to great depths, so as to reach the heated interior. When there, it may be subjected to deoxidating processes, so that the nitrogen, being left in a free state, may be driven upwards by the expansive force of heat and steam, or by hydrostatic pressure. This theory has been very generally adopted, as best accounting for the constant disengagement of large bodies of nitrogen, even where the rocks through which the spring rises are crystalline and unfossiliferous. It will, however, of course be admitted, as Professor Bischoff has pointed out, that in some places organic matter has supplied a large part of the nitrogen evolved.

Carbonic-acid gas is another of the volatilized substances discharged by the Bath waters. Dr. Gustav Bischoff, in the new edition of his valuable work on chemical and physical geology, when speaking of the exhalations of this gas, remarks that they are of universal occurrence, and that they originate at great depths, becoming more abundant the deeper we penetrate. He also observes that, when the silicates which enter so largely into the composition of the oldest rocks are percolated by this gas, they must be continually decomposed, and the carbonates formed by the new combinations thence arising must often augment the volume of the altered rocks. This increase of bulk, he says, must sometimes give rise to a mechanical force of expansion capable of uplifting the incumbent crust of the earth; and the same force may act laterally so as to compress, dislocate, and tilt the strata on each side of a mass in which the new chemical changes are developed. The calculations made by this eminent German chemist of the exact amount of distention which the origin of new mineral products may cause, by adding to the volume of the rocks, deserve the attention of geologists, as affording them aid in explaining those reiterated oscillations of level—those risings and sinkings of land—which have occurred on so grand a scale at successive periods of the past. There are probably many distinct causes of such upward, downward, and lateral movements, and any new suggestion on this head is most welcome; but I believe the expansion and contraction of solid rocks, when they are alternately heated and cooled, and the fusion and subsequent consolidation of mineral masses, will continue to rank, as heretofore, as the most influential causes of such movements.

The temperature of the Bath waters varies in the different springs from 117° to 120° F. This, as before stated, is exceptionally high, when we duly allow for the great distance of Bath from the nearest region of active or recently extinct volcanos and of violent earthquakes. The hot springs of Aix-la-Chapelle have a much higher temperature, viz. 135° F., but they are situated within forty miles of those cones and lava-streams of the Eifel which, though they may have spent their force ages before the earliest records of history, belong, nevertheless, to the most modern geological period. Bath is about 400 miles distant from the same part of Germany, and 440 from Auvergne—another volcanic region, the latest eruptions of which were geologically coëval with those of the Eifel. When these two regions in France and Germany were the theatres of frequent convulsions, we may well suppose that England was often more rudely shaken than now; and such shocks as that of October last, the sound and rocking motion of which caused so great a sensation as it traversed the southern part of the island, and seems to have been particularly violent in Herefordshire, may be only a languid reminder to us of a force of which the energy has been gradually dying out.

If you consult the geological map of the environs of this city, coloured by the Government surveyors, you will perceive that numerous lines of fault or displacement of the rocks are there laid down, and one of these has shifted the strata vertically as much as 200 feet. Mr. Charles Moore pointed out to me last spring, when I had the advantage of examining the geology of this district under his guidance, that there are other lines of displacement not yet laid down on the Ordnance Map, the existence of which must be inferred from the different levels at which the same formations crop out on the flanks of the hills to the north and south of the city. I have therefore little doubt that the Bath springs, like most other thermal waters, mark the site of some great convulsion and fracture which took place in the crust of the earth at some former period—perhaps not a very remote one, geologically speaking. The uppermost part of the rent through which the hot water rises is situated in horizontal strata of Lias and Trias, 300 feet thick; and this may be more modern than the lower part, which passes through the inclined and broken strata of the subjacent coal-measures, which are unconformable to the Trias. The nature and succession of these rocks penetrated by the Bath waters was first made out by the late William Smith in 1817, when a shaft was sunk in the vicinity in search for coal. The shock which opened a communication through the upper rocks may have been of a much later date than that which fractured the older and underlying strata; for there is a tendency in the earth's crust to yield most readily along lines of ancient fracture, which constitute the points of least resistance to a force acting from below.

If we adopt the theory already alluded to, that the nitrogen is derived from the deoxidation of atmospheric air carried down by rain-water, we may imagine the supply of this water to be furnished by some mountainous region, possibly a distant one, and that it descends through rents or porous rocks till it encounters some mass of heated matter by which it is converted into steam, and then driven upwards through a fissure. In its downward passage the water may derive its sulphate of lime, chloride of calcium, and other substances from the decomposition of the gypseous, saline, calcareous, and other constituents of the rocks which it permeates. The greater part of the ingredients are common to sea-water, and might suggest the theory of a marine origin; but the analysis of the Bath springs by Merck and Galloway shows that the relative proportion of the solid matter is far from agreeing with that of the sea, the chloride of magnesium being absolutely in excess, that is, 14 grains of it per gallon for 12 of common salt; whereas in sea-water there are 27 grains of salt, or chloride of sodium, to 4 of the chloride of magnesium. That some mineral springs, however, may derive an inexhaustible supply, through rents and porous rocks, from the leaky bed of the ocean, is by no means an unreasonable theory, especially if we believe that the contiguity of nearly all the active volcanos to the sea is connected with the access of salt water to the subterranean foci of volcanic heat.

Professor Roscoe, of Manchester, has been lately engaged in making a careful analysis of the Bath waters, and has discovered in them three metals which they were not previously known to contain—namely copper, strontium, and lithium; but he has searched in vain for cæsium and rubidium, those new metals, the existence of which has been revealed to us in the course of the last few years by what is called spectrum analysis. By this new method the presence of infinitesimal quantities, such as would have wholly escaped detection by ordinary tests, are made known to the eye by the agency of light. Thus, for example, a solid substance such as the residue obtained by evaporation from a mineral water is introduced on a platinum wire into a colourless gas-flame. The substance thus volatilized imparts its colour to the flame, and the light, being then made to pass through a prism, is viewed through a small telescope or spectroscope, as it is called, by the aid of which one or more bright lines or bands are seen in the spectrum, which, according to their position, number, and colour, indicate the presence of different elementary bodies.

Professor Bunsen, of Heidelberg, led the way, in 1860, in the application of this new test to the hot waters of Baden-Baden and of Dürkheim in the Palatinate. He observed in the spectrum some coloured lines of which he could not interpret the meaning, and was determined not to rest till he had found out what they meant. This was no easy task, for it was necessary to evaporate fifty tons of water to obtain 200 grains of what proved to be two new metals. Taken together, their proportion to the water was only as one to three million. He named the first cæsium, from the bluish-grey lines which it presented in the spectrum; and the second rubidium, from its two red lines. Since these successful experiments were made, thallium, so called from its green line, was discovered in 1861 by Mr. Crookes; and a fourth metal named indium, from its indigo-coloured band, was detected by Professor Richter, of Freiberg, in Saxony in a zinc ore of the Hartz. It is impossible not to suspect that the wonderful efficacy of some mineral springs, both cold and thermal, in curing diseases, which no artificially prepared waters have as yet been able to rival, may be connected with the presence of one or more of these elementary bodies previously unknown; and some of the newly found ingredients, when procured in larger quantities, may furnish medical science with means of combating diseases which have hitherto baffled all human skill.

While I was pursuing my inquiries respecting the Bath waters, I learned casually that a hot spring had been discovered at a great depth in a copper-mine near Redruth in Cornwall, having about as high a temperature as that of the Bath waters, and of which, strange to say, no account has yet been published. It seems that, in the year 1839, a level was driven from an old shaft so as to intersect a rich copper-mine at the depth of 1350 feet from the surface. This lode or metalliferous fissure occurred in what were formerly called the United Mines, and which have since been named the Clifford Amalgamated Mines. Through the contents of the lode a powerful spring of hot water was observed to rise, which has continued to flow with undiminished strength ever since. At my request, Mr. Horton Davey, of Redruth, had the kindness to send up to London many gallons of this water, which have been analyzed by Professor William Allen Miller, F.R.S., who finds that the quantity of solid matter is so great as to exceed by more than four times the proportion of that yielded by the Bath waters. Its composition is also in many respects very different; for it contains but little sulphate of lime, and is almost free from the salts of magnesium. It is rich in the chlorides of calcium and sodium, and it contains one of the new metals—cæsium, never before detected in any mineral spring in England: but its peculiar characteristic is the extraordinary abundance of lithium, of which a mere trace had been found by Professor Roscoe in the Bath waters; whereas in this Cornish hot spring this metal constitutes no less than a twenty-sixth part of the whole of the solid contents, which, as before stated, are so voluminous. When Professor Miller exposed some of these contents to the test of spectrum analysis, he gave me an opportunity of seeing the beautiful bright crimson line which the lithium produces in the spectrum.

Lithium was first made known in 1817 by Arfvedsen, who extracted it from petalite; and it was believed to be extremely rare, until Bunsen and Kirchhoff, in 1860, by means of spectrum analysis, showed that it was a most widely diffused substance, existing in minute quantities in almost all mineral waters and in the sea, as well as in milk, human blood, and the ashes of some plants. It has already been used in medicine, and we may therefore hope that, now that it is obtainable in large quantities, and at a much cheaper rate than before the Wheal-Clifford hot spring was analyzed, it may become of high value. According to a rough estimate which has been sent to me by Mr. Davey, the Wheal-Clifford spring yields no less than 250 gallons per minute, which is almost equal to the discharge of the King's Bath or chief spring of this city. As to the gases emitted, they are the same as those of the Bath water—namely carbonic acid, oxygen, and nitrogen.

Mr. Warington Smyth, who had already visited the Wheal-Clifford lode in 1855, re-examined it in July last, chiefly with the view of replying to several queries which I had put to him; and, in spite of the stifling heat, ascertained the geological structure of the lode and the exact temperature of the water. This last he found to be 122° Fahr. at the depth of 1350 feet; but he scarcely doubts that the thermometer would stand two or three degrees higher at a distance of 200 feet to the eastward, where the water is known to gush up more freely. The Wheal-Clifford lode is a fissure varying in width from 6 to 12 feet, one wall consisting of elvan or porphyritic granite, and the other of killas or clay-slate. Along the line of the rent, which runs east and west, there has been a slight throw or shift of the rocks. The vein-stuff is chiefly formed of cellular pyrites of copper and iron, the porous nature of which allows the hot water to percolate freely through it. It seems, however, that in the continuation upwards of the same fissure little or no metalliferous ore was deposited, but, in its place, quartz and other impermeable substances, which obstructed the course of the hot spring, so as to prevent its flowing out on the surface of the country. It has been always a favourite theory of the miners that the high temperature of this Cornish spring is due to the oxidation of the sulphurets of copper and iron, which are decomposed when air is admitted. That such oxidation must have some slight effect is undeniable; but that it materially influences the temperature of so large a body of water is out of the question. Its effect must be almost insensible; for Professor Miller has scarcely been able to detect any sulphuric acid in the water, and a minute trace only of iron and copper in solution.

When we compare the temperature of the Bath springs, which issue at a level of less than 100 feet above the sea, with the Wheal-Clifford spring found at a depth of 1350 feet from the surface, we must of course make allowance for the increase of heat always experienced when we descend into the interior of the earth. The difference would amount to about 20° Fahr., if we adopt the estimate deduced by Mr. Hopkins from an accurate series of observations made in the Monkwearmouth shaft, near Durham, and in the Dukinfield shaft, near Manchester, each of them 2000 feet in depth. In these shafts the temperature was found to rise at the rate of only 1° Fahr. for every increase of depth of from 65 to 70 feet. But if the Wheal-Clifford spring, instead of being arrested in its upward course, had continued to rise freely through porous and loose materials so as to reach the surface, it would probably not have lost anything approaching to 20° Fahr., since the renewed heat derived from below would have warmed the walls and contents of the lode, so as to raise their temperature above that which would naturally belong to the rocks at corresponding levels on each side of the lode. The almost entire absence of magnesium raises an obvious objection to the hypothesis of this spring deriving its waters from the sea; or if such a source be suggested for the salt and other marine products, we should be under the necessity of supposing the magnesium to be left behind in combination with some of the elements of the decomposed and altered rocks through which the thermal waters may have passed.

Hot springs are, for the most part, charged with alkaline and other highly soluble substances, and, as a rule, are barren of the precious metals, gold, silver, and copper, as well as of tin, platinum, lead, and many others, a slight trace of copper in the Bath waters being exceptional. Nevertheless there is a strong presumption that there exists some relationship between the action of thermal waters and the filling of rents with metallic ores. The component elements of these ores may, in the first instance, rise from great depths in a state of sublimation or of solution in intensely heated water, and may then be precipitated on the walls of a fissure as soon as the ascending vapours or fluids begin to part with some of their heat. Almost everything, save the alkaline metals, silica, and certain gases, may thus be left behind long before the spring reaches the earth's surface. If this theory be adopted, it will follow that the metalliferous portion of a fissure, originally thousands of feet or fathoms deep, will never be exposed in regions accessible to the miner until it has been upheaved by a long series of convulsions, and until the higher parts of the same rent, together with its contents and the rocks which it had traversed, have been removed by aqueous denudation. Ages before such changes are accomplished thermal and mineral springs will have ceased to act; so that the want of identity between the mineral ingredients of hot springs and the contents of metalliferous veins, instead of militating against their intimate relationship, is in favour of both being the complementary results of one and the same natural operation.

But there are other characters in the structure of the earth's crust more mysterious in their nature than the phenomena of metalliferous veins, on which the study of hot springs has thrown light—I allude to the metamorphism of sedimentary rocks. Strata of various ages, many of them once full of organic remains, have been rendered partially or wholly crystalline. It is admitted on all hands that heat has been instrumental in bringing about this re-arrangement of particles, which, when the metamorphism has been carried out to its fullest extent, obliterates all trace of the imbedded fossils. But as mountain-masses many miles in length and breadth, and several thousands of feet in height, have undergone such alteration, it has always been difficult to explain in what manner an amount of heat capable of so entirely changing the molecular condition of sedimentary masses could have come into play without utterly annihilating every sign of stratification, as well as of organic structure.

Various experiments have led to the conclusion that the minerals which enter most largely into the composition of the metamorphic rocks have not been formed by crystallizing from a state of fusion, or in the dry way, but that they have been derived from liquid solutions, or in the wet way—a process requiring a far less intense degree of heat. Thermal springs, charged with carbonic acid and with hydrofluoric acid (which last is often present in small quantities), are powerful causes of decomposition and chemical reaction in rocks through which they percolate. If, therefore, large bodies of hot water permeate mountain-masses at great depths, they may in the course of ages superinduce in them a crystalline structure; and in some cases strata in a lower position and of older date may be comparatively unaltered, retaining their fossil remains undefaced, while newer rocks are rendered metamorphic. This may happen where the waters, after passing upwards for thousands of feet, meet with some obstruction, as in the case of the Wheal-Clifford spring, causing the same to be laterally diverted so as to percolate the surrounding rocks. The efficacy of such hydrothermal action has been admirably illustrated of late years by the experiments and observations of Sénarmont, Daubrée, Delesse, Scheerer, Sorby, Sterry Hunt, and others.

The changes which Daubrée has shown to have been produced by the alkaline waters of Plombières, in the Vosges, are more especially instructive. These thermal waters have a temperature of 160° F., and were conveyed by the Romans to baths through long conduits or aqueducts. The foundations of some of their works consisted of a bed of concrete made of lime, fragments of brick, and sandstone. Through this and other masonry the hot waters have been percolating for centuries, and have given rise to various zeolites—apophyllite and chabazite among others; also to calcareous spar, arragonite, and fluor spar, together with siliceous minerals, such as opal,—all found in the interspaces of the bricks and mortar, or constituting part of their rearranged materials. The quantity of heat brought into action in this instance in the course of 2000 years has, no doubt, been enormous, although the intensity of it developed at any one moment has been always inconsiderable.

The study, of late years, of the constituent parts of granite has in like manner led to the conclusion that their consolidation has taken place at temperatures far below those formerly supposed to be indispensable. Gustav Rose has pointed out that the quartz of granite has the specific gravity of 2·6, which characterizes silica when it is precipitated from a liquid solvent, and not that inferior density, namely 2·3, which belongs to it when it cools and solidifies in the dry way from a state of fusion.

But some geologists, when made aware of the intervention on a large scale, of water, in the formation of the component minerals of the granitic and volcanic rocks, appear of late years to have been too much disposed to dispense with intense heat when accounting for the formation of the crystalline and unstratified rocks. As water in a state of solid combination enters largely into the aluminous and some other minerals, and therefore plays no small part in the composition of the earth's crust, it follows that, when rocks are melted, water must be present, independently of the supplies of rain-water and sea-water which find their way into the regions of subterranean heat. But the existence of water under great pressure affords no argument against our attributing an excessively high temperature to the mass with which it is mixed up. Still less does the point to which the melted matter must be cooled down before it consolidates or crystallizes into lava or granite afford any test of the degree of heat which the same matter must have acquired when it was melted and made to form lakes and seas in the interior of the earth's crust.

We learn from Bunsen's experiments on the Great Geyser in Iceland, that at the depth of only seventy-four feet, at the bottom of the tube, a column of water may be in a state of rest, and yet possess a heat of 120° Centigrade, or 248° F. What, then, may not the temperature of such water be at the depth of a few thousand feet? It might soon attain a white heat under pressure; and as to lava, they who have beheld it issue, as I did in 1858, from the south-western flanks of Vesuvius, with a surface white and glowing like that of the sun, and who have felt the scorching heat which it radiates, will form a high conception of the intense temperature of the same lava at the bottom of a vertical column several miles high, and communicating with a great reservoir of fused matter, which, if it were to begin at once to cool down, and were never to receive future accessions of heat, might require a whole geological period before it solidified. Of such slow refrigeration hot springs may be among the most effective instruments, abstracting slowly from the subterranean molten mass that heat which clouds of vapour are seen to carry off in a latent form from a volcanic crater during an eruption, or from a lava-stream during its solidification. It is more than forty years since Mr. Scrope, in his work on volcanos, insisted on the important part which water plays in an eruption, when intimately mixed up with the component materials of lava, aiding, as he supposed, in giving mobility to the more solid materials of the fluid mass. But when advocating this igneo-aqueous theory, he never dreamt of impugning the Huttonian doctrine as to the intensity of heat which the production of the unstratified rocks, those of the plutonic class especially, implies.

The exact nature of the chemical changes which hydrothermal action may effect in the earth's interior will long remain obscure to us, because the regions where they take place are inaccessible to man; but the manner in which volcanos have shifted their position throughout a vast series of geological epochs—becoming extinct in one region and breaking out in another—may, perhaps, explain the increase of heat as we descend towards the interior, without the necessity of our appealing to an original central heat or the igneous fluidity of the earth's nucleus.

I hinted, at the beginning of this Address, that the hot springs of Bath may be of no high antiquity, geologically speaking,—not that I can establish this opinion by any positive proofs, but I infer it from the mighty changes which this region has undergone since the time when the British seas, rivers, and lakes were inhabited by the existing species of Testacea. It is already more than a quarter of a century since Sir Roderick Murchison first spoke of the Malvern Straits, meaning thereby a channel of the sea which once separated Wales from England. That such marine straits really extended, at a modern period, between what are now the estuaries of the Severn and the Dee has been lately confirmed in a satisfactory manner by the discovery of marine shells of recent species in drift covering the watershed which divides those estuaries. At the time when these shells were living, the Cotswold Hills, at the foot of which this city is built, formed one of the numerous islands of an archipelago into which England, Ireland, and Scotland were then divided. The amount of vertical movement which would be necessary to restore such a state of the surface as prevailed when the position of land and sea were so different would be very great.

Nowhere in the world, according to our present information, is the evidence of upheaval, as manifested by upraised marine shells, so striking as in Wales. In that country Mr. Trimmer first pointed out, in 1831, the occurrence of fossil shells in stratified drift, at the top of a hill called Moel Tryfaen, near the Menai Straits, and not far from the base of Snowdon. I visited the spot last year, in company with my friend Mr. Symonds, and we collected there not a few of the marine Testacea. Mr. Darbishire has obtained from the same drift no less than fifty-four fossil species, all of them now living either in high northern or British seas, and eleven of them being exclusively arctic. The whole fauna bears testimony to a climate colder than that now experienced in these latitudes, though not to such extreme cold as that implied by the fauna of some of the glacial drift of Scotland. The shells alluded to were procured at the extraordinary height of 1360 feet above the sea-level, and they demonstrate an upheaval of the bed of the sea to that amount in the time of the living Testacea. A considerable part of what is called the glacial epoch had already elapsed before the shelly strata in question were deposited on Moel Tryfaen, as we may infer from the polished and striated surfaces of rocks on which the drift rests, and the occurrence of erratic blocks smoothed and scratched, at the bottom of the same drift.

The evidence of a period of great cold in England and North America, in the times referred to, is now so universally admitted by geologists, that I shall take it for granted in this Address, and briefly consider what may have been the probable causes of the refrigeration of central Europe at the era in question. One of these causes, first suggested eleven years ago by a celebrated Swiss geologist, has not, I think, received the attention which it well deserved. When I proposed, in 1833, the theory that alterations in physical geography might have given rise to those revolutions in climate which the earth's surface has experienced at successive epochs, it was objected by many that the signs of upheaval and depression were too local to account for such general changes of temperature. This objection was thought to be of peculiar weight when applied to the glacial period, because of the shortness of the time, geologically speaking, which has since transpired. But the more we examine the monuments of the ages which preceded the historical, the more decided become the proofs of a general alteration in the position, depth, and height of seas, continents, and mountain-chains since the commencement of the glacial period. The meteorologist also has been learning of late years that the quantity of ice and snow in certain latitudes depends not merely on the height of mountain-chains, but also on the distribution of the surrounding sea and land even to considerable distances.

M. Escher von der Linth gave it as his opinion in 1852, that if it were true, as Ritter had suggested, that the great African desert, or Sahara, was submerged within the modern or post-tertiary period, that same submergence might explain why the Alpine glaciers had attained so recently those colossal dimensions which, reasoning on geological data, Venetz and Charpentier had assigned to them. Since Escher first threw out this hint, the fact that the Sahara was really covered by the sea at no distant period has been confirmed by many new proofs. The distinguished Swiss geologist himself has just returned from an exploring expedition through the eastern part of the Algerian desert, in which he was accompanied by M. Desor, of Neuchatel, and Professor Martins, of Montpellier. These three experienced observers satisfied themselves, during the last winter, that the Sahara was under water during the period of the living species of Testacea. We had already learnt in 1856, from a memoir by M. Charles Laurent, that sands identical with those of the nearest shores of the Mediterranean, and containing, among other recent shells, the common cockle (*Cardium edule*), extend over a vast space from west to east in the desert, being not only found on the surface, but also brought up from depths of more than 20 feet by the Artesian auger. These shells have been met with at heights of more than 900 feet above the sea-level, and on ground sunk 300 feet below it; for there are in Africa, as in Western Asia, depressions of land below the level of the sea. The same cockle has been observed still living in several salt-lakes in the Sahara; and superficial incrustations of salt in many places seem to point to the drying up by evaporation of several inland seas in certain districts.

Mr. Tristram, in his travels in 1859, traced for many miles along the southern borders of the French possessions in Africa lines of inland sea-cliffs, with caves at their bases, and old sea-beaches forming successive terraces, in which recent shells and the casts of them were agglutinated together with sand and pebbles, the whole having the form of a conglomerate. The ancient sea appears once to have stretched from the Gulf of Cabes, in Tunis, to the west coast of Africa north of Senegambia, having a width of several hundred (perhaps where greatest, according to Mr. Tristram, 800) miles. The high lands of Barbary, including Morocco, Algeria, and Tunis, must have been separated at this period from the rest of Africa by a sea. All that we have learnt from zoologists and botanists in regard to the present fauna and flora of Barbary favours this hypothesis, and seems at the same time to point to a former connexion of that country with Spain, Sicily, and South Italy.

When speculating on these changes, we may call to mind that certain deposits, full of marine shells of living species, have long been known as fringing the borders of the Red Sea, and rising several hundred feet above its shores. Evidence has also been obtained that Egypt, placed between the Red Sea and the Sahara, participated in these great continental movements. This may be inferred from the old river-terraces, lately described by Messrs. Adams and Murie, which skirt the modern alluvial plains of the Nile, and rise above them to various heights, from 30 to 100 feet and upwards. In whatever direction, therefore, we look, we see grounds for assuming that a map of Africa in the glacial period would no more resemble our present maps of that continent than Europe now resembles North America. If, then, argues Escher, the Sahara was a sea in post-tertiary times, we may understand why the Alpine glaciers formerly attained such gigantic dimensions, and why they have left moraines of such magnitude on the plains of northern Italy and the lower country of Switzerland. The Swiss peasants have a saying, when they talk of the melting of the snow, that the sun could do nothing without the Föhn, a name which they give to the well-known sirocco. This wind, after sweeping over a wide expanse of parched and burning sand in Africa, blows occasionally for days in succession across the Mediterranean, carrying with it the scorching heat of the Sahara to melt the snows of the Apennines and Alps.

M. Denzler, in a memoir on this subject, observes that the Föhn blew tempestuously at Algiers on the 17th of July 1841, and then crossing the Mediterranean, reached Marseilles in six hours. In five more hours it was at Geneva and the Valais, throwing down a large extent of forest in the latter district, while in the cantons of Zurich and the Grisons it suddenly turned the leaves of many trees from green to yellow. In a few hours new-mown grass was dried and ready for the haystack; for although in passing over the Alpine snows, the sirocco absorbs much moisture, it is still far below the point of saturation when it reaches the sub-Alpine country to the north of the great chain. MM. Escher and Denzler have both of them observed on different occasions that a thickness of one foot of snow has disappeared in four hours during the prevalence of this wind. No wonder, therefore, that the Föhn is much dreaded for the sudden inundations which it sometimes causes. The snow-line of the Alps was seen by Mr. Irscher, the astronomer, from his observatory at Neuchatel, by aid of the telescope, to rise sensibly every day while this wind was blowing. Its influence is by no means confined to the summer season, for in the winter of 1852 it visited Zurich at Christmas, and in a few days all the surrounding country was stripped of its snow, even in the shadiest places and on the crests of high ridges. I feel the better able to appreciate the power of this wind from having myself witnessed in Sicily, in 1828, its effect in dissolving, in the month of November, the snows which then covered the summit and higher parts of Mount Etna. I had been told that I should be unable to ascend to the top of the highest cone till the following spring; but in thirty-six hours the hot breath of the sirocco stripped off from the mountain its white mantle of snow, and I ascended without difficulty.

It is well known that the number of days during which particular winds prevail, from year to year, varies considerably. Between the years 1812 and 1820 the Föhn was less felt in Switzerland than usual; and what was the consequence? All the glaciers, during those eight or nine years, increased in height, and crept down below their former limits in their respective valleys. Many similar examples might be cited of the sensitiveness of the ice to slight variations of temperature. Captain Godwin-Austen has lately given us a description of the gigantic glaciers of the western Himalaya in those valleys where the sources of the Indus rise, between the latitudes 35° and 36° N. The highest peaks of the Karakorum range attain in that region an elevation of 28,000 feet above the sea. The glaciers, says Captain Austen, have been advancing, within the memory of the living inhabitants, so as greatly to encroach on the cultivated lands, and have so altered the climate of the adjoining valleys immediately below, that only one crop a year can now be reaped from fields which formerly yielded two crops. If such changes can be experienced in less than a century, without any perceptible modification in the physical geography of that part of Asia, what mighty effects may we not imagine the submergence of the Sahara to have produced in adding to the size of the Alpine glaciers? If, between the years 1812 and 1820, a mere diminution of the number of days during which the sirocco blew could so much promote the growth and onward movement of the ice, how much greater a change would result from the total cessation of the same wind! But this would give no idea of what must have happened in the glacial period; for we cannot suppose the action of the south wind to have been suspended: it was not in abeyance, but its character was entirely different, and of an opposite nature, under the altered geographical conditions above contemplated. First, instead of passing over a parched and scorching desert, between the twentieth and thirty-fifth parallels of latitude, it would plentifully absorb moisture from a sea many hundreds of miles wide. Next, in its course over the Mediterranean, it would take up still more aqueous vapour; and when, after complete saturation, it struck the Alps, it would be driven up into the higher and more rarefied regions of the atmosphere. There the aërial current, as fast as it was cooled, would discharge its aqueous burden in the form of snow, so that the same wind which is now called "the devourer of ice" would become its principal feeder.

If we thus embrace Escher's theory, as accounting in no small degree for the vast size of the extinct glaciers of Switzerland and Northern Italy, we are by no means debarred from accepting at the same time Charpentier's suggestion, that the Alps in the glacial period were 2000 or 3000 feet higher than they are now. Such a difference in altitude may have been an auxiliary cause of the extreme cold, and seems the more probable now that we have obtained unequivocal proofs of such great oscillations of level in Wales within the period under consideration. We may also avail ourselves of another source of refrigeration which may have coincided in time with the submergence of the Sahara, namely, the diversion of the Gulf-stream from its present course. The shape of Europe and North America, or the boundaries of sea and land, departed so widely in the glacial period from those now established, that we cannot suppose the Gulf-stream to have taken at that period its present north-eastern course across the Atlantic. If it took some other direction, the climate of the north of Scotland would, according to the calculations of Mr. Hopkins, suffer a diminution in its average annual temperature of 12° F., while that of the Alps would lose 2° F. A combination of all the conditions above enumerated would certainly be attended with so great a revolution in climate as might go far to account for the excessive cold which was developed at so modern a period in the earth's history. But even when we assume all three of them to have been simultaneously in action, we have by no means exhausted all the resources which a difference in the geographical condition of the globe might supply. Thus, for example, to name only one of them, we might suppose that the height and quantity of land near the north pole was greater at the era in question than it is now.

The vast mechanical force that ice exerted in the glacial period has been thought by some to demonstrate a want of uniformity in the amount of energy which the same natural cause may put forth at two successive epochs. But we must be careful, when thus reasoning, to bear in mind that the power of ice is here substituted for that of running water. The one becomes a mighty agent in transporting huge erratics, and in scoring, abrading, and polishing rocks; but meanwhile the other is in abeyance. When, for example, the ancient Rhone glacier conveyed its moraines from the upper to the lower end of the Lake of Geneva, there was no great river, as there now is, forming a delta many miles in extent, and several hundred feet in depth, at the upper end of the lake.

The more we study and comprehend the geographical changes of the glacial period, and the migrations of animals and plants to which it gave rise, the higher our conceptions are raised of the duration of that subdivision of time, which, though vast when measured by the succession of events comprised in it, was brief, if estimated by the ordinary rules of geological classification. The glacial period was, in fact, a mere episode in one of the great epochs of the earth's history; for the inhabitants of the lands and seas, before and after the grand development of snow and ice, were nearly the same. As yet we have no satisfactory proof that man existed in Europe or elsewhere during the period of extreme cold; but our investigations on this head are still in their infancy. In an early portion of the postglacial period it has been ascertained that man flourished in Europe; and in tracing the signs of his existence, from the historical ages to those immediately antecedent, and so backward into more ancient times, we gradually approach a dissimilar geographical state of things, when the climate was colder, and when the configuration of the surface departed considerably from that which now prevails.

Archæologists are satisfied that in central Europe the age of bronze weapons preceded the Roman invasion of Switzerland; and prior to the Swiss-lake dwellings of the bronze age were those in which stone weapons alone were used. The Danish kitchen-middens seem to have been of about the same date; but what M. Lartet has called the reindeer period of the South of France was probably anterior, and connected with a somewhat colder climate. Of still higher antiquity was that age of ruder implements of stone such as were buried in the fluviatile drift of Amiens and Abbeville, and which were mingled in the same gravel with the bones of extinct quadrupeds, such as the elephant, rhinoceros, bear, tiger, and hyæna. Between the present era and that of those earliest vestiges yet discovered of our race, valleys have been deepened and widened, the course of subterranean rivers which once flowed through caverns has been changed, and many species of wild quadrupeds have disappeared. The bed of the sea, moreover, has in the same ages been lifted up, in many places hundreds of feet, above its former level, and the outlines of many a coast entirely altered.

MM. de Verneuil and Louis Lartet have recently found, near Madrid, fossil teeth of the African elephant, in old valley-drift, containing flint implements of the same antique type as those of Amiens and Abbeville. Proof of the same elephant having inhabited Sicily in the Postpliocene and probably within the Human period had previously been brought to light by Baron Anca, during his exploration of the bone-caves of Palermo. We have now, therefore, evidence of man having co-existed in Europe with three species of elephant, two of them extinct (namely, the mammoth and the *Elephas antiquus*), and a third the same as that which still survives in Africa. As to the first of these—the mammoth—I am aware that some writers contend that it could not have died out many tens of thousands of years before our time, because its flesh has been found preserved in ice, in Siberia, in so fresh a state as to serve as food for dogs, bears, and wolves; but this argument seems to me fallacious. Middendorf, in 1843, after digging through some thickness of frozen soil in Siberia, came down upon an icy mass, in which the carcase of a mammoth was imbedded, so perfect that, among other parts, the pupil of its eye was taken out, and is now preserved in the Museum of Moscow. No one will deny that this elephant had lain for several thousand years in its icy envelope; and if it had been left undisturbed, and the cold had gone on increasing, for myriads of centuries, we might reasonably expect that the frozen flesh might continue undecayed until a second glacial period had passed away.

When speculations on the long series of events which occurred in the glacial and postglacial periods are indulged in, the imagination is apt to take alarm at the immensity of the time required to interpret the monuments of these ages, all referable to the era of existing species. In order to abridge the number of centuries which would otherwise be indispensable, a disposition is shown by many to magnify the rate of change in prehistoric times, by investing the causes which have modified the animate and inanimate world with extraordinary and excessive energy. It is related of a great Irish orator of our day, that when he was about to contribute somewhat parsimoniously towards a public charity, he was persuaded by a friend to make a more liberal donation. In doing so he apologized for his first apparent want of generosity, by saying that his early life had been a constant struggle with scanty means, and that "they who are born to affluence cannot easily imagine how long a time it takes to get the chill of poverty out of one's bones." In like manner, we of the living generation, when called upon to make grants of thousands of centuries in order to explain the events of what is called the modern period, shrink naturally at first from making what seems so lavish an expenditure of past time. Throughout our early education we have been accustomed to such strict economy in all that relates to the chronology of the earth and its inhabitants in remote ages, so fettered have we been by old traditional beliefs, that even when our reason is convinced, and we are persuaded that we ought to make more liberal grants of time to the geologist, we feel how hard it is to get the chill of poverty out of our bones.

I will now briefly allude, in conclusion, to two points on which a gradual change of opinion has been taking place among geologists of late years. First, as to whether there has been a continuous succession of events in the organic and inorganic worlds, uninterrupted by violent and general catastrophes; and secondly, whether clear evidence can be obtained of a period antecedent to the creation of organic beings on the earth. I am old enough to remember when geologists dogmatized on both these questions in a manner very different from that in which they would now venture to indulge. I believe that by far the greater number now incline to opposite views from those which were once most commonly entertained. On the first point it is worthy of remark that although a belief in sudden and general convulsions has been losing ground, as also the doctrine of abrupt transitions from one set of species of animals and plants to another of a very different type, yet the whole series of the records which have been handed down to us are now more than ever regarded as fragmentary. They ought to be looked upon as more perfect, because numerous gaps have been filled up, and in the formations newly intercalated in the series we have found many missing links and various intermediate gradations between the nearest allied forms previously known in the animal and vegetable worlds. Yet the whole body of monuments which we are endeavouring to decipher appears more defective than before. For my own part, I agree with Mr. Darwin in considering them as a mere fraction of those which have once existed, while no approach to a perfect series was ever formed originally, it having never been part of the plan of Nature to leave a complete record of all her works and operations for the enlightenment of rational beings who might study them in after-ages.

In reference to the other great question, or the earliest date of vital phenomena on this planet, the late discoveries in Canada have at least demonstrated that certain theories founded in Europe on mere negative evidence were altogether delusive. In the course of a geological survey, carried on under the able direction of Sir William E. Logan, it has been shown that northward of the river St. Lawrence there is a vast series of stratified and crystalline rocks of gneiss, mica-schist, quartzite, and limestone, about 40,000 feet in thickness, which have been called Laurentian. They are more ancient than the oldest fossiliferous strata of Europe, or those to which the term primordial had been rashly assigned. In the first place, the newest part of this great crystalline series is unconformable to the ancient fossiliferous or so-called primordial rocks which overlie it; so that it must have undergone disturbing movements before the latter or primordial set were formed. Then again, the older half of the Laurentian series is unconformable to the newer portion of the same. It is in this lowest and most ancient system of crystalline strata that a limestone, about a thousand feet thick, has been observed, containing organic remains. These fossils have been examined by Dr. Dawson, of Montreal, and he has detected in them, by aid of the microscope, the distinct structure of a large species of Rhizopod. Fine specimens of this fossil, called *Eozoon Canadense,* have been brought to Bath by Sir William Logan, to be exhibited to the members of the Association. We have every reason to suppose that the rocks in which these animal remains are included are of as old a date as any of the formations named azoic in Europe, if not older, so that they preceded in date rocks once supposed to have been formed before any organic beings had been created.

But I will not venture on speculations respecting "the signs of a beginning," or "the prospects of an end," of our terrestrial system—that wide ocean of scientific conjecture on which so many theorists before my time have suffered shipwreck. Without trespassing longer on your time, I will conclude by expressing to you my thanks for the honour you have done me in asking me to preside over this Meeting. I have every reason to hope, from the many members and distinguished strangers whom I already see assembled here, that it will not be inferior in interest to any of the gatherings which have preceded it.

REPORTS

ON

THE STATE OF SCIENCE.

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Report on Observations of Luminous Meteors, 1863–64. *By a Committee, consisting of* James Glaisher, *F.R.S., of the Royal Observatory, Greenwich, Secretary to the British Meteorological Society, &c.;* Robert P. Greg, *F.G.S., &c.;* E. W. Brayley, *F.R.S., &c.; and* Alexander S. Herschel, *B.A.*

In presenting this Report, the Committee have the satisfaction to point out among the observations of luminous meteors contributed by Members of the Association and by others during the past year, an unusual number of the larger class, or fireballs. The largest of these, seen upon the 5th of December, 1863, produced the vivid impression of lightning over the whole area of the British isles. The magnitudes of three fireballs seen at Paris on the 6th of June, and 6th and 9th of August 1864, are therefore greatly underrated, because the first of these, recorded of the first class, is rated only six times brighter than Venus. The light of full-moon is, on the contrary, at least 1300 times greater than the light of Venus.

Many of the observations in the present Catalogue refer particularly to the radiant-points of meteors. This inquiry should be promoted with the aid of maps especially provided for the purpose. Essential service may be rendered by observations recorded upon maps, because these accumulate from year to year until the observations appeal together to the eye, more correctly than a meteoric shower would do observed without their aid.

Radiant-points were determined on the 30th November, 12th December (1863), and on the 2nd January, 10th, 13th, and 20th April (1864), with plane perspective maps, which it is feared would otherwise have escaped attention. The number of radiant-points that yet remain to be determined appears to be strictly measured by the zeal of the observers. Mr. R. P. Greg indicates between twenty and thirty radiant-points as giving rise to the greater proportion of shooting-stars observed throughout the year (see Appendix), and Professor Heis, of Münster, has supplied a similar list for the use of observers, in the Monthly Notices of the Astronomical Society*. That a radiant-point

* Vol. xxiv. p. 214.

should not, before the present Report, have been assigned to the meteors of the 10th of April, appears the more remarkable, as this date was noticed in his Catalogue of fireballs by Baumhauer in 1845, and by Wolf in 1856; and astronomers have been aware for more than thirty years, that when meteors are periodical, they invariably take their directions from a fixed perspective

A CATALOGUE OF OBSERVATIONS

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1863.	h m					
Jan. 30	6 0 p.m.	Bannockburn (Stirling).	Large	Red	A few seconds	South ....
Feb. 7	6 0 p.m.	Milton Mills (two miles south of Stirling).	....	....	A few seconds	N.E., altitude 45°..
Mar. 12	1 0 a.m.	Island of Rhodes (Mediterranean).	Magnificent bolide	....	....	Burst over the island of Rhodes.
17	7 0 p.m.	Ibid	Bolide	....	....	....
June 10	9 26 p.m.	Brading (Isle of Wight).	Very much > ♃...	White	....	From a few degrees E. of ♃, halfway to the horizon.
Aug. 10	10 40 p.m. to 11 20 p.m.	Fairlight (Hastings).	Many almost = Venus. Others quite small.	....	....	Those in N.E. were short (1° or 2°) and faint, but left trains.
10	About 9 p.m.	Eddystone Rock (English Channel).	= ♃	....	....	Shot directly across α Lyræ.
12	10 55 p.m.	Euston Road (London).	$=3\frac{1}{2}$ mag.*	....	....	From near ε Herculis.
12	11 5 p.m.	Ibid	=2nd mag.*	....	1 second	From 2° W. of β Cygni to near γ Aquilæ.
12	11 39 p.m.	Ibid	=1st mag.*	....	....	From 4° above Polaris to $1\frac{1}{2}$° above δ Ursæ Majoris.
14	9 58 p.m.	Trafalgar Square (London).	=2nd mag.*	Orange colour	0·8 second ...	Passed above α Pegasi from R. A. $328\frac{1}{2}$°, N. Decl. $20\frac{1}{2}$° to R. A. 346°, N. Decl. $15\frac{1}{2}$°.
15	9 55 p.m.	Ibid	=2nd mag.*	Bluish	0·3 second ...	From 2° W. of ζ Herculis to α Coronæ.
15	10 30 p.m.	Ibid	=3rd mag.*	Bluish	0·5 second ...	Passed below α Andromedæ from R. A. 354°, N. Decl. 30° to R.A. 3°, N. Decl. $19\frac{1}{2}$°.
16	9 23 p.m.	Sheffield	=Venus at greatest brightness.	White	....	From 3° E. of γ Delphini to ρ Antinoï.

point, which is called their "Radiant-point." The near approach of the November display of meteors in 1866 (see Appendix), makes it desirable that astronomers should note the radiant-points of shooting-stars, in order that, if any exists (from distant latitudes and longitudes), the parallax should be detected, and meteors may thus be referred to their true causes.

OF LUMINOUS METEORS.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Like red-hot cinders falling from the grate of a coal fire.	....	Perpendicular	Left a train	Mrs. Hood.
A fiery dragon with a long tail. Left a train.	....	Inclined	A kite in Scotland is called a 'dragon.'	J. MacOwen.
Detonated like a bomb ...	....	....	After its disappearance two fresh detonations were heard, followed by a prolonged humming sound.	Communicated by R. P. Greg.
Burst	....	....	No noise heard	Id.
Flashed among stormy clouds, looking very close.	....	Fell downwards in a vertical line from Arcturus.	....	W. Airy.
Upwards of 30 falling stars in 40 minutes.	....	Came from a dark part N. of the north end of the Milky Way.	....	J. Rock, Jun.
Numbers of bright shooting-stars about the same time.	....	Directed from Camelopardalus.	....	F. Howlett.
No train or sparks	10°	Towards ϵ Aquilæ	Cloudy before this time	T. Crumplen.
No train or sparks	....	....	....	Id.
No train or sparks	....	....	....	Id.
Left a train for $2\frac{1}{2}$ seconds..	18°	....	....	Id.
....	14°	....	....	Id.
....	13°	....	....	Id.
A brilliant globular meteor	....	....	....	T. Slater.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1863.	h m					
Aug. 24	8 29 p.m.	Euston Road (London).	=Venus	Orange colour	1·5 second ...	From π, 27 Pegasi to ν Cygni and 2° further.
27	7 45 p.m.	Hawkhurst (Kent).	=♃	White	0·6 second ...	From $\frac{2}{5}$ to $\frac{3}{5}$ of the distance, reckoned from h Pegasi to θ Piscium.
29	8 0 p.m.	Ibid	Three diameters of Venus.	White	2 seconds......	From d Can. Venat. to 16° above the horizon (measured).
31	10 5 p.m.	Weston - super - Mare.	=2nd mag.*	Blue	1½ second ...	From σ Andromedæ to β Persei.
Sept. 1	8 22 p.m.	Hawkhurst (Kent).	=♃	White	1·2 sec.; slow	From 1° above χ, halfway to σ Sagittarii.
4	9 35 p.m.	Trafalgar Square (London).	=2½ mag.*	White	0·5 second ...	From near β Cygni to ζ Aquilæ.
4	9 48 p.m.	Ibid	=3½ mag.*	White	0·5 second ...	From 3° or 4° above α, β Arietis.
4	10 13 p.m.	Ibid	=2nd mag.*	Ruddy	0·7 second ...	From midway between α, δ Herculis to ϵ Coronæ.
5	9 55 p.m.	Ibid	=1st mag.*	Brilliant white	....	From ½ (p Camelopardali, b Lyncis) to $\frac{2}{5}$ (π, ι) Ursæ Majoris.
5	9 56 p.m.	Wisbech (Cambridgeshire).	>1st mag.*	White	1¼ second......	From ω Cassiopeiæ to ⅓ (N, P Camelopardali).
5	10 5 p.m.	Trafalgar Square (London).	=2nd mag.*	Dull red	1 second	From α Coronæ to 2° below λ Serpentis.
6	11 0 p.m.	Hawkhurst (Kent).	=2nd mag.*	Yellow, then red.	1·2 second ...	From ½ (ϵ, ζ) Ursæ Minoris to 3° below Polaris.
7	9 28 p.m.	Weston - super - Mare.	=2nd mag.*	Bluish white...	1½ second ...	From λ Draconis to h Ursæ Majoris.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Left a spangled train for 1½ second 8° in length. Head pear-shaped, with sparks and aura, bright before and dull behind.	....		See sketch	T. Crumplen.
Slightly pear-shaped; no train or sparks.	....	....	View of the meteor impaired by clouds, twilight and moonlight.	A. S. Herschel.
Globular; left no train ...	....	Fell vertically	....	T. Humphrey.
....	....	....	Bright moonlight	W. H. Wood.
A short path connected with a flash by a few red sparks. 	4°	Almost horizontal	The meteor reappeared with a flash, after disappearing for ½°.	A. S. Herschel.
....	15°	Almost perpendicular...	....	T. Crumplen.
Left a dull train 3° or 4° in length.	20°	Horizontal towards β Persei.	....	Id.
Left a train 5° in length...	18°	Curved path. Convex towards ϵ, ζ Herculis.	....	Id.
Left no train	....		Corresponds to Wisbech, 9h 56m p.m. (See Appendix I.)	Id.
....	25°	....	On the 9th, 20th, and 21st Sept., shooting-stars were plentiful (7 or 8 per hour).	S. H. Miller.
Left a dull train on the whole of its course.	30°	Inclined towards the W.S.W. horizon.	View interrupted by buildings.	T. Crumplen.
Left no train; slight tail of sparks.	....	One radiant-point at κ Cephei, another in Musca.	....	A. S. Herschel.
....	....	....	....	W. H. Wood.

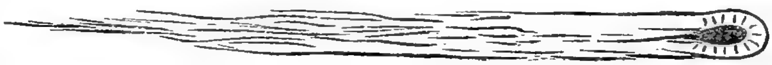
Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1863. Sept. 7	h m s 11 18 p.m.	Trafalgar Square (London).	=3rd mag.*	Dull white ...	0·4 second ...	From near A Draconis to near η Ursæ Majoris.
7	11 18 20 p.m.	Ibid	= $1\frac{1}{2}$ mag.*	Bluish	0·3 second ...	From between η and ζ Draconis to very near π Herculis.
7	11 21 p.m.	Ibid	=1st mag.*........	White	Very brief ...	Between β and γ Draconis; imperfect view.
7	11 30 p.m.	Weston - super - Mare.	=3rd mag.*	Blue	$2\frac{1}{2}$ seconds; slow.	From head of Camelopardalus to $\frac{1}{2}$ (h, α) Ursæ Majoris.
9	Disappearance 8 26 38 p.m.	Beeston Observatory (Nottingham).	= 2nd mag.*, increasing by impulses to one-third diameter of the moon.	Yellow	6 seconds (17° per second).	From $\frac{1}{2}$ (α, τ) Aquilæ to 1° 30′ above Arcturus.
10	8 51 p.m.	Weston - super - Mare.	=1st mag.*.........	Blue	1 second	From σ Aquilæ to a point in R. A. 286°, S. Decl. 6°.
11	8 45 p.m.	Queenstown (Ireland).	Large and brilliant meteor.	....	Very rapid speed.	Advanced from S.W., and disappeared S.E.
13	7 21 p.m.	Hawkhurst (Kent).	= 3 diameters of Venus.	White	1 second	From $\frac{1}{2}$ (δ, ε) Ursæ Minoris to $\frac{1}{2}$ (α, β) Ursæ Majoris.
16	10 53 p.m.	Euston Road (London).	=Capella...........	Vivid bluish white, then ruddy and dull.	0·8 second ...	From χ Persei to a point R. A. 103°, N. Decl. $54\frac{1}{2}$°.
17	9 11 p.m.	Wisbech (Cambridgeshire).	>1st mag.*	Yellow	....	From ι Lyræ to 17 Draconis.
17	9 17 p.m.	Ibid	>1st mag.*	White	....	From φ Persei to η Tarandi.
17	9 24 p.m.	Euston Road (London).	= $2\frac{1}{2}$ mag.*	White	0·5 second ...	From δ to η Aquilæ
17	9 43 p.m.	Wisbech (Cambridgeshire).	>1st mag.*	....	2 seconds......	From ψ Cassiopeiæ to head of Cepheus.
17	10 7 p.m.	Euston Road (London).	= $3\frac{1}{2}$ mag.*	White	0·5 second ...	From $\frac{1}{2}$ (β, κ) Cassiopeiæ to γ Andromedæ.
20	8 35 p.m.	Wisbech (Cambridgeshire).	>1st mag.*	White	2 seconds......	From φ across θ Andromedæ and as far again.
20	10 1 p.m.	Trafalgar Square (London).	= $2\frac{1}{2}$ mag.*	White	0·5 second ...	A few degrees below α Persei.
21	1 50 a.m.	Coast-guard Station, Camber (Hastings).	Large meteor	Reddish white	....	Moved horizontally at a low altitude.
Oct. 4	7 35 p.m.	Wisbech (Cambridgeshire).	=1st mag.*	Yellow	2 seconds......	From φ Persei to η Piscium.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Left a train on the greater part of its course.	30°	Almost perpendicularly down.	The train was apparently distinct from the head.	T. Crumplen.
Left a train 5° in length...	20°	From right to left, inclined a little downwards.	....	Id.
Left a train upon the whole visible course.	5°...........	....	Termination only seen...	Id.
Intermittent light	....	....	....	W. H. Wood.
Left a train of lingering sparks for two or three seconds, 35° in length. Head kite-shaped; brightest in front; disappeared suddenly.	102°........	....	....	E. J. Lowe.
....	....	....	....	W. H. Wood.
When the meteor crossed the harbour, the body split up into three parts.	....	The parts traversed the sky rapidly towards the E.	Lit up the harbour with a brightness almost equal to day.	'Cork Examiner.'
Left no train	....	....	View interrupted by clouds. Twilight.	Communicated by A. S. Herschel.
Left a train 10° in length, which faded gradually. Threw off a few sparks.	35°	....	A fine meteor	T. Crumplen.
....	....	....	....	S. H. Miller.
....	....	....	....	S. H. Miller.
Left a train 5° in length...	7°...........	Almost horizontal	Faint clouds obscured the sky.	T. Crumplen.
....	....	....	....	S. H. Miller.
Left a train upon its whole course.	....	A few degrees to right from perpendicular; down.	....	T. Crumplen.
....	....	....	....	S. H. Miller.
Left a train 10° in length, as observed by an opera-glass.	....	....	....	T. Crumplen.
Had all the appearance of a rocket as to sparks, &c., but on a much larger scale.	....	S.W. to N.E.	....	T. Webb (communicated by F. W. Gough).
....	....	....	....	S. H. Miller.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1863.	h m s					
Oct. 4	7 41 p.m.	Wisbech (Cambridgeshire).	=1st mag.*	Yellow	$1\frac{1}{2}$ second ...	From θ Cassiopeiæ to π Persei.
4	9 23 p.m.	Weston-super-Mare.	=1st mag.*	Bluish white...	1 second ...	From (21) to (28) Lyncis.
5	9 57 p.m.	Beeston Observatory (Nottingham).	=2nd mag.*	Yellow, not bright.	Rapid	From midway between Corona Borealis and Vega coming from the direction of the cluster in Perseus.
5	9 59 p.m.	Ibid	=2nd mag.*	Yellow	Rapid	Another from the same direction; moved along the Great Bear about 1° above the principal upper stars.
9	6 2 p.m.	Greenwich Observatory.	Bright	....	Momentary ...	In the E., passed across α Andromedæ.
9	8 5 p.m.	Weston-super-Mare.	=2nd mag.*	Blue	1 second	From η Andromedæ to β Arietis.
9	8 19 p.m.	Hawkhurst (Kent).	=α Cygni	White, then red.	3 seconds......	From *h* Tarandi to ½ (Capella, λ Persei).
10	0 35 a.m.	Coast-guard Station, Rye.	>1st mag.*	Reddish blue..	2 seconds......	First appeared altitude 45° S.W. Disappeared N.N.E.
10	2 20 a.m.	Ibid	2 > 1st mag.*......	Bright white ..	3 seconds......	From altitude 30° to altitude 5° S.E.
11	9 15 p.m.	Weston-super-Mare.	=♃	Yellow	2 seconds......	From γ to (3) Aquarii.
15	9 29 55 p.m.	Beeston Observatory (Nottingham).	> Mars in opposition.	Yellow, then blue.	....	From λ to within ½° of ι Ceti.
15	9 30 30 p.m.	Ibid	=2nd mag.*	....	....	From β Arietis to ξ Tauri.
15	9 59 p.m.	Margate	Beautiful meteor...	....	....	....
15	9 59 49 p.m.	Beeston Observatory (Nottingham).	At first=1st mag.*. At δ Ceti=Venus. At last = one-third diameter of the moon.	At first yellow, then blue.	5 seconds......	Passed from a point in R.A. $4^h 10^m$, N. Decl. 19° 57′, across ξ Tauri, above α and across δ and θ Ceti, and disappeared in R.A. $0^h 20^m$, S. Decl. 15°.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
...	...	...	...	S. H. Miller.
...	...	...	...	W. H. Wood.
Long lingering train ...	...	...	...	E. J. Lowe.
Long lingering tail ...	...	...	...	Id.
...	...	Direction N. to S. ... Inclined path. ↘	Still daylight, just getting dusk; Crystal Palace distinctly visible from the Royal Observatory.	W. C. Nash.
...	...	...	...	W. H. Wood.
Left a few red sparks...	30° ...	...	From 4 to 5 falling-stars in one hour.	A. S. Herschel.
Drew a tail 3° in length, and broke into fragments, green, red, blue, and white.	...	...	Reappeared after passing behind a dense cloud.	H. W. C. Wise (communicated by F. W. Gough).
Perfectly round. Disappeared without change behind a bank of clouds.	...	...	...	Id.
Rocket-like. Left a bright train and four or five bright sparks at last upon its track.	...	...	...	W. H. Wood.
...	...	...	...	E. J. Lowe.
...	...	...	...	Id.
A part of the luminous track gathered itself up as if attracted to one point, and took the appearance of a comet, remaining visible for more than 10 minutes.	...	...	...	G. Bowyer.
Globular, slightly prolonged behind. Disappeared instantaneously without fragments. Left a yellowish train 10° in length, which increased with the meteor, but not so rapidly.	...	...	The light rendered the distant landscape visible. The colour became blue at δ Ceti; afterwards intense blue.	E. J. Lowe.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1863. Oct. 15	h m s 10 0 p.m.	Combe, Woodstock (Oxfordshire).	....	....	....	Disappeared due S. at altitude 30° (measured).
15	10 0 p.m.	Cheltenham......	Large meteor	....	....	....
15	10 0 p.m.	Camberwell (London).	Large meteor	White	2 or 3 seconds	Midway between zenith and horizon.
17	11 47 p.m.	Weston-super-Mare.	=Sirius	Yellow	1½ second ...	From π Cassiopeiæ to (4) Lacertæ.
19	10 25 p.m.	Wisbech (Cambridgeshire).	=1st mag.*	White	3 seconds......	From μ Ceti to δ Piscium.
19	10 34 p.m.	Ibid	=Venus	Ruby colour, surrounded by yellow.	2 or 3 seconds	From *i* Orionis to λ Tauri.
19	10 42 p.m.	Ibid	=1st mag.*	White	3 seconds......	From α Tauri to δ Arietis.
23	9 25 p.m.	Regent's Park (London).	About = Venus at its brightest.	White or golden, and finally blue.	10 seconds; very rapid course.	Through Pisces, passing 3° or 4° below the moon.
30	9 54 p.m.	Beeston Observatory.	=2nd mag.*	Blue	Rapid	From 1° below β to γ Ursæ Majoris.
Nov. 1	9 6 p.m.	Ibid	=1st mag.*.........	Blue	Tolerable speed.	From α Andromedæ down towards W. at an angle of 47°.
9	9 38 p.m.	Weston-super-Mare.	=♃..................	Yellow	6–8 secs. Very slow, relaxing its speed.	From the tail of Draco to altitude 12° N.N.W.
10	9 3 p.m.	Hawkhurst (Kent).	=Sirius, then=♃	White, then blue.	1·4 second ...	From ι to β Bootis
12	0 59 57 a.m.	Ibid	=3rd mag.*	White	0·3 second ...	From B Camelopardali to ½ (κ, λ) Draconis.
12	1 30 1 a.m.	Ibid	=3rd mag.*	Yellow	0·6 second ...	From κ Cassiopeiæ to ½ (γ, ι) Cephei.
12	1 44 30 a.m.	Euston Road (London).	=3rd mag.*	Bluish white...	0·3 second ...	On a line from ζ Orionis to α Canis Majoris (centre halfway).
12	1 45 30 a.m.	Ibid	=3rd mag.*	Bluish white...	0·3 second ...	From υ Orionis to ι Leporis.
12	1 47 8 a.m.	Hawkhurst (Kent).	=1st mag.*	White	1·1 second ...	From δ Andromedæ towards the horizon.
12	1 48 a.m.	Weston-super-Mare.	=Venus	Brilliant silvery white.	1½ second; rapid.	Shot on a line from γ Geminorum to β Canis Majoris.
12	1 50 a.m.	Euston Road (London).	=Sirius	Same colour as Sirius.	1·5 second ...	From 3° above γ Eridani to near and below β Leporis.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
When the meteor disappeared, it flared up like an expiring candle, and left a cometary patch for more than ten minutes at that place.	...	W. to E.; perfectly horizontal.	Measurements from memory among particular landmarks.	J. H. Abraball.
Left a large comet in the sky where it exploded.	...	Descended obliquely ...	The 'Comet' remained visible until clouds intervened and covered the sky.	'The Times,' Oct. 17.
Appeared to be followed by a train, and burst with a flash which shed a faint light.	...	E. to W. ...	Sky misty ...	E. J. G., 'The Times,' Oct. 20.
Left a yellowish train 18° or 20° in length for two seconds, pointed at the extremities.	...	...	...	W. H. Wood.
Left a train for 2 or 3 seconds.	...	...	...	S. H. Miller.
Left a train for some time, 15° or 20° long. The dark part represents a ruby colour, the outer part a bright yellow.	... 	...	...	Id.
...	...	...	...	Id.
The light was intense even in passing near the moon.	...	E. to W. ...	...	J. L. L., 'The Standard,' Oct. 25.
Spark-like ...	...	...	...	E. J. Lowe.
Streak ...	...	...	...	Id.
A tailed meteor bursting with sparks.	...	...	...	Communicated by W. H. Wood.
After extinction, reappeared with a bright flash.	...	...	...	A. S. Herschel.
No train or sparks ...	...	...	...	A. S. Herschel and W. J. H.
No train or sparks ...	...	...	...	Id.
No train or sparks ...	12° ...	...	...	T. Crumplen and J. Parkin.
...	...	...	...	Id.
...	...	Directed from *o* Cephei..	...	A. S. Herschel and W. J. H.
Meteor sparkled, at length drawing a tail.	...	...	Corresponds to Euston Road, 1^h 50^m a.m. (See Appendix I.)	W. H. Wood.
Left a very slight train ...	...	...	...	T. Crumplen and J. Parkin.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1863. Nov. 12	h m s 1 52 a.m.	Euston Road (London).	=2nd mag.*	Ruddy	0·5 second ...	On a line from ζ Canis Minoris to ζ Orionis (centre halfway).
12	1 55 a.m.	Weston - super - Mare.	Nearly = ♃	Yellow	1 second; rapid.	From η Leonis to a point in R. A. 115°, N. Decl. 9°.
12	1 56 18 a.m.	Hawkhurst (Kent).	=3rd mag.*	Yellow	0·6 second ...	From ½ (α Cephei, β Cassiopeiæ) to γ Lacertæ, and 3° further.
12	1 59 a.m.	Euston Road (London).	=2nd mag.*	....	....	Centre ε Eridani ...
12	2 13 33 a.m.	Hawkhurst (Kent).	=2nd mag.*	White	0·8 second ...	From ½ (ψ Cassiopeiæ BAC 228) to ½ (φ Andromedæ, υ Persei).
12	2 17 30 a.m.	Euston Road (London).	=1st mag.*	Bluish	....	From δ ⅓ of the distance to α Hydræ.
12	2 46 42 a.m.	Hawkhurst (Kent).	=2½ mag.*	White	0·3 second ...	From κ to α Cassiopeiæ.
12	2 50 a.m.	Euston Road (London).	=2nd mag.*	Ruddy	0·7 second ...	To β Virginis ⅔ of the way from γ Leonis.
12	2 54 30 a.m.	Hawkhurst (Kent).	=2nd mag.*	White	0·4 second ...	From μ Persei to η Tauri.
12	2 55 a.m.	Euston Road (London).	=Procyon	Light orange colour.	0·3 second ...	From ν Geminorum two - thirds of the way to ζ Orionis.
12	2 59 a.m.	Hawkhurst (Kent).	=2nd mag.*	White	0·4 second ...	From ½ ι Aurigæ, ε Persei to η Tauri.
12	8 45 p.m.	Beeston Observatory.	=2nd mag.*	Blue	Rapid	From α to γ Tauri..
12	8 46 15 p.m.	Clapham (London).	Very bright	Orange colour	Moderate velocity.	From 2° above Polaris to β Ursæ Minoris.
12	10 37 18 p.m.	Ibid	=2nd mag.*	Orange colour	Rapid	To Polaris, halfway from Capella.
12	11 31 p.m.	Weston - super - Mare.	=2nd mag.*	Blue	1 second	From μ to α Geminorum.
13	1 30 45 a.m.	Wisbech (Cambridgeshire).	=α Lyræ...........	....	....	....
13	2 37 30 a.m.	Hawkhurst (Kent).	=3rd mag.*	White	0·5 second ...	From ½ (γ Andromedæ, φ Persei) to ½ (ν Andromedæ, ο Cassiopeiæ).
13	2 27 45 a.m.	Ibid	=3rd mag.*	Yellow	0·5 second ...	From ½ (δ, κ) Persei to ½ (γ Andromedæ, β Trianguli).
13	2 48 a.m.	Euston Road (London).	=2½ mag.*	Ruddy	0·3 second ...	From θ to ω Aurigæ

ppearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
eft a train for half a second 18° in length.	15°	....	....	T. Crumplen and J. Parkin.
eft a red train for 3 or 4 seconds 8° in length.	....	....	No meteors from 1^h 55^m to 2^h 40^m a.m.; afterwards overcast.	W. H. Wood.
o train or sparks	....	....	....	A. S. Herschel and W. J. H.
....	12°	Directed from Sirius ...	....	T. Crumplen and J. Parkin.
....	....	....	....	A. S. Herschel and W. J. H.
eft a faint train	....	....	....	T. Crumplen and J. Parkin.
o train or sparks	....	....	....	A. S. Herschel and W. J. H.
eft a momentary train 5°	....	....	....	T. Crumplen and J. Parkin.
o train or sparks	....	....	Corresponds to Euston Road, 2^h 55^m a.m. (See Appendix I.)	A. S. Herschel and W. J. H.
o train or sparks	....	....	....	T. Crumplen and J. Parkin.
o train or sparks	....	....	....	A. S. Herschel and W. J. H.
....	....	....	Very few meteors	E. J. Lowe.
o train or sparks	....	....	As large as a tennis-ball	V. Fasel.
o train or sparks	....	....	....	Id.
....	....	....	....	W. H. Wood.
....	....	....	....	S. H. Miller.
o train or sparks	....	....	....	A. S. Herschel and W. J. H.
rightest at middle of its course.	....	....	....	Id.
eft a train 10° in length, which disappeared suddenly.	....	....	From a point R. A. 90°, N. Decl. 40°, to a point R. A. 73°, N. Decl. 39½°.	T. Crumplen and J. Parkin.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1863. Nov. 13	h m s 2 48 30 a.m.	Weston-super-Mare.	=1st mag.*	Reddish	0·5 second ...	From R. A. 149°, N. Decl. 23½°, to R. A. 159°, N. Decl. 22½°.
13	2 48 45 a.m.	Hawkhurst (Kent).	=2½ mag.*	White	0·6 second ...	From a point R. A. 52°, N. Decl. 63½°, to R. A. 22½°, N. Decl. 52½°.
13	2 51 45 a.m.	Ibid	=2nd mag.*	White	0·7 second ...	From η Tauri to ⅓ (ξ₂ Ceti, β Arietis).
13	2 53 a.m.	Euston Road (London).	=1½ mag.*	Bluish	0·6 second ...	From g Orionis to E Psalterii.
13	2 54 a.m.	Weston-super-Mare.	=1st mag.*	Reddish	0·5 second ...	From R. A. 149½°, N. Decl. 23½°, to R. A. 156°, N. Decl. 20°.
13	....	Beeston Observatory.	....	....	....	....
14	8 0 p.m.	Weston-super-Mare.	=2nd mag.*	Blue	1 second	From σ to ζ Herculis.
14	11–12 p.m.	Wolverhampton (Staffordshire).	....	....	....	....
14	11 18 p.m.	Hawkhurst (Kent).	=2nd mag.*	White	0·8 second ...	From ½ (κ Draconis, ν Ursæ Minoris) to ζ Draconis.
14	11 22 30 p.m.	Ibid	=1½ mag.*	White	1·5 second ...	From P Camelop. to ½ (ι, α) Cephei.
14	11 23 p.m.	Ibid	=2nd mag.*	White	0·7 second ...	From o Glor. Fred. to η Pegasi.
14	11 26 p.m.	Ibid	=α Lyræ...........	Prismatic, i. e. blue with red tail.	3 seconds......	From η Andromedæ to r, ε Piscium.
15	0 to 30ᵐ a.m.	Wolverhampton (Staffordshire).	....	....	....	....
15	0 30 to 1 30 a.m.	Ibid	All=2nd mag.* ...	Golden with reddish tint.	2·5 to 5 secs...	From Canis Minor to Eridanus (just below the head of Cetus).
15	1 30 to 2 0 a.m.	Ibid	....	....	....	....
15	11 0 p.m.	Flimwell, Hurst Green (Sussex).	>1st mag.*	....	....	First appeared 10° from Procyon reckoned toward γ Geminorum. Disappeared 3° below Betelgeux.
18	About 10 30 p.m.	Manchester	Nearly = full moon	White	3 to 5 seconds	About altitude 45° in N.W.
29	6 2 p.m.	Prestwitch (Manchester).	=3rd mag.*	....	....	From γ to ξ Geminorum.
29	6 34 p.m.	Ibid	=2½ mag.*	....	....	From α Lyræ to A Herculis.
29	7 10 p.m.	Ibid	=1½ mag.*	Reddish	1 second	From α Arietis to ι Piscium.
29	7 16 p.m.	Ibid	=4th mag.*	....	0·5 second ...	To o, halfway from ξ₁ Ceti.
29	7 27 p.m.	Ibid	=3rd mag.*	....	....	To ι Herculis ......

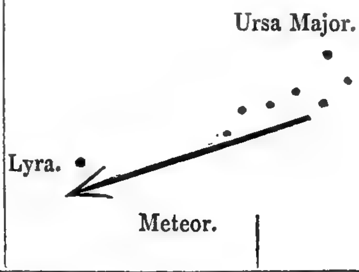
Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Left a red train for two seconds 5° in length.	....	....	....	W. H. Wood.
Left a train for 2 seconds upon half of its course.	....	....	Corresponds to Euston Road Observatory, $2^h 48^m$ a.m. (See Appendix I.)	A. S. Herschel and W. J. H.
Left a bright train for 3 seconds on four-fifths of its course.	....	....	Corresponds to Euston Road Observatory, 2^h 53^m a.m. (See Appendix I.)	Id.
Left a bright train for 2½ seconds 10° in length.	....	....	The brightest train seen. Crossed ι Orionis.	T. Crumplen and J. Parkin.
Left a red train for 2 seconds 4° in length.	....	....	....	W. H. Wood.
....	....	....	Very few meteors	E. J. Lowe.
No train or sparks	....	....	Bright aurora from 7^h 30^m to 8^h 30^m p.m.	W. H. Wood.
....	....	....	Very few shooting-stars. About 10 in the hour.	T. M. Simkiss.
Left a train for 1 second...	....	....	....	A. S. Herschel and H. T. H.
Left a train for 2 seconds	....	....	A fine shooting-star ...	Id.
No train or sparks	....	....	....	Id.
Left a bluish train for 3½ seconds.	35°	....	Blue with red tail; afterwards overcast.	Id.
....	....	....	About 30 meteors in half an hour.	T. M. Simkiss.
Left trains throughout their course.	50° to 70°..	Perfectly parallel from E. to W.; not 10° deviation.	About 60 meteors in one hour.	Id.
....	....	....	Rapid decrease in frequency.	Id.
....	....	....	....	F. Howlett.
....	15° or 20°..	Inclining downwards from W. to N.	Sky thick; moon only visible.	A. Brothers.
....	....	....	....	R. P. Greg.
....	....	....	....	Id.
Left a train	....	....	....	Id.
Left a train	....	....	....	Id.
....	5°..........	Directed from ι Cygni...	....	Id.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1863. Nov. 29	h m 7 28 p.m.	Prestwitch (Manchester).	= 2nd mag.*	Bright white..	0·75 second ...	From β Cassiopeiæ to κ Andromedæ.
29	7 31 p.m.	Ibid	= 1st mag.*	White	0·5 second ...	From ι Cephei to κ Cassiopeiæ.
29	8 45 p.m.	Weston - super - Mare.	Bright as the moon; very large.	....	....	In E., altitude 30° to 45°.
29	9 18 p.m.	Prestwitch (Manchester).	= 3rd mag.*	White	1·25 second...	From E Cephei to δ Cygni.
29	9 45 p.m. to 10 p.m.	Charing Cross (London).	As large round as the mouth of a tumbler.	....	....	From 20° N. of the zenith to N.E., altitude 20°.
30	6 0 p.m. to 6 15 p.m.	Prestwitch (Manchester).	1½′ diameter	....	3 seconds......	From υ to ψ Ursæ Majoris.
30	9 26 p.m.	Weston - super - Mare.	> 1st mag.*	Dark blue, then white.	2 seconds......	From κ Draconis to κ Cygni, passing between β, γ Ursæ Minoris.
Dec. 1	8 8 p.m.	Prestwitch (Manchester).	= 2nd mag.*	....	....	Commenced at δ Lyræ.
1	8 15 p.m.	Ibid	2 > Sirius	Bright white...	2 seconds......	From p Lyncis halfway to γ Ursæ Majoris.
1	8 16 p.m.	Ibid................	= 2nd mag.*	Whitish	....	From β Ursæ Majoris.
1	9 5 p.m.	Ibid................	= 2nd mag.*	Reddish white	2·5 seconds ...	From γ Pegasi to θ Ceti.
1	9 50 p.m.	Ibid	= 4th mag.*	....	....	From δ to ο Draconis.
2	8 57 p.m	Weston - super - Mare.	> 1st mag.*	Bright yellow	½ second ...	From θ Ursæ Majoris.
2	9 0 p.m.	Ibid	= 2nd mag.*	Blue	1 second	From θ Geminorum
2	9 29 p.m.	Ibid	= 1st mag.*	Dull yellow ...	3 seconds; very slow.	From R. A. 137° N. Decl. 35° to the N.E. ½ N horizon.
3	10 17 p.m.	Ibid	= 1st mag.*	Bluish white...	½ second	From β Eridani to β Orionis.
4	8 45 p.m.	Prestwitch (Manchester).	= 3rd mag.*	Reddish white	0·5 second ...	From φ to σ Cephei and as far again
5	Between 7 and 8 p.m.	Carnarvon	Very brilliant meteor.	....	....	Passed over the town to Bont Newydd, where it disappeared.
5	Shortly after 7 p.m.	Kingstown (Ireland).	Lit the sky like sheet lightning.	Blue	Several secs...	Appeared in the E and descended into the sea.
5	About 7 45 p.m.	Ledbury (Hereford).	A flash like lightning.	Yellow tinged with blue.	....	Disappeared before it reached the ground.
5	A few minutes before 8 p.m.	Stretton (Hereford).	....	....	....	Nearly in R.A. 15 N. Decl. 50°.
5	A few minutes before 8 p.m.	Langorse (Brecknock).	Filled the sky with light.	White	....	Facing N.W., the light appeared to be behind.
5	A few minutes before 8 p.m.	Idle, near Bradford.	Brilliant; = rocket at a few hundred yards.	Purple, blue, and white.	....	Burst into sight due W.

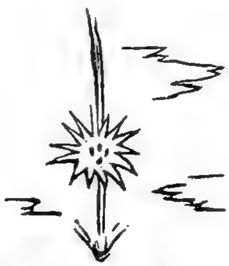
Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
....	....	....	....	R. P. Greg.
....	....	....	....	Id.
Illuminated the scene......	....	Fell vertically down ...	Interrupted view among trees (? 9^h 45^m p.m.).	Communicated by W. H. Wood.
Left a train	....	....	....	R. P. Greg.
Somewhat pear-shaped. Vivid.	....	....	Began almost overhead, and disappeared behind buildings. (Time certain.)	Communicated by T. Crumplen.
....	20°	....	....	R. P. Greg.
At first dull; became luminous, passing from blue to white.	....	....	Disappeared once, and reappeared; slow motion.	W. H. Wood.
....	10°	Directed from θ Cygni..	....	R. P. Greg.
Burst into sparks. Left a train.	....	....	....	Id.
....	10°	Directed from α Ursæ Majoris.	....	Id.
Left a train	....	....	....	Id.
....	....	....	....	Id.
Left a train	4°.........	5° to left of perpendicular; down.	....	W. H. Wood.
....	8°.........	E. to W.; horizontal ...	....	Id.
Path undulatory	....	....	....	Id.
Left a train	....	....	....	Id.
....	....	....	....	R. P. Greg.
Disappeared with an explosion.	....	....	....	'Caernarvon Herald.'
Large ball of flame with a long feathery tail of fire.	....	Descending	....	'The Standard.'
Emitted bright sparks as it fell.	....	Descended perpendicularly.	....	'Hereford Times.'
As described in other accounts.	Not > 2°...	....	The whole path foreshortened to 2°.	H. C. Key.
....	....	....	Starlight; several falling stars.	P. L., 'The Times.'
Like the bursting of a rocket a few hundred yards off.	....	....	....	Robert Sutcliffe.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1863. Dec. 5	h m A few minutes before 8 p.m.	Furness Abbey (Lancashire).	Resembled lightning.	White	....	....
5	....	Howden (W. of Hull).	....	....	....	About W.N.W.; almost touched the earth.
5	....	Blyth (Northumberland).	....	Red and green	....	First appeared due W., altitude 30°.
5	....	Beaumaris (Anglesey).	Bright as full moon	....	....	The direction of the light was W. and S.
5	....	Bath.............	A strong light	....	....	....
5	....	Manchester	Two bright flashes..	....	....	In the same field of view with α Andromedæ.
5	....	Hawkshead, Windermere.	....	....	....	....
5	....	Parkhill, Ross-shire.	Bright as full moon	Pale blue, fragments red.	2 or 3 seconds	Proceeded almost due S., at a low altitude across the sky.
5	7 54 p.m.	Hawkhurst (Kent).	Like lightning ...	White	Momentary ...	Facing S.E., the flash appeared to be behind.
5	7 55 p.m.	Coast-guard Station, Camber (Hastings).	Large fireball	....	2 or 3 seconds	From about altitude 35° to about altitude 40°.
5	....	Burton-on-Trent	4 > ♃	Pale blue, tail crimson.	Not > 2 secs.	First appeared at an altitude of 30°, N.W. by N.
5	7 55 p.m.	Chesterfield (Derbyshire).	Large fireball	Greenish white, twice changing to red	....	Higher up in the sky than Ursa Major.
5	7 55 p.m.	Little Horton, Bradford.	Large and bright...	Colours very bright.	3 seconds......	Nearly due W. ...
5	7 55 p.m.	Haslingden (Lancashire).	Cast shadows	Pale blue	A few seconds	From near γ Ursa Majoris to 4° below α Lyræ where it burst (See sketch.)

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Illuminated the scene......	....	....	Seen also at Ulverston..	H., 'Manchester Guardian.'
Nucleus of brilliant light. Burst into fragments like a shell.	....	Fell quite vertically ...	....	'The Times.'
Left several flakes, like molten drops, in its flight.	20°	....	....	M. W. Bullen.
....	....	....	....	J. Williams.
....	....	....	Sky quite covered with a thick fog.	G. H. S., 'The Times.'
The meteor burst twice ...	....	The light appeared on the west edge of the field of view in a telescope.	"At first the meteor appeared *stationary*, like Venus out of place." (Observation near Manchester.)	A. Brothers.
As described in other accounts.	....	....	In 4 or 5 minutes a meteoric sound like a train crossing a bridge, which lasted 2 or 3 seconds.	Robert S. Hart.
A ball of light with dull nebulous tail. Vanished amid deep-red falling fragments.	....	....	Heavy rain	G. M., 'The Times.'
Illuminated the whole sky	....	....	Thick drizzling rain ...	A. S. Herschel.
....	....	W. to E., slightly ascending.	Burst three times	W. E. Buck.
Globe of light with train of 4 or 5 crimson-red flakes. Left no streak.	....	Fell vertically	No report heard; vanished suddenly.	E. B. K., 'The Times.'
Disappeared with red colour.	....	Downwards, inclining to the left.	....	'Manchester Guardian.'
Followed by a long train. Disappeared with a bright coruscation.	....	....	....	C., 'Manchester Guardian.'
Brilliant egg-shaped nucleus, followed by a tail which tapered to a point.	....	....	Not much inclined to the horizon.	T. T. Wilkinson (Proceedings Lit. Phil. Soc. of Manchester).



Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1863. Dec. 5	h m 7 57 p.m.	Hale (Manchester).	Large and bright...	White; tail purplish red.	2 or 3 seconds	Disappeared about 20° above the horizon, and 15° from the west margin of the Milky Way. 
5	7 57 p.m.	Liverpool.........	Two very vivid flashes.	Tint blue	About 5 or 6 seconds.	From N.W. to N.E. Not far from the position of the Polar-star.
5	....	Broughton Bridge, Salford (Manchester).	....	....	....	Fell towards the river near the suspension-bridge.
5	7 58 p.m.	West Bromwich (Birmingham).	Large as a hen's egg.	White, green, and pink.	....	In N.W., altitude about 45°.
5	7 58 p.m.	Stretford (Manchester).	....	Purple and yellow.	2 or 3 seconds	Due W. Disappeared about halfway from the zenith to the horizon.
5	7 58 p.m.	Preston (Lancashire).	Half < moon	Blue-purple...	About 2 secs...	From near the Milky Way (W.N.W. altitude 45°) to altitude 15°.
5	About 8p.m.	Liverpool.........	Cast shadows	Pale blue	8 or 10 secs...	In N.N.W., altitude 40°.
5	About 8p.m.	Selkirk (Scotland).	=full moon.........	....	A few seconds	In the W. (disappeared behind clouds).

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Left sparks, like those off a blacksmith's anvil.	....	30° to left of perpendicular down.	Clear sky	H. Harrison.
....	....	....	The meteor itself was hidden behind high houses.	F. J. Bailey.
Like a rocket	....	....	....	R. Knowles.
A number of fragments parted from the nucleus as it descended.	....	Almost vertically down	....	James Hall.
Purple and yellow balls seen falling in the sky after two strong flashes of light.	....	....	The second flash of light stronger than the first.	J. H., 'Manchester Guardian.'
Glaring ball of light, with an adhering red and fiery tail.	20° to 30°..	Slanting downwards towards S.W.	Clear sky. The tail was several degrees in length.	J. C., 'The Times.'
At first an ordinary falling-star; burst suddenly into a large blue light: when this was fading, a red drop ran down from it, and terminated in a small explosion. (See sketch.)	10°	.... 	....	W. G. Drysdale.
Round	....	Descended with a waving motion.	....	'The Scotsman.'

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1863. Dec. 5	h m s 8 2 p.m.	Douglas (Isle of Man).	Head = diameter of full moon in length, $\frac{1}{2}$ ditto in breadth.	Head green, tail red and yellow.	As long as the flight of a rocket.	In E. or S.E., altitude 30° or 45°.
5	8 3 p.m.	Royton, Oldham (Manchester).	$\frac{1}{3}$ diameter of full moon.	....	4 seconds......	In W.S.W., from altitude 50° to altitude 38°.
6	9 50 15 p.m.	Hawkhurst (Kent).	$=1\frac{1}{2}$ mag.*	White	1·2 second ...	From C Camelopardali to $\frac{1}{2}$ (χ Persei, δ Cassiopeiæ).
6	9 56 p.m.	Ibid	$=2\frac{1}{2}$ mag.*	White	0·9 second ...	From 2° W. of d Camelopardali to A Custodis.
6	10 7 30 p.m.	Trafalgar Square (London).	=2nd mag.*	White	1 second	From μ Tauri to $\frac{1}{2}$ (γ, ν) Ceti.
6	10 7 45 p.m.	Hawkhurst (Kent).	=2nd mag.*	White	1·3 second ...	From $\frac{1}{2}$ (γ, λ) Tauri to $\frac{1}{2}$ (γ Arietis, ξ_2 Ceti).
6	10 8 p.m.	Ibid	$=2\frac{1}{2}$ mag.*	Ruddy	0·5 second ...	Described a short arc round β Andromedæ.
6	10 15 p.m.	Trafalgar Square (London).	$=3\frac{1}{2}$ mag.*	Bluish	0·4 second ...	From g Geminorum to a few degrees above and following Procyon.
6	11 13 p.m.	Hawkhurst (Kent).	=1st mag.*	White	1·5 second ...	From δ to k Piscium
8	10 8 p.m.	Ibid	$=2\frac{1}{2}$ mag.*	White	0·4 second ...	From 3° N. of η almost to ι Pegasi.
8	10 21 45 p.m.	Ibid	=2nd mag.*	White, then yellow, then red.	1·5 second ...	From N Camelopardali to $\frac{1}{2}$ (γ Ursæ Minoris, α Draconis).
8	11 56 p.m.	Ibid	$=2\frac{1}{2}$ mag.*	White	0·5 second ...	From A Custodis to ι Cassiopeiæ.
8	11 56 30 p.m.	Ibid	=3rd mag.*	Yellow	0·5 second ...	From η, γ, τ Persei to $\frac{1}{2}$ (ϕ Persei, θ Cassiopeiæ).
8	11 59 30 p.m.	Ibid	=2nd mag.*	White	....	From 2° N. of κ, to 2° preceding γ Andromedæ.
12	5 33 p.m.	Nottingham......	2 $>$ ♃	Prismatic (red and blue).	2 seconds ...	From 2° below γ Arietis over η and δ Piscium to λ Piscium.
12	5 40 p.m.	Oundle (Cambridgeshire).	Fine rocket-like meteor.	....	$<$ 2 seconds...	From $\frac{1}{2}$ (α Trianguli, α Arietis) across χ Piscium and γ Pegasi almost to the urn of Aquarius.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Head like a spear-head. Tail like a long shaft, or like a chain of gas-lights.	....	Descended	....	Communicated by S. Simpson.
Head lemon-shaped, burst at last, leaving a band of red fire in two places.	About 12°..	30° from perpendicular down.	Bright as full moonlight; clear sky.	W. Bentley.
No train or sparks	....	....	....	A. S. Herschel.
Left a slight train for 1 sec.	....	....	....	Id.
Left a train for ½ a second on a part of the course.	....	....	Corresponds to Hawkhurst 10^h 7^m 45^s p.m.	T. Crumplen.
Left a train on ⅔ of its course for 2 seconds.	....	....	See Appendix I.	A. S. Herschel.
No train or sparks	....	....	....	Id.
....	....	....	....	T. Crumplen.
No train or sparks	....	....	Dec. 7th, cloudy	A. S. Herschel.
No train or sparks	5°...........	Vertically down	....	Id.
No train or sparks	....	....	....	Id.
No train or sparks	....	....	....	Id.
No train or sparks	....	....	....	Id.
No train or sparks	....	....	....	Id.
Left a track 7° or 8° in length.	....	....	....	J. Vertu.
Disappeared midway between ζ Pegasi and θ Piscium.	....	....	....	H. Weightman.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1863.	h m s					
Dec. 12	From 6 p.m. to 10 p.m.	Norwich	Bright shooting-stars.	....	....	The part of the heavens where they were most plentiful, and whence they appeared to originate, was the constellation Perseus.
12	8 37 p.m.	Greenwich	=5th mag.* ; very faint.	Blue	Less than 1 second.	From υ Ursæ Majoris, directly towards α Ursæ Majoris.
12	9 10 p.m.	Hawkhurst (Kent).	=2nd mag.*	White	0·5 second ...	From *d* Camelopardali to *m* Custodis.
12	9 16 p.m.	Weston-super-Mare.	> 1st mag.*	Blue and white	1 second	From θ Lyræ to β Cygni.
12	9 17 p.m.	Ibid	=2nd mag.*	....	2 seconds......	From ε Ursæ Minoris to Head of Camelopardalus.
12	9 18 p.m.	Ibid	=2nd mag.*	....	1½ second ...	From δ Ursæ Minoris to Head of Camelopardalus.
12	9 19 p.m.	Trafalgar Square (London).	=3rd mag.*	....	0·4 second ...	From ½ (α, γ) Arietis to R. A. 1^h 48^m, N. Decl. 10°.
12	9 20 p.m.	Hawkhurst (Kent).	=2nd mag.*	White	2 seconds......	From θ Tauri to α Ceti.
12	9 23 p.m.	Trafalgar Square (London).	=1st mag.*.........	....	1 second	From π Orionis to 2° or 3° E. of α Ceti.
12	9 29 p.m.	Weston-super-Mare.	= ⅔ ♃	Bright yellow	2 seconds......	From ξ Draconis to δ Cygni.
12	9 52 p.m.	Trafalgar Square (London).	=1½ mag.*	White	½ second	From ½ (β, η) Pegasi to 5° W. of ζ Pegasi.
12	9 58 p.m.	Ibid	=1st mag.*.........	....	....	From (ζ, η) Ursæ Majoris to the north horizon.
12	10 9 15 p.m.	Hawkhurst (Kent).	=3rd mag.*	White	0·4 second ...	To *d* Ursæ Majoris
12	10 13 p.m.	Ibid	=3½ mag.*	White	0·5 second ...	From ν to ρ Persei
12	10 16 p.m.	Ibid	=2½ mag.*	White	0·4 second ...	From ι Aurigæ, halfway to ζ Persei.
12	10 21 p.m.	Ibid	=3rd mag.*	White	0·6 second ...	From θ Cassiopeiæ, two-thirds of the way to λ Andromedæ.
12	10 21 p.m.	Trafalgar Square (London).	=3rd mag.*	....	....	From 5° below γ Orionis to 5° below ν Tauri.
12	10 23 p.m.	Hawkhurst (Kent).	=3½ mag.*	White	0·5 second ...	From α to δ Ceti...
12	10 24 45 p.m.	Ibid	=3rd mag.*	White	0·6 second ...	From φ to η Tauri..
12	10 28 p.m.	Ibid	=2½ mag.*	White	0·8 second ...	From P Camelopardali to ½ (ε, ζ) Ursæ Minoris.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
....	....	....	Every few minutes witnessed their sudden display. Hundreds of shooting-stars.	'Norwich Mercury,' Dec. 16.
No train	....	....	....	W. C. Nash.
....	....	....	....	A. S. Herschel.
....	....	....	Cloudy after $9^h 45^m$ p.m.	W. H. Wood.
Nebulous; no nucleus ...	....	....	....	Id.
Nebulous; no nucleus ...	....	....	....	Id.
....	....	....	....	T. Crumplen.
Began suddenly	....	....	....	A. S. Herschel.
Left a train 15° in length..	25°	....	....	T. Crumplen.
Left a train of sparks	....	....	....	W. H. Wood.
Left a train 10° in length..	20°	....	....	T. Crumplen.
....	....	....	Termination concealed by buildings.	Id.
....	6°	Directed from *e* Lyncis	....	A. S. Herschel.
....	....	....	....	Id.
....	....	....	....	Id.
....	....	....	....	Id.
....	....	....	....	T. Crumplen.
....	....	....	....	A. S. Herschel.
....	....	....	....	Id.
....	....	....	....	Id.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1863.	h m s					
Dec. 12	10 33 45 p.m.	Hawkhurst (Kent).	=2½ mag.*	Yellow	1·1 second ...	To δ Aurigæ two-thirds of the way from c Telescopii and 2° further.
12	10 37 30 p.m.	Ibid	=2nd mag.*	White	0·6 second ...	From ½ (β Ursæ Minoris, α Draconis) to ν Ursæ Minoris.
12	10 41 30 p.m.	Ibid	=3rd mag.*	Yellow	0·7 second ...	From φ Tauri to ½ (η Tauri, o Persei).
12	10 44 15 p.m.	Ibid	=2nd mag.*	White	1·2 second ...	From ε Eridani ...
12	10 46 p.m.	Ibid	=3½ mag.*	White	0·5 second ...	From ½ (φ, υ) Persei (centre) to φ Andromedæ.
12	10 47 15 p.m.	Ibid	=2½ mag.*	White	0·7 second ...	From 4° below o Cygni.
12	10 50 p.m.	Ibid	=3½ mag.*	Dull	0·6 second ...	From ζ Tauri to α Ceti.
12	10 52 p.m.	Ibid	=4th mag.*	Yellow	0·6 second ...	From F Custodis to ψ Cephei.
12	10 56 p.m.	Ibid	=2½ mag.*	Orange	1·8 second ...	From i Bootis to β Draconis.
12	11 2 30 p.m.	Ibid	=2½ mag.*	White	0·7 second ...	Centre α Tauri ...
12	11 7 p.m.	Ibid	=3½ mag.*	White	0·6 second ...	From ξ Tauri to γ Ceti.
12	11 16 30 p.m.	Ibid	=2nd mag.*	White	1 second	To δ Eridani, half-way from ϖ Orionis.
13	8 11 p.m.	Ibid	=1st mag.*	White	1·2 second ...	From 2° above N Camelopardali to β Ursæ Minoris.
13	8 46 p.m.	Trafalgar Square (London).	=1½ mag.*	....	....	From below γ Pegasi to below β Piscium.
13	9 40 p.m.	Hawkhurst (Kent).	=3½ mag.*	White	0·8 second ...	From ζ Cassiopeiæ to ½ (λ Andromedæ, g Lacertæ).
13	9 42 p.m.	Ibid	=3rd mag.*	White	1 second	From μ Orionis ...
13	9 48 30 p.m.	Ibid	=3½ mag.*	Dull	1 second	From ½ (α, β) Arietis towards ξ_2 Ceti.
13	9 49 p.m.	Ibid	=2nd mag.*	White	0·8 second ...	From ½ (γ Triangulæ, c Muscæ) to ½ (α Triangulæ, γ Arietis).
13	9 54 30 p.m.	Ibid	=3½ mag.*	Orange colour	1·8 second ...	From μ Ceti to η Eridani.
13	10 0 30 p.m.	Ibid	=3rd mag.*	White	0·6 second ...	From β Pegasi......
13	10 2 p.m.	Ibid	=3rd mag.*	White	0·8 second ...	From δ to c Draconis.
13	10 5 45 p.m.	Ibid	=2nd mag.*	White	1·2 second ...	From ζ Ceti.........

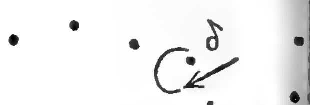
Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
	8°		Twenty meteors in two hours radiated from the neighbourhood of τ Geminorum.	A. S. Herschel.
				Id.
				Id.
	7°	Fell vertically		Id.
				Id.
	6°	Fell vertically		Id.
				Id.
				Id.
Left a streak of sparks				Id.
		Directed from ι Tauri		Id.
				Id.
				Id.
				Id.
				T. Crumplen.
				A. S. Herschel.
	8°	Vertically down		Id.
	8°			Id.
				Id.
Left a train of sparks				Id.
	6°	Towards g Pegasi		Id.
				Id.
	8°	Directed from α Ceti		Id.

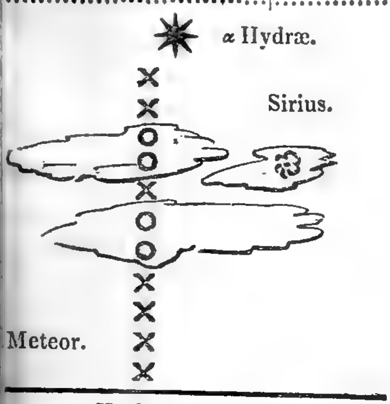
Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1863. Dec. 13	h m s 10 11 30 p.m.	Hawkhurst (Kent).	$=3\frac{1}{2}$ mag.*	Yellow	0·6 second ...	From $\frac{1}{2}$ (η, λ) Tauri
13	10 18 30 p.m.	Ibid	=3rd mag.*	White	0·6 second ...	To a Muscæ, $\frac{3}{4}$ of the course from ζ Persei.
13	10 44 30 p.m.	Ibid	=2nd mag.*	White	0·8 second ...	From 2° N. of α Andromedæ, $\frac{3}{4}$ of the course to υ Pegasi.
13	10 52 15 p.m.	Ibid	=3rd mag.*	White	1·2 second ...	From $\frac{1}{2}$ (r, f) Custodis, two-thirds of the course to ϕ Persei.
27	Evening ...	Southampton ...	Diameter $4\frac{1}{2}$ inches (!).	....	3 seconds......	First appeared in S.W., and proceeded to N.W.
27	About 6 55 p.m.	Hallow (Worcestershire).	Half diameter of the moon.	Brilliant green, passing into deep red.	5 or 6 seconds	....
27	6 55 p.m.	East Harptree, Mendip Hills.	As large as the moon.	Bright blue; followers crimson.	Slow motion; 20 seconds.	Commenced near the Pleiades; disappeared just above the south horizon.
27	6 57 p.m.	Dulverton (Somersetshire).	Large meteor	Bright bluish colour.	20 or 30 secs..	Approached the belt of Orion from 15° north of it.
27	6 57 p.m.	Wittersham Rye (Kent).	As large as two fists.	At first pale yellow, becoming blue.	....	Over Sandhurst ...
27	6 58 p.m.	Tunbridge Wells	Splendid meteor ...	Very bright green and light red.	....	In the S.W., at no great altitude.  Horizon.
27	10 45 p.m.	Hawkhurst (Kent).	2 > ♃	Yellow	0·7 second ...	From $\frac{1}{3}$ (α Andromedæ, β Pegasi).
31	6 30 p.m.	Beeston Observatory.	= ♃	Colourless; brilliant.	Slowly	N.W., altitude 45°, moving slightly downwards towards N.
1864. Jan. 1	9 51 p.m.	Weston-super-Mare.	=1st mag.*	Blue............	2 seconds......	From ξ Eridani to 54 Sceptri.
2	7 30 p.m. to 8 30 p.m.	Beeston Observatory.	....	....	....	....

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
....	6°	Towards μ Ceti	....	A. S. Herschel.
....	....	....	No other meteor seen in 30 minutes.	Id.
....	....	....	....	Id.
....	....	....	Eight meteors in one hour radiated from the neighbourhood of τ Geminorum.	Id.
Burst into two, leaving a second meteor on its track.	....	....	The first meteor was not diminished in size, but travelled faster than the other.	'Portsmouth Times.'
From a point became circular, drawing a train of sparks. Burst without report, and left no sparks.	....	....	....	R. H. H., 'The Times.'
Increased from a 1st mag.* to the diameter of the moon; followed by three smaller elongated red bodies.	....	....	Deepened in colour as it increased. The flash resembled that of vivid lightning.	C. P. Taylor.
At first no appendage; afterwards followed by a stream of light.	....	....	....	C. M., 'The Times.'
Became blue in colour, and at the same instant opened with a stream of fire.	....	....	....	Communicated by Mrs. Nares.
....	....	Descending slantwise ...	....	J. B. Caudell.
Gradually diminished	10°	Directed from ϵ Cassiopeiæ.	....	A. S. Herschel.
Long train	....	....	....	E. J. Lowe.
....	....	....	....	W. H. Wood.
....	....	....	Very many meteors ...	E. J. Lowe.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Jan. 2	h m s 7 50 p.m.	Beeston Observatory.	3 times brighter than 1st mag.*	Intense blue...	....	Due N.E., started at altitude 45°, and moved perpendicularly downwards.
2	10 0 p.m. to 1 a.m.	Prestwitch (Manchester).	50 shooting-stars. 4, 14, 23, 2, 7 = 1st, 2nd, 3rd mag.*, &c.	All bright white.	3, 13, 6, $<\frac{1}{2}$ 1, 2 seconds, remainder not noted.	In all parts of the sky.
2	10 0 p.m. to midnight.	Hawkhurst (Kent).	50 shooting-stars. 3, 21, 17, 3, 6 = 1st, 2nd, 3rd mag.*, &c.	White or yellow.	1, 16, 14, 3, 4, $<\frac{1}{2}$, 1, $1\frac{1}{2}$, 2 and 3 secs.	In all parts of the sky.
2	10 45 p.m.	Weston - super - Mare.	= Sirius	Sirius	1 second	From Cassiopeia, halfway to the Pleiades.
2	11 0 p.m. to 11 30 p.m.	Bolton	10 shooting-stars...	....	....	From Head of Hydra to a point midway between Sirius and ε Canis Majoris.
3	About 8 p.m.	Liverpool.........	Large meteor	....	....	At a considerable altitude.
3	8 25 p.m.	Epping Forest (Essex).	Large meteor	Pale blue	Moved slowly	Sank below the N.N.E. horizon from altitude 10° or 12°.
7	8 36 p.m.	Weston - super - Mare.	Width half, length two-thirds of the moon's diameter.	Intense blue...	> 2 seconds; very slow.	Visible on two parts of the course from η Eridani to β Ceti. The third part of its course hidden by obstacles.
7	8 40 p.m.	Bridgewater (Somersetshire).	Large meteor	Blue-green ...	....	Descended towards the W.
7	8 40 p.m.	Dulverton (Somersetshire).	> the meteor of Dec. 27.	Diffused light, reddish.	10 or 15 secs..	Began 20° S.S.W. from Orion's Belt, at an altitude of 60°.
8	8 40 p.m.	Hawkhurst (Kent).	= 3rd mag.*	Yellow	0·6 second ...	From $\frac{1}{2}$ (β, ζ) to τ Tauri.
21	8 40 p.m.	Ibid	2 > Venus	Greenish yellow.	$1\frac{1}{2}$ second ...	From ι Draconis $\frac{2}{3}$ of the way to the horizon.

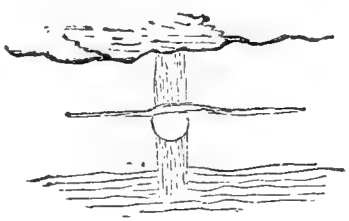
ppearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
....	....	....	....	E. J. Lowe.
ix left trains; one 2 > ♃ burst into sparks.	....	Two radiant-points; ζ Ursæ Majoris and Head of Bootes. The latter became well defined at 1^h a.m.	Most frequent from 11^h to 12^h p.m.	R. P. Greg.
eft no trains	....	Radiant-point at c Quadrantis Muralis; very definite.	....	A. S. Herschel.
....	....	....	From 12^h p.m. until 1^h or 2^h a.m. Jan. 3rd, shooting-stars fell one per minute.	Communicated by W. H. Wood.
wo very brilliant, and eight ordinary falling-stars.	....	....	....	Hugh Weightman.
....	....	Going N.N.W.	....	W. G. Drysdale.
ear-shaped, with a tail of red sparks.	....	Descended at an angle of 45°.	Clear sky	'The Standard.'
ear-shaped, with a tail. Illuminated the sky at last with three rapid flashes.	....	 Descended towards the W.	Tail and outline of meteor dimmed by fog. Last third part of the course hidden by obstacles.	W. H. Wood.
ast a strong light. Tail like that of a rocket.	....	Descended towards the W.	Gas-lights looked dim in the light.	A. Haviland.
igure and size of a walnut. Moved with a flickering light.	....	....	Illuminated the clouds like a bright aurora. No report in ten minutes.	C. M., 'The Times.'
o train or sparks	....	....	....	A. S. Herschel.
ear-shaped; left no train	8° or 10°...	....  To left from perpendicular.	Termination not seen ...	Id.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864.	h m s					
Jan. 21	8 40 p.m.	Lamberhurst (Kent).	Bright meteor ...	Yellow	....	Low in the N.......
21	8 55 p.m.	Hawkhurst (Kent).	2 > Venus	Greenish yellow.	3·5 seconds; relaxing its speed.	From ζ Leonis to a point near χ Leonis, R. A. 10^h 52^m, N. Decl. 12°.
21	10 0 p.m.	Ibid	=1st mag.*	White	0·4 second ...	From *p* to M Camelopardali.
23	About 8 p.m.	Liverpool.........	Large meteor	....	....	Commenced near α Cephei. Disappeared altitude 40° N.W.
29	8 30 p.m.	Hawkhurst (Kent).	=2nd mag.*	White	0·6 second ...	From *g* Lyncis, ⅓ of the course to ι Geminorum.
29	8 42 p.m.	Weston - super - Mare.	=Sirius	Orange colour	2·5 seconds ...	From stars (5), (8) to ε Andromedæ.
29	8 49 p.m.	Ibid	=3rd mag.*	Blue............	2·5 seconds; slow motion.	Commencement in R. A. 47°, S. Decl. 22°.
29	9 8 p.m.	Ibid	=1st mag.*.........	Blue	1 second	From Cor Caroli to λ Bootis.
29	9 15 p.m.	Hawkhurst (Kent).	=Sirius	White	0·7 second ...	From χ Herculis to δ Bootis.
29	9 27 p.m.	Ibid	=3rd mag.*	White	0·6 second ...	Commenced at γ Ceti.
Feb. 2	0 36 a.m.	Wimbledon (Surrey).	A clear disk. Seen through clouds which obscured Sirius.	....	Rather rapid flight for so large a meteor.	From α Hydræ, almost to the horizon.
3	10 30 p.m.	Southgate Road (London).	= δ Ursæ Majoris..	....	....	 In Ursa Major.

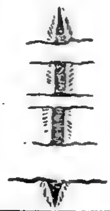
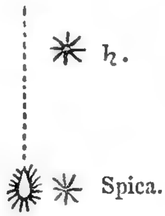
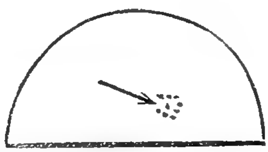
Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
....	....	 To left from perpendicular.	....	H. Hussey.
Slightly pear-shaped; diminished to a red spark. Left no train.	30°	Perpendicularly down...	....	A. S. Herschel.
....	....	....	Cloudy; full moon	Id.
Resembled the meteor of December 5, but not so large.	....	....	....	W. G. Drysdale.
No train or sparks	....	....	Clear sky	A. S. Herschel.
Left a ruddy train for 1 second, 10° in length.	....	....	....	W. H. Wood.
....	6°	Vertically down	....	Id.
....	....	....	Zodiacal light in the W. since the 1st of Jan.	Id.
No train or sparks	....	....	....	A. S. Herschel.
No train or sparks	6°............	Fell vertically	....	Id.
.... 	....	One or two degrees from perpendicular. Towards the right, down.	Nothing but a pale halo could be seen at the place of Sirius.	F. C. Penrose; communicated by J. N. Lockyer.
Exploded and turned round, with subdued light, as if to revolve round δ Ursæ Majoris.	....	....	An uncommon appearance.	Communicated by T. Crumplen.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864.	h m					
Feb. 5	7 55 p.m.	Hawkhurst (Kent).	=2nd mag.*	White	0·8 second ...	From κ Orionis ...
5	8 49 p.m.	Weston - super - Mare.	=1st mag.*.........	Dull blue	2·5 seconds ...	From λ Ursæ Majoris to ζ Leonis.
5	9 23 p.m.	Ibid	=3rd mag.*.........	Dull	1 second	From γ to α Leonis
6	7 5 p.m.	Hawkhurst (Kent).	=3rd mag.*	White	0·8 second ...	From *d* Ursæ Majoris, one-fourth of the course towards M. Camelopardali.
6	7 27 p.m.	Weston - super - Mare.	>1st mag.*	Yellow and white.	0·5 second ...	From ω Arietis to ν Piscium.
6	7 41 p.m	Hawkhurst (Kent).	=3rd mag.*	Dull	1·8 second ...	From φ to θ Andromedæ and ⅔ as far beyond.
6	7 50 p.m.	Ibid	=1st mag.*	White	2·5 seconds ...	From 1° S. of ζ Aurigæ to a point midway between α Arietis and β Triangulæ.
6	8 46 p.m.	Weston - super - Mare.	=Venus	Bright orange	2 secs., slow...	From β Canis Minoris to β Canis Majoris.
7	6 10 p.m.	Liverpool.........	Large meteor	....	....	Commenced near α Cephei. In the N.W. sky.
8	11 12 p.m.	Hawkhurst (Kent).	=2nd mag.*	Yellow	0·6 second ...	From α to δ Orionis
8	11 16 p.m.	Ibid	=2nd mag.*	Yellow	0·6 second ...	From *d* Telescopii to ι Geminorum.
8	11 19 p.m.	Ibid	=2nd mag.*	White	0·8 second ...	From ω to μ Andromedæ.
9	9 4 p.m.	Ibid	=2nd mag.*	White	0·6 second ...	From *u* Lyncis, halfway to μ Ursæ Majoris.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
No train or sparks	6°...........	Vertically down	....	A. S. Herschel.
Became extinct at the middle of its course and suddenly rekindled.	....	....	On the 4th of February, at 6^h 45^m p.m., zodiacal light as bright as Via Lactea Sagittarii; apex at π Arietis; south edge as sharply defined as an auroral streamer; north edge diffuse. Fluctuations in light and tint from atmospherical causes.	W. H. Wood.
....	....	....	....	Id.
No train or sparks	....	....	....	A. S. Herschel.
....	....	....	....	W. H. Wood.
No train or sparks	....	....	....	A. S. Herschel.
No train or sparks	....	Zodiacal light very bright. Axis from δ Piscium to δ Arietis.	....	Id.
Left a momentary train in three-fourths of its course, of ruddy colour.	....	....	....	W. H. Wood.
Resembled the meteor of December 5, but not so large.	....	....	....	W. G. Drysdale.
No train or sparks	....	....	....	A. S. Herschel.
No train or sparks	....	....	....	Id.
No train or sparks	....	....	....	Id.
No train or sparks	....	....	From 4^h 20^m to 4^h 40^m p.m., a vertical bar through the sun (see fig.). The lower branch projected nearly one diameter of the sun in front of a black cloud-bank below the sun.	Id.



Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Feb. 9	h m 9 12 p.m.	Hawkhurst (Kent).	=3rd mag.*	Yellow	0·7 second ...	From ζ to A Ursæ Minoris.
9	10 17 p.m.	Hay (S. Wales)...	About the greatest splendour of Venus.	Very fine yellow.	About 5 secs...	From a point one-third of the distance from Rigel to Sirius, to the horizon.
10	10 20 p.m.	Wolverhampton	Diameter 5′, or one-sixth diameter of the moon.	Bluish white, like Rigel.	$2\frac{3}{4}$ seconds while in sight.	From β Canis Minoris directly S. Termination concealed by buildings.
Mar. 1	8 14 p.m.	Hawkhurst (Kent).	=2nd mag.*	Orange.........	2·2 seconds ...	From ι to A Draconis.
1	9 35 p.m.	Weston-super-Mare.	=1st mag.*.........	Dull yellow ...	2·5 secs., slow	From σ Herculis to the horizon.
2	0 17 a.m.	Flimwell, Hurstgreen (Sussex).	= ♃	Topaz-yellow .	$1\frac{1}{4}$ second ...	From 4° N.E. of Saturn to 3° E. of Spica.
2	7 35 p.m.	Weston-super-Mare.	Very large meteor..	Blue and yellow.	....	Commencement 15° or 20° above the N.W. horizon.
5	8 to 9 p.m.	Hawkhurst (Kent).	Three falling stars..	....	$\frac{3}{4}$ second	From Polaris to γ Cephei.
6	7 50 p.m.	Manchester	Bright meteor	Bluish white...	Slow motion...	In the W., altitude 20°.
6	8 37 p.m.	Hawkhurst (Kent).	=3rd mag.*	....	1 second	From Polaris to γ Cephei.
9	9 30 to 10 30 p.m.	Prestwitch (Manchester).	Two shooting-stars	....	....	Near Polaris ......
12	0 30 a.m.	Ibid	Quarter diameter of the moon.	Red	....	In N.W., altitude 45°; from Capella to Cassiopeia.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
A misty object..............	....	....	....	A. S. Herschel.
....	....	Fell vertically	Continued its light undiminished (except by clouds) to the horizon.	T. W. Webb.
 Horizon.				
A well-marked disk with a steady light. Left no sparks.	Part of visible path 20°	N. to S.	....	T. M. Simkiss.
Fiery appearance. No train left.	....	....	....	A. S. Herschel.
View impaired by fog......	12°	Fell vertically............	....	W. H. Wood.
The meteor kept enlarging until it disappeared.	10° or 12°..	....  Fell vertically.	Saturn very brilliant ...	F. Howlett.
....	10° or 12°..	Inclined .... 	....	Communicated by W. H. Wood.
No sparks or trains.........	....	....	....	A. S. Herschel.
Occasionally obscured by clouds. Tailed.	15° or 20°..	....	....  Inclined.	E. Hardcastle.
....	....	....	....	A. S. Herschel.
One left a train	....	Directed from 10° above Polaris.	Radiant-point between Polaris and Capella.	R. P. Greg.
Burst with red sparks......	....	....  W. Horizon. N.	....	Communicated by R. P. Greg.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Mar. 24	h m 7 45 p.m.	Euston Road Observatory (London).	=Venus	Ruddy	3 seconds......	From between α, β Ursæ Majoris to between γ, η Virginis.
25	Between 8 and 9 p.m.	Lymington (Hants).	Very large meteor..	Quite white ...	Rapid	Tailed. Left a long streak. Vanished suddenly with many sparks.
29	10 47 p.m.	Hawkhurst (Kent).	=2nd mag.*	White	0·6 second ...	From δ Aurigæ to $\frac{1}{2}$ (b, d) Camelopardali.
29	10 57 p.m.	Ibid	=2nd mag.*	White	1 second	From a point $\frac{1}{3}$ (θ Draconis, γ Ursæ Minoris) to a point $\frac{1}{3}$ (κ Cephei, Polaris).
29	11 4 p.m.	Ibid	=2nd mag.*	White	1 second	From Regulus to Præsepe Cancri.
29	11 12 p.m.	Ibid	=3rd mag.*	Yellow	0·5 second ...	From θ Ursæ Majoris.
29	11 18 p.m.	Ibid	=3rd mag.*	Yellow	1 second ...	From 33 Cygni ...
29	11 19 p.m.	Ibid	=3rd mag.*	White	0·5 second ...	From 33 Cygni ...
29	11 37 p.m.	Ibid	=3rd mag.*	White	0·7 second ...	From a point $\frac{1}{3}$ (θ Draconis, ι Bootis), halfway towards ξ Cygni.
Apr. 2	8 5 p.m.	Weston-super-Mare.	=1st mag.*	Blue	2 seconds......	Three fourths of the course from Procyon to Sirius.
10	8 24 p.m.	Hawkhurst (Kent).	At first=1st mag.*, then=3rd mag.*	At first white, then red.	2·5 seconds ...	From λ Canis Minoris to a Monocerotis (Bode).
10	8 45 p.m.	Ibid	=Castor	White	1·3 second ...	From $\frac{1}{2}$ (δ Aurigæ, c Camelopardali) to $\frac{1}{2}$ (b, B) Camelopardali.
10	8 56 p.m.	Trafalgar Square (London).	=1st mag.*.........	....	....	From Arcturus to γ Coronæ.
10	9 30 p.m.	Royal Observatory, Greenwich.	2>1st mag.*	Yellow	About 2 secs.	From the zenith near α Ursæ Majoris to alt. 25°, a little left of Cassiopeia.
10	9 30 p.m.	Hawkhurst (Kent).	=Regulus	Brilliant white	4 secs.; very slow.	From $\frac{1}{2}$ (c Camelopardali, m Custodis) to $\frac{2}{3}$ (η, v) Persei.
10	9 42 p.m.	Ibid	=Capella, brilliant	Orange yellow	0·8 second ...	From p across L to S Camelopardali (Bode).
10	9 48 p.m.	Ibid	=2nd mag.*	Flame colour..	1·4 second ...	From $\frac{1}{2}$ (γ, δ) Ursæ Majoris to $\frac{1}{2}$ (d Ursæ Majoris, Q Camelopardali).

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Left no train			Seen by several persons	T. Slater.
From below Ursa Major to above Orion. Passed high above the Needles.	100°	E.S.E. to W.N.W., ascending.	Threw a strong light. Surrounded by sparks.	A. P. Falconer.
No train or sparks				A. S. Herschel.
Brushy appearance				Id.
Brightest at last				Id.
	3°	Towards χ Ursæ Majoris		Id.
	4°	Towards π Cygni		Id.
	3°	Towards ξ Cygni		Id.
				Id.
				W. H. Wood.
Small in half of its course	25°	Directed from ϵ Virginis		A. S. Herschel.
Brightest at first, gradually decreasing.	8°	Directed from γ Virginis		Id.
		Directed from ϵ Virginis		T. Crumplen.
Faint streak	50° or 55°	Direction N.	Corresponds to the following.	W. C. Nash, C. Jones, C. P. Trapaud.
Pear-shaped, leaving a long faint train for half a second.	25°	Directed from η Virginis	Disappeared without change. Train visible in moonlight.	A. S. Herschel.
Brightest at middle of its course, and deflected 20° or 30°.	10°	Quite crooked		Id.
Brushy appearance		Directed from ζ Virginis		Id.

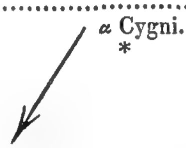
Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864.	h m					
Apr. 10	9 52 p.m.	Hawkhurst (Kent).	=Regulus	White	1·5 second ...	Across *f* Leonis to α Hydræ.
10	9 56 p.m.	Ibid	=3rd mag.*	Flame colour..	1 second	From ρ to α Leonis
10	10 7 p.m.	Ibid...............	=Denebola	White	1·7 second ...	From β to ½ (γ, ζ) Leonis.
10	10 54 p.m.	Ibid...............	=2nd mag.*	Yellowish......	1·2 second ...	From δ Leonis to *d* Leonis Minoris.
11	0 47 a.m.	Ibid	=2nd mag.*	Flame colour..	1·5 second ...	Across μ Bootis to τ Herculis.
11	2 30 a.m.	Wolverhampton.	> 1st mag.* ...... Nearly=♃.	Bright white..	....	From nearly overhead northwards.
11	9 35 p.m.	Tunbridge Wells (Kent).	=1st mag.*	....	....	From Polaris ......
11	About 10 0 p.m.	Prestwitch(Manchester).	=3rd mag.*	....	....	From π to ξ Leonis
13	0 58 a.m.	Hawkhurst (Kent).	=2nd mag.*	White	1·1 second ...	From *p* Mænali to γ Virginis.
13	1 43 a.m.	Ibid	=3rd mag.*	White	0·6 second ...	To μ Bootis, halfway from σ Herculis.
13	1 59 a.m.	Ibid	=2nd mag.*	Yellowish......	0·8 second ...	From π to ½ (ε, ζ) Herculis, and as far beyond.
13	2 2 a.m.	Ibid	=3rd mag.*	White	0·8 second ...	From *r* Canium Venat. to *c* Comæ Beren. (Bode).
13	2 16 a.m.	Ibid	=3rd mag.*	White	0·5 second ...	From *k* Lyncis......
13	2 22 a.m.	Ibid	=2nd mag.*	Yellow	0·4 second ...	From *g* Draconis to ζ Ursæ Minoris.
13	2 48 a.m.	Ibid	=2nd mag.*	Yellow	0·7 second ...	Centre ½ (α, β) Ophiuchi.
13	3 0 a.m.	Ibid	=3rd mag.*	Yellow	0·3 second ...	From ½ (μ Cygni, ι Pegasi) to κ Pegasi.
13	3 4 a.m.	Ibid	=2nd mag.*	Yellow	0·5 second ...	From θ to κ Draconis.
13	8 50 p.m.	London	=2nd mag.*	White	1 second	From β to α Ursæ Minoris.
13	9 23 p.m.	Ibid	=2nd mag.*	White	1 second	From β Ursæ Minoris to H Draconis.
15	2 9 a.m.	Hawkhurst (Kent).	=Arcturus	Like Arcturus	2·3 seconds ...	From τ Bootis......
15	2 31 a.m.	Ibid	=3rd mag.*	White	1 second	From τ, two-thirds of the course to *o* Virginis.
19	11 12 p.m.	Ibid	=3rd mag.*	White	0·8 second ...	From N Camelopardali to σ Ursæ Majoris.
20	0 17 a.m.	Ibid	=2nd mag.*	White	0·9 second ...	From ½ (*g*, ζ) Draconis to β Ursæ Minoris.

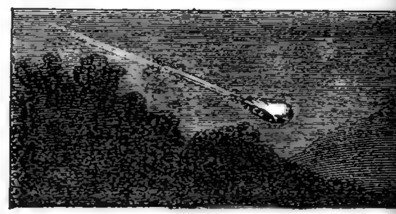
Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Stellar. Disappeared suddenly.	20°	Directed from ε Virginis	....	A. S. Herschel.
Brushy appearance	8°...........	Directed from η Virginis	Reddish aura	Id.
Brushy appearance	20°	Directed from ζ Virginis	Slight aura	Id.
Brushy appearance	20°	Directed from η Virginis	Aura about the nucleus	Id.
Brushy appearance	15°	Directed from θ Virginis	Slight aura	Id.
Left a bright train	Long flight	....	....	Communicated by T. M. Simkiss.
Faded away. Left a long luminous streak.	30°	Shot diagonally	....	J. Pope.
No train or sparks	....	....	....	R. P. Greg.
Left a train for 1 second...	30°	Directed from c Herculis	A fine shooting-star ...	A. S. Herschel.
Stellar nucleus. Bright...	6°...........	....	....	Id.
Stellar nucleus. Bright...	15°	....	....	Id.
Brushy appearance	20°	Directed from ο Herculis	Long and rapid	Id.
No train or sparks	....	Directed from β Herculis	....	Id.
Brushy appearance	15°	Directed from δ Herculis	Very rapid	Id.
Bright nucleus	10°	Directed from M Herculis	....	Id.
....	5°...........	Directed from μ Herculis	....	Id.
Bright nucleus	15°	Directed from K Herculis	Rapid	Id.
No train or sparks	....	....	....	T. Crumplen.
No train or sparks	....	....	....	Id.
Stellar nucleus. Bright...	6°...........	Directed from δ Virginis	Slow, foreshortened appearance.	A. S. Herschel.
A fine shooting-star; left a long train for 1 second.	20°	....	....	Id.
....	....	Directed from α Lyræ...	....	Id.
....	....	Directed from α Lyræ...	....	Id.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Apr. 20	h m s 0 40 a.m.	Hawkhurst (Kent).	=1st mag.*	Orange yellow	0·8 second	From ½ (α, β) Herculis to ½ (κ Ophiuchi, γ Herculis).
20	0 53 a.m.	Ibid	=1st mag.*	White	0·7 second	To χ from ½ (δ, ξ) Draconis.
20	0 59 a.m.	Ibid	=2nd mag.*	Yellow	0·7 second	To ½ (β, μ) Bootis, halfway from η Herculis.
20	1 28 a.m.	Wolverhampton	=3rd mag.*	Blue	......	From γ Ursæ Minoris to 40 Draconis.
20	1 57 a.m.	Hawkhurst (Kent).	=2nd mag.*	Yellow	0·9 second	From λ to δ Ophiuchi.
20	2 25 a.m.	Ibid	=2nd mag.*	Yellow	0·7 second	From 1° above α Lyræ to π Lyræ.
20	2 25 30 a.m.	Ibid	=1st mag.*	Yellow	0·8 second	From ⅓ (η, δ) to ⅓ (γ, λ) Cygni.
20	2 29 30 a.m.	Ibid	=2nd mag.*	Yellow	0·9 second	From ⅓ (α Lyræ, ι Herculis), halfway to *d* Draconis.
20	2 40 30 a.m.	Ibid	>1st mag.* Nearly = ♃.	White	0·9 second	To α Equulei, halfway from α Delphini.
20	2 40 a.m.	Trafalgar Square (London).	>1st mag.* Nearly = ♃.	Bright blue	¾ second	Disappeared at altitude 5°, 2½° W. of magnetic S.
20	2 55 30 a.m.	Hawkhurst (Kent).	=3rd mag.*	Dull	0·6 second	Fell vertically to α Delphini.
20	3 30 a.m.	Wolverhampton	= ♃	Golden red	......	From overhead towards the east horizon.
20	10 46 p.m.	Hawkhurst (Kent).	=2½ mag.*	Yellow	0·6 second	From ⅓ (ι, α) Draconis to ν Ursæ Minoris.
20	10 55 p.m.	Ibid	=1st mag.*	Yellow, at last orange.	1·2 second	From ½ (μ Bootis, ι Draconis) to λ Bootis and 4° beyond.
20	11 26 p.m.	Ibid	=3rd mag.*	White	1 second	From η Herculis to ζ Coronæ.
20	11 36 p.m.	Ibid	=3rd mag.*	White	1 second	On a line from α Draconis to ½ (O, N) Camelopardali. Centre midway.
20	11 40 p.m.	Ibid	=3rd mag.*	White	0·9 second	From ¼ (η, σ), halfway to ι Herculis.
21	11 20 p.m.	Wolverhampton	> ♃	Silvery blue	Very rapid	From overhead, descended to the west horizon.
25	11 30 p.m.	Nuneaton (Coventry).	3 > ♃	Pale blue	4 seconds; very slow.	From β to τ Virginis.

...ppearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
....	....	Directed from α Lyræ...	....	A. S. Herschel.
...eft a white train for 1 second.	....	Directed from α Lyræ...	....	Id.
....	....	Directed from Lyra ...	....	Id.
...eft a faint thin train......	....	....	....	T. M. Simkiss.
....	....	Directed from Lyra ...	....	A. S. Herschel.
...ery bright. Stellar nucleus.	....	Directed from Lyra ...	No train or sparks	Id.
...lassive (compact) appearance.	....	Directed from Lyra ...	No train or sparks	Id.
...ine in light and colour...	....	Directed from Lyra ...	No train or sparks	Id.
...isappeared at greatest brightness, leaving a white train at the spot for 4 seconds.	....	Directed from Lyra ...	Corresponds to Trafalgar Square, $2^h\ 40^m$ a.m.	Id.
...hrew off some dull sparks at disappearance. Left a train 5° long.	10°	Directed from Altair ...	....	T. Crumplen.
...o train or sparks	6°...........	Directed from Lyra ...	$3^h\ 15^m$ a.m.; dawn began.	A. S. Herschel.
...eft a bright train	....	....	....	Communicated by T. M. Simkiss.
...o train or sparks	....	....	....	A. S. Herschel.
...eft a train for 1 second..	....	Directed from Lyra ...	Last 4° of the course considerably deflected towards Ursa Major.	Id.
...o train or sparks	....	....	....	Id.
...o train or sparks	10°	....	....	Id.
...o train or sparks	....	....	....	Id.
Left a long bright train ...	....	....	....	Communicated by T. M. Simkiss.
Well-defined disk. Left no train.	....	....	....	T. M. Simkiss.

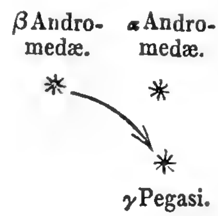
Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864.	h m					
Apr. 29	8 46 p.m.	Hawkhurst (Kent).	=Arcturus	Like Arcturus	2 seconds......	From β Ursæ Minoris to Polaris, and $\frac{1}{3}$ as far beyond.
29	10 20 p.m.	Ibid	=3rd mag.*	White	0·9 second ...	Centre ι Bootis ..
29	10 58 p.m.	Ibid	=2nd mag.*	Yellow	1 second	From ο Draconis to $\frac{1}{2}$.(ρ Draconis, α Cephei).
May 4	8 28 p.m.	Puycharnand (France).	3 > Venus	Brilliant white	$2\frac{1}{2}$ secs.; slow	From ζ Draconis to α Cephei.
13	9 24 p.m.	Greenwich	=2nd mag.*	White	0·5 second ...	Saw about 8° path of a meteor in N., altitude α Cygni; azimuth 10° W. of that star.
14	8 0 p.m.	Montauban (Toulouse, France).	> full moon	White	3 to 5 seconds	From Leo, passing east of Saturn and Spica to a few degrees below Jupiter.
17	4 0 p.m.	Weston-super-Mare.	Large meteor	....	2 or 3 seconds	Descended from altitude 45° due N.
17	10 45 p.m.	Hawkhurst (Kent).	=α Lyræ...........	White	Slow motion...	Between Auriga and Gemini.
28	10 1 p.m.	Hay (S. Wales)..	3 or 4 > ♃	White, like ♃	....	Blazed out $\frac{1}{3}$ or $\frac{1}{4}$ of the distance from Jupiter to Spica.
June 6	9 48 p.m.	Paris (France)...	6 > Venus	Nucleus, tail, and fragments white.	....	From between Corona and the feet of Hercules to between Perseus and Capella.
6	11 4 p.m.	Wolverhampton	=2nd mag.*	Bluish	2 seconds......	From δ Cygni to θ Persei.
7	0 10 a.m.	Ibid	=1st mag.*	White	2 seconds......	From overhead, halfway to the N.E. horizon.
7	0 17 a.m.	Ibid	=2nd mag.*	White	$\frac{1}{2}$ second	From τ Virginis to the horizon.
7	0 56 a.m.	Ibid	=2nd mag.*	Pale blue	2 seconds......	From ε Cassiopeiæ to ε Aurigæ.
7	10 0 p.m. ±	St. Heliers (Jersey).	Quarter diameter of the moon.	Yellow	Slow motion...	In the S.E., at an altitude of about 20°.
10	8 0 p.m.	Bagshot (Surrey)	Large meteor	Ruddy	Almost momentary.	In the S.E. sky, altitude about 30°.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
No train or sparks	30°	....	Interrupted view, cloudy sky.	A. S. Herschel.
No train or sparks	7°...........	Directed towards μ Bootis.	....	Id.
No train or sparks	....	....	....	Id.
Flickered like a candle-flame, and disappeared with two flashes.	....	....	Diffused considerable light.	'Les Mondes.'
Streak	8°...........	....	....	W. C. Nash.
Tailed meteor. Burst with a cloud of sparks, leaving a white streak for 15 or 30 minutes by different accounts.	....		See Appendix (No. III.) (Meteorites of Orgueil).	'Comptes Rendus.'
A globe and conical tail of light.	....	....	In full sunshine	Communicated by W. H. Wood.
No train or sparks	10° or 15°..	Fell vertically	....	A. S. Herschel.
At first a minute falling star; suddenly blazed out on a level with Jupiter, and falling 4° or 5°, attained three or four times his brightness.	15°	Quite vertically down...	Went out with a scattering of sparks.	T. W. Webb.
Circular, with compact conical tail. Broke into three fragments, which advanced 3° or 4° before they disappeared.	100°........	....	Diffused a considerable light; left no streak.	'Comptes Rendus.'
Left a short train; no sparks.	....	....	....	T. M. Simkiss.
Left a long train	....	....	....	Communicated by T. M. Simkiss.
No train or sparks	....	Fell vertically	....	T. M. Simkiss.
No train or sparks	....	....	....	Id.
Like a globe of light	....	Downwards from right to left. Very little inclined from horizontal.	....	Communicated by A. S. Herschel.
Broke into sparks before disappearing.	20° or 30°..	From left to right, inclining downwards.	....	J. Robertson.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864.	h m					
June 30	10 52 p.m.	Wolverhampton	=3rd mag.*	Pale blue	1½ second ...	From β Ophiuchi to γ Herculis.
July 4	9 57 p.m.	Ibid	Half diameter of the moon.	Greenish white	About 4 secs.; deliberate speed.	Disappeared above Jupiter, near β Libræ.
4	A few minutes before 10 p.m.	Bettws-y-Coed, R. Conway (N. Wales).	=12-inch globe at 200 yards.	Livid white ...	Slow; 5 or 6 seconds.	Appeared to be at the head of Conway valley, due S.
						
4	10 0 p.m.	Greenwich	=Jupiter...........	Bluish white...	2 seconds......	From ε Ursæ Majoris to a point below Spica Virginis.
5	0 30 a.m.	Fairseat, Wrotham (Sevenoaks).	Half the size of a full moon at the same altitude.	Bright golden colour.	A few seconds	First seen in S.E., at altitude about 10°.
						
16	10 55 p.m.	Hawkhurst (Kent).	=2nd mag.*	Bright white ..	1·3 second ...	From ι Herculis, halfway to α Lyræ.
20	10 45 p.m.	Wolverhampton	=3rd mag.*	Greenish	1 second	From α Pegasi to β Aquarii.
21	0 50 a.m.	Ibid	=2nd mag.*	Blue	1 second	From α to χ Ursæ Majoris.
24	10 5 p.m.	Beeston Observatory.	Large meteor	Blue	Slow motion...	Due N., alt. 50°; rose upwards.
28	9 40 p.m.	2½ miles N.W. from Wolverhampton.	3 > ♃	Orange.........	5 or 6 secs.; very slow motion.	From S.W., alt. 35°, to N.N.W., alt. 35°.
28	10 52 and 10 53 p.m.	Wolverhampton	Two meteors = 2nd mag.*	Orange and blue.	....	From δ Cygni to α Draconis.
28	11 50 p.m.	Ibid	2 > ♃	Intense white	....	From S.W., alt. 30°, to N.W., altitude 30°.
29	1 5 a.m.	Ibid	=1st mag.*	Bright orange colour.	....	From ζ Ursæ Majoris to Arcturus.
29	2 34 a.m.	Ibid	>2nd mag.*	Red	....	From α Cygni to α Draconis.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Left a short dull train ...	....	....	....	T. M. Simkiss.
The head flaming, with a long sparkling tail.	....	Directed from Polaris...	No other meteors above 5th magnitude observed on the same night.	Communicated by T. M. Simkiss.
Tail twenty times longer than the head. Outline of the meteor uncertain, and moving, close to the tail. Left a dusk-ashy streak across the sky for some little time.	....	From left to right, about 30° from horizontal, downwards.	....	H. Holiday.
Train seen 1 second	25° to 30°..	....	Partially cloudy; meteor seen this side of the clouds.	W. C. Nash.
A brilliant ball of fire, the light of which exceeded that of a full moon. Vanished suddenly. Collapsed like a soap-bubble.	....	 S.W. to N.E., or nearly S. to N., with a decided dip.	No tail and no train of sparks that could be observed, but any track it may have left was hidden by trees.	Communicated by W. E. Hickson.
Stellar nucleus. No train left.	....	....	Full moon, no other meteor in 30 minutes.	A. S. Herschel.
Left a long thin train......	....	....	....	T. M. Simkiss.
Left no train	....	....	....	Id.
Burst into a shower of sparks; left a train.	....	....	....	Miss Wilkinson.
Left a firm, distinct, unchanging train of moderate length.	....	Horizontal; left to right	Giving time for remarks	J. Mayfield.
Little or no trains	....	....	....	T. M. Simkiss.
Long feathery train	....	Horizontal; left to right	....	T. Lowe.
Left a short feathery train	....	....	....	T. M. Simkiss.
Left a long train...........	....	....	....	Id.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864.	h m					
July 29	10 0 p.m.	Wolverhampton	=2nd mag.*	Blue	....	From ζ Aquilæ to ζ Serpentis.
29	10 5 p.m.	Ibid	> ♃	Very red	Not less than 4 seconds.	From α Serpentis to χ Ursæ Majoris.
29	10 44 p.m.	Weston - super - Mare.	=3rd mag.*	Blue	½ second	From ε to *e* Pegasi.
29	10 45 p.m.	Greenwich	=1st mag.*.........	Blue	Less than 1 sec.	From β Andromedæ, curved towards α Andromedæ, and disappeared near γ Pegasi.
29	10 49 p.m.	Weston - super - Mare.	>1st mag.*	Brilliant blue	1 second ...	From α Lyræ to ξ Draconis.
29	10 57 p.m.	Ibid	=3rd mag.*	Blue	½ second ...	From λ Aquilæ ...
29	11 3 p.m.	Ibid	=Sirius	Orange.........	1½ second ...	From π Herculis to λ Serpentis.
29	11 40 p.m.	Greenwich	=2nd mag.*	Blue	Rapid; less than 1 sec.	From direction of α Lyræ, passed across β Draconis to θ Draconis.
29	11 42 p.m.	Ibid	=4th mag.*	....	Rapid motion	From the direction of α Andromedæ, passed rapidly across Cygnus, and disappeared near δ Cygni.
29	Midnight...	Ibid	=3rd mag.*	....	Momentary ...	A meteor appeared near Vulpecula, and disappeared almost immediately with scarcely any perceptible path; a flash only.
30	0 10 a.m.	Ibid	....	Blue	Very rapid motion.	From a point near ζ Cygni across α Aquilæ and about 15° beyond that star.
30	11 0 p.m.	Weston - super - Mare.	> 1st mag.*	Yellow	¾ second	From ε Ursæ Majoris to Cor Caroli.
30	11 18 p.m.	Wolverhampton	=2nd mag.*	Blue	2 seconds......	From α Aquilæ to δ Ophiuchi.
31	0 30 a.m.	Ibid	=2nd mag.*	Orange.........	1½ second ...	From *o* to χ Ursæ Majoris.
Aug. 1	9 54 p.m.	Weston - super - Mare.	>1st mag.*	Bluish white...	1 second	From ε Pegasi to θ Aquilæ.
1	9 57 p.m.	Ibid	>1st mag.*	Pale yellow ...	2 secs.; slow motion.	From ε to α Pegasi
2	10 15 p.m.	Ibid	=2nd mag.*	Colourless ...	½ second	From π to λ Sagittarii.
2	10 15 p.m.	Beeston Observatory (Nottingham).	Large meteor	Blue...........	....	Moved from N.E. to S.W., across the zenith.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
No train left				T. M. Simkiss.
Left a short train				Communicated by T. M. Simkiss.
				W. H. Wood.
No train				W. C. Nash.
Left a transient train				W. H. Wood.
	10°	Fell perpendicularly		Id.
Left a red train for 2 seconds.				Id.
Faint train				W. C. Nash.
	8°			Id.
	Less than 1°			Id.
No train	40°			Id.
Red tail for 2 seconds				W. H. Wood.
Left no train				T. M. Simkiss.
No train left				Id.
Left a white train				W. H. Wood.
Left a white train				Id.
				Id.
Left a train				Miss Wilkinson.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Aug. 2	h m 10 55 p.m.	Wolverhampton	=2nd mag.*	Orange.........	1½ second ...	From δ Cassiopeiæ to ε Persei.
2	11 25 p.m.	Greenwich	=1st mag.*.........	Blue	....	To γ Draconis......
2	11 27 and 11 29 p.m.	Ibid	Small meteors......	Blue	Rapid motion..	Two small meteors seen beneath Ursa Major.
3	8 30 p.m.	Cherbourg (France).	Large fireball	Yellowish ...	Very slow motion.	A few degrees above the south horizon.
4	10 10 p.m.	Hay (S. Wales)..	=1st mag.*	Whitish	....	Centre midway between Wega and γ, β Draconis.
4	10 17 p.m.	Ibid	=1st mag.*	....	....	From ε Cygni to m Scutum Sobieski.
4	10 22 p.m.	Wolverhampton	>2nd mag.*	White	....	From α Draconis to Arcturus.
4	10 35 p.m.	Greenwich	Very brilliant meteor.	Blue	1 second	Passed above the tail-stars of Ursa Major to ε Boötis.
4	10 38 p.m.	Hay (S. Wales)..	=1st mag.*	....	....	From Scutum Sobieski to Bow of Sagittarius.
4	10 45 p.m.	Greenwich	=2nd mag.*	Blue	1½ second ...	From Vulpecula, across Corona Borealis.
4	10 50 p.m.	Hawkhurst (Kent).	=3rd mag.*	Colourless ...	....	From α Cygni to Head of Draco.
4	10 57 p.m.	Ibid	=2nd mag.*	Colourless ...	....	From ½ (β, η) Pegasi nearly to α Pegasi.
4	11 3 p.m.	Ibid	=3rd mag.*	Colourless ...	....	From ½ (β, η) Pegasi, nearly to α Pegasi, inclining towards γ Pegasi.
4	11 8 p.m.	Wolverhampton	=2nd mag.*	Golden yellow	....	From α Aquilæ to η Serpentis.
5	1 0 a.m. to 1 30 a.m.	Weston - super - Mare.	Many 1st and 2nd mag. shooting-stars.	....	....	Radiant near the Pleiades.
5	2 25 a.m.	Wolverhampton	=2nd mag.*	White	1½ second ...	From α Ceti towards the south horizon.
5	10 25 p.m.	Ibid	>2nd mag.*	White	2 seconds......	From ψ Ursæ Majoris to 12 Comæ Berenices.

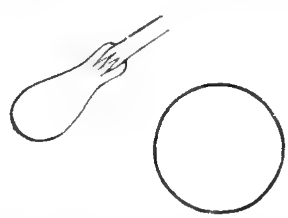
Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Left a short train		No observed uniformity of direction.	A great number of small meteors all night.	T. M. Simkiss.
Train		Directed from β Pegasi.		W. C. Nash.
	Short paths	Inclination W. E. 		Id.
Conical; increased as it descended. Burst with a shower of sparks.			From W.S.W. to E.N.E.	'Galignani.'
Left a transient streak, brightest and broadest in the middle.		N.N.E. to S.S.W.		T. W. Webb.
Left a train		Down the following branch of the Milky Way.		Id.
No train or sparks				T. M. Simkiss.
Fine train; lasted one second after meteor's disappearance.		Directed from α Draconis.		W. C. Nash.
Brightest at middle of its course.				T. W. Webb.
Faint train				W. C. Nash.
Left a golden-yellow train			Bright and steady	Communicated by A. S. Herschel.
Slight train				Id.
				Id.
Left a long sparkling train				T. M. Simkiss.
		General direction towards β Tauri.		W. H. Wood.
No train or sparks				T. M. Simkiss.
No train or sparks				Id.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Aug. 6	h m 9 12 p.m.	Hawkhurst (Kent).	=3rd mag.*	....	....	Passed across λ Andromedæ and γ or α Cassiopeiæ.
6	9 22 p.m.	Ibid	=3rd mag.*	....	....	From ½ (μ Pegasi, λ Andromedæ) to ½ (β Pegasi, α Andromedæ).
6	10 18 p.m.	Stanstead, Sevenoaks (Kent).	Somewhat smaller than full moon.	White on first appearance; but the two bodies into which it divided red and blue.	About half a minute.	First seen in the eastern part of the heavens, at an altitude of 50°.
6	10 20 p.m.	Fairseat, Wrotham (Kent).	A small disk, but as bright as the moon.	Dazzling light blue.	....	In the eastern sky; from altitude 60° to altitude 15°.
6	10 21 p.m.	Luxembourg, Paris.	Fireball, 1½–3 > Venus.	White, then blue, at length green.	3 seconds......	From between η and β Persei (near γ Persei), to the horizon, N.W.
6	11 4 p.m.	Hawkhurst (Kent).	=3rd mag.*	....	½ second	From below θ Cassiopeiæ to below β Pegasi.
6	11 6 p.m.	Ibid	=α Lyræ	White	Nearly 1 sec...	Two or three degrees above and left of η Aquarii.
6	11 15 p.m.	Ibid	=2nd mag.*	....	Slow; 1½ sec.	From 2° east of Polaris towards Capella.
6	11 19 p.m.	Ibid	=3rd mag.*	....	½ second	From ½ (α Andromedæ, β Pegasi) to ½ (α Andromedæ, γ Pegasi).
6	11 33 p.m.	Ibid	=2nd mag.*	....	¾ second	On a line from γ Draconis to α Ophiuchi, nearly the whole way.
7	0 15 a.m.	Ibid	=2nd mag.*	....	Quick	From ½ (α, γ Pegasi) to 2° above α Aquarii.
7	0 18 a.m.	Greenwich	=2nd mag.*	Blue	Almost momentary.	From δ Aquilæ towards the south horizon.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
No train or sparks	....	....	....	Communicated by A. S. Herschel.
No train or sparks	....	....	....	Id.
A bright white oval ball, much larger than Jupiter, which separated into two flambeaux of red and blue. Both suddenly vanished, one a little before the other.	....	From S. to N., with an inclination towards the earth.	Attracted much attention about Wrotham from its brilliancy.	W. Nunn.
The disk was small but very brilliant, and vanished suddenly in mid-air.	....	Almost perpendicular; thus— 	....	W. E. Hickson.
Began as a first magnitude star. Disappeared when two or three times the brightness of Venus.	25°	S.E. to N.W.	Centre of the visible path 40° E. for N., altitude 20°.	G. Chapelas, and Coulvier-Gravier.
Left a train	....	On a line from B Camelopardi to α Pegasi.	....	Communicated by A. S. Herschel.
Star-like. Disappeared suddenly at brightest.	Almost stationary.	Fell slightly south-eastwards.	....	Id.
Increased until disappearance.	....	....	....	Id.
No train or sparks	....	Directed from α Cygni..	....	Id.
No train or sparks	....	....	....	Id.
No train or sparks	....	....	....	Id.
Left a faint train	15°	.... 	....	W. C. Nash.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Aug. 7	h m s 9 45 p.m.	Hawkhurst (Kent).	=2nd mag.*	Bright white...	....	Through Taurus Poniatowski.
7	9 50 p.m.	Ibid	=3rd mag.*	....	....	Centre 5° below γ Pegasi.
7	9 55 p.m.	Ibid	= ♃	Red	Swift	On a line from α Pegasi through η Aquarii, nearly to the horizon.
7	10 42 p.m.	Ibid	=2nd mag.*	....	....	From *b* Muscæ to α Arietis.
7	10 42 p.m.	Ibid	=1st mag.*	....	....	In Lacerta ....
8	10 13 p.m.	Weston-super-Mare.	=2nd mag.*	Blue	0·5 second ...	From η Ursæ Majoris to α Bootis.
8	10 16 30 p.m.	Greenwich	....	Blue	Rapid motion	From direction of γ Draconis to ε Bootis.
8	10 37 p.m.	Hawkhurst (Kent).	=2nd mag.*	Reddish	Slow motion ..	Nearly to δ Aquarii
8	10 40 p.m.	Greenwich	=2nd mag.*	Blue	Very rapid motion.	From a point 3° above Polaris, almost to α Draconis.
8	10 44 p.m.	Hawkhurst (Kent).	=1st mag.*	White	Slow motion ..	From α Pegasi towards Cassiopeia. Passed below ι, κ, λ Andromedæ.
8	10 45 p.m.	Ibid	= ♃	....	Slow............	From under ι, κ, λ Andromedæ towards α Pegasi.
8	10 54 p.m.	Ibid	=3rd mag.*	....	....	Centre 5° W. of α Pegasi.
8	10 58 p.m.	Hawkhurst (Kent).	=3rd mag.*	....	....	Nearly from φ to λ Aquarii.
8	11 2 p.m.	Ibid	=3rd mag.*	....	....	From 3° below *b* Muscæ to 3° below α Arietis.
8	11 7 p.m.	Ibid	=1st mag.*.........	....	....	Between α Lyræ and Head of Draco.
8	11 17 p.m.	Ibid	=3rd mag.*	....	....	From δ Cygni along the Milky Way.
8	11 20 p.m.	Ibid	=2nd mag.*	....	....	From ι Cassiopeiæ to σ Cephei.
8	11 20 p.m.	Greenwich	=3rd mag.*	Blue	Rapid	In N., fell perpendicularly towards the horizon in Camelopardus.
8	11 20 30 p.m.	Hawkhurst (Kent).	=3rd mag.*	....	....	To λ Persei, halfway from H Camelopardi.
8	11 25 p.m.	Ibid	=1st mag.*	....	....	Parallel to and close to α, β Cygni.
8	11 25 p.m.	Greenwich	Small	Blue............	Momentary ...	Near Cepheus; a short path only.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
No train or sparks	Short	Directed from B Camelopardi.	....	Communicated by A. S. Herschel.
....	12°	Directed from γ Andromedæ.	....	Id.
No train or sparks; large	6° or 8° ...	....	In haze of horizon	Id.
Train ½ second	Short path..	....	....	Id.
Surrounded by aura of sparks. Train 1 second.	Short path..	Directed from Cassiopeia.	....	Id.
....	....	....	Sky overcast	W. H. Wood.
No train	15°	....	Occasionally cloudy ...	W. C. Nash.
....	15°	Directed from α Andromedæ.	....	Communicated by A. S. Herschel.
Train	7° or 8° ...	Horizontal	....	W. C. Nash.
Left a fine train distinctly separated from the head.	....	....	....	Communicated by A. S. Herschel.
No train left	Short course	Directed from H Camelopardi.	Returned on course of the last.	Id.
....	Short course	Fell vertically	....	Id.
....	....	....	....	Id.
Left a train	....	....	....	Id.
No train left	....	Conformable to B Camelopardi.	....	Id.
....	....	Conformable to B Camelopardi.	....	Id.
....	....	....	....	Id.
....	....	Perpendicular	....	W. C. Nash.
....	....	....	....	Communicated by A. S. Herschel.
Left a train for ½ second...	....	....	....	Id.
....	2°...........	....	....	W. C. Nash.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864.	h m s					
Aug. 8	11 28 p.m.	Hawkhurst (Kent).	=3rd mag.*	....	....	From ε Cygni to *l* Scuti Sobieski.
8	11 29 p.m.	Ibid	=2nd mag.*	....	....	From ½ (α, β) to *k* Aquarii.
8	11 45 p.m.	Ibid	=3rd mag.*	....	....	Nearly to Fomalhaut.
8	11 48 p.m.	Ibid	=♃	....	....	From γ Pegasi to ω Piscium.
8	Midnight...	Greenwich	=2nd mag.*	Blue	....	Across α Coronæ Borealis.
9	0 4 a.m.	Ibid	=1st mag.*.........	Blue; very brilliant.	1 to 2 seconds	From Cepheus to β Pegasi.
9	0 13 a.m.	Hawkhurst (Kent).	=♃	Greenish white	....	From (*b*) Muscæ, halfway to γ Andromedæ.
9	0 17 a.m.	Ibid	Nearly=♃	White	....	From ν Persei, halfway to η Tauri (Pleiades).
9	0 50 a.m.	Luxembourg (Paris).	Fireball, 2 > Venus	....	....	Centre 10° W. from N., altitude 18°; towards the N. horizon.
9	0 52 a.m.	Hawkhurst (Kent).	Fireball ½ diameter of full moon. 	White, green, and yellow.	Not more than 1½ second.	From *b* Camelopardi to *d* Aurigæ. Reached its full dimensions near *i* Aurigæ.
9	8 50 p.m.	Beeston Observatory.	=2nd mag.*	Orange	0·5 second ...	From α Ophiuchi, moving towards ξ Ophiuchi.
9	9 22 p.m.	Ibid	=3rd mag.*	Orange red ...	0·1 second ...	Across α Andromedæ.
9	9 31 p.m.	Ibid	=3rd mag.*	Blue...........	0·1 second ...	Upwards through Cassiopeia.
9	9 33 p.m.	Ibid	=2nd mag.*	Orange red ...	0·2 second ...	In the zenith ......
9	9 52 p.m.	Ibid	=1st mag.*	Orange.........	0·3 second ...	Across Polaris......
9	10 1 p.m.	Ibid	=4th mag.*	Colourless ...	0·1 second ...	N. of Nebula in Perseus.
9	10 1 7 p.m.	Ibid	=4th mag.*	Colourless ...	0·1 second ...	Same place and similar to the last.
9	10 2 5 p.m.	Ibid	=3rd mag.*	Colourless ...	0·1 second ...	From 1° E. of 115 Persei.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Brightest in middle of its course. Long train left.	....	....	....	Communicated by A. S. Herschel.
Began suddenly; broad train.	Short course	....	....	Id.
No train left	15°	Directed from α Andromedæ.	....	Id.
Grew to the size of Jupiter. No train or sparks.	....	....	....	Id.
....	....	Directed from γ Draconis.	....	W. C. Nash.
Fine train	30°	Due S.	....	Id.
Left no train	Short path..	....	....	Communicated by A. S. Herschel.
Left no train	....	Directed from α Persei	....	Id.
Followed by a train of greenish and bluish light.	10°	From S. to N.	....	G. Chapelas, and Coulvier-Gravier.
At first a minute star; widened quickly to a brilliant white head greater than a quarter of the moon, followed by a greenish neck or fringe, and a band of gold-coloured sparks. The whole vanished together suddenly. Left no train.	12°	Directed from B Camelopardi.	....	Communicated by A. S. Herschel.
No train	20°	....	....	E. J. Lowe.
Train of sparks	14°	....	....	Id.
Streak left	4°	....	....	Id.
Streak	7°............	Directed from Perseus...	....	Id.
Streak	....	Directed from Perseus...	....	Id.
Streak	1°............	....	....	Id.
Streak	....	....	....	Id.
Streak	3°............	Downwards at an angle of 40°.	....	Id.

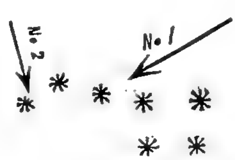
Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Aug. 9	h m s 10 3 p.m.	Greenwich	=3rd mag.*	Blue	1 second	From Equuleus towards the S. horizon.
9	10 4 6 p.m.	Beeston Observatory.	=2nd mag.*	Orange red ...	0·1 second ...	Across Aries ......
9	10 5 p.m.	Greenwich	=1st mag.*.........	Blue, brilliant	1 second	From a point between β and η Pegasi to the left of α Pegasi.
9	10 6 10 p.m.	Beeston Observatory.	=4th mag.*	Colourless ...	0·1 second ...	Halfway between α and β Persei.
9	10 8 p.m.	Ibid	=2nd mag.*	Orange	0·2 second ...	Near Polaris ......
9	10 12 10 p.m.	Ibid	=3rd mag.*	Orange	0·1 second ...	In zenith ....
9	10 14 p.m.	Ibid	=2nd mag.*	Colourless ...	0·1 second ...	In zenith ....
9	10 17 5 p.m.	Ibid	=2nd mag.*	Red	0·3 second ...	Across η Ursæ Majoris.
9	10 19 p.m.	Greenwich	=1st mag.*	Blue...........	1 second	From ε Cygni, across Delphinus and θ Aquilæ; disappeared 10° beyond the latter star.
9	10 23 p.m.	Beeston Observatory.	=3rd mag.*	Orange red ...	0·1 second ...	Just below No. 115 Persei.
9	10 25 p.m.	Ibid	=1st mag.*.........	Orange red ...	0·7 second ...	From γ Ursæ Minoris towards γ Bootis.
9	10 25 p.m.	Weston-super-Mare.	Larger than 1st mag.*	Reddishyellow	1·5 second ...	From α Herculis to R. A. 251°, Decl. S. 12°.
9	10 26 p.m.	Ibid	=3rd mag.*	Blue	1 second	From R. A. 268°, Decl. N. 7°, to R. A. 280°, Decl. S. 3°.
9	10 27 20 p.m.	Beeston Observatory.	=3rd mag.*	Orange red ...	0·1 second ...	In zenith ....
9	10 30 p.m.	Ibid	=1st mag.*.........	Orange red ...	0·7 second ...	From η towards θ Persei.
9	10 31 p.m.	Weston-super-Mare.	=2nd mag.*	Yellow	1 second	Through (12), (13) Camelopardi.
9	10 32 p.m.	Ibid	=1st mag.*	Blue	2 seconds ...	From R. A. 75°, Decl. N. 83°.
9	10 32 p.m.	Greenwich	=1st mag.*	Blue	1 second	To Equuleus ......

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Slight train	....	....	Fine clear night	W. C. Nash.
				
Streak	18°	....	....	E. J. Lowe.
Train	15°	....	....	W. C. Nash.
No sparks	....	Directed from No. 115 Persei, rose nearly perpendicular upwards.	....	E. J. Lowe.
Streak	11°	Directed from No. 115 Persei.	....	Id.
Streak	3°........	....	....	Id.
Streak	3°........	....	....	Id.
Streak	18°	Directed from No. 115 Persei.	....	Id.
Fine train, lasted 2 secs...	45°	....	....	W. C. Nash.
Streak	½°........	....	....	E. J. Lowe.
Streak	23°	....	....	Id.
Tail of sparks for 2 seconds	....	....	Overcast on the 8th, and partially cloudy on the 9th.	W. H. Wood.
....	....	....	....	Id.
Streak	....	....	....	E. J. Lowe.
Streak	2°........	....	....	Id.
Tail	14°	Horizontal	....	W. H. Wood.
Tail	25°	40° left of ⊥ downwards	Slow	Id.
Train	....	Directed from α Andromedæ.	....	W. C. Nash.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Aug. 9	h m s 10 32 30 p.m.	Greenwich	=1st mag.*	Blue	1 second	From the centre of the space between Cassiopeia and Perseus due N. towards the horizon. Point of disappearance 30° perpendicularly below Polaris.
9	10 35 p.m.	Weston-super-Mare.	Larger than 1st mag.*	Blue	¼ second	Through (12), (13) Camelopardi.
9	10 36 p.m.	Ibid	=1st mag.*	Blue	1 second	α Cassiopeiæ to γ Andromedæ.
9	10 37 p.m.	Ibid	=2nd mag.*	Blue	1 second	From α Cassiopeiæ northwards.
9	10 42 p.m.	Beeston Observatory.	=3rd or 4th mag.*	....	0·2 second ...	5° below No. 115 Persei.
9	10 46 20 p.m.	Ibid	=3rd mag.*	Orange red ...	0·2 second ...	In Cassiopeia towards Polaris.
9	10 47 p.m.	Hawkhurst (Kent).	=4th mag.*	....	....	On the line from α Lyræ to α Herculis. Centre halfway.
9	10 48 p.m.	Beeston Observatory.	=3rd mag.*	Colourless ...	0·1 second ...	Near Polaris ......
9	10 51 p.m.	Hawkhurst (Kent).	=Polaris	....	....	From 2° below Polaris to *i* Draconis.
9	10 54 p.m.	Beeston Observatory.	=4th mag.*	Colourless ...	0·1 second ...	In Aquila ....
9	10 57 p.m.	Weston-super-Mare.	=2nd mag.*	Blue	1 second	From μ to ε Sagittarii.
9	10 59 30 p.m.	Beeston Observatory.	=2nd mag.*	Red	0·3 second ...	From near 115 Persei.
9	11 0 p.m.	Hawkhurst (Kent).	= α Aquilæ.........	....	....	From ζ Draconis, ¾ of the way to η Herculis.
9	11 2 p.m.	Ibid	=2nd mag.*	....	....	From ε Aquilæ to *l* Scuti Sobieski.
9	11 2 30 p.m.	Ibid	= α Cygni	Bright white...	....	From ζ or σ Cephei across δ Cygni to F, K Cerberi, and 2° or 3° further.
9	11 2 30 p.m.	Greenwich	Small, =5th mag.*	....	....	A short path of 3° or 4° between Vulpecula and Delphinus.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Train	....	....	....	W. C. Nash.
A flash; left a train	3°...........	Horizontal	....	W. H. Wood.
....	....	....	....	Id.
....	15°	....	....	Id.
Streak	3°...........	To N., falling down towards the N. horizon.	....	E. J. Lowe.
Streak	....	....	....	Id.
....	5°...........	....	....	Communicated by A. S. Herschel.
Streak	....	Directed from the Nebula in Perseus.	....	E. J. Lowe.
Left a train	....	....	....	Communicated by A. S. Herschel.
Streak	....	Discordant	....	E. J. Lowe.
Tail	....	....	....	W. H. Wood.
Streak	2°...........	Perpendicularly downwards.	....	E. J. Lowe.
....	....	....	....	Communicated by A. S. Herschel.
Left a train	....	....	....	Id.
Left a pale golden-yellow train considerably separated from the head; spindle-shaped, shorter than the path, and lasting three-quarters of a second after disappearance of the head.	40°	....	....	Id.
No train	3° or 4° ...	Vertically downwards...	....	W. C. Nash.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864.	h m s					
Aug. 9	11 3 p.m.	Greenwich	=1st mag.*	Bluish white...	1½ second ...	To Delphinus ......
9	11 5 7 p.m.	Beeston Observatory.	=2nd mag.*	Blue	0·2 second ...	Near E. horizon ...
9	11 6 p.m.	Weston-super-Mare.	=2nd mag.*	Blue	1 second	η to ζ Pegasi ......
9	11 6 p.m.	Ibid	=2nd mag.*	Blue	1 second	η to g Pegasi ......
9	11 6 30 p.m.	Beeston Observatory.	=2nd mag.*	Colourless ...	0·2 second ...	In S. ....
9	11 10 5 p.m.	Ibid	=4th mag.*	Colourless ...	0·1 second ...	In Perseus ....
9	11 10 20 p.m.	Ibid	=3rd mag.*	Colourless ...	0·1 second ...	Through ϵ Cassiopeiæ.
9	11 10 40 p.m.	Ibid	=5th mag.*	Colourless ...	0·1 second ...	Through 115 Persei
9	11 14 6 p.m.	Ibid	=4th mag.*	Colourless ...	0·1 second ...	Near 115 Persei ...
9	11 15 p.m.	Greenwich	=1st mag.*	Blue	1 to 2 seconds	To β Bootis ......
9	11 18 p.m.	Ibid	=Venus	Orange	1 to 2 seconds	From the left of α Lyræ to a group of small stars near γ Ophiuchi.
9	11 19 30 p.m.	Beeston Observatory.	=2nd mag.*	Orange red ...	0·2 second ...	In zenith ....
9	11 20 p.m.	Weston-super-Mare.	Larger than 1st mag.*	Red	2 seconds......	α Capricorni to χ Sagittarii.
9	11 22 30 p.m.	Beeston Observatory.	=1st mag.*	Yellowish......	Rapid	Across Polaris and over Kochab.
9	11 23 40 p.m.	Ibid	=1st mag.*	Yellowish......	Rapid	2° below χ Draconis, passing half-way between δ and ϵ Ursæ Majoris.
9	11 24 25 p.m.	Ibid	=4th mag.*	Yellowish......	Rapid	From δ to γ Cassiopeiæ.
9	11 25 p.m.	Ibid	=2nd mag.*	Yellowish......	Rapid	From Polaris across Ursa Minor.
9	11 26 p.m. (2 meteors).	Greenwich	No. 1 =2nd mag.* No. 2 = 4th mag.*	Both blue ...	Each lasted 1 second.	In N., in the vicinity of Ursa Major: No. 1, from the direction of Polaris almost to ϵ Ursæ Majoris; No. 2, traversed a short distance in the direction of the horizon near η Ursæ Majoris.
9	11 26 p.m.	Weston-super-Mare.	=2nd mag.*	Blue	1 second	From η Ursæ Majoris to Cor Caroli.
9	11 27 p.m.	Beeston Observatory.	=5th mag.*	Yellowish......	Rapid	In zenith ....
9	11 29 10 p.m.	Ibid	=2nd mag.*	Orange red ...	Slow, duration 2 seconds.	From 3½° above No. 114 Persei across ϵ Cassiopeiæ.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Fine train; lasted 2 secs.	30°	Directed from α Cassiopeiæ.		W. C. Nash.
			Lightning at the same time.	E. J. Lowe.
Tail			Fell together.	W. H. Wood.
Tail				
Streak			Only a glimpse caught.	E. J. Lowe.
Streak	1°			Id.
Streak	6°	Upwards		Id.
Streak	1°	Horizontally towards N.		Id.
Streak	1°	Moved upwards		Id.
Train; lasted 2 seconds	20° ±	Directed from γ Draconis.		W. C. Nash.
Fine train; lasted 3 secs.	30° +		A magnificent meteor.	Id.
Streak	10°	Moving towards Altair.		E. J. Lowe.
Red tail; 2 seconds				W. H. Wood.
Long train			Lightning in E. at the same time.	E. J. Lowe.
Long train	21°			Id.
Short train	3½°			Id.
Short train				Id.
No. 1, train; No. 2, none	No. 1=15°; No. 2=3° or 4°.	 Ursa Major.	Two meteors appeared almost simultaneously.	W. C. Nash.
				W. H. Wood.
	2°			E. J. Lowe.
Many sparks	4½°	Upwards		Id.

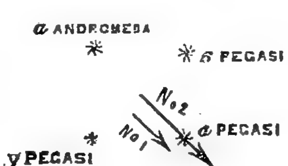
Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Aug. 9	h m s 11 30 27 p.m.	Beeston Observatory.	=1st mag.*	Red	Rapid	From τ Andromedæ towards η Andromedæ, disappearing 5° before reaching that star.
9	11 30 30 p.m. (2 meteors).	Greenwich	Both 2nd or 3rd mag.*	Blue	Each lasted 1 second.	In the vicinity of Ursa Major: No. 1 directed upon ε Ursæ Majoris, and No. 2 passed a few degrees to the right of β Ursæ Majoris; direction parallel to a line joining α and γ Ursæ Majoris.
9	11 30 45 p.m.	Ibid	Small	Blue	Less than 1 sec.	From the right of α Persei to γ Persei.
9	11 33 30 p.m.	Ibid	=2nd mag.*	Blue	1 second	From a point to the right of α Persei, to β Persei.
9	11 37 35 p.m.	Beeston Observatory.	=2nd mag.*	Red	Rapid	From 0° 30′ below α Arietis to 2° 30′ below γ Arietis.
9	11 38 3 p.m.	Ibid	=1st mag.*	Red	Rapid	1° above γ Andromedæ to 1° above α Trianguli.
9	11 38 10 p.m.	Ibid	=3rd mag.*	....	Rapid	1° above γ to 1° above α Andromedæ.
9	11 38 30 p.m.	Ibid	=2nd mag.*	Yellow	Rapid	From θ across γ Ursæ Minoris.
9	11 38 40 p.m.	Ibid	=2nd mag.*	Yellow	Rapid	From 0° 30′ above β to 1° above γ Arietis.
9	11 39 p.m.	Greenwich	=2nd mag.*	....	1 second	On the right of Perseus.
9	11 39 p.m.	Ibid	=2nd mag.*	Blue	1 second	From a point 10° to the left of β Aurigæ towards N. horizon.
9	11 39 30 p.m.	Ibid	....	Blue	1 second	A few degrees W. of the place of preceding meteor, nearly the same altitude.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Long streak..................	16°	....	....	E. J. Lowe.
No. 1, train ; No. 2, train	No. 1=5° ; No. 2=10° or 12°.	.... 	These meteors appeared with an interval of about 3 seconds between them.	W. C. Nash.
No train	10°	....	....	Id.
Faint train	10°	....	....	Id.
Train of sparks	....	....	....	E. J. Lowe.
Train of sparks	14°	....	....	Id.
....	....	....	....	Id.
Train of sparks	....	....	....	Id.
Train of sparks	....	....	....	Id.
Train visible 2 seconds ...	8°............	.... 	....	W. C. Nash.
Train	10°	.... 	....	Id.
Train	8° or 10°...	Path parallel to that of the preceding meteor. 	....	Id.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864.	h m s					
Aug. 9	11 41 31 p.m.	Beeston Observatory.	=4th mag.*	Yellow	Rapid	Across Polaris ...
9	11 42 3 p.m.	Ibid	=4th mag.*	Yellow	Rapid	From δ Ursæ Majoris.
9	11 43 30 p.m.	Greenwich	=2nd mag.*	Blue	1 second	To a point midway between Capella and β Aurigæ, from 11° above.
9	11 44 45 p.m.	Beeston Observatory.	=2nd mag.*	Yellow	Rapid	Across Polaris ...
9	11 46 p.m. (2 meteors.)	Ibid...............	=2nd mag.* ...... =3rd mag.*	....	....	One from 41 Muscæ Borealis towards the east horizon, the other from λ Andromedæ across η Pegasi.
9	11 46 5 p.m.	Ibid...............	=3rd mag.*	....	....	From τ across μ Cygni.
9	11 48 p.m.	Greenwich	=2nd mag.*	Blue	1 second	Across the Pleiades towards horizon.
9	11 48 p.m.	Ibid	=2nd mag.*	Blue	Less than 1 second.	In the space between the upper part of Auriga, and Perseus.
9	11 48 10 p.m.	Beeston Observatory.	=2nd mag.*	Red	Slow............	1° below the Nebula in Perseus.
9	11 49 32 p.m.	Ibid	=1st mag.*	Yellowish......	Rapid	From halfway between μ and ξ Cygni across β Delphini.
9	11 51 20 p.m.	Ibid	=2nd mag.*	Yellowish ...	Rapid	From β Andromedæ towards Algenib.
9	11 52 p.m.	Greenwich	=1st mag.*; very brilliant.	Blue	1 second	Across Ursa Major, and disappeared near γ Ursæ Majoris.
9	11 53 p.m.	Beeston Observatory.	=5th mag. stars...	....	....	....
9	11 55 30 p.m.	Ibid	=2nd mag.*	Yellow	Rapid	1° west of χ Cygni to μ Herculis.
9	11 58 p.m.	Ibid	=3rd mag.*	Colourless ...	Slow............	About 10° below Corona Borealis, coming towards N.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Train of sparks	....	Directed from the Cluster in Perseus.	....	E. J. Lowe.
Train of sparks	34°	Towards Arcturus	....	Id.
Train	11°	Path parallel to those of 11^h 39^m (No. 2) and 11^h 39^m 30^s.	....	W. C. Nash.
Train of sparks	17°	Directed from the Cluster in Perseus.	....	E. J. Lowe.
....	13°	....	....	Id.
....	10°	....	....	Id.
Faint train	10°	.... 	....	W. C. Nash.
....	10°	Exactly parallel path to that of the preceding meteor.	....	Id.
Short streak	1°............	....	....	E. J. Lowe.
Long streak.................	23°	....	....	Id.
Long train	17°	....	....	Id.
Train	15° to 20°..	.... 	....	W. C. Nash.
....	....	....	Five shooting-stars	E. J. Lowe.
Train	33°	....	....	Id.
Train	....	Coming towards N. ...	Discordant	Id.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Aug. 9	h m s 11 59 30 p.m.	Greenwich	Very brilliant	Blue	1 second + ...	Fell vertically from the space between Auriga and Perseus towards horizon.
10	0 0 30 a.m.	Beeston Observatory.	=1st mag.*	Yellow	Rapid	From ι across ε Pegasi.
10	0 1 10 a.m.	Ibid	=1st mag.*	Yellow	Rapid	From θ Delphini across θ Antinöi.
10	0 3 40 a.m.	Ibid	=2nd mag.*	Yellow	Rapid	From γ Trianguli...
10	0 7 31 a.m.	Ibid	=1st mag.*	Yellow	Rapid	From 0° 30′ N. of ε Cassiopeiæ towards β Cephei.
10	0 7 35 a.m.	Ibid	=1st mag.*	Yellow	Rapid	From η Pegasi across Lacerta.
10	0 8 40 a.m.	Ibid	=2nd mag.*	Yellow	Rapid	χ Draconis across ξ Ursæ Majoris.
10	0 10 a.m.	Greenwich	=2nd mag.*	Blue	1 second	Passed close to γ Pegasi; centre of path near that star.
10	0 13 a.m.	Ibid	Bright meteor	Blue	1 second	From β Aquarii to a point near δ Aquarii.
10	0 16 45 a.m.	Beeston Observatory.	=3rd mag.*	Colourless ...	Slow	From α Tauri perpendicularly down.
10	0 17 30 a.m.	Greenwich	=2nd mag.*	Bluish white...	1 second	Passed about 7° below Equuleus.
10	0 18 35 a.m.	Beeston Observatory.	=3rd mag.*	Yellow	Rapid	From No. 5 Draconis to η Ursæ Majoris.
10	0 19 30 a.m.	Ibid	=3rd mag.*	Yellow	Rapid	Started halfway between α and β Persei.
10	0 21 a.m.	Greenwich	=2nd mag.*	Blue	1 second	From a point midway between α Pegasi and the horizon; fell almost perpendicularly towards S.S.E. horizon.
10	0 25 30 a.m. (2 meteors.)	Ibid	No. 1, =3rd mag.* No. 2, =1st mag.*	Blue	Rapid motion..	Two meteors pursuing parallel paths in Pegasus; No. 1 seen before No. 2 by less than ½ second.
10	0 29 a.m.	Beeston Observatory.	=4th mag.*	....	....	From η towards θ Persei.
10	1 15 40 a.m.	Ibid	=3rd mag.*	Orange red ...	Rapid	From H 19 Camelopardi to λ Draconis.

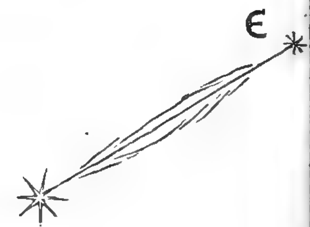
Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Train	15° to 20°			W. C. Nash.
Train	17°			E. J. Lowe.
Train				Id.
Train	4°	Towards 1° N. of α Arietis.		Id.
Train	9°			Id.
Train	14°			Id.
Train	27°			Id.
Faint train	5°			W. C. Nash.
Train	12°			Id.
Train	4°			E. J. Lowe.
		Directed from γ Pegasi		W. C. Nash.
Train	26°			E. J. Lowe.
Short train	2°	Directed from 115 Persei		Id.
Train	15°	Latter portion of path curved thus— 		W. C. Nash.
No. 1, no train; No. 2, train seen.	No. 1, about 6°. No. 2, = 15°			Id.
	1°			E. J. Lowe.
Train	25°		Twelve small meteors in the last interval.	Id.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864.	h m s					
Aug. 10	1 47 a.m.	Beeston Observatory.	=3rd mag.*	Yellowish ...	Rapid	From γ Trianguli, across α Arietis.
10	2 2 30 a.m.	Ibid	=2nd mag.*	Reddish	Rapid	γ Andromedæ ......
10	2 2 35 a.m.	Ibid	=2nd mag.*	Yellow	Rapid	α Andromedæ ......
10	2 28 a.m.	Vogogna (Piedmont).	=2nd mag.*	....	....	From κ Pegasi to γ Delphini.
10	2 31 a.m.	Ibid	=4th mag.*	....	....	From φ to η Persei.
10	2 32 a.m.	Ibid	=1st mag.*	....	....	From γ Pegasi to α Piscium.
10	2 33 a.m.	Ibid	=4th mag.*	....	....	From λ Andromedæ to *f* Lacertæ.
10	2 35 a.m.	Ibid	=4th mag.*	....	....	From ο to α Piscium.
10	2 40 a.m.	Ibid	=3rd mag.*	....	....	From α Pegasi to ω Piscium.
10	2 41 a.m.	Ibid	=1st mag.*	....	....	From Algol to Musca.
10	2 42 a.m.	Ibid	=1st mag.*	....	....	From ζ to θ Cassiopeiæ.
10	2 43 a.m.	Ibid	=2nd mag.*	....	....	From ε Andromedæ, halfway to ι Piscium.
10	2 44 a.m.	Ibid	=3rd mag.*	....	....	From α Cassiopeiæ, halfway to *f* Lacertæ.
10	2 47 a.m.	Ibid	=2nd mag.*	....	....	From α Pegasi to γ Piscium.
10	2 53 a.m.	Ibid	=3rd mag.*	....	....	From γ Andromedæ, halfway to α Triangulæ.
10	2 57 a.m.	Ibid	=4th mag.*	....	....	From ι to κ Persei..
10	3 1 a.m.	Ibid	=1st mag.* =Sirius.	....	....	In Cepheus and Andromeda.
10	3 2 a.m.	Ibid	=Sirius	....	Slow; 1 sec...	From α to σ Persei.
10	3 3 a.m.	Ibid	=3rd mag.*	....	....	In Triangula ......
10	3 6 a.m.	Ibid	=Sirius	....	....	From ι to ½ (α, η) Cephei.
10	8 15 p.m.	Hawkhurst (Kent).	=Sirius or ♃	....	....	From below α Lyræ
10	8 45 p.m.	Baveno, Lake Maggiore (Piedmont).	Like the largest rocket.	Flame colour..	Slow motion...	From ι Pegasi to β Triangulæ.
10	8 50 p.m.	Stelvio Pass, Bormio (Lombardy).	= ¼ diameter of the moon.	Orange colour	Moderate speed.	Disappeared overhead, crossing the zenith from S.W. to N.E.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Train	11°	....	Twelve small meteors in the last interval.	E. J. Lowe.
Train	....	....	Five small meteors in the last interval.	Id.
Train	....	....	2^h 4^m 30^s a.m., clouds came over.	Id.
Left no train	....	....	....	A. S. Herschel.
....	....	....	....	Id.
Left no train	....	....	....	Id.
....	....	....	....	Id.
....	....	....	....	Id.
....	....	....	....	Id.
Left a train	....	....	....	Id.
No train left	....	....	....	Id.
No train left	....	....	....	Id.
....	....	....	....	Id.
No train left	....	....	....	Id.
Left a train	....	....	....	Id.
....	....	....	....	Id.
Both meteors left trains...	....	Directed from B Camelopardi.	Two meteors in quick succession.	Id.
Left a train	3°........	Path crooked and foreshortened.	....	Id.
....	....	Directed from B Camelopardi.	....	Id.
Left a train for 4 seconds..	....	....	In the last interval of 40 minutes forty meteors seen: one-third of the sky visible; clear sky, no moon.	Id.
α Lyræ itself scarcely visible in the twilight.	....	Southwards	....	Communicated by A. S. Herschel.
Disappeared in mid-air. Drew a train like a rocket.	Longer flight than usual.	....	Seen by many on the Place Bellevue.	Id.
Shape oval. Disappeared without bursting.	....	 From S.W. to N.E. ...	....	Communicated by R. P. Greg.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Aug. 10	h m s 9 4 30 p.m.	Lee, Kent ……	=Venus …………	Yellow ………	$1\frac{1}{2}$ second …	Passed a little below β Ursæ Majoris.
10	9 22 p.m.	Greenwich ……	=3rd mag.*………	Yellow ………	1 second …	From a point near α Draconis almost to ζ Ursæ Majoris.
10	9 29 p.m.	Hawkhurst (Kent).	………………	………………	………………	Between α and β Ursæ Majoris.
10	9 31 p.m.	Ibid ……………	$=1\frac{1}{2}$ mag.* ………	………………	Slow motion…	From Lacerta to Vulpecula.
10	9 34 p.m.	Greenwich ……	=1st mag.* ……	Blue ………	$1\frac{1}{2}$ second …	Passed from a point 10° E. of ζ Cygni across that star and disappeared near α Aquilæ.
10	9 35 p.m.	Hawkhurst (Kent).	=1st mag.*………	………………	………………	Near γ Ursæ Minoris.
10	10 5 p.m.	Lee (Kent) ……	=1st mag.* ……	Yellow ……	1 second ……	This meteor moved in the same path as that at 9^h 4^m 30^s.
10	10 10 p.m.	Hawkhurst (Kent).	………………	………………	………………	From γ Cassiopeiæ to π Pegasi.
10	10 13 p.m.	Weston-super-Mare.	Larger than 1st mag.*	Red …………	1 second ……	From α Lyræ to ε Aquilæ.
10	10 14 p.m.	Ibid ……………	=2nd mag.* ……	Blue ………	1 second ……	From μ to ε Sagittarii
10	10 14 p.m.	Ibid ……………	=3rd mag.* ……	Blue ………	$\frac{3}{4}$ second ……	From μ to ζ Sagittarii
10	10 16 p.m.	Ibid ……………	=2nd mag.* ……	White blue …	1 second …	From γ Pegasi …
10	10 17 p.m.	Hawkhurst (Kent).	=1st mag.* ……	………………	………………	From η, π Pegasi to below Delphinus.
10	10 19 p.m.	Ibid ……………	………………	………………	………………	From η to θ Aquarii.
10	10 21 p.m.	Ibid ……………	=2nd mag.* ……	………………	………………	To α Lyræ ………
10	10 23 p.m.	Ibid ……………	………………	………………	………………	Between d and ε Pegasi.
10	10 24 p.m.	Ibid ……………	………………	………………	………………	In Lacerta ………
10	10 25 p.m.	Weston-super-Mare.	=3rd mag.* ……	Blue ………	1 second ……	From γ Pegasi, 50° right of ⊥.
10	10 26 p.m.	Ibid ……………	=Jupiter…………	Yellow ……	2·5 seconds …	From ξ Aquarii to R. A. 312°, Decl. S. 30°.
10	10 31 p.m.	Hawkhurst (Kent).	………………	………………	………………	Between Delphinus and Altair.
10	10 34 p.m.	Ibid ……………	………………	………………	………………	From Polaris ……
10	10 35 p.m.	Ibid ……………	=1st mag.*………	………………	………………	From between α, β Cephei nearly to α Lyræ.
10	10 36 p.m.	Ibid ……………	=1st mag.* ……	………………	………………	From ω Piscium to A Fluvii.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
....	....	Horizontal, E. to W. ...	....	C. W. Jones.
....	....	....	....	J. P. Trapaud.
eft a train	....	Directed from B Camelopardi.	....	J. F. W. Herschel.
eft a train	....	....	....	Communicated by A. S. Herschel.
ine streak, lasted 2 secs.	30° to 40°..	....	Cloudy after 10^h........	W. C. Nash.
....	....	Fell vertically .... ↓	....	Communicated by A. S. Herschel.
o train	25°	Horizontal	....	C. W. Jones.
isappeared in midway and reappeared further on; left a train.	....	....	Train completely broken in midway.	Communicated by A. S. Herschel.
ail (red)	....	....	Clear fine night	W. H. Wood.
....	....	....	....	Id.
....	....	....	....	Id.
ail	10°	Downwards towards the right, 50° from perpendicular.	....	Id.
....	....	Directed towards η Aquilæ.	....	Communicated by A. S. Herschel.
....	....	....	....	Id.
ft a train	10°	Directed from β, γ Cephei.	....	Id.
....	....	Parallel to β, α Pegasi...	....	Id.
ain ½ second	Short course	As if from Polaris	....	Id.
ne	....	Same as the meteor 10^h 16^m p.m.	....	W. H. Wood.
ft a train for 3 seconds...	....	....	....	Id.
....	....	Parallel to Milky Way...	....	Communicated by A. S. Herschel
....	Short course	Directed towards Capella.	....	Id.
ft a long train	....	....	....	Id.
....	....	....	....	Id.

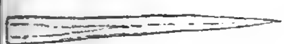
Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Aug.10	h m s 10 40 p.m.	Clifton (lat. 51° 28′ N., long. 2° 36′ E.).	= ♃ at max.	....	2 seconds......	From ϵ Ursæ Majori 
10	10 43 p.m.	Hawkhurst (Kent).	= 2nd mag.∗	....	....	To η Aquarii ....
10	10 46 p.m.	Weston - super - Mare.	= 2nd mag.∗	Blue	1 second	From γ Andro medæ to ν P sclum.
10	10 46 30 p.m.	Hawkhurst (Kent).	= 2nd mag.∗	....	....	From below α Ca siopeiæ to Glori Frederici.
10	11 15 p.m.	Weston - super - Mare.	= 2nd mag.∗	Red	1 second	From midway be tween α Hercul and η Serpentis
10	11 26 p.m.	Ibid	= 2nd mag.∗	White and blue	0·5 second ...	From Head of Au riga.
10	11 27 p.m.	Ibid	= 1st mag.∗.........	Reddish yel- low.	0·5 second ...	From β Persei....
10	11 31 p.m.	Ibid	= 2nd mag.∗	Yellow	0·5 second ...	From ν Andromed to γ Pegasi.
10	11 31 p.m.	Ibid	= 2nd mag.∗	Blue	0·5 second ...	From γ Pegasi....
10	11 32 p.m.	Ibid	= 2nd mag.∗	Orange yellow	0·5 second ...	From α Pegasi to Aquarii.
10	11 32 p.m.	Greenwich	= 3rd mag.∗	Light blue ...	Less than 1 sec.	To a point midwa between β Pers and α Arietis.
10	11 33 p.m.	Hawkhurst (Kent).	= 2nd mag.∗	....	....	On a line fro β, γ Androm. ζ Persei, cent halfway.
10	11 34 p.m.	Weston - super - Mare.	= 2nd mag.∗	Yellow	0·5 second ...	From η Persei to Andromedæ.
10	11 37 p.m.	Lady - Well, Lewisham.	= 3rd mag.∗	Yellow	1¼ second ...	From ζ Aquilæ to wards the ho rizon.
10	11 39 30 p.m.	Greenwich	= 1st mag.∗; bril- liant.	Blue	1 second	Passed rapidly b low Delphinu across θ Aquil
10	11 42 p.m.	Weston - super - Mare.	Larger than 1st mag.∗	Deep yellow...	0·5 second ...	Near (12), (13) C melopardi.
10	11 42 30 p.m.	Greenwich	....	....	1 second	Disappeared nea Pegasi.
10	11 44 p.m.	Lady - Well, Lewisham.	= 2nd mag.∗	Slightly red- dish.	1¾ second ...	From ζ, to a poi near θ Aquilæ.

ppearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
eft a train for ½ second..	20°	40° downwards from horizontal, to left.	....	W. C. Burder.
....	....	Directed from γ Andromedæ.	....	Communicated by A. S. Herschel.
eft a train	....	....	....	W. H. Wood.
eft a train	....	....	....	Communicated by A. S. Herschel.
eft a train	....	....	....	W. H. Wood.
eft a train	8°............	To left downwards, 30° from perpendicular.	....	Id.
eft a train	8°............	Downwards to right, 45° from perpendicular.	....	Id.
eft a train	....	....	....	Id.
eft a train	10°	Downwards to right, 50° from perpendicular.	....	Id.
eft a train	....	....	....	Id.
o perceptible train	....	Directed from β Andromedæ.	Cloudy between 10^h and 11^h at Greenwich.	W. C. Nash.
....	15°	....	....	Communicated by A. S. Herschel.
eft a train	....	....	....	W. H. Wood.
....	....	Path parallel to γ, α, and β Aquilæ.	....	J. P. Trapaud.
ine train, lasted 2 seconds	....	....	....	W. C. Nash.
eft a train	4°............	10° from horizontal, towards the left, down.	....	W. H. Wood.
....	....	Directed from Cassiopeia.	....	W. C. Nash.
rain	20°	Perpendicular	....	J. P. Trapaud.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Aug. 10	h m s 11 44 30 p.m.	Lady-Well, Lewisham.	=2nd mag.*	Yellow	2 seconds......	From a little below ε Cygni to ε Aquilæ.
10	11 45 p.m.	Hawkhurst (Kent).	=2nd mag.*	....	....	From near δ Cygni towards μ Aquilæ.
10	11 47 p.m.	Ibid	=1st mag.*	....	....	On a line from γ Cassiopeiæ to α Lyræ, centre halfway.
10	11 47 10 p.m.	Lady-Well, Lewisham.	=3rd mag.*	Yellow	1½ second ...	From a little above α Ophiuchi to midway between α and β Ophiuchi.
10	11 48 p.m.	Ibid	=3rd mag.*	Yellow	1 second	Fell vertically downwards from β Ophiuchi.
10	11 48 p.m.	Hawkhurst (Kent).	=α Lyræ...........	....	Moderate duration.	Near *m* Custodis...
10	11 50 p.m.	Ibid	=4th mag.*	....	....	From Polaris ......
10	11 50 p.m.	Ibid	....	....	....	From between β and γ to τ Ursæ Minoris, and several degrees further.
10	11 53 p.m.	Ibid	....	....	....	On a line from γ Andromedæ to γ Pegasi. Commenced below β Andromedæ.
10	11 55 p.m.	Ibid	=3rd mag.*	....	....	From τ Ursæ Minoris to *i* Bootis.
10	11 56 p.m.	Lady-Well, Lewisham.	=2nd mag.*	....	1½ second ...	From a point near α Herculis to a point near β Ophiuchi.
10	11 59 p.m.	Ibid	=2nd mag.*	Yellow	2 seconds......	From β Cygni to ε Aquilæ.
11	0 1 a.m.	Hawkhurst (Kent).	=2nd mag.*	....	....	From *a* Lacertæ to ½ (θ, ε) Pegasi.
11	0 4 a.m.	Ibid	=4th mag.*	....	....	From β Draconis towards ζ Coronæ.
11	0 7 a.m.	Ibid	=3rd mag.*	....	....	From near ζ Herculis across κ Herculis, and several degrees further.
11	0 13 a.m.	Ibid	=♃	Yellow	....	From *k* to *m* Ursæ Majoris.
11	0 13 30 a.m.	Ibid	=4th mag.*	....	Swift	From σ to 2° over β Ursæ Majoris.
11	0 19 a.m.	Ibid	=3rd mag.*	....	....	From 3° or 4° N. of α Cygni nearly to ζ Draconis.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Left a train	Somewhat less than 30°.	....	....	J. P. Trapaud.
....	....	Parallel to δ, β Cygni...	....	Communicated by A. S. Herschel.
....	20°	....	....	Id.
Slight train	8° to 10°...	Almost perpendicular...	....	J. P. Trapaud.
No train	....	Perpendicular	....	Id.
A flash blazed out until it equalled α Lyræ.	Almost stationary.	....	....	Communicated by A. S. Herschel.
....	Shortcourse	Directed towards Capella.	....	Id.
....	....	Directed from Polaris...	....	Id.
....	....	....	....	Id.
Left no train	....	....	....	Id.
No train	15°	Inclined	....	J. P. Trapaud.
Train	15°	....	....	Id.
No train left	....	....	....	Communicated by A. S. Herschel.
No train left	....	....	....	Id.
No train left	....	Directed from B Camelopardi.	....	Id.
No train left	....	Directed from ζ Ursæ Minoris.	....	Id.
Left no train	....	....	....	Id.
....	....	....	....	Id.

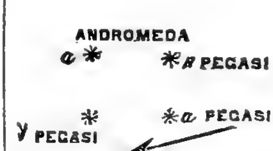
Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Aug. 11	h m s 0 22 a.m.	Hawkhurst (Kent).	= ♃	Deep yellow...	....	Fell perpendicularly from α Ophiuchi.
11	0 23 a.m.	Ibid	= ♃	Bluish white...	Slow motion...	β Cerberi to γ Ophiuchi.
11	0 25 a.m.	Ibid	=2nd mag.*	....	Swift	To 3° below ε Aquarii.
11	0 29 a.m.	Ibid	=3rd mag.*	....	....	Between α, δ Cygni
11	0 31 a.m.	Ibid	=4th mag.*	....	....	On a line from α Cassiopeiæ to Altair, centre at ζ Cygni.
11	0 34 a.m.	Ibid	=1st mag.*	....	....	From 5° E. of γ Pegasi to below ω Piscium.
11	0 36 a.m.	Ibid	> ♃, nearly equal Venus.	....	....	From 10° below, and a few degrees S. of γ Pegasi.
11	0 36 15 a.m.	Ibid	= ♃	....	....	From *k* Norma Aquarii to midway between α β Capricorni.
11	0 40 a.m.	Ibid	=2nd mag.*	....	....	From θ Aquarii to between α and ε Pegasi.
11	0 40 30 a.m.	Ibid	= α Lyræ	....	....	From near γ Pegasi
11	0 42 a.m.	Ibid	=4th mag.*	....	....	From near γ Pegasi
11	0 44 30 a.m.	Ibid	2 > Venus	....	....	To λ Aquarii from near γ Piscium.
11	0 45 45 a.m.	Ibid	> ♃	Yellow	....	From Algol ....
11	0 46 a.m.	Ibid	=4th mag.*	....	....	From γ Cassiopeiæ to α Andromedæ
11	0 49 a.m.	Greenwich	=1st mag.*	Blue	....	In the E., between Aries and the upper part of Taurus.
11	0 50 a.m.	Ibid	=2nd mag.*	Blue	....	In the same position as the preceding meteor and with a similar direction.
11	0 54 a.m.	Hawkhurst (Kent).	=4th mag.*	....	....	From ξ to the Nebula near ν Andromedæ.
11	0 55 a.m.	Ibid	=2nd mag.*	....	....	On the line from α Persei to α Ursæ Majoris, nearer to the latter star than to the former.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
Increased gradually, left a broad train.	....	Directed from α Lyræ...	....	Communicated by A. S. Herschel.
Train separate from the head.	....	....	....	Id.
....	Long flight.	Directed from α Andromedæ.	....	Id.
....	....	Directed from ι Cassiopeiæ.	....	Id.
Left a thin sharp tail	12°	Directed from α Cassiopeiæ.	....	Id.
Train ¾ second, terminated abruptly. 	20°	Directed from γ Andromedæ.	....	Id.
....	15°	Directed from α Persei...	....	Id.
No train left	....	Directed from Equuleus	....	Id.
Decreased gradually	....	Ascending	The course appeared crooked towards the E. on arriving at θ Aquarii.	Id.
Steady light............	....	Directed towards Fomalhaut.	....	Id.
....	....	Towards A Fluvii Aquarii.	....	Id.
Left no train. Increased steadily to twice the brightness of Venus.	....	Directed from α Andromedæ.	....	Id.
Left a fine train	15°	Directed from γ Cassiopeiæ.	....	Id.
....	....	....	....	Id.
Fine train	20°	Moved towards the horizon. 	....	W. C. Nash.
Faint train	10°	Path of this meteor exactly parallel to that of 0^h 49^m.	....	Id.
....	....	....	....	Communicated by A. S. Herschel.
No train left	Short course	....	....	Id.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Aug. 11	h m s 0 56 a.m.	Hawkhurst (Kent).	= ♃		A flash	In the Cluster (χ) of Perseus.
11	0 58 a.m.	Ibid	=4th mag.*			On a line from the head of Perseus towards Musca, centre midway.
11	1 2 a.m.	Ibid	=3rd mag.*			From Polaris
11	1 3 a.m.	Ibid	=4th mag.*			From ζ Cygni to α Aquilæ.
11	1 6 a.m.	Ibid	=4th mag.*			From δ to ζ Persei.
11	1 6 30 a.m.	Ibid	=5th mag.*		Exceedingly swift.	From 2° E. of μ to 2° E. of α Andromedæ.
11	1 6 30 a.m.	Ibid	=5th mag.*		Exceedingly swift.	From β Andromedæ towards γ Pegasi.
11	1 7 a.m	Ibid	=4th mag.*			From ½ (ι, κ) Pegasi nearly to α Cephei.
11	1 11 a.m.	Ibid	=1st mag.*	Yellow		On a line from γ Pegasi to Fomalhaut.
11	1 13 30 a.m.	Ibid	2 > Venus			In Pisces
11	1 15 a.m.	Ibid	3 > Venus			To α Cygni, two thirds of the course from Cassiopeiæ.
11	1 15 30 a.m.	Ibid	=2nd mag.*			From β Cephei to α Lyræ.
11	1 19 30 a.m.	Ibid	=1st mag.*			On the line from α Persei to α Ursæ Majoris centre halfway.
11	1 21 a.m.	Ibid	=4th mag.*			From γ Andromedæ
11	1 25 30 a.m.	Ibid				From δ towards β Cassiopeiæ.
11	1 31 30 a.m.	Ibid	=2nd mag.*			From 12° below β Andromedæ.
11	1 31 45 a.m.	Ibid	=2nd mag.*			Centre λ Piscium.
11	1 36 a.m.	Ibid	=3rd mag.*			From α to Cygni.
11	1 37 a.m.	Ibid	=Venus			Moved on a line continued through θ, from γ Persei. Commenced 3° or 4° from θ.
11	1 37 30 a.m.	Ibid	=2nd mag.*			From α to 1½° N. of ζ Pegasi.
11	1 37 45 a.m.	Ibid	=2nd mag.*			From α Andromedæ to γ Pegasi.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
The nucleus became immediately converted into a bright train.	Almost stationary.	Direction from B Camelopardi.	....	Communicated by A. S. Herschel.
....	6°	....	....	Id.
....	5°	Towards Capella	....	Id.
Left a sharp thin train ...	....	....	....	Id.
....	....	....	....	Id.
Left no train	10°	....	....	Id.
Left no train	10°	....	Simultaneous with the former.	Id.
....	25°	....	....	Id.
....	....	....	....	Id.
The nucleus became elongated; left a faint train.	....	Directed from κ Persei..	....	Id.
Very bright and broad train.	....	....	....	Id.
....	....	....	....	Id.
....	Short course	....	....	Id.
....	Short course	Directed from γ Persei..	....	Id.
....	Short course	....	....	Id.
Very broad train..........	15°	Parallel to β, δ Andromedæ.	....	Id.
....	....	....	....	Id.
Left a train	....	....	....	Id.
Left a short broad swelling train.	3° or 4° ...	....	....	Id.
....	....	....	....	Id.
....	....	....	....	Id.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Aug. 11	h m s 1 39 a.m.	Hawkhurst (Kent).	=2nd mag.* ……	……………	……………	From γ Pegasi towards δ Aquarii.
11	1 44 30 a.m.	Ibid …………	……………	……………	……………	From δ Arietis …
11	1 45 a.m.	Ibid …………	=2nd mag.* ……	……………	……………	From γ Andromedæ
11	1 45 30 a.m.	Ibid …………	=2nd mag.* ……	……………	……………	From γ Andromedæ
11	1 48 a.m.	Ibid …………	=3rd mag.* ……	……………	……………	To α Andromedæ…
11	1 48 a.m.	Ibid …………	=3rd mag.* ……	……………	……………	On a line from χ Persei to γ Pegasi, centre at ε Andromedæ.
11	1 49 a.m.	Ibid …………	=2nd mag.* ……	……………	……………	To α Aquilæ from υ Cygni.
11	1 51 30 a.m.	Ibid …………	=2nd mag.* ……	……………	……………	To α Lyræ ………
11	1 55 30 a.m.	Ibid …………	=5th mag.* ……	……………	……………	From 2° S. of γ Andromedæ, nearly to α Cassiopeiæ.
11	1 56 30 a.m.	Ibid …………	=2nd mag.* ……	……………	……………	From α, below β Arietis, halfway to Fomalhaut.
11	59 a.m.	Ibid …………	=3rd mag.* ……	……………	……………	From 2° S. of ζ Cygni to ε Delphini.
11	2 0 a.m.	Ibid …………	……………	……………	……………	From α Pegasi to Delphinus.
11	2 0 45 a.m.	Ibid …………	=Venus …………	White ………	Very quick …	To ½ (κ, λ) Draconis.
11	2 1 a.m.	Ibid …………	2 or 3 > Venus …	White, with green and blue rays.	Momentary …	In Camelopardus, near γ Persei.
11	9 29 p.m.	Ibid …………	=1st mag.* ……	Blue ………	1 second ……	Towards N., and below γ Bootis.
11	9 36 p.m.	Blackheath ……	Very bright; globular in form; much larger than 1st mag.*	Yellow ……	Less than 1 sec.	Dropped from η Ursæ Majoris towards N.N.W. horizon. After falling through about 12°, the meteor was hidden behind trees.
11	9 38 p.m.	Lee (Kent) ……	=1st mag.* ………	Yellow ……	1 second ……	Towards N., below α Pegasi.
11	9 42 30 p.m.	Ibid …………	……………	……………	¾ second ……	Towards N., about 3° below α Aquilæ.
11	9 46 15 p.m.	Ibid …………	=4th mag.* ……	……………	1 second ……	Passed across ε Bootis in a southerly direction.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
...	20° ...	...	...	Communicated by A. S. Herschel.
...	...	Directed from δ Cassiopeiæ.	...	Id.
Left a train ...	Short course	Directed from ½ (α, γ) Persei.	...	Id.
Left a train ...	Short course	Directed from ¼ (γ, α) Persei.	...	Id.
Left a thin train for ¾ sec.	15° ...	Directed from χ Persei..	Two shooting-stars at once.	Id.
...	15° ...	...	...	Id.
...	...	...	...	Id.
Left a broad train for one or two seconds.	12° ...	Directed from α Cephei..	...	Id.
...	20° ...	...	...	Id.
Left a train ...	...	...	...	Id.
...	15° ...	...	...	Id.
Broad train of light yellow sparks.	...	...	...	Id.
Increased rapidly; train widest at middle, yellow without sparks.	20° ...	...	...	Id.
Increased instantly to a brilliant flash.	Almost stationary.	...	...	Id.
Train ...	30° ...	Inclined ...	...	Charles W. Jones.
A very fine train ...	12°+ ...	Perpendicular ...	Bore a great resemblance to the falling ball of a Roman candle.	W. C. Nash.
No train ...	...	...	...	Charles W. Jones.
				
...	15° ...	Vertical ...	...	Id.
...	10° ...	Inclined ...	...	Id.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Aug. 11	h m s 10 10 30 p.m.	Lee (Kent)	=2nd mag.*	Blue	½ second	This meteor passed left of Draconis in an easterly direction.
11	10 19 p.m.	Greenwich	=2nd mag.*	Blue	1 second	From the direction of Cassiopeia; passed above Polaris to the vicinity of α Draconis.
11	10 23 p.m.	Lee (Kent)	=4th mag.*	Blue	1 second	From λ Draconis to ε Ursæ Majoris.
11	10 27 p.m.	Weston-super-Mare.	=1st mag.*	White blue ...	0·5 second ...	ι to φ Sagittarii ...
11	10 29 p.m.	Greenwich	=1st mag.*	Yellowish......	1 second	In N.; dropped perpendicularly from an altitude of 20°, and disappeared at an altitude of 10°. The point of appearance was vertically below Polaris.
11	10 29 45 p.m.	Lee (Kent)	=3rd mag.*	Blue	1 second	This meteor passed about 2° below α Corona Borealis towards S.
11	10 44 p.m.	Greenwich	=3rd mag.*	Blue	1 second	From direction of γ Andromedæ; disappeared below γ Pegasi.
11	10 50 p.m.	Ibid	=4th mag.*	Bluish white...	1 second	Fell vertically downwards from a point 10° below Polaris towards horizon, passing between τ and υ Ursæ Majoris.
11	10 51 p.m.	Lee (Kent)	=2nd mag.*	Blue	1 second	Almost exactly in the same direction as the meteor at 10h 29m 45s.
11	10 51 30 p.m.	Ibid	=2nd mag.*	Deep blue ...	1 second	Passed downwards between α Coronæ Borealis and γ Bootis.
11	10 52 p.m.	Weston-super-Mare.	Larger than 1st mag.*	Deep red ...	1·5 second ...	α Aquilæ to R. A. 280°, Decl. S. 10°.
11	10 56 p.m.	Lee (Kent)	=4th mag.*	Blue	1 second	From the direction of Polaris, passed below α Draconis.
11	11 1 p.m.	Greenwich	=1st mag.*	Bluish white...	Less than 1 sec.	Near φ Andromedæ. Disappeared almost immediately.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
....	10°	Inclined	....	Charles W. Jones
Faint train	....	....	....	W. C. Nash.
....	17°	Nearly horizontal	....	Charles W. Jones.
....	....	....	Clear, fine night	W. H. Wood.
Train	10°	Perpendicular	....	W. C. Nash.
....	25°	Inclined	....	Charles W. Jones.
No train	12° ±	....	....	W. C. Nash.
No train	15°	Perpendicular	....	Id.
Train	15° to 20°..	Inclined	....	Charles W. Jones.
....	8°...........	Perpendicular	....	Id.
Train of reddish sparks, 2½ seconds.	....	....	....	W. H. Wood.
....	10°	....	....	Charles W. Jones.
Train	3°...........	 .... ←	....	W. C. Nash.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Aug. 11	h m s 11 14 p.m	Greenwich	=3rd mag.*	Blue	Less than 1 sec.	Vertically down towards horizon, across α Herculis.
11	11 14 p.m.	Ibid	=3rd mag.*	Blue	½ second	From a point near ε Ursæ Majoris, nearly to 12 Canum Venaticorum.
11	11 17 p.m.	Ibid	=2nd mag.*	....	....	From α Serpentis to the right of α Herculis.
11	11 21 30 p.m. and 11 22 p.m.	Ibid	=2nd mag.*	Both meteors blue.	1 second each	From direction of Polaris to β Draconis.
11	11 24 p.m.	Lee (Kent)	=2nd mag.*	Blue	....	From the direction of δ Cassiopeiæ to β Persei.
11	11 26 p.m.	Greenwich	=2nd mag.*	Blue	1 second	Across β Bootis towards W. horizon.
11	11 28 p.m.	Ibid	=1st mag.*.........	Blue	1 second	From γ Cygni to β Draconis.
11	11 29 30 p.m.	Ibid	=1st mag.*	Blue	1 second	From ζ Cygni; passed to the left of Delphinus.
11	11 34 30 p.m.	Ibid	=2nd mag.*	Bluish white...	4 or 5 seconds	Moved slowly from τ Ursæ Majoris to small stars near α Persei.
12	9 20 p.m.	Lee (Kent)	=2nd mag.*	Yellow	1 second	From a little above β Pegasi in the direction of α Andromedæ.
12	9 49 p.m.	Ibid	....	Blue	1 second	From about 3° below Polaris to a point equidistant between α Ursæ Majoris and α Draconis.
12	10 10 p.m.	Ibid	=3rd mag.*	Yellow	1 second	Across β Pegasi, downwards.
12	10 50 p.m.	Lady - Well, Lewisham.	....	Yellow	2 seconds......	From near α Aquilæ to θ Aquilæ.
12	11 5 p.m.	Greenwich	=2nd mag.*	Blue	½ second	From μ Coronæ Borealis to a point on the right of α Coronæ Borealis.
12	11 14 p.m.	Ibid	=1st mag.*.........	Bluish white...	Less than 1 sec.	From the direction of Cassiopeia to δ Cephei.
12	11 52 p.m.	Ibid	=1st mag.*.........	Blue	1 second	Across β Persei towards horizon.
13	0 5 a.m.	Ibid	=4th mag.*	....	....	Across ι Aurigæ ...

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
No train	15°	Perpendicular	....	W. C. Nash.
No train	15°	....	....	Arthur Harding.
....	20° to 25°..	....	....	W. C. Nash.
....	10° to 12°..	Horizontal. Parallel paths.	Two meteors in the same position.	Id.
Train	15°	Inclined	....	Charles W. Jones.
No train	15°	....	....	W. C. Nash.
Fine train	33°	....	....	Id.
Train	30°	....	....	Id.
No train	About 45°...	....	This meteor moved more slowly than any I had ever observed.	Id.
....	10°	Inclined	....	Charles W. Jones.
....	....	Horizontal	....	Id.
....	15°	Inclined	....	Id.
No train	....	....	....	John P. Trapaud.
No train	12°	....	....	Arthur Harding.
Fine train	10°	....	....	W. C. Nash.
Train	10°	....	....	Id.
No train	12°	From W.N.W. to E.S.E., nearly horizontal.	....	Id.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864.	h m s					
Aug. 13	9 39 p.m.	Greenwich	Very brilliant	....	Momentary ...	The meteor itself was not seen, but upon looking up, the train was seen distinctly extending from the zenith in the vicinity of β Draconis to near α Coronæ Borealis.
13	9 39 p.m.	Lee (Kent)	....	....	....	The same flash seen
13	10 18 p.m.	Blackheath	=2nd mag.*	Bluish white...	....	In E. a meteor fell perpendicularly from the direction of α Andromedæ.
13	10 35 p.m.	Greenwich	...	Blue	....	From ζ to θ Cassiopeiæ.
13	11 13 30 p.m.	Lady - Well, Lewisham.	=2nd mag.*	Orange	$1\frac{1}{4}$ second ...	From α Herculis to β Ophiuchi.
21	8 15 p.m.	Edinburgh	Large fireball	....	Quick motion	In S.E., about 40° above the horizon.
26	10 55 p.m.	Hay (S. Wales)..	Half the size of the moon.	Orange colour. Not a very dazzling light.	3 seconds......	From $\frac{1}{2}$ (α Cygni, α Cephei) to $\frac{1}{2}$ (γ Ursæ Minoris, η Draconis). Disappearing to a few degrees above Mizar.
26	11 0 p.m.	Grantham	Considerably > 1st mag.*; transmitted considerable light.	Bright reddish white, changing to violet, and at last deep violet.	Moved with an apparently very slow speed.	From near β Sagittæ to the constellation Libra.
26	11 0 p.m.	Weston - super - Mare.	Very large meteor..	Orange.........	Very slow motion for a meteor; 7 or 8 seconds.	First appeared above the Pleiades and *set* behind a hill in N.W.
26	11 0 p.m.	Bristol	Meteor of extraordinary size.	Blue	Very slow motion.	Passed from near the zenith to near the horizon in the constellation of Ursa Major.

Appearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
A sudden very brilliant flash like a flash of lightning; train after disappearance of meteor lasted 2 seconds.	....	....	The flash lit up the street with a brilliant white light, in strong contradistinction to the yellow light given by the gas-burners. After 6 or 7 seconds a dull report was heard, somewhat doubtful, owing to the street noises.	W. C. Nash.
....	....	....	No further information than that given at Greenwich.	Charles W. Jones.
Faint train	....	Perpendicular	....	W. C. Nash.
....	....	....	....	Arthur Harding.
Train tinged with orange...	....	Inclined	....	John P. Trapaud.
....	....	Obliquely down from right to left.	....	Communicated by R. P. Greg.
After a startling flash, the meteor was seen in the zenith as a streak. Descending, the preceding part became more brilliant, and at last broke out into a pear-shaped orange mass, which became suddenly extinguished, leaving above this spot, and to the left of its path, three or four small green globes, one above another.	....	.... 	Time perhaps 5 minutes slow. Very few meteors seen the same evening. The white flash, the increasing orange flame, and the globes of green light, formed three distinct features in succession.	T. W. Webb.
View at first appearance obstructed by trees; broke at length into a number of beautiful fragments.	....	....	Bright frosty night. Only two other small meteors.	E. M. Rogers.
Very long and brilliant tail.	....	....	....	J. H. S. Pigott.
Burst with a profusion of sparks.	Very long course.	....	Commencement of meteor not seen.	'Western Daily Press,' Aug. 29.

Date.	Hour.	Place of Observation.	Apparent Size.	Colour.	Duration.	Position, or Altitude and Azimuth.
1864. Aug. 26	h m 11 8 p.m.	Wolverhampton	One-fifth diameter of full moon.	Red; afterwards blue.	6 seconds ...	From η or χ Cygn to α Serpentis.
29	9 24 p.m.	Weston-super-Mare.	=1st mag.*	Orange	3 seconds......	From B Persei to c Piscium.
31	10 30 p.m.	Exeter (Devonshire).	Splendid meteor ...	Blue and red; very striking.	Comparatively slow.	From *f*, *g* (near ω) Aurigæ to nea the Pleiades (a little N.), wher the meteor burst
31	About 10 30 p.m.	Frant (Sussex)...	Ball of a Roman candle.	....	....	In the S.W. horizon.

APPENDIX.

I. Meteors doubly observed.

(1.) Shooting-star; 1863, August 8th, $10^h 55^m$ P.M.

A shooting-star of long flight, leaving a long train; observed at Portsmouth and Hawkhurst (see Catalogue). Path, 142 miles in 2·8 seconds. Velocity, forty-nine miles per second. Direction, from azimuth W. from S. 264°, altitude 30°. Began 141 miles above the north of France (N. lat. 50° 20′, long. 3° 3′ E.); disappeared seventy-one miles above the English Channel (N. lat. 50° 9′, long. 0° 15′ W.).

(2.) Fireball; 1863, August 10th, $8^h 30^m$ P.M.

Described by Dr. Bianconi (Report for 1863, pp. 274, 335), and observed at Venice by Herr v. Wüllerstorf (Proc. Vienna Acad. vol. xlviii., 8th Oct. 1863). The streaks extended from near Corona to the stars of Scorpius. Although, from the motion of the streak, the meteor appeared to be in the region of the winds, the two observations, with a base line of eighty-five miles from Venice to the Samoggia, indicate a considerable elevation. The first appearance took place at a height of sixty miles, in lat. 45° 18′ N., long. 11° 22′ E., between Padua and Mantua. The meteor disappeared at a height of twenty miles, between Parma and Carrara, in lat. 44° 25′ N., long. 10° 12′ E. Path, eighty miles. Direction, from the well-known radiant-point between Perseus and Cassiopeia.

(3.) Shooting-star; 1863, September 5th, $9^h 55^m$ P.M.

Observed at London and at Wisbech in Cambridgeshire (see Catalogue). Path, sixty miles in $1\frac{1}{4}$ second. Velocity, forty-eight miles per second. Direction, from azimuth W. from S. 283°, altitude 34°. Began 102 miles above the North Sea (N. lat. 53° 29′, long. 1° 1′ E.); disappeared sixty-nine miles above the coast of Lincolnshire (N. lat. 53° 35′, long. 0° 0′).

ppearance; Train, if any, and its Duration.	Length of Path.	Direction; noting also whether Horizontal, Perpendicular, or Inclined.	Remarks.	Observer.
urst at end of path into about five first magnitude and several smaller stars.	....	....	Changed colour. Moved slowly. Separate portions very bright after bursting.	Communicated by T. M. Simkiss.
eft a reddish streak 15° in length.	....	....	....	W. H. Wood.
large ball and tail of blue light, leaving behind a red fragment and several sparks.	....	....	The red ball appeared to stand still for a second, and the blue envelope (for such it appeared to be) passed on, leaving a train of blue light.	Ed. Parfitt, 'The Times,' Sept. 3.
he tail was luminous and expanded at the extremity like that of a comet.	About 45°..	....	The tail was projected from the nucleus in jets.	F. C. R., 'The Times,' Sept. 3.

(4.) Shooting-star; 1863, November 13th, 2^h 48^m A.M.

Observed at Euston Road Observatory and Hawkhurst (see Catalogue). Path, thirty-nine miles in half a second. Direction, from azimuth W. from S. 238°, altitude 69°. Began ninety-three miles above the west of London (N. lat. 51° 30′, long. 0° 13′ W.); disappeared fifty-six miles above the neighbourhood of Chertsey (N. lat. 51° 30′, long. 0° 13′ W.). The velocity and duration of the flight are doubtful.

(5.) Shooting-star; 1863, November 13th, 2^h 53^m A.M.

Observed at Euston Road Observatory and Hawkhurst (see Catalogue). Path, forty-seven miles in 0·7 second. Direction, from azimuth W. from S. 302°, altitude 60°. Began eighty-seven miles above the sea (N. lat. 50° 32′, long. 1° 11′ W.); disappeared forty-seven miles above the Hampshire coast (N. lat. 50° 43′, long. 1° 39′ W.).

(6.) Fireball; 1863, December 5th, 7^h 55^m P.M.

A meteor which illuminated all the coasts of Britain with the semblance of a flash of lightning (see Catalogue). The locality of the phenomenon was thirty or sixty miles above the sea, between the Lancashire coast and the Isle of Man. The accounts of its apparent course are too conflicting for discussion.

(7.) Shooting-star; 1863, December 6th, 10^h 7^m 30^s P.M.

Observed at Euston Road Observatory and Hawkhurst (see Catalogue). Path, sixty-five miles in 1·3 second. Velocity, fifty miles per second. Direction, from azimuth W. from S. 263°, altitude 6°. Began 122 miles above the sea (N. lat. 49° 51′, long. 0° 57′ E.); disappeared 115 miles above the sea (N. lat. 49° 44′, long. 0° 31′ W.).

(8.) Fireball; 1863, December 12th, 5^h 45^m P.M.

Observed at Nottingham and Oundle (see Catalogue). Path, 125 miles in $1\frac{3}{4}$ second. Velocity, seventy-one miles per second. Direction, from azimuth W. from S. 236°, altitude 9°. Began 126 miles above the North Sea (N. lat. 51° 55′, long. 1° 55′ E.); disappeared 108 miles above the Sussex coast (N. lat. 50° 55′, long. 0° 27′ E.).

(9.) Fireball; 1863, December 27th, 6h 55m P.M.

Observations, at East Harptree and at Dulverton in Somersetshire (see Catalogue), agree with a path of eighty miles in 4 seconds. Direction, from azimuth W. from S. 277°, altitude 45°. Began eighty miles above the Channel (N. lat. 50° 37′, long. 0° 42′ W.); disappeared twenty-five miles above Poole, in Dorsetshire (N. lat. 50° 43′, long. 2° 0′ W.). The fireball agrees with an aërolitic date.

(10.) Fireball; 1864, January 3rd, 8h 25m P.M.

In the north of England; observed at Liverpool, and Epping, near London (see Catalogue).

(11.) Fireball; 1864, January 7th, 8h 36m P.M.

South of the Cornish coast; observed at Weston-super-Mare and Dulverton, in Somersetshire (see Catalogue). The overcast state of the sky appears to have precluded more general observations.

(12.) Shooting-star; 1864, April 10th, 9h 30m P.M.

Observed at Greenwich Observatory and Hawkhurst (see Catalogue). The position, in N.W., is unfavourable for calculation.

(13.) Shooting-star; 1864, April 20th, 2h 40m 30s A.M.

Observed at London and Hawkhurst (see Catalogue). The view was impaired by sunrise.

(14.) Fireball; 1864, July 4th, 10h 0m P.M.

Observed at Llanrwst (N. Wales) and at Wolverhampton, by Mr. T. M. Simkiss (see Catalogue), who concludes the path to have been from fifty miles above Stafford to thirty miles above Llandovery (in Wales). The meteor observed through clouds at Greenwich (see Catalogue) is perhaps identical with this.

(15.) Fireball; 1864, August 6th, 10h 20m P.M.

Observed at Wrotham (Kent) and at Paris (see Catalogue). It also attracted attention in Germany. From observations at Münster, Essen, and Kempen, Professor Heis concludes its path to have been directed from a considerable height above the North Sea, north-west of Holland, to thirty or thirty-five miles above the sea, due north of Holland. It fell with a steep incline from S.W. towards N.E.

(16.) Fireball; 1864, August 9th, 0h 52m A.M.

Observed at Hawkhurst, and at the Luxembourg in Paris (see Catalogue). Path, after the expansion, twenty-nine miles in one second. Direction, from azimuth W. from S. 250°, altitude 60°. Expanded 106 miles above the North Sea (N. lat. 53° 15′, long. 3° 22′ E.); disappeared eighty-two miles above the sea (N. lat. 53° 11′, long. 3° 4′ E.).

(17.) Fireball; 1864, August 10th, 8h 45m 50s P.M.

Observed in Italy. Belongs among the few whose paths are known to lie from the west to the east of the meridian. Path, sixty miles in 3 or 4 seconds. Velocity, fifteen or twenty miles per second. Direction, from azimuth W. from S. 30°, altitude 12° (near Antares). Began forty miles above Lecco (N. lat. 45° 52′, long. E. 9° 25′); disappeared thirty miles above the Stelvio Pass (N. lat. 46° 30′, long. E. 9° 55′). Directed from some radiant-point in the southern part of Ophiuchus, or Scorpius.

(18.) Fireball; 1864, August 26th, 11h 0m P.M.

Observed at Hay (South Wales), Wolverhampton, and Grantham (see Catalogue). Path, 110 miles in 5 seconds. Velocity, twenty-two miles per second. Direction, from azimuth W. from S. 330°, altitude 45°. Began 100 miles above Monmouth (N. lat. 51° 50′, long. 2° 43′ W.); disappeared twenty miles above Barmouth, in North Wales (N. lat. 52° 43′, long. 4° 4′ W.). The height at first appearance is affected by considerable errors of observation.

II. Meteoric Shower of August 1864.

The annual display was less abundant than in 1863, and the meteors of the 9th and 10th of August did not exceed the ordinary scale of the phenomenon, either in numbers, brilliancy, or uniformity of direction. One meteor only was simultaneously observed at Greenwich Observatory and at Hawkhurst.

1864, August 9th, 11h 3m G.M.T.

A shooting-star, leaving a train, observed	Began.		Ended.	
	Azimuth W. from S.	Altitude.	Azimuth W. from S.	Altitude.
At Greenwich Observatory..	312°·7	67°·7	0°·7	45°·8
At Hawkhurst (Kent)	239·7	84·5	41·0	62·5

Beginning.				End.			
Lat.	Long.	Height.	Distance from Hawkhurst.	Lat.	Long.	Height.	Distance from Hawkhurst.
		Miles.	Miles.			Miles.	Miles.
51° 8′ N.	0° 44′ E.	82	84	50° 41′ N.	0° 7′ E.	53	63

Length of Path.	Duration at Greenwich.	Velocity.	Direction of flight, from	
			Azimuth W. from S.	Altitude.
	Seconds.	Miles per second.		
46	1·5	31	221°	24°

Apparent brightness at Hawkhurst.	Brightness at 1 mile, compared to full moon.	Consumption of coal-gas for equal luminous effect.	Weight of meteoric matter arrested at 30 miles per second.
		Cubic feet.	Grs.*
α Cygni.	0·06	1·5	14

* In the last column but one of Table III., p. 330 of the Report for 1863, the decimal point is misplaced, and the weights in the last column of that Table are ten times larger than the truth.

The following are Mr. Lowe's observations at Beeston Observatory, 1864, August 9th, P.M. :—

1st. *Number of meteors,*	$8^h\ 50^m$ P.M. to 10^h P.M.		= 5
,, ,,	10^h ,, 11^h ,,		= 18
,, ,,	11^h ,, 12^h ,,		= 33
,, ,,	12^h ,, 1^h A.M.		= 22
,, ,,	1^h A.M. to 2^h ,,		= 27
2nd. *Magnitude of meteors* :—	Above 1st mag.*		= 0
,, ,,	Equal 1st mag.*		= 12
,, ,,	,, 2nd mag.*		= 25
,, ,,	,, 3rd mag.*		= 19
,, ,,	4th & 5th mag.*		= 49
3rd. *Colours of meteors* :—	Colourless	= 14	
,, ,,	Blue	= 2	
,, ,,	Red	= 9	
,, ,,	Orange-red	= 11	
,, ,,	Orange	= 4	
,, ,,	Yellow	= 25	
4th. *Length of path of meteors* :—	Under 5° in length		= 22
,, ,,	5° to 10° ,,		= 5
,, ,,	10° to 20° ,,		= 15
,, ,,	20° to 40° ,,		= 9

5th. *Peculiar features* :—No very large or bright meteors, 2nd magnitude prevailing until midnight, then 4th and 5th magnitude stars, apparently more distant than at 10^h P.M.

Majority very similar in appearance.

Much fewer blue than usual.

Point of divergence about H 115 Persei. Very few discordant.

The paths of meteors in Perseus very short; those in Ursa Minor and Ursa Major very long.

Mostly very rapid, and about equal in speed.

The point of divergence lower and more northerly than last year.

On the 9th, at Weston-super-Mare, 8 meteors brighter than 3rd magnitude stars were seen from $10^h\ 30^m$ P.M. to 11^h P.M., by Mr. W. H. Wood.

Between 10^h P.M. on the 9th and $0^h\ 30^m$ A.M. on the 10th, at Greenwich Observatory, Mr. W. C. Nash saw 1 meteor equal to Venus and 20 meteors greater than 2nd magnitude stars.

On the 10th, from 3^h A.M. to $3^h\ 40^m$ A.M., at Vogogna in Italy, Mr. A. S. Herschel observed 40 meteors, of which 3 equal Sirius and 6 equal 1st magnitude star.

Among 105 meteors observed on this night by Mr. Lowe, 51 left trains; 5 meteors with trains were observed by Mr. Wood, 23 by Mr. Nash, and 12 by Mr. Herschel. The whole, being drawn on a map, present an ill-defined radiant-point near the head of Perseus.

From 10^h P.M. on the 10th to 2^h A.M. on the morning of the 11th, meteors were observed at Hawkhurst to radiate from Perseus and from other coexisting radiant-points.

Radiant-points of meteors.

From a point between α and γ Persei	= 48	meteors.
,, Polaris	= 12	,,
,, Pegasus	= 7	,,
,, Undetermined radiants .	= 11	,,
Total	78	,,

Number of meteors from	10^h to $10^h\ 45^m$ P.M.	=	12*
" "	$11^h\ 30^m$ to 12^h "	=	8*
" "	12^h to 1^h A.M.	=	24
" "	1^h A.M. to 2^h A.M.	=	30
	Total		74

Of these meteors, twenty-four left trains.

From $10^h\ 30^m$ P.M. to 11^h P.M., on the 10th, at Baveno (Italy), Mr. A. S. Herschel saw 36 meteors. Of these nine left trains: four were equal to 1st magnitude stars.

On the night of the 10th, at Greenwich, there were seen by Messrs. W. C. Nash, C. W. Jones, and P. Trapaud, of the Magnetical and Meteorological Department of the Royal Observatory, from 9^h P.M. to 1^h A.M., sixteen meteors larger than 3rd magnitude stars. The sky was mostly cloudy.

On the same evening, at Weston-super-Mare, fifteen meteors larger than 2nd magnitude stars were seen, by Mr. W. H. Wood, from $10^h\ 15^m$ to $11^h\ 45^m$ P.M., who reports as follows:—

"The 8th was overcast; the 9th clear at intervals; the 10th and also the 11th clear and fine. The 9th and 10th were pretty good displays, but far inferior to that of August 1863. The meteors were sporadic, with occasional cessations; and they exhibited a singular predominance of red and yellow colour."

Messrs. T. W. Webb and T. M. Simkiss report, respectively, from Hay (South Wales) and Wolverhampton, regarding the meteors of the 10th August:—

"A good many shooting-stars on the night of the 10th, but not so many on the whole as on the previous night.

"Not so many shooting-stars on the night of the 10th as on the previous night, but of the same character and general directions."

III. 'Heights of Shooting-stars,' by Professor Newton.

(Am. Journ. Sci., 2nd ser., vol. xxxvi., July 1864.)

Many of the heights of shooting-stars obtained by Brandes, Benzenberg, Boguslawski, Heis, Schmidt, &c., have been unavoidably advanced on slender grounds. The telegraph is now employed to insure identity among the meteors simultaneously observed†. Professor H. A. Newton has, however, collected upwards of 300 examples where the heights of falling-stars have (previously to this practice) been credibly determined. A similar inquiry was undertaken for the British Association, on the occasion of an unusually bright display of meteors observed in England on the 10th of August 1863, and the heights collected were found to correspond with the average of the heights observed on that occasion‡. A few large bolides are contained in Professor

* Sky partly overcast and hazy; afterwards clear. A fifth part of the time was spent in recording the meteors.

† From the 6th to the 10th August (1864), 93 meteors were doubly observed between Rome and Civita Vecchia by the intervention of the electric telegraph. Parallax varying from 15° to 40° was observed in the zenith of Rome, corresponding to heights of meteors between 50 and 150 miles from the surface of the earth.

‡ Report, 1863, p. 332. Note at the foot of the page.

Newton's list, which therefore affords wider average limits of height than those given in the last Report. The results may be thus compared:—

Average height at first appearance,	No. of Observations,	Reference.
70·1 Brit. St. miles.	178 since Sept. 1798.	B. A. Report, 1863.
73·5 " "	234 " "	Am. Journ. Sci., July 1864.

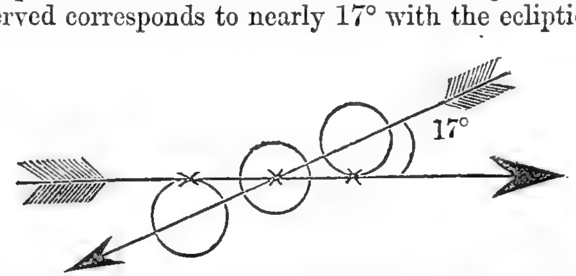
Average height at disappearance,	No. of Observations,	Reference.
54·2 Brit. St. miles.	210 since Sept. 1798.	B. A. Report, 1863.
50·6 " "	290 " "	Am. Journ. Sci., July 1864.

The mean height of luminous meteors at appearance is accordingly 72, and at disappearance 52 British statute miles above the level of the sea, with a probable error of *only two miles.*

IV. 'NOVEMBER STAR-SHOWERS,' by Professor Newton.

(Am. Journ. Sci. vol. xxxvii. p. 377, and vol. xxxviii. p. 53.)

Comparing together the dates of thirteen historic star-showers, from October 13th, 902, to November 13th, 1833, the existence of a *common meteoric shower* becomes apparent. The node of the ring has an annual *pro*-cession of $1'{\cdot}711$ (reckoned from mean equinox), or of $52''{\cdot}56$ reckoned from a fixed equinox along the ecliptic. By this amount the date of the return has been delayed one day in every 34 years since the first appearance of the shower; and the narratives are in accordance with a single meteoric phenomenon, of which the yearly period is 365·271 days, returning with especial intensity four times in every 133 years. A want of punctuality of one, two, or even three years in the return of the display may be accounted for by the revolution of the earth on its axis, by which observers were deprived of a view of the spectacle during a part of its existence. The explanation of the periodicity depends, not upon the perturbations of the earth or of the ring, but upon the true periodical time of revolution of the cloud. Its displacement $\frac{4}{133}$ parts of a revolution from the node per annum may be accompanied with 0, 1, or 2 complete revolutions round the sun, but with *no fractional* part of a revolution, because the cloud has been encountered at the node with almost equal intensity on two successive years (1832 and 1833). The displacement cannot be accompanied with any greater *integral* number of revolutions than two, on account of its distance from the sun. As, moreover, the true motion of the November meteors is sensibly perpendicular to a radius-vector from the sun, probability must be held to decide in favour of the nearly circular orbit, with $1 \pm \frac{4}{133}$ revolution per annum, and with a velocity nearly equal to that of the earth, but in a retrograde direction. The inclination observed corresponds to nearly 17° with the ecliptic.



Should more than one revolution be performed in one year by the meteoric cloud, the two or three successive encounters which compose one principal meteoric epoch must fall earlier in the year, and *vice versâ.* Sufficient materials do in fact exist for preferring this alternative. In this case the period from node to node is 354·621 days, with a probable error not exceeding 16 minutes. The orbit is nearly circular, with a semi-major axis 0·9805, a velocity of arrival in the atmosphere (allowing for the attraction of the earth) 20·17 miles, and a velocity of passage through the atmosphere 38·7 miles, or nearly forty miles per second.

A maximum display on the morning of the 14th November, 1866, is expected to be chiefly visible on the western Atlantic.

V. Meteorites.

(Proc. Vienna Acad. Sci. vols. xlviii. and xlix.)

(1.) 1863, August 11th, 11^h 30^m A.M.

Near Shytal, Dacca, about 150 miles N.E. from Calcutta. A report like thunder was presently followed by the fall of a meteoric stone. The stone weighed 5 lbs., measuring 4 inches to 6 inches in different parts, and struck 17 inches into the ground. It is entirely covered by a thin black crust, and the interior substance resembles (by large patches) the meteorites of Weston—by veins of darker colour the stones of Lixna and Macao, and those of Parnallee by a general variegated appearance. It has been forwarded to the British Museum through the Asiatic Society of Bengal. A section is destined for the Museum of Vienna. The direction of the meteor was from E. to W.

(2.)

Dr. Haidinger, of Vienna, concludes a paper on the physical connexion of meteorites with fireballs and shooting-stars by the following remarks (vol. xlix. p. 16):—"One of the conclusions which appear to be established by recent observations is, that the three classes of meteorites, fireballs, and shooting-stars are assemblages of fragments, finer or coarser. A study of the fused surfaces of the meteorites of Stannern shows that these, at least occasionally, enter the atmosphere in a crowd. Dr. Schmidt observed a similar structure, by aid of the telescope, in the case of a detonating fireball, on the 19th October, 1863. Mr. Alexander Herschel also arrives at the same conclusion, on independent grounds, with respect to shooting-stars, and supposes them to consist of dust, more or less arenaceous in its form." The fireball observed by Dr. Schmidt, the Researches on Metoerites, and those on Shooting-stars, referred to in this paragraph, are described in former papers of the Academy.

(3.) 1863, December 7th, 11^h A.M.

Tourinnes la Grosse, Tirlemont, near Waterloo in Flanders. A ball of white-hot matter shot suddenly from S.E. to N.W. across the sky, which was cloudy. Shortly afterwards a crash was heard, followed by a whistling noise. Two aërolites were precipitated, 14 lbs. and 15 lbs. in weight, and distant two miles from one another, one of which broke the trunk of a fir-tree 12 inches in circumference, and buried itself 6 inches in the earth. The second, falling on a footway in the village of Tourinnes la Grosse, splintered a flagstone, and broke into 25 or 30 fragments, severely burning the fingers of those who attempted to collect them. A third stone of 2½ lbs. weight, which fell without injury from branch to branch of a tree, is preserved in the Museum of Natural History at Paris. Daubrée and Haidinger conclude that meteorites reach the earth with a velocity less than that of a cannon-ball. The detonations are a proof of the violence with which their planetary velocity is destroyed by the resistance of the air. The Tourinnes stones are light grey, and, from the presence of spherules, chondritic. Chladnite (nickeliferous iron) and troilite (magnetic iron-pyrites) are disseminated through the stones in grains, and the latter pretty large. The crust is one-fiftieth of an inch in thickness, and dull black.

A stone of 2½ ozs. is in the Museum of Mineralogy at Vienna, 2½ lbs. in the Museum of Natural History at Paris, and a fragment, 1 lb. in weight, in the British Museum.

(4.) 1864, March 14th, and 1864, May 2nd.

"*May 8th to 14th is an aërolitic period, and its radiant-point should be determined.*" (R. P. Greg, Manchester, 14th March, 1864.)

"*May the 12th will be the next time to verify, and has of late years been very richly aërolitic.*" (R. P. Greg, Manchester, 2nd May, 1864.)

The aërolitic period so defined by Mr. Greg was verified by the fall of a meteorite at Orgueil (S. France), on the evening of the 14th May, 1864. The meteorites are rich in carbon and soluble salts, among which are those of ammonia. (Comptes Rendus, vol. lviii., for May 23, and following numbers contain full particulars. At pp. 1100 and 1212 the trajectory of the meteor is described.)

VI. Radiant-points of Shooting-stars.

Showers of meteors are of comparatively frequent occurrence, and, since the display of November 1833, it is well known that the meteoric tracks on these occasions take their directions from a point (termed the radiant-point of the shower) which retains its apparent place unchanged among the stars during the continuance of the shower. The following observations were expressly conducted for the purpose of determining the radiant-points of meteors on particular dates, since the last Report:—

Date of Observation.	Approximate Position of Radiant-point.	R. A.	N. Decl.	No. of Observations.	General Accuracy of Divergence.
		°	°		
1863, Aug. 10–11	*k* Persei	43·8	56·2	120	Great.
„ Dec. 12–13	*τ* Geminorum	105·5	30·5	17	Considerable.
1864, Jan. 2–3	*c* Quadrantis	234·0	50·9	100	Great.
„ Apr. 10–11	*δ* Virginis	192·3	4·2	12	Average.
„ Apr. 12–13	Cerberus	270·0	25·0	16	Inconsiderable.
„ Apr. 19–20	near *α* Lyræ	277·5	34·6	23	Great.
„ Aug. 9–10	D Camelopardi	49·8	55·0	87	Considerable.

The position of the radiant-point on the night of the 2nd January differs only 5° from the centre of eight very luminous excursions, observed by the late Stillman Masters, in America, at daybreak on the 2nd January, 1863 (R. A. 238°·0, N. P. D. 43°·6). The fixity of this radiant-point for two successive years, under circumstances so widely differing from one another in hour and place, is a strong argument for the astronomical nature of periodical meteors. A radiant-point near *α Lyræ* was observed in America, by the late E. C. Herrick, on the morning of the 19th April, 1839, a quarter of a century before the observation recorded in this list. Relying upon the general stability of meteoric phenomena, it is possible to determine the radiant-points of sporadic meteors (if these exist), in the same manner as the radiant-points of periodical shooting-stars, from observations of a long series of years. The Reports of the British Association, Coulvier Gravier's Catalogues, and other less extensive observations afford more than sufficient materials for the purpose. The centres of excursion of sporadic meteors continue for weeks, or even months, in one position, until their epochs overlap. Two or more centres of excursions then coexist for a time, and afterwards give place to other radiant-points. The following list of general radiant-points of shooting-stars, arranged by Mr. Greg, is remarkably verified in many of its positions by the corresponding list of radiant-points contributed by Dr. Heis, in the 'Monthly Notices' of the Astronomical Society (vol. xxiv. p. 213).

General Radiant-points of Shooting-stars.

Comparison of the Epochs and Positions of Radiant-points of Shooting-stars, concluded independently, by R. P. Greg, Esq., and Dr. E. Heis.

From Observations contained in the British Association Catalogues, 1845–1863. (R. P. Greg.)						Observed at Münster, 1849–61. (E. Heis.)			
No.	Epochs in their order of commencement.	No. of Meteors.	Distinctive Number. (Greg.)	R.A.	N. Decl.	Distinctive Letters.	R.A.	N. Decl.	Epochs to the nearest half-month.
1	Dec. 20 to Jan. 30...	20	II.	22°	75°	A_1	29°	50°	January 1 to 15.
						A_2	15	63	January 16 to 31.
2	Dec. 20 to Jan. 30...	13	II.*a*	5	85	N_1	285	84	January 1 to 15.
						N_2	0	90	January 16 to 31.
3	Dec. 21 to Feb. 4 ...	28	III.	68	17	A G_1			
4	January 2 to 3	52	I.	234	51	K_3	235	52	December 16 to 31.
						K_1	242	51	January 1 to 15.
5	Jan. 2 to Feb. 4 ...	30	IV.	133	40	? M_2	166	52	January 16 to 31.
6	January 5 to 25 ...	15	IV.*a*	173	32	M G_1			
7	February 4 to 26 ...	36	V.	147	34	M_3	150	60	February 1 to 14.
8	February 7 to 26 ...	20	VI.	136	70	M_4	130	63	February 15 to 28.
9	February 9 to 17 ...	13	VII.	76	40	A_3	65	51	February 1 to 14.
						A_4	91	37	February 15 to 28.
10	Feb. 10 to Mar. 17...	21	VIII.	168	9	S_1	170	11	February 15 to 28.
						S_2	178	7	March 1 to 15.
						S_3	173	23	March 16 to 31.
11	Feb. 11 to Mar. 16...	10	VIII.*a*	37	1	S G_1			
12	February 19 to 26...	10	VI.*a*	220	84	N_3	0	90	February 1 to 14.
						N_4	250	83	February 15 to 28.
13	March 3 to 27	11	XIII.	44	72	N_5	340	80	March 1 to 15.
14	March 3 to 31	30	IX.	145	67	M_5	125	52	March 1 to 15.
						M_6	140	50	March 16 to 31.
15	March 3 to 31	18	X.	186	58	? M_6	140	50	March 16 to 31.
16	March 12 to 20 ...	20	XII.	223	39	M G_2			
17	April 1 to June 2 ...	52	XI.	194	52	M_7	160	53	April 1 to 15.
						M_8	150	61	April 16 to 30.
18	April 2 to May 1 ...	20	XIV.	189	4	S_5	194	5	April 16 to 30.
19	April 8 to May 28...	20	XIX.	227	−8	S G_2			
20	April 13 (A.M.)	17	XVI.	276	26	Q G			
21	April 16 to May 3 ...	30	XV.	96	87	N_8	265	83	April 16 to 30.
22	April 19 to 20	25	XVII.	282	33	D G_1			
23	April 25 to June 4...	28	XVIII.	255	48	D G_2			
24	April 30 to June 4...	15	XX.	243	20	Q_1	218	20	May 1 to 31.
25	May 9 to June 3 ...	16	XVIII.*a*	277	42	D			
26	May 9 to June 4 ...	8	XXI.	286	21	W	292	15	June 1 to 30.
27	May 29 to June 17...	18	XXII.	336	45	B_1	332	60	May 1 to 31.
						B_2	333	42	June 1 to 30.
28	June 1 to 30	9	XX.*a*	236	30	Q_2	242	12	June 1 to 30.
29	June 1 to 30	12	XXIII.	300	85	N_9	290	80	May 1 to 31.
						N_{10}	150	83	June 1 to 30.
30	July 2 to 24	51	XXIV.	291	53	B_3	315	54	July 1 to 15.
				to 313	43				
31	July 10 to Aug. 6 ...	26	XXVII.	257	13	Q_3	262	12	July 1 to 15.
32	July 20 to Aug. 4 ...	46	XXV.	359	70	N_{11}	20	85	July 1 to 15.
						N_0	337	86	July 16 to Aug. 15.

General Radiant-points of Shooting-stars (*continued*).

Comparison of the Epochs and Positions of Radiant-points of Shooting-stars, concluded independently, by R. P. Greg, Esq., and Dr. E. Heis.

From Observations contained in the British Association Catalogues, 1845–1863. (R. P. Greg.)						Observed at Münster, 1849–61. (E. Heis.)			
No.	Epochs in their order of commencement.	No. of Meteors.	Distinctive Number. (Greg.)	R. A.	N. Decl.	Distinctive Letters.	R. A.	N. Decl.	Epochs to the nearest half-month.
33	July 22 to Aug. 10...	70	XXVI. ...	344°	12°	T_1	314	15	August 16 to 31.
				to 327	10				
34	July 29 to Aug. 22...	123	XXIV.*a* ...	302	44				
				to 288	42	B_4	306	59	August 16 to 31.
				& 298	58	B_0	302	65	July 16 to Aug. 15.
35	Aug. 6 to Sept. 10...	80	XXIX. ...	0	90	N_{12}	295	79	August 16 to 31.
						N_{13}	130	84	September 1 to 15.
36	August 7 to 16	...	XXVIII....	45	55	A_0	50	51	July 16 to Aug. 15.
				to 20	62				
37	Aug. 17 to Sept. 12	9	XXVII.*a*...	245	5	Q_3	262	12	July 1 to 15.
				to 262	12				
38	Aug. 17 to Sept. 30	18	XXIV.*b*, or XXX.*a*.	282	42	B_5	293	57	September 1 to 15.
39	Aug. 17 to Sept. 30	150	XXX.	333	50	E G			
				viz. 314	52	E	330	50	October 16 to 31.
				to 347	47	A_{11}	35	63	September 1 to 15.
				& 333	41	A_{12}	44	63	September 16 to 30.
				to 333	62	A_{13}	51	61	October 1 to 15.
40	Aug. 18 to Sept. 29	27	XXXI., or	13	34	R_1	53	35	September 1 to 15.
			XXX.*b*.			R_2	46	37	September 16 to 30.
41	Aug. 22 to Nov. 5 ...	27	XXXII. ...	1	15	T_2	343	10	September 1 to 15.
						T_3	1	11	September 16 to 30.
						T_4	3	11	October 1 to 15.
42	Sept. 6 to Nov. 23...	18	XXXIV....	22	−9	T G			
						U	10	−11	October 16 to 31.
43	Sept. 20 to Oct. 11...	35	XXXV. ...	83	48	A G_2			
44	Sept. 25 to Oct. 10...	16	XXXVI. ...	51	84	N_{14}	65	84	September 16 to 30.
45	Sept. 27 to Nov. 2...	67	XXXIII....	14	58	A_{14}	20	42	October 16 to 31.
						A_{15}	25	40	December 1 to 15.
46	October 3 to 20......	11	XXXVII...	140	45	L G			
						? L_1	115	55	December 1 to 15.
47	Oct. 4 to Nov. 10 ...	35	XXXVIII.	45	33	R_3	45	32	October 1 to 15.
48	Oct. 18 to Nov. 3 ...	30	XXXIX....	83	12	O			
49	Oct. 20 to Nov. 21...	33	XL.........	91	56	F	75	40	October 16 to 31.
50	Oct. 31 to Dec. 9 ...	14	XLIII. ...	139	7	L H			
51	November 1 to 23...	75	XLI.	16	49	A G_3			
52	November 7 to 15...	...	XLII.......	153	22	L_0	150	28	November 1 to 30.
53	Nov. 23 to Dec. 9 ...	9	XLV.	279	56	D G_3			
54	Nov. 24 to Dec. 10...	37	XLIV. ...	59	58	A_{16}	37	59	December 16 to 31.
55	Nov. 26 to Dec. 30...	84	XLVII. ...	96	36	G			
						? L_1	115	55	December 1 to 15.
56	Nov. 27 to Dec. 19	10	XLVI. ...	157	71	K G			
	Total days, 1655.	1746							

Each of the foregoing fifty-six radiant-points of shooting-stars depends upon the average of one meteor recorded per night for thirty successive nights, which is the average duration of a meteoric shower. Even cursory observations are calculated to add to the precision with which it will in future be desirable to fix the epochs and positions of these radiant-points. When the epochs and positions of the different general radiant-points of shooting-stars are more exactly circumscribed, it may be reasonably expected that fireballs and meteorites will be shown to belong, like shooting-stars, to meteoric showers.

The results arrived at independently by Professor Heis, of Münster, are in general strongly corroborative of those obtained by Mr. Greg, of Manchester, though in certain cases the latter exhibits radiants not given by the former, and *vice versâ*. Professor Heis, however, has somewhat arbitrarily divided his meteor-showers and radiants into bi-monthly divisions, and has thus occasionally presented the same shower with a number of radiants more or less closely allied to each other.

Mr. Greg has endeavoured to give as nearly as possible the precise duration and limit of each shower, as well as the average position of its connected radiant.

The general results may be thus summed up, with a tolerable degree of certainty, as regards the *meteor-showers*.

They appear to endure for almost any period, from twenty-four hours to eight or possibly ten weeks, differing from one another in richness or intensity of display. In some there appears to be a tendency to maximum display on particular days, as for example xlvii., lasting from November 26th to December 30th; but the most abundant display occurs from December 9th to 13th. In others no such maximum can be perceived. Their number, of fully fifty as yet ascertained, will probably not be much exceeded, unless by short-lived showers, and by others whose radiants culminate just before dawn. There is no confusion or chance in their return, but, on the contrary, the showers are very regularly recurrent every year, and, allowing a *radiant-region* of 10° to 15° in diameter for each, the so-called "sporadic" meteors will become extremely scarce, now that the principal showers and their radiants have been pointed out. A well-marked instance of long persistence, and remarkable for having its radiant very small and fixed, is the shower of August 6th to September 10th, no. xxix. The great majority have, at the present time, been as clearly defined (as regards the time of their occurrence, duration, and positions of their radiants) as is the case with the older and better-known showers of August and November. On the average of many years, the radiant-regions of a few are, however, still very extensive. In all, a plane, oval, or double-headed region of radiation appears to represent the conditions of the showers more correctly than a point. This elongation of the radiant-region is in most cases perpendicular to the ecliptic, or parallel to the *via lactea*, in or near which the greater number of the radiants in the latter half of the year are placed. The meteors of particular showers vary in their distinctive characters, some being larger and brighter than others, some whiter, some more ruddy than others; some swifter, and drawing after them more persistent trains than those of other showers. Their connexion with the epochs and directions of large meteors still remains to be established.

Report on the best Means of providing for a Uniformity of Weights and Measures, with reference to the Interests of Science. By a Committee consisting of Lord Wrottesley*, *D.C.L., F.R.S.,* The Rt. Hon. C. B. Adderley*, *M.P.,* Sir William Armstrong, *C.B., F.R.S.,* The Astronomer Royal, *F.R.S.,* Samuel Brown*, W. Ewart, *M.P.,* T. Graham, *F.R.S.,* Sir John Hay*, *Bart., M.P., F.R.S.,* Prof. Hennessy*, *F.R.S.,* James Heywood*, *M.A., F.R.S.,* Dr. Lee*, *F.R.S.,* Dr. Leone Levi*, *F.S.A., F.S.S.,* Prof. W. A. Miller, *F.R.S.,* Prof. Rankine*, *F.R.S.,* Rev. Dr. Robinson, *F.R.S.,* Col. Sykes*, *M.P., F.R.S.,* W. Tite, *M.P., F.R.S.,* Prof. A. W. Williamson*, *F.R.S.,* James Yates, *M.A., F.R.S., and* Frederick Purdy*.

For a uniformity of weights and measures with reference to the interests of science, the Committee recommend to the British Association the following resolutions:—

1. That it is desirable, in the interests of science, to adopt a decimal system of weights and measures.

2. That in furtherance of this proposal, it is desirable, from its scientific capabilities, to adopt the metric system†.

3. That as the weights and measures of this country are gradually undergoing a process of decimalization, it would be more advantageous, instead of drifting by degrees into a heterogeneous variety of systems, to change at once to a really convenient system.

4. That it be recommended to the Government, in all cases in which statistical documents issued by them relate to questions of international interest, to give the metric equivalents to English weights and measures.

5. That in communications respecting weights and measures, presented to foreign countries which have adopted the metric system, equivalents in the metric system be given for the ordinary English expressions for length, capacity, bulk, and weight.

6. That it be recommended to the authors of scientific communications, in all cases where the expense or labour involved would not be too great, to give the metric equivalents of the weights and measures mentioned.

7. That the influence of the British Association would be beneficially exerted in obtaining from Paris an authorized set of metric weights and measures, to be placed in some public and frequented building in London.

8. That advantage will be derived from the recent publication of metric tables, by C. H. Dowling, C.E., in which British standard weights and measures are compared with those of the metric system‡. That treatises explaining the metric system, with diagrams, should be forthwith laid before the public. That works on arithmetic should contain metric tables of weights and measures, with suitable exercises on those tables; and that inspectors of schools should examine candidates for pupil-teachers in the metric system.

9. On the subject of temperature, it is recommended that the authors of Reports to be presented to the British Association, relative to temperature,

* Those members whose names have an asterisk (*) added have attended meetings of the Committee.

† Professor Rankine has dissented from the second Resolution.

‡ London, Lockwood and Co., 1864.

be requested to give the degrees of heat or cold according to both the Centigrade and Fahrenheit's thermometers.

10. It is recommended that the scales of thermometers constructed for scientific purposes be divided both according to the Centigrade and Fahrenheit scales; and that barometric scales be divided into fractions of the metre, as well as into those of the foot and inch.

11. That a committee on uniformity of weights and measures be reappointed, with a grant of £20.

Prince Talleyrand, in 1790, distributed among the members of the Constituent Assembly of France a proposal, founded upon the excessive diversity and confusion of the weights and measures then prevailing all over that country, for the reformation of the system, or rather for the foundation of a new system upon the principle of a single and universal standard*.

A Committee of the Academy of Sciences, consisting of five of the most eminent mathematicians of Europe—Borda, Lagrange, Laplace, Monge, and Condorcet—were subsequently appointed, under a decree of the Constituent Assembly, to report upon the selection of a natural standard; and the Committee proposed in their Report that the ten-millionth part of the quarter of the meridian of Dunkirk should be taken as the standard unit of linear measure.

Delambre and Méchain were appointed to measure an arc of the meridian between Dunkirk and Barcelona. They commenced their labours at the most agitated period of the French revolution. At every station of their progress in the field-survey they were arrested by the suspicions and alarms of the people, who took them for spies or engineers of the invading enemies of France. The result was a very wonderful approximation to the true length, and one in the highest degree "creditable to the French astronomers and geometricians, who carried on their operations, under every difficulty and at the hazard of their lives, in the midst of the greatest political convulsion of modern times"†.

By means of the arc of the meridian measured between Dunkirk and Barcelona, and of the arc measured in Peru, in 1736, by Bougner and La Condamine, the length of the quarter of the meridian, or the distance from the pole to the equator, was calculated. This length was partitioned into ten millions of equal parts, and one of these parts was taken for the unit of length, and called a metre ‡, from the Greek word μέτρον (*a measure*).

If the arc of the meridian be calculated from the result of French researches, the metre itself is equal, in English measurement, to 39·37079 inches; and multiplying this length by 10,000,000, the length of the quadrant of the meridian, when converted into feet, will be, 32,808,992 feet. Sir John Herschel estimates the length of the quadrant of the meridian at 32,813,000 feet; so that, according to his calculation, there is a difference between the French and the new estimate of the quadrant, of 4008 feet, and therefore the French length of the quadrant is $\frac{1}{8194}$th too short, and the metre is $\frac{1}{208}$th of an inch less than the length of the ten-millionth part of the quadrant.

An error of $\frac{1}{208}$th of an inch in the determination of the metre is more than counterbalanced by the extreme simplicity, symmetry, and convenience of the metric system. Professor Bessel observed with respect to

* Report of John Quincy Adams on Weights and Measures, p. 49. Washington, 1821.

† Essay on the Yard, the Pendulum, and the Metre, by Sir John F. W. Herschel, Bart., K.H., M.A., F.R.S., &c., p. 19. London, 1863.

‡ Briot's 'Arithmetic,' translated by J. Spear, Esq., p. 152. R. Hardwicke: London, 1863.

the metre, that, "in the measurement of a length between two points on the surface of the earth, there is no advantage at all in proving the relation of the measured distance to a quadrant of the meridian"*. Professor Miller, of Cambridge, who quotes this remark, deems the error in the relation of the metre to the quadrant of the meridian to be of no consequence; and he mentions another slight error in the metric system, discovered by recent research, and relating to the density of water, which he gives in the following words of Bessel †:—

"The kilogramme (1000 grammes) is not exactly the weight of a cubic decimetre of water. Many of the late weighings show that water at its maximum density has a different density from that which was assumed by the French philosophers who prepared the original standard of the kilogramme; but nobody wishes to alter the value of the gramme on that account."

M. Chevalier stated to the Committee of the House of Commons on Weights and Measures, in 1862, that, in calculation, the metric system spares both time and labour, exactly as a good machine would do for spinning or weaving.

The metric system is considered by Sir William Armstrong to be "the only one which has any chance of becoming universal."

Two important principles form the basis of the metric system.

1. That the unit of linear measure, applied to matter, in its three forms of extension, viz. length, breadth, and thickness, should be the standard of all measures of length, surface, and solidity.

2. That the cubic contents of the linear measure, in distilled water, at a temperature of great contraction, should furnish at once the standard weight and measure of capacity.

Scientific advisers were summoned to the counsels of King Louis Philippe, on his accession to the French throne, and that monarch has the credit of having enforced the metric system in France. The opposition to the metric system, among the French, had not arisen from the requirements of commerce; the Department of the Bridges and High Roads and the officials of the naval arsenals had, with the consent of the French government, already adopted the metric system, and the new system came into general operation in 1840.

The Department of Commerce in France superintends the proper observance of weights and measures. Standards made for the course of trade are very numerous.

"If you have been walking about Paris," says M. Chevalier, "you may have seen the metre in the streets, fixed in the wall of many a public building. It is made by public authority. Any buyer, who is afraid that he has been cheated, can go to some street at a short distance, and there he finds the measurement of the metre, fixed by authority for the use of the people; besides, he has a process more simple, to know whether he has been dealt with fairly; he has his own metre in his pocket."

Verifiers of weights and measures are appointed in every district (*arrondissement*) of France, and each verifier has his own set of these instruments. Measures are made very cheap in Paris: balances furnished with small weights may be purchased at a small expense; and in the larger weights, the principal expense is in the metal.

* Report of a Committee of the House of Commons on Weights and Measures, p. 109. 1862.

† From the 'Populäre Vorlesungen,' by Professor Bessel, published in 1848, soon after his death.

Gutch's 'Literary and Scientific Register' for 1864* contains a useful comparison of metric and English measures, compiled by Mr. Warren De la Rue, F.R.S., in which the different quantities of the metric system are expressed in their English equivalents, and the value of several important English weights and measures is given in the terms of the metric system.

Until comparative tables of the English and metric systems had been published, the labour of converting English weights and measures into the metric system was so excessive, that when communications to scientific societies were published in England, with merely British weights and measures, such papers were frequently not translated in foreign countries, and the labours of the Englishman of science were consequently not appreciated beyond the limits of Anglo-Saxon dominions.

Practical inconvenience was felt, during the negotiation of the commercia treaty between France and England, on account of the English inch not being at that time usually divided, except into quarters and eighths.

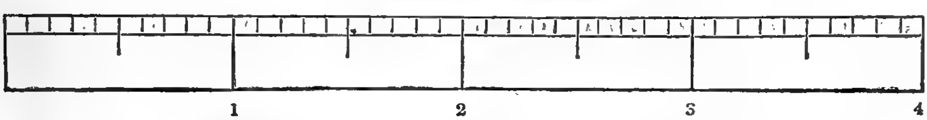
Mr. Ogilvie, Surveyor General of the Custom House in London, who assisted Mr. Cobden in the French treaty, found the advantage of the minute subdivisions of French measures, such as the millimetre, which is one-third less than one-sixteenth of an inch, and is the one-thousandth part of the metre.

French workmen are familiar with the millimetre as a unit of width, and as especially useful with reference to plates of iron or other materials. Duties had to be calculated for the treaty on rolled iron, in cases where the work of rolling increased the value of the iron, and where a slight diminution of width was of great importance.

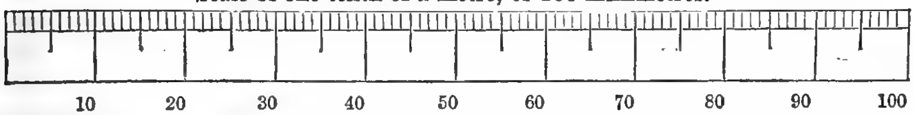
The following diagram, from Gutch's 'Scientific Register,' will show the minute subdivision of the millimetre, and will also exhibit the near approximation of 100 millimetres to 4 inches.

COMPARISON OF ENGLISH AND METRIC MEASUREMENT.

Scale of four inches.



Scale of one-tenth of a metre, or 100 millimetres.



Mr. J. Mumford, Master of the British School at Highgate, recommends decimals to be placed immediately after numeration in the ordinary arithmetic-books, instead of being put after compound interest and other difficult rules. The children in schools, who usually follow the order of subjects in an arithmetic-book, would thus learn decimals at an earlier period of their education.

So much time is occupied in schools in committing to memory the various tables of English weights and measures, and in working examples of compound addition, subtraction, multiplication, and division, that Mr. James Yates is of opinion that a year would be saved in the education of boys,

* Published by B. Blake, 421 Strand, London.

if the metric system were to take the place of the existing tables of weights and measures in England.

The English workmen engaged in building-trades, such as carpenters, masons, and bricklayers, Professor Donaldson considers to be generally very intelligent; and whatever would afford to them facility in calculation would be acceptable as soon as it had been explained to them.

In railway operations a civil engineer ascertains weight by computation of measure: he cannot take scales and beams, and weigh pieces of iron of twenty tons and upwards; he knows the specific gravity of the iron, and he ascertains by measurement the weight of a given quantity of that metal. The metric system aids in all calculations relating to specific gravity.

Mr. W. Crosley, C.E., stated to the Committee of the House of Commons on Weights and Measures that he believes the decimal system is extending itself very much, especially for scientific purposes and amongst professional men. "It is extending itself among them very considerably, without any law whatever."

Chemists, pursuing important researches, employ generally metric weights and measures. Thus, in the Royal Institution of Great Britain, in Albemarle Street, the operations of the laboratory are carried on with the aid of the metric system; and Dr. Frankland, one of the chemists of that Society, finds the metric weights and measures particularly valuable in his experimental investigations respecting gases. The gramme, with its multiples and minute subdivisions, is a popular weight with chemists.

In the practical business of a druggist the metric system of weights and measures, if generally adopted, would, in the opinion of Mr. Squire, save a great deal of labour to the rising generation. In the metric system, Mr. Squire observes, as the divisions and multiplications are all by ten, the subject and the calculations would be much simplified *.

A meeting, held in June 1863, of the Pharmaceutical Society of Great Britain, adopted a petition to the House of Commons, in which they recommended an assimilation of the weights and measures of all nations, as likely "to tend greatly to the convenience of pharmaceutists † and the safety of the public."

The Pharmaceutical Society of Great Britain felt assured that a "very few years would familiarize both prescribers and dispensers with the new weights and measures, and that the easy multiplication or division of them by the decimal system, universally applied, would afford such facilities of computation as to recommend it strongly to the adoption of medical men and chemists; and they are strengthened in this opinion by the invariable practice of English and all other analytical chemists already to state the results of their investigations in decimals."

Some metric measures and weights approach very nearly to corresponding English quantities: thus, in liquid measure, five litres are nearly equal to $1\frac{1}{10}$ gallon, or 1 gallon 0·402 of a quart.

A half-kilogramme, or weight of 500 grammes, is equivalent to 1 lb. 1 oz. 10·191 drams avoirdupois.

The following brief table, by Mr. Samuel Brown, condenses the system of all the metric measures and weights into a small compass;—

* Pharmaceutical Journal, July 1863, p. 8. † Ibid. p. 9.

System of Metric Measures and Weights.

	Length.	Surface.	Capacity.	Weight.
Multiples.				
Myria	10,000	..	..	10,000
Kilo	1,000	..	1,000	1,000
Hecto	100	100	100	100
Deka	10	..	10	10
UNITS	Mètre.	Are.	Litre.	Gramme.
Divisions.				
Deci	·1	..	·1	·1
Centi	·01	·01	·01	·01
Milli	·001	..	..	·001

It will be observed that the multiples of the unit, in each case, are designated, in the metric system, by Greek prefixes:—*Myria*, 10,000; *Kilo*, or *Chilio*, 1000; *Hecto*, or *Hecato*, 100; *Deka*, 10: whilst the divisions of the unit, in each case, are expressed by Latin prefixes:—*Deci*, $\frac{1}{10}$th; *Centi*, $\frac{1}{100}$; *Milli*, $\frac{1}{1000}$.

The English equivalents to the measures of length and capacity, and to the weights, according to the metric system, are thus given:—

Metric Measures of Length, with English equivalents.

Metric Names.	English Equivalents.			
	inches.	feet.	inches.	yards.
Millimètre (1-1000th)........	0·039			
Centimètre (1-100th)	0·394			
Décimètre (1-10th)..........	3·937			
1 MÈTRE	39·371	3	3·371	1·094
Dékamètre (10 mètres)	....	32	9·708	10·936
Hectomètre (100 mètres)	....	..	..	109·363
Kilomètre (1000 mètres)	....	..	..	1093·633

Metric Measures of Capacity, with English equivalents.

Metric Names.	English Equivalents.			
	gill.	quart.	gallons.	quart.
Centilitre	0·070			
Décilitre....................	0·704			
LITRE	....	0·880		
Dékalitre (10 litres)	....	....	2	0·804
Hectolitre (100 litres)	....	....	22	0·039

Metric Weights, with English equivalents.

Metric Names.	Avoirdupois.				Troy.
	cwt. qrs.	lb.	oz.	drams.	grains.
1 décigramme (1-10th)....	......	....	....	....	1·543
1 GRAMME	......	....	....	....	15·432
1 dékagramme (10 grammes)	......	....	....	5·644	
1 hectogramme (100 grms.)	......	....	3·527		
1 kilogramme, or kilo (1000 grammes)...........	......	2·205			
1 myriagramme (10 kilos)..	......	22·046			
1 metric quintal (or 100 kilos)	1 3·874				
1 metric tonne (1000 kilos)	19 2·736				

Professor Chevalier, in his evidence to the Committee of the House of Commons on Weights and Measures, states his opinion that some objections may be made to the Gramme as the unit of weight. "It is very small: perhaps it would have been better to have taken the kilogramme; but such a change can be easily made. If you think our measure of weight is too small, in case you adopt the system, you may take the kilogramme" (observes the Professor) "for the unit."

The metric system of weights and measures has been adopted, not only by France, but by Italy (except the portion under Pontifical government), Spain, Portugal, Belgium, and Holland; it has been partially received in Switzerland, which adopts the half-kilogramme as the pound. The majority of the States composing the "Zollverein," or Customs League, in Germany, have expressed their approval of the metric system. The half-kilogramme has been introduced into all great mercantile operations in Austria.

At the International Statistical Congress, held at Berlin, in September 1863, thirty-three nations of Europe and America were represented by statistical delegates, and the congress agreed to the following fundamental resolution on weights and measures:—

"The adoption of the same measure in international commerce is of the highest importance. The metric system appears to the congress to be the most convenient of all the measures that could be recommended for international measures."

A commission of the Imperial Academy of Sciences in St. Petersburg has recommended that such alterations should be made in Russian weights and measures as would put them in conformity with the metric system of France. The Grand Duke Constantine, brother of the Emperor of Russia, is in favour of the metric system; and Dr. Kupffer, a delegate from the Russian government, has declared that Russia would recommend the adoption of the pure metric system, if Great Britain would take the lead.

"We wish England," said Dr. Kupffer, "to take the lead. England is a country of prior civilization. Let England do it, and we are sure to follow."

In the new Belgian law on weights and measures, the units of the metric system have been extended by adopting the doubles of each unit, and of its multiples and subdivisions. The Belgians have also adopted the principle of having weights representing 50, 20, 5, 2, and 1; and they have followed a similar arrangement with regard to measures of length and measures of capacity.

In Holland the law requires the use of the metric system in all things, except weighing medicines. The old Dutch names, such as "elle" and "palm," are preserved in the metric tables; the "elle" is the metre (3·2809 feet), and the "palm" the decimetre (or 3·937 inches). A "kan" in Holland is the name for a litre, or 1·760 pint. In weights, the "ons" is the Dutch name for a hectogramme*, or 3·527 ounces; and a "pond" corresponds to the kilogramme (=2·205 lbs.).

In Spain the government has purchased 600 sets of metric weights and measures, and it intends to buy more, so that it may supply each important town with standards for comparison. On the Spanish railways, distances are measured by kilometres, and weights by kilogrammes. Tables are published containing the equivalents of the old Spanish weights and measures in metric quantities, and calculated in each case from 1 to 1000.

Official tables are published in Portugal, containing Portuguese measurements in metrical quantities, and *vice versâ*. Inspectors of schools, appointed by the general superintendents of weights and measures, have inspected 2720 public and private schools, and schools are established under the same superintendence to explain the new system†. A great number of elementary works have been published in Portugal on metrical weights and measures for the use of schools, as well as for the public.

In the United States of America a committee has been appointed by Congress to consider the subject of metric weights and measures. The Confederate States of North America have also expressed a wish to introduce into their republic the metric system of weights and measures; and the same system has been adopted in Mexico, Chili, Peru, New Granada, Bolivia, Venezuela, and French and Dutch Guiana.

Mr. Samuel Brown, in his evidence, in 1862, before the Committee of the House of Commons on Weights and Measures, states, that in 1859, of the total trade of Great Britain, including 79,405 vessels, there were 47,393 vessels going to or from countries using the kilogramme, or about 60 per cent. of the total number of vessels; and of 19,332,174 tons, there were 7,726,148 tons carried to or from countries using the kilogramme, or about 40 per cent. of the total tonnage.

Postal arrangements between Great Britain and France are complicated by the French weight for letters being somewhat heavier than the English foreign weight.

An English ounce weighs 28·349 grammes; and the quarter of an ounce, or English foreign weight, weighs 7·087 grammes.

In France the postal weight for single letters from England is 7·5 grammes; so that the French allow an excess of weight of ·413 of a gramme, or more than $\frac{1}{3}$rd of a gramme more than the English.

If a letter be prepaid by stamps, the advance is 4*d.* in England for every quarter of an ounce, and 40 centimes in France for every weight of $7\frac{1}{2}$ grammes.

The postal treaty between the two countries declares that "no letter, of which the postage is paid by stamps, is to be treated as an insufficiently paid letter, unless the value of the stamps be less than the amount required for its payment, according to the weight allowed, not only by the English, but by the French scale of weight, of which $7\frac{1}{2}$ grammes is the unit."

In practice the postal officials in London weigh letters going to France, and

* Woolhouse's 'Weights and Measures of all Nations,' p. 79.

† The Marquis d'Avila's Report, quoted in Ruggles's 'Reports,' p. 64.

paid by stamps, with French weights. Sir Rowland Hill informed the House of Commons Committee, that if the prepaid letter does not exceed the French allowance, no additional charge is levied; if it does exceed that allowance, it is marked as insufficiently paid.

Local letters in France are charged by a scale similar to that of England. It begins at 15 grammes, then it advances to 30, then to 60, and then to 90 grammes, and so on.

Ten grammes are equal to nearly $\frac{1}{3}$rd of an ounce, 15 grammes are a little more than $\frac{1}{2}$ an ounce, an ounce being 28·349 grammes.

The use of metric weights and measures has recently been legalized in Great Britain; and the Act on this subject has been passed in 1864, "for the promotion and extension of our internal as well as our foreign trade, and for the advancement of science."

Mr. William Ewart, M.P., has ably conducted this measure through the House of Commons; Earl Fortescue has had the successful charge of it in the House of Lords; and the Bill has been also supported by the International Decimal Association, in whose labours Mr. James Yates has taken an active and leading part. The investigations of the Committee of the House of Commons on Weights and Measures, in 1862, have assisted in forming an influential parliamentary party in its favour.

Various recommendations were made, in 1862, by the House of Commons Committee, at the close of their Report, among which were the following:—

"That a Department of Weights and Measures be established in connexion with the Board of Trade.

"The metric system should form one of the subjects of examination in the competitive examinations of the civil service.

"The *gramme* should be used as a weight for foreign letters and books at the Post Office.

"The Committee of Council on Education should require the metric system to be taught (as may easily be done, by means of tables and diagrams) in all schools receiving grants of public money.

"The Committee further suggest that, in the public statistics of the country, quantities should be expressed in terms of the metric system, in juxtaposition with those of our own, as suggested by the International Statistical Congress."

It will be satisfactory to notice that, in a Report in 1862, by Mr. J. Ball, published by the British Association for the Advancement of Science, "On Thermometric Observations in the Alps," the temperatures are given according to the Centigrade scale, the corresponding temperatures according to Fahrenheit being frequently added in brackets.

Sometimes the observations in this Report merely record the fluctuations of the mercury in the Centigrade thermometer.

Observations may, in like manner, be easily registered, both according to the English and French scales of temperature, and the fluctuations of the barometer may also be noted so as to be intelligible both in France and Great Britain.

At the end of Mr. Dowling's "Metric Tables," a comparison of the scales of Fahrenheit's, the Centigrade, and Réaumur's thermometers is given, as well as a comparison of the British and metric barometers, the latter containing the equivalents, from 27 inches to 30·98 inches, in linear inches and millimetres.

Under the head of Chemistry, in the Matriculation Examinations of the University of London, candidates are frequently asked, among other questions, to convert a given number of degrees of Fahrenheit into the corresponding degrees of a Reaumur or a Centigrade thermometer.

Sir William Armstrong remarked, at Newcastle-upon-Tyne, in his address to the British Association in 1863, that our thermometric scale had been originally founded in error: he regarded it as most inconvenient in division, and advised that the Centigrade scale should be recognized by the numerous men of science composing the British Association.

The distinguished President of the British Association stated his regret that two standards of measure, so nearly alike as the English yard and the French metre, should not be made absolutely identical. We in England, observed Sir William, have no alternative but to conform with France, if we desire general uniformity. He was convinced that the adoption of the decimal division of the French scale would be attended with great convenience, both in science and commerce. He could speak, from personal experience, of the superiority of decimal measurement in all cases where accuracy is required in mechanical construction. In the Elswick works, as well as in some other large establishments of the same description, the inch is adopted as the unit, and all fractional parts are expressed in decimals. "No difficulty has been experienced in habituating the workmen to the use of this method, and it has greatly contributed to the precision of workmanship. The inch, however, is too small a unit, and it would be advantageous to substitute the metre, if general concurrence could be obtained."

Report of Experiments respecting the Development and Migrations of the Entozoa. By T. Spencer Cobbold, *M.D., F.R.S., F.L.S., Lecturer on Comparative Anatomy at the Middlesex Hospital.*

At the Cambridge Meeting of this Association in 1862, I offered a brief *résumé* of the principal facts then known in relation to the origin and mode of development of the Entozoa liable to infest the human body; but, notwithstanding the very interesting discoveries which Continental observers had made on this subject, it still appeared that there was room for further inquiry. In this view I proposed to institute a series of experiments, partly for the purpose of verifying previously recorded statements, but more particularly with the intention of adding to our stock of helminthological facts. The General Committee, in approval, sanctioned and encouraged this proposition; and I therefore proceed to explain the nature of the experiments adopted. Though the results arrived at exhibit, for the most part, a negative aspect, yet in some instances the reverse of this is the case, whilst, under any circumstances, the facts are calculated to prove more or less instructive, and all of them tend to advance a department of science in the progress of which our present and future social welfare is deeply concerned.

I have not, indeed, limited my inquiries to particular human parasites, but have employed all such helminthic forms as I have been able to procure in a satisfactory condition for experiment. In this country, and especially in London, great difficulties are placed in the way of any one engaged in biological pursuits involving the keeping of dogs and other animals; and, last year (1863), these obstructions were, I fear, somewhat enhanced by certain misguided individuals who seem to entertain the idea that physiologists delight in the practice of cruelty. The destruction of game by the sportsman, the capture of fish by the hook, and the slaughter of domestic animals for food are attended with far more inconvenience and misery to the creatures thus destroyed than obtains, in the majority of cases, where animals are sacrificed on the altar of science; for, in the latter case, not only are the experimental animals generally destroyed suddenly, but, in those instances where the act of life-departure is more prolonged, the employment of anæsthetics is frequently made use of. Believing, however, that it is not necessary to offer any further apology in favour of the experimental methods commonly adopted in our biological inquiries, I now proceed to notice the several species of Entozoa which have been made the subject of investigation.

1. *Tænia echinococcus.*—Of all the mischievous parasites known to infest the human body, none are capable of producing such dire results as those affected by the larvæ of this very minute tapeworm. I will merely add, that it is not only the cause of the formidable Echinococcus-endemic in Iceland, but that it also in this country destroys many persons annually.

On the 30th September, 1862, I fed a house-dog with several hundred Echinococcus-heads (scolices), obtained from the body of a young person who had been destroyed by this parasite. On the 28th of November of the same year I killed the dog, but could discover no trace of the *Tæniæ* to which these larvæ are believed to be referable.

On the 14th January, 1863, I administered five small Echinococcus-vesicles to a dog which ate them greedily. Similar administrations were also made on the 24th of the same month, and again on the 6th of February. To the results likely to be obtained from these experiments I looked forward with considerable interest; but, on the evening previous to the day I had appointed for the dog's destruction, some person liberated the animal. Should the experiments in this case happen to have been successful, the freedom of the dog could only serve to spread abroad the very formidable disease which it is the object of these experiments to check. Those, therefore, who are hostile to our researches should bear in mind that interference with our pursuits may be attended with results seriously affecting the welfare of the community.

On the 2nd of February, 1863, I fed another dog with several Echinococcus-vesicles taken from the lungs of a sheep; and, on the 6th of the same month, I repeated the dose with very fresh cysts. On the 25th of February I also destroyed this dog, but found no examples of the characteristic *Tæniæ.* The animal would not have been destroyed thus early, only I feared losing it altogether from the cause above mentioned.

On the 6th of February, 1863, I gave about fifty Echinococcus-scolices to a puppy. This animal was destroyed on the 10th of March, 1863; but, so far as the Echinococci were concerned, the result was entirely negative.

On the 28th of March, 1863, I administered to another dog scrapings from the interior of a large Echinococcus-cyst, which, associated with several other vesicles, had caused the death of a second person. The first patient came under the medical care of Dr. Greenhow, while this case belonged to Dr. Murchison. On the 9th of April following the animal was destroyed; but I had not succeeded in rearing the *Tænia echinococcus.* Had the parasites been present in this or any other of the dogs thus carefully examined, I am confident they would not have escaped my notice, especially since the possession of specimens of the adult tapeworm kindly sent me by Professor Leuckart, of Giessen, had rendered me familiar with its characters.

2. *Tænia serrata.*—This well-known species infests the dog in its adult stage, the larvæ being, beyond all dispute, the well-known pea-shaped

hydatids (*Cysticercus pisiformis*) commonly found in rabbits. I offer the following facts, therefore, partly in confirmation of previously ascertained results.

On the 21st November, 1862, I administered to a dog one immature Cysticercus-vesicle taken from the abdominal cavity of a rabbit; and to the same dog I also gave, on the 24th of the same month, four mature examples of *Cysticercus pisiformis* taken from the mesentery of another rabbit, one of the larvæ being injured. On the 28th of November the dog was destroyed; and the result gave three examples of immature *Tænia serrata*, each measuring about half an inch in length. Their size indicated clearly whence they were derived, whilst the non-development of the injured Cysticercus, as well as that of the imperfectly developed larva, is sufficiently accounted for, and accords with my previous experience.

On the 19th January, 1863, on the 6th of February, and again on the 23rd of the latter month, I administered several mature examples of *C. pisiformis* to the dog, which was subsequently liberated, without my being able to ascertain the result of my worm-feedings.

On the 20th February, 1863, I gave to another dog eight *immature* larvæ taken from the abdomen of a rabbit; and again, on the 6th of March succeeding, two mature larvæ (*C. pisiformis*) were given to the same dog. This animal was destroyed on the 18th of March, and the result was entirely satisfactory. There were two examples of *Tænia serrata*, each about four inches in length, none of the migrating or immature larvæ having continued their development.

On the 27th May, four fresh Cysticerci from a rabbit were given to another dog, which, on being destroyed on the 3rd of the following June, was found to contain four examples of *Tænia serrata*. In this instance, I believe, only one of the Cysticerci had developed into its strobila-form, one being about three inches in length: the others were upwards of a foot long, and could not, I presume, be referable to the three other larvæ. This experiment, therefore, was partially negative.

3. *Tænia marginata*.—On the 5th November, 1862, I fed a monkey with eggs of this worm; but he swallowed only a very small portion of the potato in which I had placed them. The destruction of the animal on the 5th of February, 1863, only yielded a negative result.

4. *Tænia cucumerina*.—On the 3rd November, 1862, I fed several cockroaches (*Blatta orientalis*) with mature proglottides of *Tænia cucumerina*. Subsequent careful dissections of these insects, at various intervals, failed to reveal the existence of Cysticerci within their tissues.

On the 7th of November, 1863, and again on the 12th, I fed other *Blattæ* with proglottides and eggs, mixed with sugar, treacle, potatoes, and bread; but these administrations only gave negative results.

On the 20th January, 1864, I removed a proglottis of the so-called *Tænia elliptica* (in the act of migrating) from the external surface of the body of a cat. I placed it on glass, and noticed that it discharged eggs during its movements. The proglottis was subsequently broken up and mixed with paste. Five or six *Blattæ* were next captured; and, on being brought in contact with the food, they very soon devoured the paste and all the enclosed fragments of the proglottis, including the eggs. Forty-two hours afterwards I dissected one of the larger cockroaches, and found at least one hundred tapeworm eggs in its stomach. Each egg contained a six-hooked embryo. There were one or two empty shells; but I did not succeed in finding a free embryo. Here the experiment ended; for the other *Blattæ* successfully made their escape a few days afterwards.

5. *Distoma hepaticum.*—On the 6th of January, 1863, numerous eggs from the uterine tubes of one dozen flukes were placed in a jar of fresh water containing living vegetable matter (*Anacharis*). An examination of the contents of the glass, on the 16th of March, revealed the presence of many empty egg-shells, and others with immature embryos in their interior. On the 13th April following, all the embryos had apparently escaped; but they were not found in the water. Possibly they had been devoured by Entomostraca.

On the 6th January, 1863, a quantity of flukes' eggs were administered to a frog; but a subsequent examination of the reptile, after death, only gave a negative result.

6. *Ascaris osculata.*—On the 11th October, 1862, sections of two female nematodes, taken from a seal, were given to a dog. The seal had recently died, its stomach containing upwards of 200 ascarides. None of the eggs in these worms contained embryos; but the yelk was undergoing segmentation. Subsequently, eggs of this parasite, containing embryos, were also given to the same dog, and likewise, at a still later date, several free embryos. On destroying the dog, November 28, 1862, no young nematodes could be detected in its intestines.

On the 31st October, 1862, numerous eggs containing embryos were given to a dace (*Leuciscus rutilus*) and to a goldfish (*Cyprinus auratus*). On the 3rd November following, the dace was killed, without my finding any trace of the ova; but on the day following (Nov. 4) I destroyed the gold-carp, and found in its intestinal canal numerous empty egg-shells of *Ascaris osculata*. In the large tank, however, I sought in vain for these minute embryos.

On the 29th October, and on the 4th November, 1862, many eggs containing embryos were administered to frogs. Two of these Batrachians were subsequently examined (Nov. 10), without my finding either ova or embryos in their interior; but the water of the large glass vase which had imprisoned the frogs was found to contain a number of empty egg-shells of *Ascaris osculata*, as well as numerous living embryos, apparently referable to these ova.

On the 4th November, 1862, eggs with embryos were given to several freshwater fishes (gudgeon, carp, and dace); but the subsequent destruction and examination of some of these fishes only yielded a negative result.

On April 13th, 1863, several free embryos of *A. osculata* were administered to a dog, which was afterwards destroyed on the 3rd of June. No young ascarides, however, could be detected.

On the 11th October, 1862, when I first procured the adult ascarides from the seal, some of the ova were placed in a glass jar of fresh water containing *Chara*, others in jars of salt water supplied with *Zostera*. On the 15th of the same month, none of the ova appeared to have undergone any material change. On the 29th (18 days) the majority of those placed in the fresh water had developed into embryos within their shells, and not a few had escaped free into the water. At the same date, however, the eggs placed in the salt water had made comparatively little progress. Their yelk-segmentation had certainly advanced; but no embryos could be seen. One solitary empty shell was found in the salt water; but this may have resulted from injury. On the 7th November, some of the free embryos in the fresh water were found to display signs of growth, and one of them showed a tolerably well-developed digestive apparatus. On the 2nd of the following December, a large number of the embryos in the fresh water had either perished or had been devoured by Entomostraca present in the jar; others were found at the bottom of the vessel inactive, stretched out, and apparently dead. By this time (December 2nd, 1862), the development of the salt-water ova had much more advanced; the yelk had, in many instances, become transformed into embryos more or less complete, and several of the latter had quitted their shells. On the 13th of April these embryos had acquired well-marked digestive organs, and I thought I could discern the rudiments of an internal reproductive apparatus. They now exhibited a condition corresponding with that which the freshwater embryos had obtained at so early a period as the 7th of November. In other words, the freshwater embryos at one month (after immersion of the ova) were as far advanced as the salt-water embryos at six months. I do not attempt to explain this; I can only speak to the facts as they were presented. On the 16th of July, 1863, all the freshwater embryos had disappeared; a few dead ova, with dark granular contents, lay at the bottom of the jar; and there were a great number of empty shells, with parasitic algoids growing from their outer surfaces. In the salt water, on the 23rd September, 1863, there were still many eggs containing segmented yelks, and others with fully formed embryos, these being likewise associated with numerous free living embryos.

On the 25th of April, 1864, I still found some embryos alive in the salt water; but I could not discover any traces of the original eggs. The movements of the young worms were tolerably free, the largest specimen measuring about $\frac{1}{40}$ of an inch in length.

A careful search, made on the 21st of July last, failed to reveal any evidence of their existence; but as it is quite possible that one or two may still be living, I have retained the contents of the jar for subsequent final examination.

7. *Ascaris marginata.*—On the 25th February, 1863, a quantity of eggs were taken from the uterus of a full-grown female, and placed in fresh water supplied with *Anacharis.* On the 16th of July following, most of the ova appeared to contain embryos, which were moving freely within their shells; but none were found to have escaped. On the 23rd September, 1863, similar facts presented themselves; and although I detected no free embryos, there were, nevertheless, several empty egg-shells at the bottom of the vessel. The same conditions were still observed on the 20th April, 1864; but when I last examined the water (July 21, 1864), one or two embryos were found free.

8. *Ascaris lumbricoides.*—On the 8th December, 1862, a large number of ova were placed in a jar containing fresh water. By the 13th of March many of them appeared to have reached an early stage of embryonic formation, and then to have perished.

9. *Ascaris megalocephala.*—On the 24th of April, 1863, several thousand eggs, in some of which yelk-segmentation had commenced, were placed in two jars containing fresh water and *Anacharis.* On the 17th of the following July, a large proportion of the eggs were found to inclose well-developed embryos; but none were observed free. On the 23rd of September, not only were there a quantity of empty shells in both vessels, but also a corresponding number of free embryos, some of which appeared to have grown considerably since quitting the egg.

On the 18th of July, 1863, some of the immature eggs, as well as eggs containing embryos, were placed in a small vessel containing pond-mud (thin clay). On the 23rd September following, I found the mud to contain many eggs still undergoing yelk-segmentation, others with immature embryos, some few empty shells, and several highly active embryos adhering by their finely pointed tails to the glass slide on which the mud was spread out. The whole aspect and behaviour of these embryo nematodes differed very markedly from those of *Ascaris osculata*, and also from the young *Anguillulæ*. The digestive organs were well developed in several; but at least one specimen was dead and disintegrated internally. I could not satisfy myself as to the existence of any rudiments of a reproductive apparatus.

On the 18th of July, 1863, I also placed some of the above advanced eggs in muddy pond-water, to which I added some cowdung. This was also examined on the 23rd September, when a few empty shells were seen, their former occupants not being visible. Most of the eggs contained segmented yelks and young embryos. On the 25th of April, 1864, the same conditions were still observed: none of the embryos had escaped. At the above-mentioned date (July 18), ova were also put into another jar of pond-water, with horse-dung added. In this case (September 23) a few living embryos were detected, free and active. On the 25th of April, 1864, I found the eggs still segmenting, a few with embryos; but none of the latter were observed free. At the same period (July 18) other eggs were deposited in simple horse-dung; and here also (September 23) a few embryos had freed themselves of their egg-covering, and were still living. On the 25th April, 1864, I found numerous embryos free, active, and much grown.

On the 23rd December, 1863, I still found the majority of the eggs in the fresh water (of April 24th), with their embryos coiled in the interior and alive. One free embryo was particularly active, and there were several empty shells. On the 25th April, 1864, they still seemed to have undergone no material change, and I did not on this occasion observe any free embryos.

As the free embryos of *A. megalocephala*, reared in horse-dung, had, on the 4th of January, 1864, attained considerable size, and likewise exhibited traces of the sexual organs, I washed them out of the excreta; and, after straining through muslin, they were placed in a large jar with the water employed in separating them. My next object was to administer part of them to a horse, with the view of rearing the sexually mature worm. This was done on the 26th of April, 1864; but here again I was prevented ascertaining the result. The horse, becoming violent and vicious (from other causes), was slaughtered on the seventh day after the worm-feeding; and, by another mischance, I was also prevented from examining the intestines.

When I last examined the ova first placed in fresh water on the 24th of April, 1863, many of them still displayed living embryos in their interior, whilst hundreds of embryos were found free; the latter, however, showed no further advance in growth, and were by no means so active and healthy-looking as those contained in the jar of impure water. I satisfied myself, moreover, that these last were a trifle more advanced in development.

10. *Oxyuris vermicularis.*—On the 22nd December, 1862, numerous eggs were deposited in the substance of the pulp of two partially rotten pears and one decayed apple. I had not noticed embryos in *any* of the eggs at the time of their lodgment within the parent oviducts; but, on examining the fruits ten days later (January 1st, 1863), I found many of the ova to contain the characteristic tadpole-like embryos of *Oxyuris*. On the 13th of March following, none of the embryos appeared to have escaped their shells; but when I again examined these pears and the apple, on the 17th and 18th of the succeeding July, I found multitudes of minute nematodes which, at

the time, I referred to the ova and embryos in question. To add strength to that conclusion, I noticed a number of empty egg-shells of *Oxyuris* amongst the loose and decayed vegetable parenchyma. These little nematodes measured about $\frac{1}{40}$ of an inch in length, but their form did not correspond with the shape of the *Oxyuris*-embryo. The contents of one of the pears and the apple were subsequently employed in new experiments; but the other pear, which had now become thoroughly rotten and of a blackish-brown colour, was retained for the purpose of preserving these young nematodes. On the 23rd of September, 1863, I again examined this pear, and found a considerable number of the nematodes which had scarcely advanced in length or breadth. On the day following (24th) I had an opportunity of showing them to Professor Leuckart, of Giessen, who considered it possible that they might be the young of *Oxyuris*, notwithstanding their little resemblance to the tadpole-like condition of the embryo as it exists in ova. He suggested the probability, however, of their being *Anguillulæ*, and was resolved to satisfy his doubt on this score by repeating my experiment. It is known that *Anguillulæ* may suddenly make their appearance in decaying vegetable matter under similar conditions to those here recorded: but it seemed rather singular that they should appear in such remarkable abundance in the three specimens of fruit specially selected for my experiment. The fact that empty egg-shells were found in the pear, associated with the equally important fact that, before I introduced the eggs, I took the precaution to examine the partially decayed pulp of these fruits, and ascertained that no *Anguillulæ* or other nematodes existed in them, appeared at the time to warrant the conclusion that the nematodes in question could only be referable to *Oxyuris vermicularis*. I have, however, since satisfied myself that they were true Anguillules (*A. pyri*, T.S.C.)*.

On the 18th July, 1863, a portion of decayed pear, containing the Anguillules, was placed in cowdung. This mass, though inclosed in a jar, became very dry at the surface; but on the 23rd September, when it was carefully examined, several of the young nematodes were still alive, though very little advanced in size. One, which appeared dead and rather smaller than the others, still measured only the $\frac{1}{40}$ of an inch.

At the same date (July 18) others were placed in the same material, with water added, and here also I subsequently (September 23) found a few inactive individuals. One appeared to be quite dead, its parenchyma having degenerated into a mass of large fat-globules.

At the same date (July 18), several Anguillules were placed, with portions of the pear, in a small jar of pond-water. Numbers of these were afterwards found (Sept. 23) at the bottom of the vessel, stretched out and exhibiting very few signs of vitality. They displayed traces of a pharynx, but the intestinal canal had not developed. Their bodies only contained a quantity of fine granules.

At the same date (July 18) a considerable number of the Anguillules were

* Having recently forwarded specimens to Mr. Henry Charlton Bastian, F.L.S., that gentleman (who has specially and most successfully devoted his attention to the free nematoids) has informed me (December 30th, 1864) that he recognizes two distinct species from the pear. They belong to his genera *Apheleuchus* and *Plectus* respectively, "two out of the four genera whose members possess extraordinary tenacity of life." He proposes to call the one *Apheleuchus pyri*, leaving the other at present undescribed. The portions of pear which I forwarded were perfectly dry and brittle; and in confirmation of my statements respecting the vitality of the nematodes, Mr. Bastian remarks, in a letter to me, as follows:—"After soaking for a few hours in water they resumed all their activity, as you had observed."—Jan. 21st, 1865.

mixed with simple moist horse-dung, which was also examined (September 23), with the following result:—Many were found alive, one or two being active, but most of them closely coiled upom themselves in various ways. Those that were stretched out and apparently lifeless were afterwards seen to move slowly their slightly curved tails. In one example the digestive tube, from mouth to anus, seemed well developed and complete, and in none of them did there appear to be any traces of decomposition.

On the 5th of October, 1863, I re-examined the Anguillules in the pear and found them still alive. The longest measured $\frac{1}{30}''$.

On the 28th October, 1863, I commenced a new series of experiments (ten in number), with the view of verifying the previous results. I again procured a considerable number of perfectly fresh eggs, containing embryos, and placed them in portions of decayed apples and pears; and in all cases I examined these fruits with high magnifying powers, previous to my employing them for experiment. In no single instance could I detect the presence of *Anguillulæ*, or any other kind of animal parasite, within their parenchyma.

On the 30th December, 1863, I re-examined the apples and pears, which had all become mouldy. In none could I find any free embryos; and the contents of the eggs appeared to have perished, the eggs themselves having turned to a yellow-brown colour. I strained off the pulp in water, for subsequent examination, before finally abandoning this series of experiments.

On the 4th January, 1864, I commenced another series of experiments, with the view of again testing the results above mentioned. I procured two partially decayed pears and one apple, and (having by careful microscopic examination satisfied myself that they contained no animal parasites of any kind) I inserted several entire female Oxyurides, and also a few loose ova, into each. A very large proportion of the eggs contained the characteristic tadpole-like embryos. On examining the decayed fruits, on the 20th April, 1864, I could find no trace of the embryonic Oxyurides; neither were there any Anguillules.

These several sets of experiments appeared sufficient to establish the fact that we cannot rear the eggs of embryos of *Oxyuris* either in fresh or in decaying vegetable matters.

The presence of Anguillules in the original experiment must be regarded as accidental; but as their development is not without interest, I may, before dismissing the subject, further observe that, on the 30th December, 1863, I reexamined one of the pears, which was first employed for experiment more than a year previously (December 22nd, 1862). In the pulp (which was perfectly free from mould, though still in a loosely closed vessel) I found large numbers of Anguillules in every conceivable stage of development, from the early free embryo, measuring $\frac{1}{50}''$, to the sexually mature condition, measuring $\frac{1}{25}''$. Some of them contained a single egg. There were also a few discoloured *Oxyuris*-eggs, with dead granular contents, and a considerable number of free Anguilluline ova. These latter were pale, almost colourless, and contained actively moving embryos in their interior, totally unlike those of *Oxyuris*. On the 20th April, 1864, hundreds of the Anguillules were still living. They were still living on the 21st of July last, and, I have no doubt, are yet in the enjoyment of an active vitality.

Eggs of *Oxyuris*, containing embryos, placed in water on the 22nd December, 1862, and others again on the 4th of January, 1864, failed either to develope further or to set free their embryonic contents.

On the 5th October, 1863, I placed some full-grown female Oxyurides in pure fresh water. On examining the water (December 23, 1863), I found that a large number of the eggs had escaped (probably by the bursting of the worms), some of which contained the characteristic tadpole-like embryos. I could not, however, find one single embryo, although there were hundreds of empty eggs and broken-up egg-shells. One embryo presented an appearance of central division—the only instance I had seen up to the date in question.

From a subsequent and final examination, it was clear that the yelk and embryonic contents of all the ova had disintegrated, sometimes causing the shell to burst.

On the 2nd of January, 1863, I fed a monkey (*Macacus*) with numerous eggs of *Oxyuris*, containing living embryos. On the 11th of February this animal was destroyed; but there were no young Oxyurides discoverable in its intestinal canal. At one time I almost looked for a positive result, as the monkey displayed marked signs of anal irritation after the worm-feeding.

On the 10th and on the 14th of January, 1863, fresh eggs of *Oxyuris*, in which the characteristic embryos were well developed, were administered to a large goat. This animal was destroyed on the 21st of January, without furnishing any other than a negative result.

11. *Strongylus armatus.*—On the 9th of March, 1863, I placed a quantity of the eggs of this species in a jar of fresh water, without any vegetable matter. On examining the contents of the jar, on the 16th of the following July, I could find no embryos, ova, or entire egg-shells; but there was a quantity of granular débris at the bottom of the vessel.

12. *Prosthecosacter inflexus.*—Through the kindness of Mr. Kiel, I received, on the 19th of October, 1863, the lungs of a porpoise which had just died at the Zoological Society, Regent's Park. The lungs were quite fresh, and plugged throughout by the presence of multitudes of this parasite. After examining the ova very carefully, I placed a quantity of them, already containing incompletely developed embryos, in salt water; and I also mixed some of the bronchial mucus of the porpoise (which, besides eggs, contained several free embryos) with salt water in a separate vessel.

On the 23rd December, 1863, I carefully examined the contents of both jars. In the jar originally containing eggs only, I found one egg with an embryo still coiled within it, many of the other eggs having apparently disappeared, leaving a very small quantity of débris, partly consisting of shell-fragments. Two living embryos were detected, severally measuring about $\frac{1}{125}''$ and $\frac{1}{80}''$. They displayed a tolerably complete digestive apparatus; but there were no certain traces of sexual organs. There were a few specimens of *Euplotes* travelling about.

The jar containing eggs and young displayed, at the same date of examination, several active embryos in all respects resembling those above mentioned, and also an astonishing number of animalcules (*Euplotes*). But there were also several larval nematodes of much larger size, and yet possibly belonging to the same species. There were, it is true, some slight differences, possibly due to their more advanced growth. They measured about $\frac{1}{30}''$.

On 25th April, 1864, I found both jars to contain living embryos, those mixed with frothy mucus from the bronchi being more numerous and much more largely developed. The longest specimen, developed from the ova, measured no more than $\frac{1}{40}''$ in length.

When I last examined the contents of these jars (July 21, 1864), both still contained living worms, the larger specimens reared from the egg still measuring only $\frac{1}{40}$ of an inch. The largest embryo from the jar containing the frothy mucus measured, as before, about $\frac{1}{30}''$, and displayed, moreover, rudimentary traces of male reproductive organs.

Report on the Physiological Action of Nitrite of Amyl. *By* Benjamin W. Richardson, *M.A., M.D.*

The Report which I have the honour to lay before the Physiological Section springs out of a short paper read at the Newcastle Meeting last year, entitled "On the Physiological Action of the Nitrite of Amyl." In that paper I stated a few preliminary facts, to one or two of which I would again briefly direct attention, in order that the present audience may be enabled to follow the subject, connectively, from its commencement.

The nitrite of amyl is a fluid of amber colour, and having a flavour and odour of over-ripe pears. It approaches, in fact, in matter of flavour the acetate of oxide of amyl, the substance commonly sold under the name of essence of pears. The composition of the nitrite is $C_{10}H_{11}NO_3+HO$. It is made by the action of nitrous acid gas on fusel oil—amylic alcohol. The fluid, when pure, has a specific gravity of 913, and it boils at 182° Fahr. It is soluble in equal parts of chloroform, pure alcohol, and ether.

Diffused through the air in a chamber or jar, the vapour of nitrite of amyl extinguishes flame unless it be largely diluted with air, or unless the flame be introduced slowly. Under the latter circumstances the vapour explodes in a sharp puff.

Placed so as to diffuse through a closed bottle or jar with phosphorus, it prevents the oxidation of the phosphorus.

Placed in a closed jar with animal or vegetable substances, it acts like ammonia, ether, chloroform, and alcohol in preventing decomposition. As an antiseptic it is equal to ammonia, but is less active in this respect than chloroform, ether, and alcohol. It also is objectionable in that it destroys the colour of both vegetable and animal structures, turning the vegetable reds brown, and giving to the muscular tissues of animals, first a pale white, and afterwards a dirty brown appearance.

Physical Effect on Dead Organic Matters.

I have made a large number of experiments to determine the antiseptic power of the nitrite, of which I may give a few illustrations.

Observations.—Series 1. Five minims of nitrite of amyl were placed in a glass jar capable of receiving 40 cubic inches of common air. A rose with leaves attached to the stalk was next placed in the jar, and the stopper was inserted. In a few minutes the green colour of the rose was turned of a dirty brown, and the red colour, moving at first to violet, lapsed also after a time into brown. After the colour was in this way destroyed no further change followed, and the flower remained in the jar for nine months without undergoing the slightest decomposition. This experiment was repeated with mignonette, calceolarias, leaves of camellias, and other plants; the results were the same.

Observations.—Series 2. The viscera of animals and portions of the muscular structure were placed in jars capable of receiving 100 cubic inches of air. Into each jar was then poured half a drachm of the nitrite of amyl, and the jar was closed. The effect in every case was to change the animal tissue of a whitey-brown colour, which in time became dark or dirty looking. Decomposition of the tissue was, however, arrested, and I have several specimens of a pathological character which have been thus preserved for six months.

In the extreme heat of the past summer, I placed in jars of equal size two frogs that had recently died; the jars were lightly covered with cloth substance, and each one was covered to the same extent. Into one jar was poured ten minims of the nitrite; the other was left untouched. The frog in the jar that contained common air only was rapidly decomposing in six hours, and on the following day was putrid. The frog in the jar through which the nitrite was diffused in vapour was quite fresh three days after, and remained fresh so long as the smell of the nitrite could be detected, showing that it had not entirely evaporated. When the odour could no longer be perceived, signs of putrefaction were observed in the animal, and these gradually advanced, but the change was very slow, and the body dried up at last rather than putrefied.

Observations.—Series 3. Specimens of blood were drawn into open glass vessels, containing proportions of nitrite varying from one to fifteen per cent. in respect of the blood drawn. The blood thus charged coagulated in the usual manner and in the natural space of time; it became, however, of a dirty red colour. Set aside in the open air, serum escaped from the clot; but the upper surface of the blood, instead of soon becoming of a bright red from the absorption of oxygen, remained long dark. In proportion to the time of escape of the nitrite the blood remained free from decomposition, and the period of change in each vessel (five vessels were used) varied precisely according to the degree with which the blood, while in the fluid state, was charged with the nitrite. So long as there was distinct odour of the amyl-compound there was no change. The first sign of change, which even in the specimens containing the lowest charge was never observed before six hours, consisted in reddening of the upper surface of the clot; then softening followed, decomposition, and fluidity. In the heat of summer I found blood containing fifteen per cent. of the nitrite remain unchanged for five days. The same observations were made on simple albuminous fluids, on fluids from animal cysts, and on saliva and certain other of the excretions.

We gather from these experiments that nitrite of amyl, like chloroform, alcohol, or other bodies to which reference has been made, arrests by its presence the change known as decomposition, preventing by catalysis the combination of oxygen. That the nitrite itself remains undecomposed admits of ready proof, because it can be re-collected; and that it does not combine with the structures or parts of the structures which it preserves, is shown by the fact that the process of decomposition is set up only as the nitrite makes its escape by evolution.

Physiological Effects on living Organisms.

Effects on the Skin.

Observations.—Series 4. When nitrite of amyl is applied to the cutaneous human surface and held in close contact with it by being placed under oiled silk or tinfoil, it produces after a brief period some injection of the vessels, and a slight tingling sensation with heat. If the skin be previously moistened with water for a long time, the effect of the nitrite is somewhat increased; but at no time is the action so rapid and marked as is that of chloroform or turpentine. To test the relative powers of the nitrite and of chloroform, I placed a pledget of bibulous paper an inch square, and saturated with nitrite, on one of my arms, and covered the paper with thin metal. On the other arm I placed a similar pledget saturated with chloroform, and covered it in the same manner. The nitrite, retained on until it was quite dry, produced only pale redness and slight irritation: the chloroform caused great pain, so that I had some difficulty to keep it on, intense injection and redness, and some excoriation of skin.

At the same time I may observe that the nitrite is undoubtedly absorbed by the skin. To prove this, I applied it to the skin of a frog by immersing the hinder limbs of the animal in a solution of it. In a few minutes the symptoms which markedly characterize the action of the substance, viz., violent circulatory action followed by prostration, were developed. I also applied some of the substance to my own skin, carefully retaining it in contact over a six-inch surface: during the application the pulse rose, sensation of fullness in the head followed, and other signs which will be more fully described in the sequel.

Observations.—Series 5. Administered by the mouth the nitrite is comparatively slow in its action, but very decisive. Administered to rabbits in doses of five, ten, fifteen and twenty minims, and in more potent doses, its effects are striking. It admits of being readily given in tincture diluted with water. In five-minim doses it produces on these animals temporary excitement. The circulation is quickened, the breathing is quickened, the pupil is dilated, and the animal is restless; the symptoms subside in from five to ten minutes, and no harm seems to have been done. In doses of ten minims the symptoms are the same, but more marked. In doses of twenty minims, after the stage of excitement has passed away, depression follows, and continues several minutes, and there may be feeble convulsive action, but the animal recovers. There is no indication of vomiting.

In drachm doses the nitrite is often fatal to dogs, cats, and rabbits. The symptoms induced are violent action of the heart, rapid breathing, wide dilatation of the pupil, convulsions, not clonic but quick, and after an interval of a few minutes rapid collapse and paralysis of motion. The heart falls in its beats to a minimum, and the breathing may be reduced to one respiration in two or even four minutes. To appearance, in fact, the animal is nearly dead. It lies like an animal profoundly narcotized with chloroform, but still it feels. When it is touched at any part or lightly pinched, it winces instantly if it has the power to move. The period of death is usually prolonged; and often when the animal seems so nearly dead that recovery appears hopeless, it continues still to breathe, it throws off the nitrite by the lungs, and ultimately recovers.

Observations.—Series 6. Administered by inhalation, the effects of the nitrite are elicited with remarkable precision and quickness, and the phenomena are amongst the most striking, perhaps are the most striking of any I have seen in all my large physiological experience. If a piece of bibulous paper be formed into a tube, and if an expanded end of the tube be made to absorb two or at most three minims of the nitrite, a surface sufficiently charged for inhalation even by the human subject is obtained. If the tube, charged as directed, be held about two inches from the nose, and respiration be carried on in the usual manner, the following symptoms rapidly show themselves. The action of the heart is suddenly and greatly increased, so that in one minute I have counted it rising eighty beats; the breathing also becomes quickened; the face becomes deeply suffused with blood, the suffusion extending over the whole face, down the neck, and in persons who are bald, more or less over the head. The eyes are also injected, and occasionally fill with tears; the pupil slightly dilates, and over the suffused surface there is sensation of heat, described by some as burning heat, and by others as mere tingling. When these symptoms are at their height, a peculiar sensation is felt in the head, a sensation of tightness across the forehead, of fullness, giddiness, and prostration, but with no acute pain. The agent being taken away, the effects cease rapidly.

I have now witnessed these effects on more than two hundred occasions, and have experienced them myself forty times: I can pronounce them absolute and valid phenomena, in no way dependent on mental excitement or fancied excitement. They are nevertheless developed differently in intensity in different persons, and they even slightly differ in the same person on different occasions. I will give briefly two examples.

On Mr. Kempton, a friend who has inhaled the vapour many times, the effect on the heart is so rapid that it can be felt after the first three inhalations. His pulse will rise from 72 to 105 in ten seconds, and he is conscious of pulsation in every large artery in his body. His face becomes as red as vermilion, and is not only subjectively but objectively heated.

On Dr. Gibb, after inhalation a quarter of a minute, the pulse rises during the following quarter minute eight beats, and during the next quarter twenty beats; rising successively from 68 beats per minute to 76 and 88; the face meantime becomes greatly suffused, and giddiness is experienced. In both the gentlemen named, the pulse comes down to the natural standard in two minutes after cessation of the inhaling process. On myself the symptoms are almost identical with those presented by Dr. Gibb.

In one instance I was so unhappy as to see the inhalation carried to the extreme of danger. An incredulous friend seeing a bottle of the nitrite on my library mantelshelf, during a minute in which I was absent from the room, opened the bottle and commenced inhaling from the mouth. When I returned I found him walking the library still inhaling, his face and neck red as raw beef. In spite of all I could do, he would continue, till as he said he felt some effect. While I was using forcible efforts to get the bottle from him, he suddenly gave it me himself, and became speechless. I shall never forget the gallop of that man's heart. As he leaned against a table, the table vibrated and recorded visibly the pulsations. He panted for breath as one who has run to the extremity: I could not get him to move reasonably, and had the greatest difficulty in leading him into the open air. In a little time the excitement declined, and was succeeded by depression and partial loss of power; but fortunately he slowly recovered, and I do not think he was any worse for his misadventure; although, being a stout middle-aged man, I feared that during the excitement some mischief might have happened to the vessels of the brain.

In the anxiety of looking after this gentleman, I did not count minute by minute the pulsations of the heart; but the action was at one time 130 per minute, and the violence was extreme: both sounds were lost, or rather they occurred so quickly that the ear could not distinguish them, and the rapid motion communicated a peculiar synchronous tremor to the upper limbs.

My friend explained to me afterwards that his first sensation was that of burning in the face, but that he thought this arose from laughing; that the next thing he felt, and which at length alarmed him, was the hearing the pulsations of his own body very loudly and painfully. Then he felt a peculiar powerlessness which could not be described; but at no time did he lose either sensation or consciousness. I estimated, from the loss in the bottle, that this gentleman had been exposed to the vapour derived from the escape of twenty minims of the nitrite, much of which necessarily was lost by distribution in the air.

In a long series of experiments I have submitted animals to the inhalation of the nitrite, and with the most interesting results. I must, at the risk of being tedious, give the salient points of observation.

Into a jar capable of receiving 200 cubic inches of air, a large healthy frog was placed, and ten minims of the nitrite were slowly introduced. The animal, after exhibiting violent vascular action with reddening of the feet, sank into a condition which so closely resembled death, that I thought it was dead. At 11 o'clock at night it remained the same (the experiment was made at 8 P.M.), and I laid it aside as dead; but I was struck with one fact, that the eyelid was not contracted, as is common in these animals after dissolution: on the following morning, upon going into the laboratory, I found the animal alive and as active as though nothing had happened to it.

This observation led me naturally to make many inquiries as to the condition of frogs during this state of suspended animation; and I found little difficulty in obtaining a repetition of the phenomenon. The experiment usually succeeds well, and the suspension of animation may, under proper supervision, be sustained even for days. In one case an animal came back to consciousness after nine days. The experimentalist must, however, be prepared for some failures. Thus, if the frogs are not fresh and strong, if they have been kept in confinement for some weeks, and are thin and feeble, the experiment will fail; or if after the cessation of motion the animal is left too dry, so that he loses water, the experiment will not succeed; or if the amount of amyl-vapour given is too great, the experiment may not succeed.

In six cases where the animals recovered, I made numerous observations. Examining the web of the foot, I found that there was no sign of circulation there. Laying open the thigh muscles and exposing them to continuous galvanic current as well as to the induction-current, and to shocks from the positive conductor of the friction-machine, I found no evidence of irritability. Exposing the muscles to water warmed to various degrees, from 70° to 120° Fahr., there was no evidence of irritability. The only circumstance that would lead an observer to infer that death had not actually taken place, was that the limbs remained flaccid. In cases where *rigor mortis* came on, although the animals would lie for many hours without undergoing decomposition, they never afterwards showed signs of irritability, but ultimately became flaccid and decomposed.

On warm-blooded animals the nitrite produces conditions similar, but not so extreme in character. Administered gradually by inhalation to a strong rabbit until complete prostration was induced, I laid the animal on a table and found that the respirations were reduced to one per minute. The limbs were flaccid and motionless; and when they were moved and were laid in any given position, there they remained. The pupils were widely dilated, and the red portions of the body, as the mucous membranes of the mouth and eyelids, were absolutely white; the action of the heart could not be felt, nor was it certain that the motion could be heard with the stethoscope. Certainly the two sounds were lost. In this condition, breathing softly but sharply once in sixty or eighty seconds, the animal continued for two hours; then the breathing gradually rose. In three hours and a quarter the action of the heart could be felt by the hand; in three hours there was movement of the limbs, and in five hours the animal had recovered so as to be able to move. The animal, whenever he had the power, winced on being touched, and showed signs of consciousness.

In an experiment performed by Dr. Gibb and myself, a cat was rapidly struck down by being placed in a thousand cubic inch jar through which the vapour from one fluid-drachm of the nitrite had been diffused from a surface of bibulous paper. Death took place in two minutes. The animal was removed and was watched with great care, but the breathing had ceased. The pupils were dilated to their fullest extent. After a time we laid open the chest. On exposure to the air, the heart was found contracting most vigorously, and soon the muscles of respiration also commenced spontaneously to contract, moving the ribs, and disturbing the abdominal viscera. The diaphragm contracted very steadily, and a muscle of the thigh, on being laid bare, did the same. These contractions actually continued spontaneously from twenty-four minutes past twelve until forty-eight minutes past one in the day—a phenomenon which has I believe never before been observed after death in any of the muscles of warm-blooded animals except the heart.

Respecting the heart itself, in this case it continued contracting on the right side when all the other muscles were at rest. To observe the local action of the nitrite on the heart, we gradually instilled three minims of it on the right auricle. The muscular structure soon became of a dirty white, but the contractions continued. At seven in the evening the auricle, with a segment of the ventricle, was still contracting five times in the minute; at ten o'clock it was contracting in the same way, although the lower limbs of the animal were rigid from *rigor mortis*; at twelve (midnight) it was contracting at the rate of two per minute; at one it was reported by Dr. Henry as contracting strongly from one to two beats per minute; at five A.M. I found it myself contracting three times in a minute and a half, and at eight it made a contraction on being touched with a needle. For many hours before this all the other muscles of the body were rigid. Thus there was witnessed the strange phenomenon of muscular contractility in the heart while all the other muscles were rigid; and of muscular contractility of the heart for nearly eighteen hours after what would technically be considered the death of the animal.

Observations.—Series 7. If instead of administering the nitrite of amyl through the skin, by the mouth, or by the lungs, it be injected under the skin with a hollow needle, it exerts its influence in the same way, and leads, though more slowly, to the same symptoms. From an injection of twenty minims decided symptoms are induced in such animals as rabbits, cats, and dogs, but after a time they recover. In the case of a young cat, Dr. Gibb and I slowly instilled twenty minims of the nitrite under the skin, and when the first symptoms had subsided we instilled twenty more. The result was that the animal fell into a powerless condition, but continued to breathe. Four hours after the last instillation it was the same, and was breathing six times in the minute. Eight hours afterwards, the upper and lower limbs and the muscles of the neck being rigid, it was breathing once in two minutes, and the respiratory motion did not absolutely cease for two hours later.

Observations.—Series 8. *Local effects of the nitrite.* I have made some very minute observations on the effect of the nitrite upon the capillary vessels of the web of the frog's foot. The results are very uniform and decisive. A few seconds after the web is treated with the nitrite, the capillary vessels are seen to dilate to more than twice their natural calibre, and the rate of motion of blood is immensely quickened. After an interval of fifty or sixty seconds, the vessels become tortuous as from irregular contraction of their walls; then there follows a decided narrowing of the vessel at its minutest part, which continues until at last the vessel becomes indistinct, and all motion of blood is lost, except a faint oscillation in vessels which are running transversely into a main current. These experiments were confirmed by observations made by my friends Dr. Henry and Mr. Yeats.

Observations.—Series 9. *On the blood.* The blood of animals destroyed by the nitrite may always be smelt as charged with the substance. On a large animal that had been killed by the injection of forty minims, I drew off an ounce of blood from the right side of the heart into a flask, and on inhaling from the flask, absorbed sufficient of the nitrite vapour to induce the specific signs of its action. The fluid, however, in no way interferes with coagulation, but, as I have said before, it arrests oxidation and decomposition. On the corpuscles it exerts a powerful osmotic action. It has no effect on them in the way of dissolution, nor does it, when added to them, destroy their form or modify the central depression, but it reduces them to half their ordinary size, leaving them well defined and capable of running together in the ordinary and natural way.

From these narrations of experiments we may learn, in brief, the following facts in reference to the physiological action of the nitrite of amyl.

1. It is absorbed by the bodies of animals however introduced into the organism—by the skin, by the stomach, by the lungs, by the cellular tissue.

2. After its absorption its effects are seen immediately on the heart and circulation; there is in the first instance violent action of the heart with dilatation of the capillaries, followed by diminished but not extinguished power of the heart, and contraction of the extreme vessels. As an excitant of vascular action, the nitrite of amyl may be considered the most powerful agent as yet physiologically discovered.

3. On animals, such as frogs, whose bodies admit of its removal spontaneously, and whose circulatory and respiratory systems are simple, the nitrite suspends animation, and when the animals are placed under favourable conditions for the process of recovery, they may recover after considerable periods of time. There is no other known substance that suspends animation in these animals for so long a period. On warm-blooded animals, which are clothed in thick and less penetrable skin, and in whose bodies the circulatory and respiratory systems are more complicated, the nitrite cannot actually stop the movements of respiration and circulation without destroying life. But even in these animals it can without destroying life reduce the forces of respiration and circulation so extremely, that a condition precisely analogous to what is known as *trance* or *catalepsy* in the human subject, can be brought on and sustained for many hours.

4. The nitrite of amyl is not an anæsthetic. By it consciousness is never destroyed, unless a condition approaching to death be produced.

5. The effects of the nitrite on the organism are directed to the motive force, which it first wildly excites and then subdues.

6. The *modus operandi* of the nitrite appears to be by arresting the process of oxidation in the tissues.

7. Physically the nitrite holds a place between the volatile bodies, such as chloroform, and the solid bodies, such as opium and woorali. Hence its effects are less evanescent than those of the very volatile substances, and less certainly destructive than the solid substances. In this lies the secret of its prolonged action.

Pathological Effects of the Nitrite of Amyl.

In cases where the nitrite of amyl is carried to its extremest effects, the appearances of the internal organs present some modifications. The appearances are not the same in every instance, but vary according to the mode in which the substance is administered. If it be administered very quickly, the lungs and all the other organs are found blanched and free of blood, the right side of the heart is engorged with blood, and the left side is empty, the brain being free of congestion. If the substance be administered slowly, the lungs are congested, the brain is congested, and blood is found both on the right and left sides of the heart. The organs of the body are also of a dirty reddish-brown colour, and the blood is similarly discoloured, no distinction in colour existing between the arterial and venous bloods. Notwithstanding the violent action of the heart, I have never seen rupture of any vessel nor extravasation of blood. The inner lining of the blood-vessels is unchanged, and the valvular mechanism of the heart maintains its integrity. It is to be remembered that these observations have all been made on healthy animals.

Comparison of Effects of the Nitrite with other Amyl-compounds and other Bodies.

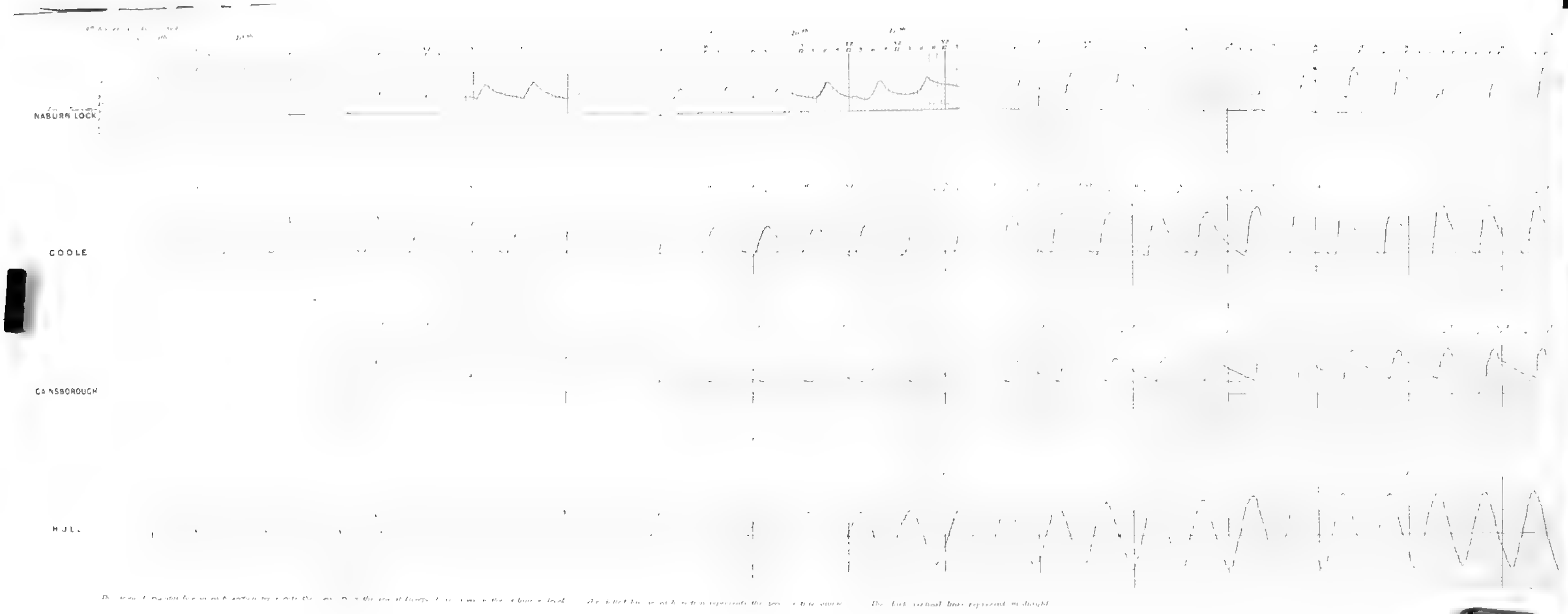
Observations.—Series 10. I have compared the action of nitrite of amyl with certain other of the amyl-compounds, but I have not had sufficient time to complete this line of research, each new compound opening up for itself a new field of observation rich in variety. As yet I have only tried the comparison with amylene and acetate of amyl. Amylene differs from the nitrite in that it acts as an anæsthetic; but it resembles the nitrite in exciting the circulation in a minor degree and in causing redness of the skin. The symptoms produced by amylene are, however, very transitory as compared with those following the use of nitrite; there is this in common, that neither of them entirely destroy consciousness, but amylene destroys sensibility, which the nitrite does not. I once saw Dr. Snow give amylene to a boy who was being subjected to an operation, and who was playing with a ball the whole time. The acetate of amyl, in comparison with the nitrite, seems to me to produce a more marked local and a less severe general effect. It causes on inhalation, not only redness of the face, but swelling and soreness of the mucous surfaces, without any violent excitation of the heart. From chloroform the nitrite differs in that it does not produce anæsthesia; and the same remark applies to ether, the monochloruretted chloride of ethyle, nitrous oxide gas, Dutch liquid, turpentine, and ammonia, although it resembles all these in that it excites the circulation in the early stages of its action. The only substance which approaches the nitrite in action is woorali, a vegetable compound which is much the same in its elementary composition. Woorali produces less preliminary excitement of the circulation, it paralyzes more determinately all the muscles except the heart, and being a solid substance, possessing no means of escaping from the body except in solution, it is more slowly eliminated. Woorali and the nitrite have, however, this in common, they produce paralysis of the extreme filaments of nerves before they influence the central portions of the nervous circuit.

Cause of the Rapidity of the Circulation under Nitrite of Amyl.

Why the nitrite of amyl should produce such suddenly increased action of the heart is a point of great physiological interest. I thought at first that this must be an effect primarily manifested on the blood, then on the heart, and through the increased impetus of the heart, on the capillary circulation. It was, however, soon apparent that the injection of the capillary system was too quickly developed to be a sequence of mere overaction of the pulsatory power of the central organ of the circulation, and the experiments on the web of the frog's foot settled the question, I think, absolutely. It is possible that the action of the nitrite is exerted immediately upon the extreme filaments of the vaso-motor nerves, and that the heart beats quickly, because the resistance to its force is taken off by the dilatation of the minute vessels which it supplies with blood. At the same time the vascular currents of the heart itself are quickened, and its movement is intensified proportionately.

On the facts so far presented in this Report, two questions call for a moment's consideration. The first is:—Whether we ought dogmatically to deny the possibility of placing the human body in such a condition that it may for some hours, or even some days, assume the appearance of temporary death? We are conversant of rare cases of disease, called cases of trance or catalepsy, in which life, seeming for an interval suspended, is restored: we have heard of other cases in which it is said that certain natives of India who are called Fakirs, produce, by some secret art, an imitation of death so determinate that the most intelligent are deceived. I cannot but feel, after what I have seen in the experiments on which the present inquiry is based, that the explanation of the cataleptic state admits of a better solution than ever before it did, and that the validity of the Fakir experiment is rendered, at the least, probable. I doubt not that in catalepsy there is formed in the body itself a chemical substance which, without actually stopping the motions of the heart and of respiration, suspends them so nearly that passive life only is carried on, and that this condition is continued until such time as the substance is removed from the circulation. I conceive it is also quite reasonable to presume that the Fakir holds in his hand some substance derived from the vegetable world, which, more effective than the agent that has been before us this day, possesses the power, when introduced into the body, of suspending the common signs of animation for a certain number of hours, and that "in this borrowed likeness of shrunk death" the facts of the phenomena are presented and explained.

The second question is:—Whether, from what we have learned in this inquiry, any knowledge may be gathered relative to the application of the nitrite of amyl as a remedy in disease? I have been too closely and intently occupied in the task of obtaining elementary facts, to devote time to the practical elucidation of this important point. But, subject to further and better experience, I should infer that in cases where in a healthy organism sudden death is apprehended from failure of the heart, as for example in syncope from severe pain, fright, or inhalation of chloroform, the cautious administration of the nitrite by inhalation might call into action the failing organ and give it time to recover from the shock to which it has been subjected. Again, I believe that in tetanus the nitrite might be employed with advantage. Paralyzing the extreme filaments of nerves, and reducing the muscular power of all the voluntary muscles in the same manner as does woorali, the nitrite possesses advantages over woorali which the man of science will at once recognize. It is more easily administered; it does not necessarily destroy the power of the muscles of respiration, and it is much more easily removed from the organism by excretion. It might therefore in tetanus, for which there is now no remedy, be employed to suspend the violent spasm, and give the system time to throw off the primary evil. Physiologists have long felt


NABURN LOCK
GOOLE
HULL

that in tetanus this is the direction in which to move, and practice has shown that whenever recovery does take place from tetanus, it has been in rare cases where time has been gained, in cases, that is to say, where the sufferer has lived through the acute stage of the terrible ordeal to which he has been subjected.

As regards the mode of administration of the nitrite. It may be given by direct inhalation; it may be given by inhalation in combination with chloroform and ether; or it may be given by the mouth as an alcoholic tincture in doses of three, five, or ten minims, or even in larger doses, according to the effects produced. It would of course be the safest plan to use it in small doses at first, and to keep up the effect by frequent and cautious repetition.

In the course of preparing this Report, many new lines of inquiry have suggested themselves, and many temptations to leave the immediate subject and to explore new paths and promising fields of discovery have been offered. The examination of the whole of the amyl series of bodies in a physiological point of view is particularly important. In this series there is probably to be found another and safer anæsthetic than chloroform: in the same series we may hope to find bodies analogous in their action to quinine; and other bodies more potent in suspending animation than the one to which I have invited attention to-day. But I had one object before me, and that itself has demanded undivided work. Should the labours thus far carried out be considered by this learned body of sufficient importance to call for further and more extended research, I need only add that I shall feel myself the debtor of the Section in being again its servant.

Report on Tidal Observations made on the Humber and Rivers Trent and Ouse, 1864. *By a Committee, consisting of* James Oldham, C.E.; J. F. Bateman, C.E., F.R.S.; John Scott Russell, C.E., F.R.S.; *and* Thomas Thompson.

Your Committee for the above purpose, after reporting a series of tidal observations made at Hull, New Holland, and Goole, at the Meeting of the British Association at Cambridge in 1862, were reappointed for more extended observations, to be reported upon at Newcastle last year, but, owing to circumstances over which we had no control, we were unable then to comply with the resolution of the Association; but as the question of the tides of the Humber and some of its tributaries was considered of importance in a scientific point of view, the request was again repeated, and we your Committee reappointed, with a grant of £50 at their disposal for the expenses attending our observations.

Your Committee have now therefore to report to the Association that they have obtained tidal observations at Hull, at Gainsborough on the Trent, and at Goole and Naburn Lock on the Yorkshire Ouse. Those at Hull were obtained by your Committee from the Dock Company's gauge at that place; those at Goole from that of the Aire and Calder Navigation Company; for those at Naburn Lock permission was kindly given to your Committee by the Commissioners of the River Ouse Navigation to use their tide-gauge; those at Gainsborough were made at a point on the town side of the river about 300 yards below the bridge, from a gauge which we procured and erected. The observations at each station were made at intervals of 15 minutes, and extended over fifty-four tides, commencing at 12 o'clock at noon on the 9th of

May, and ceasing at 12 o'clock at noon on the 6th of June of the present year. The books in which the whole of the observations were entered are herewith presented to the Association.

In order, however, to give a more readily comprehended explanation of the results of our labours, the entire sets of observations have been drawn in section by contour lines, as will be seen by the accompanying drawings, also now presented to the Association. The vertical lines give the hours and minutes of the observed time of the tides in rising and falling, and the horizontal lines or divisions give in feet and inches the observed height of such rise and fall. The red line running through each section represents the datum line of the mean rise of the sea at Liverpool, as given by the Ordnance Survey Board, in the published work entitled "Abstracts of the principal lines of Spirit Levelling in England and Wales, by Colonel Sir Henry James, R.E., F.R.S., &c." The zero of the tide-gauge in each case is represented by a dotted line on the section above or below the red line, as the case may be: that of Naburn Lock is 1·680 feet above the said line; Goole is 3·823 feet below; Gainsborough 3·140 feet above; and Hull 14·707 feet below. The tidal wave is represented by the blue contour lines.

During the whole of the time the observations were being made the weather was not unduly influenced by either rain or wind, and therefore the tides were natural and of a regular character.

The phenomenon as to the time of high water above a certain point of the Hull Dock gauge, referred to in the last Report, is again verified, *i. e.* when the tide has reached the 16-feet mark of the tide-gauge above the dock-sill, or 1·293 feet above the mean rise of the sea at Liverpool, it then, in every tide, wants exactly three hours to high water.

Tidal Observations taken at the Ship Lock, Goole, as to the time of high water after the tide has reached the 8-feet mark, by Mr. Thomas Kendall, Dock Master.

		Morning.			*Evening.*		
State of tides.	Date.	Time when 8 feet water on gauge.	Time when high water.	Difference.	Time when 8 feet water on gauge.	Time when high water.	Difference.
	1864.	h m	h m	h m	h m	h m	h m
Neaps ..	Aug. 10.				10 45	12 45	2 0
,, ..	11.	10 50	12 50	2 0			
,, ..	12.	12 20	2 0	1 40	12 45	2 20	1 35
,, ..	13.	1 20	3 15	1 55	2 0	3 45	1 45
Springs	14.	2 20	4 40	2 20	3 0	5 10	2 10
,,	15.	3 10	5 20	2 10	3 55	6 10	2 15
,,	16.	4 15	6 20	2 5	4 40	7 0	2 20
,,	17.	4 25	6 45	2 20	5 25	7 45	2 20
,,	18.	5 25	7 50	2 25	6 10	8 15	2 5
,,	19.	6 15	8 10	1 55	6 50	9 0	2 10
,,	20.	6 50	8 55	2 5	7 35	9 40	2 5
,,	21.	7 35	9 35	2 0	8 25	10 30	2 5
Neaps ..	22.	8 23	10 25	2 2	9 10	11 20	2 10
,, ..	23.	9 10	11 30	2 20	10 0	12 15	2 15
,, ..	24.	10 10	12 20	2 10	11 15	1 15	2 0

The fact exists; but the immediate cause of this occurrence your Committee are still unable to determine, and must therefore leave the solution for further light and knowledge to be brought to bear upon it.

The nearest approximation to this fixed law occurs at Goole, where we find that when the tide has reached the 8-feet mark of the tide-gauge, or 4·177 feet above the mean rise of the sea at Liverpool, the *average* time to high water, as observed over twenty-seven tides and recorded in the following Tables, is 2 hours and 6 minutes, but the extreme variation is found to extend from 1 hour and 35 minutes to 2 hours and 25 minutes.

In analyzing or reducing the observations of the various stations, the following are the results on the fifty-four tides in reference to the zero of each gauge:—

Place.	Mean rise over the entire observations.	Highest tide above zero of gauge.	Lowest tide above zero of gauge.	Highest low water above zero of gauge.	Lowest low water above zero of gauge.
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
Naburn Lock	6 4	10 11	4 10	4 3	1 3
Goole	11 0	16 9	10 3	3 10	2 3
Gainsborough	5 8	8 11	3 0	3 0	0 0¼
Hull	16 3	26 4	20 3	10 4	4 5

The following Table gives the greatest rise of tide during the observations above the Ordnance datum at each station:—

Place.	Greatest rise above the Ordnance datum.
	feet.
Naburn Lock, May 9th, 1864	13·50
Gainsborough, May 9th, 1864	12·25
Goole, May 25th, 1864	12·93
Hull, May 25th, 1864	11·63

It will be seen by the above that the highest surface-rise occurred on the 9th of May at Naburn Lock and at Gainsborough, and that at Goole and Hull on the 25th of May. The excessive height at Naburn Lock and Gainsborough taking place on the above date, indicates a considerable flush in the rivers at the time from rains which had fallen previously in districts above the pointsof observation. The superior rise at Hull and Goole only indicates tidal influence.

The following Table gives the time at each station the tides on an average require in rising and falling:—

Place.	Rising tide.	Falling tide.
Naburn Lock	2 to 2¼ hours.	10 to 10¼ hours.
Goole	about 3 hours.	about 9¼ hours.
Gainsborough	2 to 2¼ hours.	10 to 10¼ hours.
Hull	about 5½ hours.	about 6¾ hours.

TABLE giving the time of flood and high water at Naburn Lock, Goole, and Gainsborough after it is flood and high water at Hull.

Place.	Flood tide.	High water.
	h m	h m
Naburn Lock	7 15	3 50
Goole	3 15	1 25
Gainsborough	6 20	2 50

The following statement shows the difference between the mean and extreme rise of the tides at Hull and Goole as taken in 1862 and 1864:—

Place.	Mean rise.	Extreme rise.
	feet.	feet.
Hull, 1862	16·95	27·92
Hull, 1864	16·25	26·33
Difference ..	·70	1·59
Goole, 1862	11·67	15·33
Goole, 1864	11·00	16·75
Difference ..	·67	1·42

By the above it will be observed that the mean rise at Hull in 1864 was less by ·70 feet than in 1862, and that the extreme rise in 1864 was less by 1·59 feet than in 1862; and at Goole the mean rise was less in 1864 than in 1862 by ·67 feet, but the extreme rise in 1864 was more by 1·42 feet than in 1862.

In bringing their labours to a conclusion, your Committee confidently hope that, although they may not have shed any new light on the phenomena of the tides of the Humber, they may have established such data as may enable others to follow out the inquiry so as to lead to valuable results.

Your Committee cannot close their report without expressing their great obligation to W. H. Huffam, Esq., and R. A. Marrillier, Esq., of Hull; Thomas Wilson, Esq., and W. H. Bartholomew, Esq., of Leeds; and Luke Thompson, Esq., of York, for the valuable assistance they have received from those gentlemen.

Tidal Observations taken at Hull, Gainsborough, Goole*, and Naburn Lock, May 9 to June 6, 1864.

May 9.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 P.M.	14 2		12 0 P.M.	8 0	E.S.E.	12 0 P.M.	11 3	E.S.E.	12 0 P.M.	11 10	E.
15	13 4		15	7 9		15	10 9	,,	15	11 4	
30	12 4		30	7 6		30	10 2	,,	30	10 10	
45	11 6		45	7 3		45	9 10	,,	45	10 4	
1 0	10 7		1 0	7 1		1 0	9 6	,,	1 0	9 11	
15	10 0		15	6 11		15	9 2	,,	15	9 8	
30	9 3		30	6 9		30	8 10	,,	30	9 4	
45	8 7		45	6 6		45	8 6	,,	45	9 0	
2 0	7 10		2 0	6 3		2 0	8 2	,,	2 0	8 6	Deals up.
15	7 5		15	6 1		15	7 11	,,	15	8 0	
30	6 8		30	6 0		30	7 7	,,	30	7 8	
45	6 2		45	5 9		45	7 2	,,	45	7 5	E.
3 0	6 0		3 0	5 6½		3 0	6 11	,,	3 0	7 2	
15	6 1		15	5 4		15	6 9	,,	15	6 11	
30	6 2		30	5 2		30	6 6	,,	30	6 9	
45	6 10		45	5 0½		45	6 3	,,	45	6 6	
4 0	7 10		4 0	4 11½	E.	4 0	5 11	,,	4 0	6 4	
15	8 11		15	4 10		15	5 9	,,	15	6 2	
30	10 0		30	4 9		30	5 7	,,	30	6 0	
45	11 1		45	4 6½		45	5 4	,,	45	5 10	E.
5 0	12 2		5 0	4 5½		5 0	5 2	,,	5 0	5 8	
15	13 6		15	4 4		15	4 11	,,	15	5 7	
30	14 11		30	4 2½		30	4 9	,,	30	5 6	
45	16 3		45	4 0¾		45	4 8	E.	45	5 4	
6 0	17 4		6 0	4 0		6 0	4 6	,,	6 0	5 3	E.
15	18 10		15	3 10		15	4 5	,,	15	5 2	
30	19 11		30	3 9		30	4 3	,,	30	5 0	
45	21 0		45	3 8		45	4 1	,,	45	4 11	
7 0	21 11		7 0	3 6½		7 0	3 11	,,	7 0	4 10	
15	22 11		15	3 6		15	3 10	,,	15	4 9	
30	23 3		30	3 5		30	4 10	,,	30	4 9	
45	23 11		45	3 3		45	7 5	,,	45	4 8	
8 0	24 4		8 0	3 1½		8 0	9 6	,,	8 0	4 7	
15	24 8		15	3 1		15	11 3	,,	15	4 6	
30	24 11		30	3 1		30	12 3	,,	30	4 6	
45	25 0		45	3 0		45	13 4	,,	45	4 6	
9 0	24 10		9 0	3 0		9 0	14 0	,,	9 0	4 6	
15	24 5		15	4 6		15	14 10	,,	15	4 5	
30	23 10		30	6 0		30	15 5	,,	30	4 4	
45	23 3		45	6 10		45	15 9	,,	45	4 4	
10 0	22 5		10 0	7 5		10 0	15 11	,,	10 0	4 4	
15	21 5		15	8 0		15	15 10	,,	15	4 3	
30	20 11		30	8 3		30	15 7	,,	30	6 2	
45	20 0		45	8 6		45	14 11	,,	45	7 4	
11 0	19 3		11 0	8 9		11 0	14 2	,,	11 0	8 4	
15	18 3		15	8 11		15	13 4	,,	15	9 3	
30	17 4		30	8 9		30	12 9	,,	30	9 11	
45 P.M.	16 2		45 P.M.	8 3		45 P.M.	12 0	,,	45 P.M.	10 6	

* The observations are taken from the lower Sill of the Outer Ship Lock at Goole.

May 10.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	15 5		12 0 A.M.	7 11	E.	12 0 A.M.	11 4	E.	12 0 A.M.	10 9	E.
15	14 5		15	7 10		15	10 9	,,	15	10 11	
30	13 5		30	7 7		30	10 2	,,	30	10 8	
45	12 6		45	7 4		45	9 9	,,	45	10 1	
1 0	11 8		1 0	7 2		1 0	9 5	,,	1 0	9 8	
15	11 0		15	6 11		15	9 1	,,	15	9 2	
30	10 2		30	6 10		30	8 9	,,	30	8 10	
45	9 7		45	6 7		45	8 5	,,	45	8 6	
2 0	8 10		2 0	6 4		2 0	8 1	N.E.	2 0	8 2	
15	8 3		15	6 2		15	7 8	,,	15	7 11	
30	7 9		30	6 1		30	7 5	,,	30	7 8	
45	7 5		45	5 10		45	7 1	,,	45	7 6	
3 0	7 2		3 0	5 8½		3 0	6 10	,,	3 0	7 3	
15	7 2		15	5 5		15	6 6	,,	15	7 0	
30	7 6		30	5 3		30	6 3	,,	30	6 10	
45	8 3		45	5 1		45	5 11	,,	45	6 8	
4 0	9 3		4 0	4 11		4 0	5 8	,,	4 0	6 5	
15	10 3		15	4 10		15	5 5	,,	15	6 3	
30	11 5		30	4 8½		30	5 3	,,	30	6 1	
45	12 3		45	4 6½		45	5 1	,,	45	5 11	
5 0	13 6		5 0	4 5		5 0	4 10	,,	5 0	5 10	
15	14 6		15	4 4½		15	4 8	,,	15	5 8	
30	15 8		30	3 11½		30	4 6	,,	30	5 7	
45	16 6		45	3 9		45	4 4	,,	45	5 5	
6 0	17 6		6 0	3 8	E.N.E.	6 0	4 3	E.N.E.	6 0	5 4	N.
15	18 9		15	3 6½		15	4 1	,,	15	5 3	
30	19 10		30	3 5½		30	4 0	,,	30	5 1	
45	20 10		45	3 4		45	3 10	,,	45	5 0	
7 0	21 9		7 0	3 3		7 0	3 8	,,	7 0	5 0	
15	22 6		15	3 2		15	3 11	E.	15	4 11	
30	23 2		30	3 1½		30	5 4	,,	30	4 10	
45	23 8		45	3 0		45	6 10	,,	45	4 9	
8 0	24 2		8 0	3 0		8 0	8 9	,,	8 0	4 8	
15	24 7		15	2 11		15	10 4	,,	15	4 7	
30	24 10		30	2 10		30	11 8	,,	30	4 6	
45	25 0		45	2 9		45	12 8	,,	45	4 6	
9 0	24 11		9 0	2 9		9 0	13 7	,,	9 0	4 5	N.E.
15	24 7		15	2 8		15	14 4	,,	15	4 4	
30	24 1		30	4 8		30	15 0	,,	30	4 4	
45	23 5		45	6 0		45	15 5	,,	45	4 3	
10 0	22 9		10 0	6 8		10 0	15 8	,,	10 0	4 2	
15	22 0		15	7 4½		15	15 9	,,	15	4 2	
30	21 1		30	7 9½		30	15 7	,,	30	5 6	N.E.
45	20 2		45	7 11½		45	15 0	,,	45	6 5	
11 0	19 3		11 0	8 4		11 0	14 2	,,	11 0	7 5	
15	18 5		15	8 7		15	13 5	,,	15	8 6	
30	17 5		30	8 8½		30	12 8	,,	30	9 3	
45 A.M.	16 6		45 A.M.	8 6		45 A.M.	11 10	,,	45 A.M.	9 9	

May 10.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 P.M.	15 7		12 0 P.M.	8 0	E.N.E.	12 0 P.M.	11 4	E.N.E.	12 0 P.M.	10 5	E.
15	14 10		15	7 4½		15	10 9	E.	15	10 8	
30	13 9		30	7 1½		30	10 3	,,	30	10 7	
45	13 0		45	7 0¾		45	9 9	,,	45	10 1	
1 0	12 1		1 0	6 8		1 0	9 3	,,	1 0	9 6	N.E.
15	11 5		15	6 6		15	8 10	,,	15	9 0	
30	10 7		30	6 4		30	8 7	,,	30	8 8	
45	10 0		45	6 1		45	8 4	,,	45	8 4	
2 0	9 2		2 0	5 11¾		2 0	7 11	,,	2 0	8 0	
15	8 7		15	5 9		15	7 7	,,	15	7 8	
30	8 0		30	5 7		30	7 3	,,	30	7 6	
45	7 7		45	5 4½		45	7 0	,,	45	7 3	
3 0	7 2		3 0	5 3	N.E.	3 0	6 9	,,	3 0	7 0	N.E.
15	6 0		15	5 0½		15	6 6	,,	15	6 9	
30	6 8		30	4 10		30	6 3	,,	30	6 7	
45	6 9		45	4 9		45	5 11	,,	45	6 4	
4 0	7 2		4 0	4 7		4 0	5 9	,,	4 0	6 2	
15	7 10		15	4 6		15	5 7	,,	15	6 0	
30	8 6		30	4 4		30	5 5	E.S.E.	30	5 10	
45	9 6		45	4 2		45	5 3	,,	45	5 8	
5 0	10 4		5 0	4 1		5 0	5 0	,,	5 0	5 6	E.
15	11 5		15	4 0		15	4 10	,,	15	5 4	
30	12 5		30	3 10		30	4 8	,,	30	5 3	
45	13 6		45	3 9		45	4 6	,,	45	5 2	
6 0	14 5		6 0	3 8½	E.N.E.	6 0	4 4	,,	6 0	5 0	
15	15 7		15	3 6		15	4 2	E.	15	4 11	
30	16 8		30	3 4		30	4 0	,,	30	4 10	
45	17 8		45	3 3		45	3 11	,,	45	4 9	
7 0	18 7		7 0	3 2		7 0	3 10	,,	7 0	4 8	N.E.
15	19 9		15	3 1		15	3 9	,,	15	4 7	
30	20 8		30	3 0		30	3 7	,,	30	4 6	
45	21 5		45	2 11		45	3 6	,,	45	4 5	
8 0	22 2		8 0	2 10		8 0	4 0	,,	8 0	4 4	
15	22 9		15	2 9		15	5 5	,,	15	4 3	
30	23 2		30	2 8		30	6 9	,,	30	4 2	
45	23 6		45	2 6		45	8 11	,,	45	4 1	
9 0	23 8		9 0	2 6		9 0	10 4	,,	9 0	4 1	
15	23 10		15	2 6		15	11 5	E.N.E.	15	4 1	N.E.
30	23 10		30	2 6		30	12 3	,,	30	4 0	
45	23 7		45	2 6		45	12 11	,,	45	3 10	
10 0	23 2		10 0	2 6		10 0	13 6	,,	10 0	3 9	
15	22 6		15	4 3		15	13 11	,,	15	3 9	
30	22 0		30	5 0		30	14 3	,,	30	3 8	
45	21 5		45	5 8		45	14 6	,,	45	3 8	
11 0	20 8		11 0	6 0		11 0	14 4	,,	11 0	3 6	
15	19 10		15	6 7		15	14 0	,,	15	4 8	N.E.
30	19 3		30	6 10		30	13 3	N.E.	30	5 8	
45 P.M.	18 5		45 P.M.	7 1		45 P.M.	12 7	,,	45 P.M.	6 7	

May 11.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	17 7		12 0 A.M.	7 3	E.N.E.	12 0 A.M.	11 10	N.E.	12 0 A.M.	7 4	N.E.
15	16 7		15	7 6		15	11 3	,,	15	8 0	
30	15 6		30	7 0		30	11 0	,,	30	8 8	
45	14 8		45	7 0		45	10 5	,,	45	9 2	
1 0	13 9		1 0	6 10		1 0	9 8	,,	1 0	9 5	
15	13 0		15	6 7		15	9 3	,,	15	9 3	
30	12 2		30	6 4		30	8 11	,,	30	8 11	
45	11 7		45	6 0		45	8 7	,,	45	8 7	
2 0	10 8		2 0	5 9½		2 0	8 3	,,	2 0	8 4	
15	10 3		15	5 7		15	7 11	,,	15	7 10	N.E.
30	9 6		30	5 4		30	7 8	,,	30	7 5	
45	9 2		45	5 0½		45	7 4	,,	45	7 1	
3 0	8 7		3 0	4 10		3 0	7 0	,,	3 0	6 10	
15	8 3		15	4 9½		15	6 9	,,	15	6 7	
30	8 0		30	4 7		30	6 5	,,	30	6 5	
45	8 0		45	4 4		45	6 2	,,	45	6 3	
4 0	8 4		4 0	4 0¾		4 0	6 0	,,	4 0	6 0	
15	8 9		15	3 11½		15	5 9	,,	15	5 10	
30	9 6		30	3 10		30	5 6	,,	30	5 8	
45	10 3		45	3 9		45	5 3	,,	45	5 6	
5 0	11 3		5 0	3 7½		5 0	5 0	,,	5 0	5 4	N.E.
15	12 2		15	3 6		15	4 10	,,	15	5 2	
30	13 1		30	3 5		30	4 8	,,	30	5 1	
45	13 10		45	3 3		45	4 6	,,	45	4 11	
6 0	14 10		6 0	3 2½		6 0	4 4	,,	6 0	4 10	N.E.
15	15 9		15	3 1		15	4 2	E.N.E.	15	4 9	
30	16 9		30	3 0		30	4 0	,,	30	4 7	
45	17 7		45	2 11		45	3 11	,,	45	4 6	
7 0	18 7		7 0	2 9		7 0	3 9	,,	7 0	4 5	
15	19 7		15	2 8		15	3 8	,,	15	4 4	
30	20 6		30	2 6		30	3 6	,,	30	4 3	
45	21 3		45	2 6		45	3 7	,,	45	4 2	
8 0	22 0		8 0	2 4		8 0	4 4	,,	8 0	4 1	
15	22 6		15	2 3		15	5 4	,,	15	4 0	
30	22 11		30	2 2		30	6 7	,,	30	4 0	
45	23 4		45	2 1		45	8 0	,,	45	3 11	
9 0	23 7		9 0	2 0		9 0	9 7	,,	9 0	3 10	
15	23 10		15	2 0		15	10 9	E.	15	3 9	
30	23 11		30	1 11		30	11 9	,,	30	3 9	
45	23 8		45	1 9½		45	12 6	,,	45	3 8	
10 0	23 5		10 0	1 9½		10 0	13 0	,,	10 0	3 8	E.
15	22 10		15	2 0		15	13 6	,,	15	3 6	
30	22 2		30	4 0		30	13 11	,,	30	3 6	
45	21 7		45	4 9		45	14 3	,,	45	3 6	
11 0	20 11		11 0	5 0		11 0	14 4	E.S.E.	11 0	3 5	
15	20 3		15	5 11		15	14 2	,,	15	3 11	
30	19 7		30	6 3		30	13 8	,,	30	5 0	
45 A.M.	18 10		45 A.M.	6 8		45 A.M.	13 0	,,	45 A.M.	5 11	

May 11.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 P.M.	17 10		12 0 P.M.	6 11	E.N.E.	12 0 P.M.	12 4	E.S.E.	12 0 P.M.	6 4	E.
15	17 1		15	7 0		15	11 8	,,	15	7 6	
30	16 1		30	7 0		30	10 11	,,	30	8 4	
45	15 4		45	6 6		45	10 7	,,	45	8 8	
1 0	14 6		1 0	6 1½		1 0	10 1	,,	1 0	9 0	
15	13 8		15	5 10		15	9 7	,,	15	9 3	
30	12 10		30	5 8		30	9 3	,,	30	8 10	
45	12 2		45	5 6		45	8 10	,,	45	8 5	
2 0	11 5		2 0	5 4		2 0	8 6	,,	2 0	8 0	E.
15	10 10		15	5 2½		15	8 2	,,	15	7 7	
30	10 2		30	5 0½		30	7 10	,,	30	7 3	
45	9 7		45	4 10½		45	7 7	,,	45	7 0	
3 0	8 10		3 0	4 9		3 0	7 4	,,	3 0	6 10	
15	8 5		15	4 7		15	7 1	,,	15	6 7	
30	7 11		30	4 5		30	6 10	,,	30	6 5	
45	7 7		45	4 3		45	6 7	,,	45	6 3	
4 0	7 5		4 0	4 2		4 0	6 4	,,	4 0	6 0	E.
15	7 2		15	4 0		15	6 1	,,	15	5 10	
30	7 5		30	3 10		30	5 10	,,	30	5 8	
45	7 10		45	3 9		45	5 7	,,	45	5 5	
5 0	8 6		5 0	3 7		5 0	5 4	,,	5 0	5 3	
15	9 3		15	3 6		15	5 1	E.	15	5 1	
30	10 2		30	3 4½		30	4 10	,,	30	5 0	
45	11 2		45	3 3		45	4 8	,,	45	4 11	
6 0	12 1		6 0	3 1½	E.	6 0	4 6	,,	6 0	4 9	
15	12 11		15	3 0¼		15	4 5	,,	15	4 8	
30	13 9		30	2 11		30	4 3	,,	30	4 6	
45	14 10		45	2 9¼		45	4 1	,,	45	4 5	
7 0	15 7		7 0	2 8		7 0	3 11	,,	7 0	4 4	N.E.
15	16 6		15	2 7		15	3 10	,,	15	4 3	
30	17 8		30	2 6		30	3 8	,,	30	4 1	
45	18 5		45	2 5		45	3 7	,,	45	4 0	
8 0	19 3		8 0	2 3		8 0	3 6	,,	8 0	3 11	
15	20 1		15	2 1¾		15	3 4	,,	15	3 10	
30	20 8		30	2 0		30	3 5	,,	30	3 9	
45	21 6		45	1 10		45	4 0	,,	45	3 8	
9 0	21 11		9 0	1 9		9 0	5 1	,,	9 0	3 7	N.E.
15	22 3		15	1 8		15	6 6	,,	15	3 6	
30	22 5		30	1 8		30	8 0	,,	30	3 5	
45	22 8		45	1 7		45	9 3	,,	45	3 5	
10 0	22 9		10 0	1 6		10 0	10 2	,,	10 0	3 4	
15	22 7		15	1 6		15	11 0	,,	15	3 3	
30	22 5		30	1 6		30	11 8	,,	30	3 3	
45	22 3		45	1 6		45	12 2	,,	45	3 2	
11 0	21 7		11 0	2 6		11 0	12 8	,,	11 0	3 2	
15	21 0		15	3 6		15	13 0	,,	15	3 1	
30	20 6		30	4 0		30	13 2	,,	30	3 1	
45 P.M.	19 10		45 P.M.	4 6		45 P.M.	13 2	,,	45 P.M.	3 1	

May 12.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	19 4		12 0 A.M.	5 0	E.N.E.	12 0 A.M.	12 10	E.	12 0 A.M.	3 0	
15	18 7		15	5 6		15	12 3	E.S.E.	15	4 0	
30	17 8		30	5 9½		30	11 9	,,	30	4 9	
45	16 11		45	6 0		45	11 2	,,	45	5 6	
1 0	15 11		1 0	6 0		1 0	10 8	,,	1 0	6 3	
15	15 4		15	5 7		15	9 10	,,	15	6 11	
30	14 5		30	5 4½		30	9 5	,,	30	7 8	
45	13 8		45	5 2		45	9 0	,,	45	7 11	
2 0	12 10		2 0	5 0		2 0	8 8	,,	2 0	8 0	
15	12 4		15	4 10		15	8 4	,,	15	7 10	N.E.
30	11 6		30	4 10		30	8 0	,,	30	7 6	
45	11 0		45	4 9		45	7 8	,,	45	7 2	
3 0	10 5		3 0	4 7		3 0	7 4	,,	3 0	6 10	
15	9 8		15	4 5		15	7 1	,,	15	6 6	
30	9 5		30	4 3½		30	6 9	E.	30	6 3	
45	9 2		45	4 2		45	6 6	,,	45	6 0	
4 0	8 11		4 0	4 1		4 0	6 3	,,	4 0	5 10	
15	8 10		15	3 10		15	6 0	,,	15	5 8	
30	9 0		30	3 9½		30	5 9	,,	30	5 6	
45	9 5		45	3 6		45	5 6	,,	45	5 5	
5 0	10 1		5 0	3 3½		5 0	5 3	,,	5 0	5 3	
15	10 10		15	3 2		15	5 0	,,	15	5 1	
30	11 7		30	3 0		30	4 10	,,	30	4 11	
45	12 3		45	2 11		45	4 8	,,	45	4 10	
6 0	13 3		6 0	2 10		6 0	4 6	,,	6 0	4 9	N.E.
15	14 1		15	2 9		15	4 5	N.E.	15	4 8	
30	14 11		30	2 8		30	4 2	,,	30	4 7	
45	15 8		45	2 5		45	4 0	,,	45	4 6	
7 0	16 9		7 0	2 3		7 0	3 11	,,	7 0	4 5	
15	17 3		15	2 2½		15	3 9	,,	15	4 4	
30	18 1		30	2 1		30	3 8	,,	30	4 3	
45	18 9		45	2 0		45	3 6	,,	45	4 1	
8 0	19 8		8 0	1 11		8 0	3 5	,,	8 0	4 0	
15	20 4		15	1 10½		15	3 6	,,	15	3 11	
30	21 0		30	1 9		30	4 3	,,	30	3 10	
45	21 6		45	1 8½		45	5 1	,,	45	3 9	
9 0	22 0		9 0	1 7		9 0	6 1	,,	9 0	3 8	N.
15	22 5		15	1 6		15	7 1	,,	15	3 7	
30	22 9		30	1 6		30	8 2	,,	30	3 6	
45	22 10		45	1 5		45	9 3	,,	45	3 6	
10 0	22 11		10 0	1 4		10 0	10 2	,,	10 0	3 5	
15	22 10		15	1 3		15	11 0	E.N.E.	15	3 4½	
30	22 8		30	1 2½		30	11 8	,,	30	3 4	
45	22 4		45	1 2½		45	12 2	,,	45	3 3½	
11 0	21 9		11 0	2 1½		11 0	12 8	,,	11 0	3 3	
15	21 5		15	3 1		15	13 0	,,	15	3 2½	
30	20 10		30	3 9½		30	13 3	,,	30	3 2	
45 A.M.	20 4		45 A.M.	4 4		45 A.M.	13 4	,,	45 A.M.	3 1	

May 12.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 P.M.	19 8		12 0 P.M.	4 10	N.E.	12 0 P.M.	13 0	E.N.E.	12 0 P.M.	3 3	N.E.
15	19 0		15	5 2		15	12 6	N.E.	15	4 0	
30	18 3		30	5 6		30	11 9	,,	30	4 9	
45	17 5		45	5 9½		45	11 3	,,	45	5 5	
1 0	16 7		1 0	6 0		1 0	10 9	,,	1 0	6 0	
15	15 10		15	5 10		15	10 2	,,	15	6 8	
30	14 11		30	5 9		30	9 8	,,	30	7 4	
45	14 3		45	5 3		45	9 3	,,	45	7 9	
2 0	13 6		2 0	5 0		2 0	8 10	,,	2 0	8 0	
15	12 9		15	4 9½		15	8 6	,,	15	7 11	
30	12 1		30	4 9		30	8 2	,,	30	7 7	
45	11 6		45	4 7		45	7 10	,,	45	7 2	
3 0	10 10		3 0	4 5		3 0	7 7	,,	3 0	6 9	N.E.
15	10 5		15	4 3½		15	7 4	,,	15	6 6	
30	9 9		30	4 2		30	7 1	,,	30	6 3	
45	9 3		45	4 1		45	6 10	,,	45	6 0	
4 0	8 10		4 0	3 11½		4 0	6 7	,,	4 0	5 10	
15	8 5		15	3 9		15	6 4	,,	15	5 8	
30	8 3		30	3 7½		30	6 1	,,	30	5 6	
45	8 2		45	3 6		45	5 10	,,	45	5 4	
5 0	8 2		5 0	3 4½		5 0	5 7	,,	5 0	5 1	
15	8 5		15	3 3¼		15	5 4	,,	15	5 0	
30	8 10		30	3 2		30	5 1	,,	30	4 10	
45	9 5		45	3 0½		45	4 11	,,	45	4 9	
6 0	10 0		6 0	2 11		6 0	4 9	,,	6 0	4 7	N.E.
15	10 9		15	2 9½		15	4 7	E.	15	4 6	
30	11 6		30	2 8½		30	4 5	,,	30	4 5	
45	12 2		45	2 7		45	4 3	,,	45	4 4	
7 0	12 10		7 0	2 6		7 0	4 1	,,	7 0	4 2	
15	13 7		15	2 5		15	3 11	,,	15	4 0	
30	14 5		30	2 3		30	3 9	,,	30	3 10	
45	15 5		45	2 1		45	3 7	,,	45	3 9	
8 0	16 2		8 0	2 0		8 0	3 6	,,	8 0	3 7	
15	16 11		15	2 0		15	3 4	,,	15	3 6	
30	17 8		30	1 11		30	3 3	,,	30	3 5	N.E.
45	18 6		45	1 10		45	3 1	,,	45	3 4	
9 0	18 11		9 0	1 9		9 0	3 1	,,	9 0	3 3	
15	19 6		15	1 8		15	3 5	E.N.E.	15	3 2	
30	20 2		30	1 7		30	4 0	,,	30	3 1	
45	20 7		45	1 6		45	4 9	,,	45	3 1	
10 0	20 10		10 0	1 5		10 0	5 8	,,	10 0	3 0	
15	21 3		15	1 4		15	6 8	,,	15	3 0	
30	21 4		30	1 3		30	7 9	,,	30	3 0	
45	21 5		45	1 2		45	8 7	,,	45	2 11	
11 0	21 4		11 0	1 1		11 0	9 1	,,	11 0	2 11	
15	21 3		15	1 0		15	9 10	,,	15	2 10	
30	21 0		30	1 0		30	10 4	,,	30	2 10	
45 P.M.	20 8		45 P.M.	1 0		45 P.M.	10 9	N.W.	45 P.M.	2 10	

May 13.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	20 4		12 0 A.M.	1 0	N.	12 0 A.M.	11 1	N.W.	12 0 A.M.	2 9	N.E.
15	19 10		15	1 9		15	11 5	,,	15	2 9	
30	19 5		30	2 5		30	11 6	,,	30	2 9	
45	18 11		45	2 9		45	11 4	,,	45	2 9	
1 0	18 3		1 0	3 4		1 0	10 11	,,	1 0	2 8	
15	17 7		15	3 10		15	10 5	,,	15	3 0	
30	16 10		30	4 2		30	9 11	,,	30	3 5	
45	16 2		45	4 5		45	9 5	,,	45	4 0	
2 0	15 3		2 0	4 5		2 0	8 11	,,	2 0	4 6	N.
15	14 7		15	4 3		15	8 7	,,	15	5 0	
30	13 10		30	4 0		30	8 2	,,	30	5 6	
45	13 2		45	3 10		45	7 9	,,	45	5 11	
3 0	12 5		3 0	3 7½		3 0	7 6	,,	3 0	6 2	
15	11 11		15	3 5		15	7 3	,,	15	6 2	
30	11 3		30	3 4½		30	6 11	,,	30	6 0	
45	10 10		45	3 3		45	6 8	,,	45	5 9	
4 0	10 5		4 0	3 1		4 0	6 5	,,	4 0	5 6	
15	10 0		15	2 11		15	6 2	,,	15	5 3	
30	9 9		30	2 10		30	5 11	,,	30	5 0	
45	9 7		45	2 8½		45	5 8	,,	45	4 10	
5 0	9 8		5 0	2 7		5 0	5 5	,,	5 0	4 8	
15	9 10		15	2 6		15	5 3	,,	15	4 6	
30	10 2		30	2 4		30	5 0	,,	30	4 5	
45	10 7		45	2 3½		45	4 10	,,	45	4 4	
6 0	11 2		6 0	2 3		6 0	4 8	,,	6 0	4 3	N.
15	11 9		15	2 2		15	4 6	,,	15	4 2	
30	12 5		30	2 1		30	4 4	,,	30	4 1	
45	13 1		45	1 11		45	4 1	,,	45	4 0	
7 0	13 10		7 0	1 10		7 0	3 11	,,	7 0	3 11	
15	14 6		15	1 9		15	3 9	,,	15	3 10	
30	15 2		30	1 8		30	3 8	,,	30	3 9	
45	15 9		45	1 7		45	3 6	,,	45	3 8	
8 0	16 5		8 0	1 6		8 0	3 4	,,	8 0	3 6	
15	17 1		15	1 5		15	3 2	,,	15	3 5	N.E.
30	17 9		30	1 4		30	3 1	,,	30	3 4	
45	18 6		45	1 3		45	3 1	N.N.E.	45	3 4	
9 0	19 2		9 0	1 2		9 0	3 5	,,	9 0	3 3	
15	19 9		15	1 1		15	4 1	,,	15	3 3	
30	20 4		30	1 0		30	4 7	,,	30	3 2	
45	20 9		45	1 0		45	5 4	,,	45	3 1	
10 0	21 2		10 0	0 11		10 0	6 0	,,	10 0	3 1	
15	21 4		15	0 10		15	6 10	,,	15	3 0	
30	21 7		30	0 9½		30	7 8	,,	30	3 0	N.E.
45	21 8		45	0 8		45	8 7	,,	45	2 11	
11 0	21 7		11 0	0 7		11 0	9 3	,,	11 0	2 11	
15	21 5		15	0 6½		15	9 10	,,	15	2 10	
30	21 2		30	0 6½		30	10 5	,,	30	2 10	
45 A.M.	20 10		45 A.M.	0 9		45 A.M.	10 10	,,	45 A.M.	2 9	

May 13.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 P.M.	20 5		12 0 P.M.	1 5½	N.	12 0 P.M.	11 2	N.N.E.	12 0 P.M.	2 9	
15	20 1		15	2 0		15	11 6	E.N.E.	15	2 8	
30	19 8		30	2 6		30	11 7	,,	30	2 8	
45	19 2		45	3 0		45	11 7	,,	45	2 7	
1 0	18 7		1 0	3 4½		1 0	11 2	,,	1 0	2 9	E.
15	18 0		15	3 9		15	10 8	,,	15	3 1	
30	17 3		30	4 0		30	10 2	,,	30	3 8	
45	16 5		45	4 9		45	9 8	,,	45	4 3	
2 0	15 7		2 0	4 6½		2 0	9 2	,,	2 0	4 9	
15	14 10		15	4 3		15	8 9	E.S.E.	15	5 0	
30	14 2		30	4 0		30	8 5	,,	30	5 6	
45	13 6		45	3 9		45	8 1	,,	45	6 1	
3 0	12 10		3 0	3 7½		3 0	7 9	,,	3 0	6 3	
15	12 3		15	3 6		15	7 5	,,	15	6 4	
30	11 8		30	3 3½		30	7 1	,,	30	6 5	Deals [down.
45	11 1		45	3 0		45	6 10	,,	45	6 1	
4 0	10 6		4 0	3 2		4 0	6 7	,,	4 0	5 11	Deals up.
15	10 1		15	3 1		15	6 4	,,	15	5 7	
30	9 8		30	3 0		30	6 1	E.	30	5 3	S.E.
45	9 3		45	2 10		45	5 11	,,	45	5 0	
5 0	8 11		5 0	2 9		5 0	5 9	,,	5 0	4 9	
15	8 9		15	2 8		15	5 7	,,	15	4 7	
30	8 7		30	2 7		30	5 5	,,	30	4 6	
45	8 8		45	2 6		45	5 2	,,	45	4 4	
6 0	8 10		6 0	2 4		6 0	4 11	S.E.	6 0	4 3	
15	9 2		15	2 2½		15	4 9	,,	15	4 1	
30	9 6		30	2 1		30	4 7	,,	30	4 0	
45	10 0		45	2 0		45	4 5	,,	45	3 11	N.E.
7 0	10 5		7 0	1 11		7 0	4 3	,,	7 0	3 9	
15	11 1		15	1 10		15	4 0	,,	15	3 8	
30	11 7		30	1 9		30	3 10	,,	30	3 7	
45	12 5		45	1 7½		45	3 8	,,	45	3 6	
8 0	13 2		8 0	1 6		8 0	3 6	,,	8 0	3 4	
15	13 10		15	1 5½		15	3 5	,,	15	3 3	
30	14 5		30	1 4½		30	3 3	,,	30	3 2	
45	15 3		45	1 4		45	3 2	,,	45	3 1	
9 0	15 11		9 0	1 3		9 0	3 0	,,	9 0	3 0	Calm.
15	16 9		15	1 1½		15	2 11	,,	15	3 0	
30	17 4		30	1 1		30	2 10	,,	30	2 11	
45	17 11		45	1 1		45	2 9	,,	45	2 10	
10 0	18 5		10 0	1 0½		10 0	3 0	,,	10 0	2 10	
15	19 2		15	1 0		15	3 6	,,	15	2 9	
30	19 7		30	0 11		30	4 0	,,	30	2 8	
45	20 0		45	0 11		45	4 8	,,	45	2 8	
11 0	20 3		11 0	0 10½		11 0	5 5	,,	11 0	2 7	
15	20 6		15	0 9		15	6 3	,,	15	2 7	
30	20 7		30	0 8		30	7 0	,,	30	2 6	
45 P.M.	20 8		45 P.M.	0 8		45 P.M.	7 10	,,	45 P.M.	2 6	

May 14.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	20 7		12 0 A.M.	0 7	N.	12 0 A.M.	8 6	S.E.	12 0 A.M.	2 6	
15	20 5		15	0 8		15	9 0	"	15	2 6	
30	20 2		30	1 3		30	9 6	"	30	2 5	
45	19 11		45	1 9		45	9 11	"	45	2 5	
1 0	19 7		1 0	2 6		1 0	10 2	"	1 0	2 5	
15	19 2		15	3 0		15	10 6	"	15	2 4	
30	18 10		30	3 5		30	10 7	"	30	2 4	
45	18 5		45	3 7		45	10 5	"	45	2 4	
2 0	17 9		2 0	4 0		2 0	10 0	"	2 0	2 3	
15	17 3		15	4 0		15	9 6	"	15	2 6	N.E.
30	16 5		30	3 11		30	9 3	"	30	2 10	
45	15 10		45	3 9		45	8 8	"	45	3 2	
3 0	15 0		3 0	3 7		3 0	8 4	"	3 0	3 6	
15	14 5		15	3 6		15	7 11	N.W.	15	3 9	
30	13 8		30	3 3		30	7 6	"	30	4 4	
45	13 2		45	3 2½		45	7 3	"	45	4 9	
4 0	12 6		4 0	3 1		4 0	7 0	"	4 0	5 1	Calm.
15	11 10		15	3 0		15	6 9	"	15	5 2	
30	11 5		30	2 10		30	6 6	"	30	5 3	
45	11 2		45	2 8		45	6 0	"	45	4 11	
5 0	10 8		5 0	2 6½		5 0	5 9	"	5 0	4 9	
15	10 6		15	2 4		15	5 6	"	15	4 6	
30	10 5		30	2 3		30	5 4	"	30	4 4	
45	10 4		45	2 1½		45	5 2	"	45	4 3	
6 0	10 5		6 0	2 0	N.	6 0	5 0	"	6 0	4 1	Calm.
15	10 8		15	1 10		15	4 10	N.E.	15	4 0	
30	11 2		30	1 9		30	4 8	"	30	3 11	
45	11 5		45	1 8		45	4 6	"	45	3 10	
7 0	11 10		7 0	1 7		7 0	4 4	"	7 0	3 9	
15	12 4		15	1 6		15	4 2	"	15	3 8	
30	12 11		30	1 5		30	4 0	"	30	3 7	
45	13 5		45	1 4		45	3 10	"	45	3 7	
8 0	14 1		8 0	1 3		8 0	3 8	"	8 0	3 6	S.E.
15	14 8		15	1 2		15	3 7	"	15	3 5	
30	15 4		30	1 1		30	3 5	"	30	3 4	
45	15 10		45	1 0		45	3 4	"	45	3 2	
9 0	16 6		9 0	0 11		9 0	3 2	"	9 0	3 2	
15	17 2		15	0 11		15	3 1	"	15	3 1	
30	17 9		30	0 10		30	3 0	"	30	3 1	
45	18 5		45	0 9		45	3 3	"	45	3 0	
10 0	18 10		10 0	0 7		10 0	3 9	S.S.E.	10 0	3 0	
15	19 4		15	0 7		15	4 4	"	15	2 11	
30	19 9		30	0 6		30	4 10	"	30	2 10	
45	20 2		45	0 5		45	5 4	"	45	2 9	S.E.
11 0	20 5		11 0	0 5		11 0	6 0	"	11 0	2 9	
15	20 8		15	0 4½		15	6 7	"	15	2 8	
30	20 10		30	0 4½		30	7 3	"	30	2 7	
45 A.M.	20 11		45 A.M.	0 3½		45 A.M.	8 0	"	45 A.M.	2 7	

May 14.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 P.M.	20 10		12 0 P.M.	0 3	S.	12 0 P.M.	8 8	S.S.E.	12 0 P.M.	2 7	
15	20 8		15	0 2		15	9 3	S.	15	2 7	
30	20 5		30	0 1½		30	9 8	,,	30	2 6	
45	20 2		45	0 7		45	10 0	,,	45	2 6	
1 0	19 9		1 0	0 9		1 0	10 5	,,	1 0	2 6	
15	19 5		15	1 3		15	10 8	,,	15	2 5	E.
30	19 0		30	1 9		30	10 9	,,	30	2 5	
45	18 7		45	2 1½		45	10 9	,,	45	2 5	
2 0	18 1		2 0	2 6		2 0	10 3	,,	2 0	2 7	
15	17 5		15	2 10		15	9 11	,,	15	2 9	
30	16 8		30	3 1		30	9 5	,,	30	3 0	
45	16 0		45	3 4		45	9 0	,,	45	3 6	
3 0	15 4		3 0	3 6		3 0	8 8	,,	3 0	3 11	
15	14 8		15	3 6		15	8 4	,,	15	4 6	
30	14 0		30	3 4		30	7 11	,,	30	5 0	
45	13 5		45	3 1		45	7 7	,,	45	5 3	[down.
4 0	12 9		4 0	3 0	S.E.	4 0	7 4	,,	4 0	5 8	Deals
15	12 1		15	2 10		15	7 1	,,	15	5 10	
30	11 7		30	2 9		30	6 10	,,	30	5 9	
45	11 0		45	2 8		45	6 7	,,	45	5 9	
5 0	10 7		5 0	2 6½		5 0	6 4	S.E.	5 0	5 1	Deals up.
15	10 2		15	2 6		15	6 1	,,	15	4 11	
30	9 9		30	2 4		30	5 10	,,	30	4 8	
45	9 5		45	2 3		45	5 7	,,	45	4 5	
6 0	9 1		6 0	2 0¾	E.S.E.	6 0	5 5	,,	6 0	4 2	Calm.
15	8 11		15	2 0		15	5 3	,,	15	4 1	
30	8 10		30	1 11½		30	5 0	,,	30	3 11	
45	8 11		45	1 9		45	4 10	,,	45	3 10	
7 0	9 1		7 0	1 9		7 0	4 8	,,	7 0	3 9	
15	9 3		15	1 8		15	4 6	,,	15	3 8	
30	9 8		30	1 7		30	4 4	,,	30	3 6	
45	10 2		45	1 6		45	4 2	,,	45	3 4	
8 0	10 7		8 0	1 5		8 0	4 0	,,	8 0	3 3	
15	11 3		15	1 3½		15	3 10	,,	15	3 2	
30	11 10		30	1 2½		30	3 8	,,	30	3 1	
45	12 5		45	1 2		45	3 6	,,	45	3 0	
9 0	13 1		9 0	1 1		9 0	3 4	,,	9 0	3 0	
15	13 9		15	1 0		15	3 2	,,	15	2 11	
30	14 5		30	0 11		30	3 1	,,	30	2 9	
45	15 1		45	0 10½		45	3 0	S.	45	2 9	
10 0	15 9		10 0	0 10		10 0	2 11	,,	10 0	2 8	
15	16 8		15	0 9½		15	2 10	,,	15	2 8	
30	17 3		30	0 9		30	2 9	,,	30	2 7	
45	17 11		45	0 8½		45	2 8	,,	45	2 6	
11 0	18 5		11 0	0 7		11 0	3 0	,,	11 0	2 6	
15	18 10		15	0 6½		15	3 6	,,	15	2 5	
30	19 2		30	0 6		30	3 11	,,	30	2 5	
45 P.M.	19 7		45 P.M.	0 5½		45 P.M.	4 6	,,	45 P.M.	2 5	

May 15.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	19 11		12 0 A.M.	0 5½	S.E.	12 0 A.M.	5 1	S.	12 0 A.M.	2 4	
15	20 2		15	0 5		15	5 11	W.	15	2 4	
30	20 3		30	0 4		30	6 10	,,	30	2 4	
45	20 3		45	0 3		45	7 6	,,	45	2 3	
1 0	20 3		1 0	0 2		1 0	8 1	,,	1 0	2 3	
15	20 1		15	0 8		15	8 8	,,	15	2 3	
30	19 10		30	1 0		30	9 2	,,	30	2 2	
45	19 8		45	1 4		45	9 7	,,	45	2 2	
2 0	19 5		2 0	1 8		2 0	9 10	,,	2 0	2 1	
15	19 2		15	1 11		15	10 0	,,	15	2 1	Calm.
30	18 8		30	2 3		30	10 3	,,	30	2 0	
45	18 5		45	2 5		45	10 2	,,	45	2 0	
3 0	17 10		3 0	2 8		3 0	9 11	,,	3 0	2 0	
15	17 3		15	2 10		15	9 7	,,	15	2 0	
30	16 7		30	3 0		30	9 3	,,	30	2 3	
45	15 11		45	2 11½		45	8 10	,,	45	2 6	
4 0	15 1		4 0	2 10		4 0	8 6	,,	4 0	3 0	
15	14 6		15	2 9		15	8 0	,,	15	3 4	
30	13 8		30	2 8		30	7 8	,,	30	4 0	
45	13 3		45	2 7		45	7 3	,,	45	4 4	N.W.
5 0	12 7		5 0	2 6½		5 0	7 0	,,	5 0	4 7	
15	12 2		15	2 6		15	6 9	,,	15	4 9	
30	11 8		30	2 4½		30	6 6	,,	30	4 10	
45	11 5		45	2 3		45	6 3	,,	45	4 8	
6 0	10 10		6 0	2 1½	W.N.W.	6 0	6 0	,,	6 0	4 5	
15	10 7		15	2 1		15	5 10	S.	15	4 3	
30	10 5		30	2 0		30	5 7	,,	30	4 0	
45	10 4		45	1 10½		45	5 4	,,	45	3 11	
7 0	10 3		7 0	1 9½		7 0	5 1	,,	7 0	3 10	
15	10 5		15	1 8		15	4 11	,,	15	3 9	
30	10 8		30	1 7		30	4 9	N.W.	30	3 8	
45	11 0		45	1 6		45	4 7	,,	45	3 7	
8 0	11 5		8 0	1 5½		8 0	4 5	,,	8 0	3 6	W.
15	11 10		15	1 3		15	4 2	,,	15	3 4	
30	12 5		30	1 3		30	4 0	,,	30	3 3	
45	12 10		45	1 1		45	3 11	,,	45	3 2	
9 0	13 7		9 0	1 0		9 0	3 9	,,	9 0	3 1	
15	14 1		15	0 11		15	3 7	,,	15	3 0	
30	14 7		30	0 10		30	3 5	,,	30	2 11	
45	15 2		45	0 9		45	3 3	,,	45	2 10	
10 0	15 9		10 0	0 8		10 0	3 2	,,	10 0	2 9	W.
15	16 5		15	0 7		15	3 1	,,	15	2 8	
30	17 2		30	0 6½		30	3 0	,,	30	2 7	
45	17 8		45	0 6		45	2 11	,,	45	2 6	
11 0	18 3		11 0	0 6		11 0	3 5	,,	11 0	2 6	
15	18 10		15	0 5		15	3 11	,,	15	2 5	
30	19 4		30	0 5		30	4 3	,,	30	2 5	
45 A.M.	19 9		45 A.M.	0 4½		45 A.M.	4 9	,,	45 A.M.	2 4	

May 15.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 P.M.	20 2		12 0 P.M.	0 4½	N.W.	12 0 P.M.	5 2	N.W.	12 0 P.M.	2 4	
15	20 5		15	0 4		15	5 11	,,	15	2 4	
30	20 7		30	0 3		30	6 8	,,	30	2 3	
45	20 8		45	0 2½		45	7 5	,,	45	2 3	
1 0	20 9		1 0	0 2		1 0	8 2	,,	1 0	2 3	W.
15	20 8		15	0 1		15	8 7	,,	15	2 2	
30	20 7		30	0 1		30	9 4	,,	30	2 2	
45	20 5		45	0 5		45	9 9	,,	45	2 1	
2 0	20 2		2 0	0 5		2 0	10 2	,,	2 0	2 1	
15	19 10		15	0 6		15	10 5	,,	15	2 0	
30	19 5		30	1 1		30	10 8	,,	30	2 0	W
45	19 0		45	1 5½		45	10 8	,,	45	2 0	
3 0	18 6		3 0	1 9		3 0	10 7	,,	3 0	2 0	
15	18 0		15	2 3		15	10 4	,,	15	2 2	
30	17 4		30	2 9		30	9 10	,,	30	2 5	
45	16 7		45	3 0		45	9 6	S.E.	45	2 9	
4 0	15 11		4 0	3 0		4 0	9 1	,,	4 0	3 1	
15	15 3		15	3 4½		15	8 8	,,	15	3 6	
30	14 7		30	3 4½		30	8 4	,,	30	4 2	
45	13 10		45	3 4		45	8 0	,,	45	4 6	
5 0	13 3		5 0	3 0½		5 0	7 8	,,	5 0	4 11	W
15	12 7		15	2 11¾		15	7 4	,,	15	5 1	
30	12 2		30	2 9		30	7 1	,,	30	5 0	
45	11 6		45	2 7		45	6 10	,,	45	4 11	
6 0	11 0		6 0	2 7	N.W.	6 0	6 7	,,	6 0	4 9	W.
15	10 5		15	2 6		15	6 4	,,	15	4 8	
30	10 0		30	2 4½		30	6 1	,,	30	4 6	
45	9 8		45	2 3		45	5 10	,,	45	4 3	
7 0	9 4		7 0	2 1		7 0	5 8	,,	7 0	4 1	
15	9 1		15	2 0		15	5 6	,,	15	3 11	S.E.
30	8 10		30	1 11		30	5 4	,,	30	3 10	
45	8 11		45	1 10		45	5 1	,,	45	3 8	
8 0	9 0		8 0	1 9		8 0	4 10	,,	8 0	3 7	
15	9 2		15	1 7½		15	4 8	,,	15	3 6	
30	9 6		30	1 6¾		30	4 6	,,	30	3 6	
45	9 10		45	1 5		45	4 4	,,	45	3 5	
9 0	10 3		9 0	1 4		9 0	4 2	,,	9 0	3 4	
15	10 10		15	1 3		15	4 0	,,	15	3 2	
30	11 5		30	1 2		30	3 10	,,	30	3 1	
45	12 2		45	1 1		45	3 8	,,	45	3 0	
10 0	12 9		10 0	1 0		10 0	3 6	,,	10 0	3 0	
15	13 6		15	0 11		15	3 4	,,	15	2 11	
30	14 2		30	0 10		30	3 3	,,	30	2 10	
45	14 9		45	0 9		45	3 1	,,	45	2 9	
11 0	15 5		11 0	0 8		11 0	2 11	,,	11 0	2 8	
15	16 2		15	0 7½		15	2 10	,,	15	2 7	
30	16 8		30	0 7		30	2 9	,,	30	2 6	
45 P.M.	17 6		45 P.M.	0 6		45 P.M.	2 8	,,	45 P.M.	2 6	

May 16.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	18 2		12 0 A.M.	0 5	N.N.E.	12 0 A.M.	2 9	S.E.	12 0 A.M.	2 5	
15	18 7		15	0 5		15	3 2	E.	15	2 5	
30	19 2		30	0 4½		30	3 8	,,	30	2 4	
45	19 6		45	0 4½		45	4 3	,,	45	2 4	Calm.
1 0	19 10		1 0	0 4		1 0	4 11	,,	1 0	2 3	
15	20 1		15	0 3½		15	5 8	,,	15	2 3	
30	20 4		30	0 3		30	6 5	,,	30	2 2	
45	20 5		45	0 2		45	7 2	,,	45	2 2	
2 0	20 7		2 0	0 1½		2 0	7 11	,,	2 0	2 1	
15	20 6		15	0 1½		15	8 7	,,	15	2 0	
30	20 4		30	0 1		30	9 2	,,	30	2 0	
45	20 2		45	0 5		45	9 7	,,	45	2 0	
3 0	19 10		3 0	0 6		3 0	9 10	,,	3 0	1 11	
15	19 7		15	1 0		15	10 3	,,	15	1 11	
30	19 2		30	1 5		30	10 5	,,	30	1 11	
45	18 10		45	1 11		45	10 6	,,	45	1 10	Calm.
4 0	18 4		4 0	2 7		4 0	10 5	,,	4 0	1 10	
15	17 10		15	2 10		15	10 2	,,	15	1 10	
30	17 2		30	3 0		30	9 9	,,	30	2 1	
45	16 6		45	3 2		45	9 4	,,	45	2 3	
5 0	15 9		5 0	3 2		5 0	8 11	,,	5 0	2 8	
15	15 2		15	3 1		15	8 7	,,	15	3 1	
30	14 6		30	3 1		30	8 2	,,	30	3 7	
45	13 10		45	3 0		45	7 9	,,	45	4 2	
6 0	13 2		6 0	3 0	E.S.E.	6 0	7 5	,,	6 0	4 6	Calm.
15	12 8		15	2 8		15	7 3	S.E.	15	4 9	
30	12 0		30	2 6		30	6 11	,,	30	5 0	
45	11 7		45	2 4		45	6 8	,,	45	5 0	
7 0	11 2		7 0	2 2		7 0	6 5	,,	7 0	4 9	
15	10 10		15	2 1		15	6 2	,,	15	4 7	
30	10 5		30	2 0		30	5 11	,,	30	4 5	
45	10 3		45	1 11		45	5 9	,,	45	4 3	S.E.
8 0	10 2		8 0	1 9½		8 0	5 6	,,	8 0	4 1	
15	10 1		15	1 8		15	5 4	,,	15	3 11	
30	10 3		30	1 7		30	5 1	,,	30	3 9	
45	10 6		45	1 5		45	4 10	,,	45	3 8	
9 0	10 10		9 0	1 4		9 0	4 8	,,	9 0	3 7	
15	11 3		15	1 4		15	4 6	,,	15	3 6	
30	11 9		30	1 3½		30	4 4	,,	30	3 5	
45	12 5		45	1 3		45	4 2	,,	45	3 4	
10 0	12 11		10 0	1 1½		10 0	4 0	,,	10 0	3 3	S.E.
15	13 7		15	1 1		15	3 11	,,	15	3 2	
30	14 1		30	1 0		30	3 9	,,	30	3 1	
45	14 8		45	0 11		45	3 7	,,	45	3 0	
11 0	15 4		11 0	0 9½		11 0	3 5	,,	11 0	2 11	
15	16 0		15	0 9		15	3 3	,,	15	2 10	
30	16 8		30	0 8		30	3 1	,,	30	2 9	S.
45 A.M.	17 4		45 A.M.	0 7		45 A.M.	3 0	,,	45 A.M.	2 9	

May 16.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 P.M.	17 10		12 0 P.M.	0 6	E.S.E.	12 0 P.M.	2 11	S.	12 0 P.M.	2 8	S.
15	18 6		15	0 6		15	3 3	S.S.W.	15	2 7	
30	19 1		30	0 5½		30	3 10	,,	30	2 7	
45	19 6		45	0 5		45	4 4	,,	45	2 6	
1 0	19 10		1 0	0 4½		1 0	4 10	,,	1 0	2 6	
15	20 3		15	0 4½		15	5 5	,,	15	2 5	
30	20 6		30	0 4		30	6 0	,,	30	2 4	
45	20 8		45	0 3½		45	6 8	,,	45	2 4	
2 0	20 10		2 0	0 3		2 0	7 7	,,	2 0	2 3	S.E.
15	20 10		15	0 2½		15	8 5	S.E.	15	2 3	
30	20 9		30	0 1½		30	9 0	,,	30	2 2	
45	20 6		45	0 1		45	9 7	,,	45	2 2	
3 0	20 3		3 0	0 1		3 0	9 10	,,	3 0	2 1	
15	19 11		15	0 2½		15	10 7	,,	15	2 1	
30	19 7		30	0 8		30	10 8	,,	30	2 0	
45	19 2		45	1 3		45	10 10	,,	45	2 0	
4 0	18 8		4 0	1 6		4 0	10 10	,,	4 0	2 1	
15	18 1		15	2 0		15	10 8	,,	15	2 4	S.E.
30	17 4		30	2 9½		30	10 3	,,	30	2 6	
45	16 7		45	2 10		45	9 8	,,	45	2 9	
5 0	15 10		5 0	3 1		5 0	9 5	,,	5 0	3 1	
15	15 2		15	3 5		15	9 1	,,	15	3 7	
30	14 6		30	3 6		30	8 9	,,	30	4 1	
45	13 9		45	3 5½		45	8 5	,,	45	4 6	Deals down.
6 0	13 0		6 0	3 3½	E.S.E.	6 0	8 1	,,	6 0	5 6	
15	12 5		15	3 0½		15	7 9	,,	15	5 10	
30	11 10		30	3 0		30	7 5	,,	30	6 0	
45	11 2		45	2 9½		45	7 1	,,	45	6 1	S.E.
7 0	10 7		7 0	2 8½		7 0	6 10	,,	7 0	5 11	
15	10 2		15	2 7		15	6 7	,,	15	5 10	
30	9 10		30	2 6		30	6 4	,,	30	5 9	
45	9 4		45	2 4½		45	6 1	,,	45	5 0	Deals up.
8 0	8 11		8 0	2 3		8 0	5 10	,,	8 0	4 9	
15	8 7		15	2 0		15	5 8	,,	15	4 5	
30	8 3		30	1 11		30	5 6	,,	30	4 1	S.E.
45	8 2		45	1 11		45	5 4	,,	45	3 11	
9 0	8 2		9 0	1 10		9 0	5 1	,,	9 0	3 9	
15	8 4		15	1 8½		15	4 10	,,	15	3 7	
30	8 8		30	1 7½		30	4 7	,,	30	3 5	
45	9 1		45	1 6		45	4 5	,,	45	3 3	
10 0	9 6		10 0	1 6		10 0	4 2	,,	10 0	3 1	
15	10 2		15	1 5½		15	4 0	,,	15	3 0	
30	10 10		30	1 4		30	3 10	,,	30	2 11	
45	11 6		45	1 3		45	3 8	,,	45	2 10	
11 0	12 2		11 0	1 2		11 0	3 6	,,	11 0	2 8	
15	12 11		15	1 0		15	3 4	,,	15	2 7	
30	13 9		30	0 11½		30	3 2	,,	30	2 6	
45 P.M.	14 7		45 P.M.	0 10½		45 P.M.	3 1	,,	45 P.M.	2 5	

May 17.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	15 3		12 0 A.M.	0 9	E.S.E.	12 0 A.M.	3 0	S.E.	12 0 A.M.	2 4	
15	16 1		15	0 8		15	2 11	,,	15	2 4	
30	16 8		30	0 7		30	2 9	,,	30	2 3	
45	17 5		45	0 6		45	2 8	,,	45	2 2	
1 0	17 11		1 0	0 5½		1 0	2 8	,,	1 0	2 2	
15	18 6		15	0 5		15	2 10	,,	15	2 1	
30	19 2		30	0 4½		30	3 4	,,	30	2 0	
45	19 8		45	0 4		45	4 1	,,	45	2 0	
2 0	20 1		2 0	0 3½		2 0	4 10	,,	2 0	2 0	
15	20 5		15	0 3		15	5 10	,,	15	1 11	
30	20 8		30	0 2½		30	6 9	,,	30	1 10	
45	20 10		45	0 2		45	7 7	,,	45	1 9	
3 0	20 11		3 0	0 1½		3 0	8 5	,,	3 0	1 8	
15	20 10		15	0 1½		15	9 0	,,	15	1 7	
30	20 8		30	0 1		30	9 6	,,	30	1 7	
45	20 5		45	0 1		45	10 0	,,	45	1 6	
4 0	20 2		4 0	0 4		4 0	10 4	,,	4 0	1 6	
15	19 8		15	0 10		15	10 8	,,	15	1 6	
30	19 3		30	1 3		30	10 10	,,	30	1 6	
45	18 11		45	1 9		45	11 0	,,	45	1 7	
5 0	18 5		5 0	2 2		5 0	10 10	,,	5 0	1 9	
15	17 8		15	2 6		15	10 7	,,	15	1 11	
30	17 2		30	3 0		30	10 0	,,	30	2 3	
45	16 5		45	3 4		45	9 7	,,	45	2 8	
6 0	15 8		6 0	3 6	E.S.E.	6 0	9 2	S.S.E.	6 0	3 2	S.E.
15	14 10		15	3 7		15	8 10	,,	15	3 7	
30	14 3		30	3 7		30	8 5	,,	30	4 1	
45	13 6		45	3 6		45	8 0	,,	45	4 6	[down.
7 0	12 9		7 0	3 4		7 0	7 8	,,	7 0	4 11	Deals
15	12 2		15	3 2		15	7 5	,,	15	5 7	
30	11 8		30	3 1		30	7 2	,,	30	6 2	
45	11 1		45	2 10		45	6 10	,,	45	6 1	
8 0	10 7		8 0	2 8½		8 0	6 7	,,	8 0	6 0	
15	10 2		15	2 7		15	6 4	,,	15	5 10	
30	10 8		30	2 6		30	6 1	,,	30	5 8	
45	9 4		45	2 4½		45	5 10	,,	45	5 0	Deals up.
9 0	9 2		9 0	2 3		9 0	5 7	,,	9 0	4 7	
15	8 10		15	2 1		15	5 4	,,	15	4 4	
30	8 11		30	1 11		30	5 2	,,	30	4 1	
45	9 2		45	1 10		45	4 11	,,	45	3 11	
10 0	9 5		10 0	1 9		10 0	4 9	,,	10 0	3 9	S.E.
15	9 10		15	1 8		15	4 7	,,	15	3 7	
30	10 6		30	1 7		30	4 5	,,	30	3 6	
45	11 2		45	1 6		45	4 3	,,	45	3 5	
11 0	11 10		11 0	1 4		11 0	4 0	,,	11 0	3 4	
15	12 7		15	1 3		15	3 10	,,	15	3 3	
30	13 3		30	1 2		30	3 8	,,	30	3 2	
45 A.M.	14 0		45 A.M.	1 1		45 A.M.	3 7	,,	45 A.M.	3 1	

May 17.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 P.M.	14 9		12 0 P.M.	1 0	S.W.	12 0 P.M.	3 5	S.E.	12 0 P.M.	3 0	S.E.
15	15 6		15	0 11½		15	3 3	S.	15	2 11	
30	16 3		30	0 11		30	3 1	,,	30	2 10	
45	17 2		45	0 10		45	3 0	,,	45	2 9	
1 0	17 9		1 0	0 9		1 0	2 11	,,	1 0	2 9	
15	18 5		15	0 8		15	2 10	,,	15	2 8	
30	19 1		30	0 7		30	3 0	,,	30	2 7	
45	19 9		45	0 6		45	3 6	,,	45	2 7	
2 0	20 2		2 0	0 4½		2 0	4 3	,,	2 0	2 7	
15	20 8		15	0 3½		15	5 0	,,	15	2 8	
30	21 0		30	0 3		30	5 11	,,	30	2 8	
45	21 4		45	0 2½		45	7 3	,,	45	2 8	
3 0	21 6		3 0	0 1		3 0	8 0	,,	3 0	2 8	S.E.
15	21 7		15	0 1		15	9 0	,,	15	2 8	
30	21 6		30	0 1		30	9 10	,,	30	2 9	
45	21 5		45	0 1		45	10 9	,,	45	2 9	
4 0	20 11		4 0	0 1		4 0	10 10	,,	4 0	2 9	
15	20 6		15	0 6		15	11 3	,,	15	2 10	
30	20 1		30	1 1½		30	11 7	S.E.	30	2 10	
45	19 7		45	2 0		45	11 9	,,	45	2 11	
5 0	19 0		5 0	2 6		5 0	11 10	,,	5 0	2 11	S.E.
15	18 4		15	3 0½		15	11 8	,,	15	3 0	
30	17 8		30	3 6		30	11 4	,,	30	3 3	
45	16 11		45	3 9		45	10 6	,,	45	3 7	
6 0	16 2		6 0	4 0	S.E.	6 0	10 2	,,	6 0	4 1	E.
15	15 4		15	4 3		15	9 9	,,	15	4 10	
30	14 7		30	4 4		30	9 4	,,	30	5 5	
45	13 10		45	4 2		45	8 10	,,	45	5 11	
7 0	13 0		7 0	3 10		7 0	8 5	,,	7 0	6 5	
15	12 5		15	3 6½		15	8 1	,,	15	6 8	
30	11 8		30	3 5		30	7 9	,,	30	6 10	
45	11 0		45	3 4		45	7 5	,,	45	6 10	
8 0	10 3		8 0	3 3		8 0	7 2	,,	8 0	6 6	
15	9 10		15	3 1		15	6 10	,,	15	6 4	
30	9 3		30	2 11		30	6 7	,,	30	6 2	
45	8 8		45	2 9		45	6 4	,,	45	6 0	
9 0	8 2		9 0	2 7		9 0	6 1	,,	9 0	5 10	S.E.
15	7 11		15	2 6		15	5 10	,,	15	5 7	
30	7 3		30	2 5		30	5 7	,,	30	5 6	
45	7 6		45	2 4		45	5 4	,,	45	5 5	
10 0	7 6		10 0	2 3½		10 0	5 1	,,	10 0	5 4	
15	7 9		15	2 2½		15	4 10	,,	15	5 3	
30	8 2		30	2 2		30	4 8	,,	30	5 2	
45	8 8		45	2 1		45	4 5	,,	45	5 1	
11 0	9 8		11 0	2 0		11 0	4 3	,,	11 0	5 0	
15	10 2		15	1 11		15	4 1	,,	15	5 0	
30	10 10		30	1 10½		30	3 11	,,	30	4 12	
45 P.M.	11 9		45 P.M.	1 8		45 P.M.	3 9	,,	45 P.M.	4 11	

May 18.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		m	ft. in.		h m	ft. in.	
12 0 A.M.	12 6		12 0 A.M.	1 6	S.E.	12 0 A.M.	3 7	S.E.	12 0 A.M.	4 10	Calm.
15	13 5		15	1 7		15	3 6	S.	15	4 10	
30	14 3		30	1 5		30	3 5	"	30	4 9	
45	15 2		45	1 2½		45	3 3	"	45	4 8	
1 0	16 1		1 0	1 0½		1 0	3 1	"	1 0	4 8	
15	16 8		15	1 0½		15	2 11	"	15	4 7	
30	17 6		30	0 11½		30	2 10	"	30	4 7	
45	18 5		45	0 10½		45	2 9	"	45	4 6	
2 0	18 11		2 0	0 8		2 0	2 9	"	2 0	4 6	
15	19 9		15	0 6½		15	3 1	"	15	4 5	
30	20 5		30	0 6		30	4 0	"	30	4 5	
45	20 11		45	0 5		45	5 0	"	45	4 4	
3 0	21 5		3 0	0 4½		3 0	6 2	"	3 0	4 4	
15	21 8		15	0 4		15	7 7	"	15	4 3	
30	21 11		30	0 3		30	8 7	"	30	4 2	
45	22 2		45	0 2½		45	9 5	"	45	4 1	
4 0	22 2		4 0	0 2		4 0	10 0	"	4 0	4 0	
15	21 10		15	0 1½		15	10 9	"	15	3 11	
30	21 7		30	0 1		30	11 1	"	30	3 11	
45	21 4		45	0 8½		45	11 6	"	45	3 11	
5 0	20 9		5 0	1 3	N.	5 0	12 0	"	5 0	3 10	
15	20 3		15	2 0		15	12 3	"	15	3 9	
30	19 8		30	2 7		30	12 4	"	30	3 8	
45	19 1		45	3 6		45	12 3	"	45	3 8	
6 0	18 7		6 0	3 10	N.	6 0	11 10	"	6 0	3 9	
15	17 9		15	4 3		15	11 3	"	15	4 2	
30	16 11		30	4 6		30	10 8	"	30	4 10	
45	16 1		45	4 7		45	10 1	"	45	5 6	
7 0	15 3		7 0	4 9		7 0	9 7	"	7 0	6 0	
15	14 6		15	4 6		15	9 2	"	15	6 6	N.W.
30	13 9		30	4 3		30	8 9	"	30	6 10	
45	13 0		45	3 9		45	8 4	"	45	7 2	
8 0	12 4		8 0	3 7		8 0	8 0	"	8 0	7 4	
15	11 8		15	3 6		15	7 8	"	15	7 2	
30	11 2		30	3 5		30	7 5	"	30	6 10	
45	10 7		45	3 4		45	7 1	"	45	6 8	
9 0	10 0		9 0	3 2		9 0	6 10	"	9 0	6 4	
15	9 6		15	3 0		15	6 7	"	15	6 1	
30	9 1		30	2 10		30	6 4	N.W.	30	5 10	
45	8 9		45	2 8		45	6 1	"	45	5 6	
10 0	8 0		10 0	2 6		10 0	5 10	"	10 0	5 4	
15	8 4		15	2 5		15	5 7	"	15	5 3	
30	8 5		30	2 3		30	5 4	"	30	5 2	
45	8 8		45	2 2		45	5 1	"	45	5 0	N.W.
11 0	9 1		11 0	2 0½		11 0	4 10	"	11 0	4 10	
15	9 8		15	1 11½		15	4 8	"	15	4 8	
30	10 4		30	1 10½		30	4 6	"	30	4 7	
45 A.M.	11 0		45 A.M.	1 8½		45 A.M.	4 3	"	45 A.M.	4 6	

May 18.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 P.M.	11 9		12 0 P.M.	1 $6\frac{1}{2}$	N.W.	12 0 P.M.	4 1	N.W.	12 0 P.M.	4 5	
15	12 7		15	1 $5\frac{1}{2}$		15	3 10	,,	15	4 4	
30	13 7		30	1 $3\frac{1}{2}$		30	3 8	,,	30	4 3	
45	14 5		45	1 $2\frac{1}{2}$		45	3 7	,,	45	4 1	
1 0	15 3		1 0	1 1	E. by N.	1 0	3 6	,,	1 0	4 0	N.
15	16 0		15	1 0		15	3 4	,,	15	3 10	
30	16 10		30	0 11		30	3 2	,,	30	3 8	
45	17 10		45	0 10		45	3 0	,,	45	3 7	
2 0	18 7		2 0	0 8		2 0	2 11	,,	2 0	3 6	
15	19 5		15	0 7		15	2 10	,,	15	3 5	
30	20 1		30	0 6		30	3 3	,,	30	3 4	
45	20 10		45	0 4		45	4 0	,,	45	3 3	
3 0	21 4		3 0	0 3		3 0	4 11	,,	3 0	3 2	
15	21 9		15	0 $2\frac{1}{2}$		15	6 0	,,	15	3 1	
30	22 2		30	0 2		30	7 5	,,	30	3 0	
45	22 4		45	0 $1\frac{1}{2}$		45	8 7	,,	45	3 0	
4 0	22 6		4 0	0 1		4 0	9 8	,,	4 0	2 11	
15	22 7		15	0 $0\frac{3}{4}$		15	10 8	,,	15	2 11	W.
30	22 4		30	0 $0\frac{1}{2}$		30	11 3	,,	30	2 10	
45	22 0		45	0 $0\frac{1}{4}$		45	11 9	,,	45	2 10	
5 0	21 6		5 0	1 2		5 0	12 2	,,	5 0	2 9	
15	21 0		15	2 0		15	12 6	,,	15	2 9	
30	20 5		30	2 8		30	12 9	,,	30	2 9	
45	19 10		45	3 $3\frac{1}{2}$		45	12 10	E.S.E.	45	2 9	
6 0	19 2		6 0	3 11	E.N.E.	6 0	12 8	,,	6 0	3 2	
15	18 5		15	4 3		15	12 2	S.E.	15	3 6	E.
30	17 7		30	4 7		30	11 9	,,	30	4 0	
45	16 8		45	5 0		45	10 10	,,	45	4 9	
7 0	15 8		7 0	5 2		7 0	10 3	,,	7 0	5 4	
15	14 10		15	5 2		15	9 9	,,	15	6 0	
30	14 0		30	5 0		30	9 4	,,	30	6 7	
45	13 1		45	4 6		45	8 6	,,	45	7 1	
8 0	12 3		8 0	4 3		8 0	8 3	,,	8 0	7 5	E.
15	11 7		15	3 $11\frac{1}{2}$		15	8 0	,,	15	7 5	
30	10 10		30	3 10		30	7 9	,,	30	7 0	
45	10 2		45	3 10		45	7 6	,,	45	6 8	
9 0	9 7		9 0	3 7		9 0	7 3	,,	9 0	6 4	
15	9 0		15	3 5		15	7 0	,,	15	6 1	
30	8 5		30	3 4		30	6 9	,,	30	5 10	
45	8 0		45	3 $3\frac{1}{2}$		45	6 5	,,	45	5 7	
10 0	7 7		10 0	3 2		10 0	6 2	,,	10 0	5 3	
15	7 2		15	3 1		15	5 10	,,	15	5 0	
30	6 11		30	2 11		30	5 7	,,	30	4 10	
45	6 10		45	2 10		45	5 4	,,	45	4 8	
11 0	6 11		11 0	2 $8\frac{1}{2}$		11 0	5 1	,,	11 0	4 7	
15	7 3		15	2 $5\frac{1}{2}$		15	4 11	,,	15	4 5	
30	7 10		30	2 $4\frac{1}{2}$		30	4 9	,,	30	4 3	
45 P.M.	8 6		45 P.M.	2 4		45 P.M.	4 7	,,	45 P.M.	4 1	

May 19.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	9 4		12 0 A.M.	2 2	E.N.E.	12 0 A.M.	4 4	S.E.	12 0 A.M.	4 0	
15	10 1		15	2 0½		15	4 2	E.	15	3 11	
30	11 1		30	2 0		30	4 0	,,	30	3 9	Calm.
45	11 11		45	1 11		45	3 10	,,	45	3 7	
1 0	12 10		1 0	1 10		1 0	3 8	,,	1 0	3 6	
15	13 9		15	1 8½		15	3 6	,,	15	3 5	
30	14 10		30	1 7		30	3 4	,,	30	3 4	
45	15 10		45	1 6		45	3 3	,,	45	3 3	
2 0	16 10		2 0	1 5		2 0	3 2	,,	2 0	3 1	
15	18 3		15	1 4		15	3 0	,,	15	3 0	
30	18 11		30	1 3½		30	2 11	,,	30	3 0	
45	19 9		45	1 2		45	2 10	,,	45	2 11	Calm.
3 0	20 5		3 0	1 0		3 0	2 10	,,	3 0	2 11	
15	21 2		15	0 10		15	3 7	,,	15	2 10	
30	21 9		30	0 8		30	4 9	,,	30	2 10	
45	22 2		45	0 6		45	5 11	,,	45	2 9	
4 0	22 6		4 0	0 4½		4 0	7 3	,,	4 0	2 9	Calm.
15	22 9		15	0 3½		15	8 10	,,	15	2 8	
30	22 11		30	0 3		30	10 2	,,	30	2 6	
45	22 11		45	0 2½		45	11 3	,,	45	2 5	
5 0	22 10		5 0	0 2		5 0	11 10	,,	5 0	2 4	Calm.
15	22 5		15	0 1		15	12 5	E.S.E.	15	2 4	
30	22 0		30	0 10		30	12 10	,,	30	2 4	
45	21 5		45	2 6		45	13 2	,,	45	2 3	
6 0	20 11		6 0	3 5	E.N.E.	6 0	13 4	,,	6 0	2 3	
15	20 4		15	4 1		15	13 5	,,	15	2 2	Calm.
30	19 8		30	4 5		30	13 2	,,	30	2 2	
45	19 0		45	4 10		45	12 6	,,	45	3 0	
7 0	18 2		7 0	5 2		7 0	11 10	,,	7 0	4 0	
15	17 4		15	5 4		15	11 3	,,	15	4 11	
30	16 5		30	5 7		30	10 7	,,	30	5 10	
45	15 6		45	5 7		45	10 1	,,	45	6 6	
8 0	14 7		8 0	5 6		8 0	9 7	,,	8 0	7 0	
15	13 9		15	5 0		15	9 3	,,	15	7 6	S.E.
30	13 1		30	4 7		30	8 10	,,	30	7 9	
45	12 2		45	4 3		45	8 5	,,	45	7 8	
9 0	11 7		9 0	4 1		9 0	8 1	,,	9 0	7 5	
15	10 10		15	4 0		15	7 9	,,	15	7 0	
30	10 4		30	3 11		30	7 6	,,	30	6 7	
45	9 5		45	3 9		45	7 2	,,	45	6 3	
10 0	8 10		10 0	3 6½		10 0	6 10	,,	10 0	5 10	
15	8 5		15	3 5		15	6 7	,,	15	5 7	
30	8 0		30	3 3		30	6 4	,,	30	5 4	
45	7 8		45	3 1½		45	6 0	,,	45	5 2	
11 0	7 5		11 0	2 11¾		11 0	5 9	,,	11 0	5 0	E.
15	7 4		15	2 9½		15	5 6	,,	15	4 10	
30	7 5		30	2 6½		30	5 3	,,	30	4 7	
45 A.M.	7 11		45 A.M.	2 5¾		45 A.M.	5 0	,,	45	4 4	

May 19.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 P.M.	8 6		12 0 P.M.	2 4	E.	12 0 P.M.	4 9	E.S.E.	12 0 P.M.	4 3	
15	9 2		15	2 3		15	4 7	E.S.E.	15	4 2	
30	10 2		30	2 1		30	4 5	,,	30	4 0	
45	11 1		45	1 11¾		45	4 3	,,	45	3 10	
1 0	12 2		1 0	1 10		1 0	4 1	,,	1 0	3 9	S.E.
15	13 2		15	1 9		15	3 11	,,	15	3 8	
30	14 1		30	1 6½		30	3 9	,,	30	3 6	
45	15 0		45	1 5¾		45	3 7	,,	45	3 5	
2 0	15 11		2 0	1 4½		2 0	3 5	,,	2 0	3 4	
15	16 11		15	1 3		15	3 3	,,	15	3 3	
30	17 11		30	1 2½		30	3 1	,,	30	3 1	
45	19 0		45	1 1		45	3 0	,,	45	3 0	
3 0	19 10		3 0	1 0		3 0	2 11	,,	3 0	2 11	S.E.
15	20 6		15	0 10½		15	3 0	,,	15	2 10	
30	21 4		30	0 8½		30	4 1	,,	30	2 9	
45	21 11		45	0 7½		45	5 4	,,	45	2 8	
4 0	22 5		4 0	0 6½		4 0	6 8	,,	4 0	2 7	
15	22 10		15	0 6		15	8 2	,,	15	2 6	
30	23 2		30	0 4½		30	9 7	,,	30	2 5	
45	23 3		45	0 4		45	10 9	,,	45	2 5	
5 0	23 3		5 0	0 3		5 0	11 6	,,	5 0	2 4	
15	23 2		15	0 2½		15	12 4	,,	15	2 4	
30	22 9		30	0 1½		30	13 0	,,	30	2 4	
45	22 3		45	2 5		45	13 4	,,	45	2 4	
6 0	21 9		6 0	3 3	E.	6 0	13 8	,,	6 0	2 3	
15	21 0		15	4 0		15	13 10	S.E.	15	2 2	E.
30	20 4		30	4 6		30	13 10	,,	30	2 2	
45	19 6		45	5 0		45	13 7	,,	45	2 9	
7 0	18 8		7 0	5 6		7 0	12 10	,,	7 0	3 8	
15	17 11		15	5 9		15	12 4	,,	15	4 3	
30	16 11		30	6 0	S.	30	11 9	,,	30	5 4	
45	16 0		45	6 1		45	11 0	,,	45	6 0	
8 0	15 0		8 0	6 0		8 0	10 6	,,	8 0	6 11	
15	14 1		15	5 6½	E.	15	10 0	,,	15	7 7	
30	15 2		30	5 2½		30	9 7	,,	30	8 0	
45	12 3		45	4 9½		45	9 1	,,	45	8 3	S.
9 0	11 7		9 0	4 6		9 0	8 8	,,	9 0	8 1	
15	10 10		15	4 4½		15	8 3	,,	15	7 7	
30	10 2		30	4 3		30	7 11	,,	30	7 1	
45	9 4		45	4 1½		45	7 7	,,	45	6 7	
10 0	8 8		10 0	4 0		10 0	7 3	,,	10 0	6 4	
15	8 0		15	3 11		15	6 11	,,	15	6 0	
30	7 6		30	3 10		30	6 8	,,	30	5 10	
45	6 11		45	3 9		45	6 5	,,	45	5 8	
11 0	6 5		11 0	3 7		11 0	6 1	,,	11 0	5 6	
15	6 1		15	3 5		15	5 11	,,	15	5 4	
30	5 10		30	3 2		30	5 8	,,	30	5 2	
45 P.M.	5 9		45 P.M.	3 0		45 P.M.	5 4	,,	45 P.M.	4 11	

May 20.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	6 2		12 0 A.M.	2 9½	E.	12 0 A.M.	5 1	S.E.	12 0 A.M.	4 8	
15	6 8		15	2 6½		15	4 10	N.W.	15	4 6	
30	7 7		30	2 4		30	4 7	,,	30	4 4	
45	8 6		45	2 2		45	4 4	,,	45	4 2	
1 0	9 7		1 0	2 1½		1 0	4 2	,,	1 0	4 0	Calm.
15	10 6		15	1 11½		15	4 0	,,	15	3 10	
30	11 8		30	1 10		30	3 10	,,	30	3 8	
45	12 7		45	1 9		45	3 8	,,	45	3 6	
2 0	13 8		2 0	1 7½		2 0	3 6	,,	2 0	3 5	
15	14 10		15	1 5		15	3 4	,,	15	3 3	
30	15 11		30	1 2½		30	3 2	,,	30	3 1	
45	17 0		45	1 1		45	3 1	,,	45	3 0	
3 0	18 2		3 0	1 0		3 0	3 0	,,	3 0	2 10	
15	19 3		15	0 11½		15	2 11	,,	15	2 9	
30	20 1		30	0 11		30	2 10	,,	30	2 8	
45	21 0		45	0 10½		45	2 9	,,	45	2 7	
4 0	21 9		4 0	0 9		4 0	3 5	,,	4 0	2 6	Calm.
15	22 5		15	0 8½		15	4 11	,,	15	2 5	
30	22 11		30	0 7½		30	6 9	,,	30	2 5	
45	23 2		45	0 6½		45	8 6	,,	45	2 4	
5 0	23 4		5 0	0 5½		5 0	9 9	,,	5 0	2 4	
15	23 6		15	0 4½		15	11 1	,,	15	2 3	
30	23 6		30	0 3½		30	12 1	,,	30	2 2	
45	23 3		45	0 2½		45	12 8	,,	45	2 2	
6 0	22 10		6 0	0 1½	N.	6 0	13 3	,,	6 0	2 2	Calm.
15	22 3		15	2 9		15	13 7	,,	15	2 1	
30	21 8		30	3 9		30	13 9	,,	30	2 1	
45	20 10		45	4 8		45	13 11	,,	45	2 0	
7 0	20 2		7 0	5 1	S.W.	7 0	13 10	,,	7 0	2 0	
15	19 8		15	5 6		15	13 6	,,	15	2 8	Calm.
30	18 6		30	5 9		30	12 11	,,	30	3 6	
45	17 8		45	6 0		45	12 1	,,	45	4 5	
8 0	16 10		8 0	6 3		8 0	11 5	,,	8 0	5 3	
15	16 0		15	6 3		15	10 9	,,	15	6 2	
30	15 1		30	6 0		30	10 3	,,	30	7 0	
45	14 2		45	5 6		45	9 9	,,	45	7 8	
9 0	13 4		9 0	5 2		9 0	9 3	W.	9 0	8 2	S.
15	12 3		15	4 9		15	8 9	,,	15	8 3	
30	11 6		30	4 8		30	8 4	,,	30	8 0	
45	10 8		45	4 5½		45	8 0	,,	45	7 6	
10 0	10 0		10 0	4 3		10 0	7 9	,,	10 0	7 0	
15	9 2		15	4 1		15	7 5	,,	15	6 8	
30	8 6		30	4 0		30	7 1	,,	30	6 4	S.E.
45	7 11		45	3 9½		45	6 9	,,	45	6 0	
11 0	7 5		11 0	3 7½		11 0	6 6	,,	11 0	5 9	
15	6 10		15	3 6		15	6 2	,,	15	5 6	
30	6 5		30	3 3½		30	5 10	,,	30	5 3	
45 A.M.	6 2		45 A.M.	3 1½		45 A.M.	5 7	,,	45 A.M.	5 0	

May 20.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 P.M.	5 11		12 0 P.M.	2 11¾	S.W.	12 0 P.M.	5 4	W.	12 0 P.M.	4 10	
15	6 0		15	2 10		15	5 1	S.	15	4 8	
30	6 6		30	2 7		30	4 10	,,	30	4 6	
45	7 2		45	2 6		45	4 8	,,	45	4 4	S.
1 0	8 0		1 0	2 3½		1 0	4 6	,,	1 0	4 1	
15	9 3		15	2 0½		15	4 4	,,	15	3 11	
30	10 5		30	2 0		30	4 2	,,	30	3 9	
45	11 7		45	1 10½		45	4 0	,,	45	3 7	
2 0	12 7		2 0	1 9		2 0	3 10	,,	2 0	3 6	S.
15	13 8		15	1 7½		15	3 8	,,	15	3 5	
30	14 9		30	1 6	S.	30	3 6	S.E.	30	3 4	
45	15 10		45	1 4½		45	3 4	,,	45	3 3	W.
3 0	17 0		3 0	1 3½	S.W.	3 0	3 2	,,	3 0	3 2	
15	18 1		15	1 1½		15	3 1	,,	15	3 1	
30	19 6		30	1 0½		30	3 0	,,	30	3 0	W.
45	20 6		45	1 0	W.N.W.	45	2 11	,,	45	2 11	
4 0	21 3		4 0	0 11½		4 0	2 10	,,	4 0	2 10	
15	22 2		15	0 9		15	3 6	,,	15	2 9	
30	22 9		30	0 8		30	4 4	,,	30	2 8	
45	23 3		45	0 7		45	6 8	N.W.	45	2 8	
5 0	23 7		5 0	0 6½		5 0	8 6	,,	5 0	2 7	
15	23 9		15	0 6		15	10 2	,,	15	2 6	N.
30	23 10		30	0 5		30	11 6	,,	30	2 5	
45	23 10		45	0 4		45	12 3	,,	45	2 5	
6 0	23 8		6 0	0 3	N.	6 0	13 0	,,	6 0	2 4	N.W.
15	23 3		15	0 3		15	13 5	N.W.	15	2 3	
30	22 8		30	2 9		30	13 10	,,	30	2 3	
45	21 10		45	3 10		45	14 0	,,	45	2 3	
7 0	21 2		7 0	4 5		7 0	14 2	,,	7 0	2 2	
15	20 4		15	5 1		15	14 1	,,	15	2 2	
30	19 6		30	5 7		30	13 8	,,	30	2 6	N.W.
45	18 6		45	5 11		45	12 10	N.	45	3 9	
8 0	17 6		8 0	6 3		8 0	12 3	,,	8 0	4 7	
15	16 6		15	6 6		15	11 6	,,	15	5 9	
30	15 8		30	6 8		30	10 11	,,	30	6 6	
45	14 10		45	6 6		45	10 4	,,	45	7 5	
9 0	13 10		9 0	5 11½		9 0	9 10	,,	9 0	8 3	[down.
15	12 11		15	5 6		15	9 5	,,	15	8 9	Deals
30	12 0		30	5 0½		30	9 0	,,	30	8 7	
45	11 3		45	4 9		45	8 7	,,	45	8 2	
10 0	10 7		10 0	4 7		10 0	8 3	,,	10 0	7 9	N.W.
15	9 8		15	4 5		15	7 11	,,	15	7 3	Deals up.
30	9 2		30	4 3		30	7 7	,,	30	6 7	
45	8 5		45	4 2		45	7 3	,,	45	6 3	
11 0	7 9		11 0	4 0		11 0	6 11	,,	11 0	6 11	
15	7 2		15	3 10		15	6 7	,,	15	5 9	
30	6 8		30	3 8		30	6 4	,,	30	5 6	
45 P.M.	6 0		45 P.M.	3 6		45 P.M.	6 0	,,	45 P.M.	5 3	

May 21.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	5 8		12 0 A.M.	3 4	N.	12 0 A.M.	5 9	N.	12 0 A.M.	5 1	
15	5 7		15	3 2		15	5 6	,,	15	4 10	
30	5 10		30	3 1		30	5 3	,,	30	4 8	
45	6 3		45	3 0		45	5 0	,,	45	4 6	
1 0	7 1		1 0	2 10½		1 0	4 10	,,	1 0	4 4	
15	8 2		15	2 8		15	4 8	,,	15	4 2	
30	9 5		30	2 7		30	4 6	,,	30	4 0	
45	10 5		45	2 6		45	4 4	,,	45	3 10	
2 0	11 6		2 0	2 4½		2 0	4 2	,,	2 0	3 8	
15	12 8		15	2 3		15	4 0	,,	15	3 6	
30	14 0		30	2 2		30	3 10	,,	30	3 4	
45	15 0		45	2 0		45	3 8	,,	45	3 3	
3 0	16 2		3 0	1 10½		3 0	3 6	,,	3 0	3 2	
15	17 4		15	1 9		15	3 4	,,	15	3 1	
30	18 11		30	1 8		30	3 2	,,	30	3 0	
45	20 0		45	1 7		45	3 0	N.N.W.	45	2 11	
4 0	20 10		4 0	1 5		4 0	2 10	,,	4 0	2 10	
15	22 1		15	1 3½		15	2 9	,,	15	2 9	
30	22 10		30	1 1		30	3 2	,,	30	2 9	N.
45	23 6		45	0 11½		45	5 0	,,	45	2 8	
5 0	23 9		5 0	0 10		5 0	7 6	,,	5 0	2 7	
15	24 5		15	0 9		15	9 3	,,	15	2 7	
30	24 8		30	0 8½		30	11 3	,,	30	2 6	
45	24 10		45	0 8		45	12 6	,,	45	2 6	
6 0	25 0		6 0	0 7	N.	6 0	13 6	,,	6 0	2 6	
15	24 10		15	0 6		15	14 4	N.N.W.	15	2 6	N.W.
30	24 8		30	0 4		30	14 10	,,	30	2 6	
45	24 0		45	3 6		45	15 3	,,	45	2 6	
7 0	23 3		7 0	4 7		7 0	15 5	,,	7 0	2 5	
15	22 6		15	5 0		15	15 6	,,	15	2 5	
30	21 9		30	6 0		30	15 2	,,	30	2 5	N.
45	20 11		45	6 9		45	14 7	,,	45	3 6	
8 0	20 2		8 0	7 2		8 0	13 10	,,	8 0	4 7	
15	19 2		15	7 6		15	12 10	,,	15	5 8	
30	18 3		30	7 9		30	12 0	,,	30	6 11	
45	17 3		45	7 9½		45	11 5	,,	45	8 0	
9 0	16 4		9 0	7 7		9 0	10 10	,,	9 0	9 0	
15	15 5		15	6 8		15	10 4	,,	15	9 7	
30	14 6		30	6 3		30	9 9	,,	30	10 0	
45	13 5		45	6 0		45	9 3	,,	45	9 11	
10 0	12 7		10 0	5 6		10 0	8 10	,,	10 0	9 5	N.
15	11 8		15	5 4		15	8 6	,,	15	8 10	
30	10 11		30	5 3		30	8 2	,,	30	8 3	
45	10 0		45	5 1		45	7 10	,,	45	7 10	
11 0	9 5		11 0	4 10		11 0	7 6	,,	11 0	7 6	
15	8 9		15	4 9		15	7 2	,,	15	7 2	
30	8 0		30	4 7		30	6 11	,,	30	6 10	
45 A.M.	7 5		45 A.M.	4 3		45 A.M.	6 9	,,	45 A.M.	6 5	

May 21.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 P.M.	7 0		12 0 P.M.	4 1½	N.	12 0 P.M.	6 7	N.N.W.	12 0 P.M.	6 1	
15	6 7		15	3 10		15	6 3	N.	15	5 10	N.W.
30	6 3		30	3 9		30	6 0	,,	30	5 8	
45	6 2		45	3 7½		45	5 9	,,	45	5 6	
1 0	6 5		1 0	3 6	W.	1 0	5 6	,,	1 0	5 4	
15	7 0		15	3 3½		15	5 3	,,	15	5 3	
30	7 10		30	3 2		30	5 0	,,	30	5 1	
45	9 0		45	3 0		45	4 10	,,	45	4 11	
2 0	9 9		2 0	2 9½		2 0	4 8	,,	2 0	4 9	
15	11 0		15	2 8¼		15	4 6	,,	15	4 7	
30	12 2		30	2 6¼		30	4 3	,,	30	4 5	
45	13 3		45	2 5½		45	4 1	,,	45	4 4	
3 0	14 5		3 0	2 3½		3 0	3 11	,,	3 0	4 3	S.
15	15 8		15	2 2		15	3 9	,,	15	4 2	
30	16 10		30	1 11½		30	3 7	,,	30	4 0	
45	18 2		45	1 10		45	3 5	,,	45	3 11	
4 0	19 6		4 0	1 9		4 0	3 4	,,	4 0	3 9	
15	20 6		15	1 8		15	3 3	,,	15	3 8	
30	21 7		30	1 7		30	3 2	,,	30	3 7	W.
45	22 6		45	1 6		45	3 1	,,	45	3 6	
5 0	23 2		5 0	1 4½		5 0	4 1	,,	5 0	3 6	
15	23 10		15	1 3		15	6 8	,,	15	3 5	
30	24 3		30	1 2		30	8 8	,,	30	3 4	
45	24 7		45	1 1		45	10 5	,,	45	3 3	
6 0	24 9		6 0	1 0	W.	6 0	12 1	,,	6 0	3 3	
15	24 10		15	1 0		15	13 2	N.W.	15	3 2	
30	24 7		30	0 11		30	14 0	,,	30	3 1	W.
45	24 3		45	0 10		45	14 10	,,	45	3 1	
7 0	23 8		7 0	3 6		7 0	15 4	,,	7 0	3 0	
15	22 11		15	4 6		15	15 6	,,	15	3 0	
30	22 2		30	5 5		30	15 7	,,	30	2 11	
45	21 4		45	6 3		45	15 6	,,	45	2 11	
8 0	20 5		8 0	6 10		8 0	15 1	,,	8 0	4 1	W.
15	19 5		15	7 2		15	14 3	,,	15	5 3	
30	18 4		30	7 6		30	13 7	,,	30	6 3	
45	17 5		45	7 8		45	12 9	,,	45	7 6	
9 0	16 8		9 0	7 9		9 0	12 0	,,	9 0	8 7	
15	15 7		15	7 6		15	11 4	,,	15	9 6	
30	14 7		30	7 0		30	10 9	,,	30	10 0	W.
45	13 8		45	6 3		45	10 3	,,	45	10 2	
10 0	12 9		10 0	6 0		10 0	9 9	,,	10 0	9 11	
15	11 8		15	5 9		15	9 3	,,	15	9 6	
30	10 10		30	5 6		30	8 10	,,	30	9 0	
45	10 0		45	5 3		45	8 5	,,	45	8 5	
11 0	9 4		11 0	4 11		11 0	8 0	,,	11 0	7 9	
15	8 8		15	4 9		15	7 8	,,	15	7 4	
30	7 11		30	4 6		30	7 4	,,	30	7 0	
45 P.M.	7 2		45 P.M.	4 3		45 P.M.	7 0	,,	45 P.M.	6 8	

May 22.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	6 6		12 0 A.M.	4 0	N.N.W.	12 0 A.M.	6 9	N.W.	12 0 A.M.	6 5	W.
15	6 2		15	3 10		15	6 6	,,	15	6 3	
30	5 7		30	3 8½		30	6 2	,,	30	6 0	
45	5 2		45	3 6		45	5 11	,,	45	5 9	
1 0	5 2		1 0	3 4		1 0	5 8	,,	1 0	5 6	
15	5 5		15	3 2		15	5 5	,,	15	5 3	
30	6 2		30	3 0½		30	5 2	,,	30	5 1	
45	7 3		45	2 10		45	4 11	,,	45	4 11	
2 0	8 5		2 0	2 9		2 0	4 8	,,	2 0	4 9	W.
15	9 3		15	2 7½		15	4 6	,,	15	4 7	
30	10 9		30	2 5		30	4 4	,,	30	4 5	
45	11 11		45	2 4		45	4 2	,,	45	4 3	
3 0	13 0		3 0	2 2½		3 0	4 0	,,	3 0	4 1	
15	14 3		15	2 1		15	3 10	,,	15	3 11	
30	15 6		30	1 10		30	3 8	,,	30	3 9	
45	16 9		45	1 9		45	3 6	,,	45	3 7	
4 0	17 10		4 0	1 8		4 0	3 5	,,	4 0	3 6	
15	19 3		15	1 7		15	3 4	,,	15	3 5	
30	20 6		30	1 5		30	3 3	,,	30	3 4	
45	21 4		45	1 4		45	3 2	,,	45	3 3	
5 0	22 10		5 0	1 2		5 0	3 0	,,	5 0	3 3	
15	23 3		15	1 1½		15	3 6	,,	15	3 2	
30	24 2		30	1 1		30	5 11	,,	30	3 1	
45	24 7		45	1 0		45	8 2	,,	45	3 0	
6 0	24 10		6 0	1 0	N.N.W.	6 0	9 10	,,	6 0	2 11	
15	25 2		15	1 0		15	11 6	,,	15	2 10	
30	25 5		30	1 0		30	12 10	,,	30	2 10	
45	25 4		45	0 11		45	13 11	,,	45	2 9	
7 0	25 0		7 0	0 10		7 0	14 9	,,	7 0	2 9	
15	24 7		15	3 4		15	15 5	,,	15	2 8	
30	23 10		30	4 8		30	15 9	,,	30	2 7	
45	23 0		45	5 4		45	15 11	,,	45	2 7	
8 0	22 3		8 0	6 4	N. by W.	8 0	15 8	,,	8 0	2 6	
15	21 5		15	6 11		15	15 2	,,	15	2 6	
30	20 6		30	7 6		30	14 5	,,	30	4 0	
45	19 5		45	7 9		45	13 7	,,	45	5 6	
9 0	18 7		9 0	8 0		9 0	12 9	,,	9 0	6 7	N.W.
15	17 8		15	8 2½		15	12 0	,,	15	8 0	
30	16 7		30	8 0		30	11 4	,,	30	9 1	
45	15 6		45	7 7		45	10 9	,,	45	9 11	
10 0	14 8		10 0	7 0		10 0	10 3	,,	10 0	10 3	
15	13 8		15	6 5		15	9 8	,,	15	10 3	
30	12 9		30	5 11½		30	9 2	,,	30	9 9	N.W.
45	11 10		45	5 8½		45	8 9	,,	45	9 1	
11 0	11 1		11 0	5 5		11 0	8 5	,,	11 0	8 7	
15	10 2		15	5 3		15	8 1	,,	15	7 11	
30	9 5		30	5 1		30	7 9	,,	30	7 6	
45 A.M.	8 9		45 A.M.	4 11		45 A.M.	7 5	,,	45 A.M.	7 2	

May 22.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 P.M.	8 0		12 0 P.M.	4 9	W.S.W.	12 0 P.M.	7 1	N.W.	12 0 P.M.	6 9	
15	7 6		15	4 6		15	6 10	,,	15	6 7	
30	6 10		30	4 2½		30	6 7	,,	30	6 3	
45	6 3		45	4 1		45	6 4	,,	45	6 0	
1 0	5 11		1 0	4 0		1 0	6 1	,,	1 0	5 9	
15	5 8		15	3 10½		15	5 11	,,	15	5 6	W.
30	5 8		30	3 8		30	5 8	,,	30	5 4	
45	6 2		45	3 6		45	5 5	,,	45	5 1	
2 0	6 10		2 0	3 4		2 0	5 2	,,	2 0	4 10	
15	7 10		15	3 2		15	4 11	,,	15	4 8	
30	8 11		30	2 11½		30	4 8	,,	30	4 6	
45	10 0		45	2 10½		45	4 6	,,	45	4 4	
3 0	11 3		3 0	2 8¾		3 0	4 4	,,	3 0	4 2	
15	12 4		15	2 6¾		15	4 2	,,	15	4 1	
30	13 7		30	2 4		30	4 0	,,	30	3 11	
45	14 9		45	2 3		45	3 10	,,	45	3 9	
4 0	16 2		4 0	2 2¼		4 0	3 9	,,	4 0	3 8	S.W.
15	17 9		15	2 0		15	3 8	,,	15	3 6	
30	19 0		30	1 10		30	3 6	,,	30	3 4	
45	20 0		45	1 9½		45	3 4	,,	45	3 3	
5 0	21 2		5 0	1 9		5 0	3 3	,,	5 0	3 2	
15	22 3		15	1 8		15	3 2	,,	15	3 0	
30	23 1		30	1 6		30	3 4	,,	30	2 11	
45	23 10		45	1 5		45	5 6	,,	45	2 11	
6 0	24 2		6 0	1 4	E.	6 0	7 9	,,	6 0	2 10	
15	24 8		15	1 3		15	9 8	S.E.	15	2 9	
30	24 11		30	1 1½		30	11 3	,,	30	2 8	
45	25 2		45	1 1		45	12 9	,,	45	2 7	
7 0	25 2		7 0	1 0½		7 0	13 9	N.W.	7 0	2 6	W.
15	25 1		15	1 0		15	14 9	,,	15	2 6	
30	24 7		30	3 3		30	15 7	,,	30	2 5	
45	24 0		45	4 6		45	15 10	,,	45	2 5	
8 0	23 2		8 0	5 1½	W.	8 0	16 0	,,	8 0	2 4	
15	22 6		15	6 3		15	16 1	,,	15	2 3	
30	21 7		30	7 0		30	15 11	W.	30	3 11	
45	20 8		45	7 6		45	15 5	,,	45	4 2	W.
9 0	19 8		9 0	7 9		9 0	14 8	,,	9 0	5 7	
15	18 10		15	8 1		15	13 10	,,	15	6 8	
30	18 1		30	8 2		30	12 11	,,	30	8 0	
45	16 10		45	8 0		45	12 1	,,	45	9 0	
10 0	16 0		10 0	7 6		10 0	11 6	,,	10 0	9 10	
15	15 0		15	7 0		15	10 11	,,	15	10 4	
30	13 11		30	6 6		30	10 3	,,	30	10 5	
45	12 9		45	6 0		45	9 9	,,	45	10 0	
11 0	11 10		11 0	5 9		11 0	9 3	,,	11 0	9 5	
15	11 0		15	5 6		15	8 10	,,	15	8 7	
30	10 3		30	5 3		30	8 5	,,	30	8 0	
45 P.M.	9 5		45 P.M.	5 2		45 P.M.	8 0	,,	45 P.M.	7 7	W

May 23.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	8 7		12 0 A.M.	5 0	N.W.	12 0 A.M.	7 8	W.	12 0 A.M.	7 3	
15	8 0		15	4 11		15	7 5	N.W.	15	6 11	
30	7 2		30	4 8		30	7 1	,,	30	6 6	
45	6 7		45	4 5		45	6 9	,,	45	6 3	
1 0	5 11		1 0	4 3		1 0	6 5	,,	1 0	6 0	W.
15	5 5		15	4 0		15	6 2	,,	15	5 9	
30	4 10		30	3 10		30	5 11	,,	30	5 7	
45	4 8		45	3 7		45	5 8	,,	45	5 4	
2 0	4 11		2 0	3 6½		2 0	5 5	,,	2 0	5 2	
15	5 8		15	3 3		15	5 2	,,	15	4 11	
30	6 7		30	3 1		30	4 11	,,	30	4 8	
45	7 6		45	2 10		45	4 8	,,	45	4 5	
3 0	8 9		3 0	2 8		3 0	4 6	,,	3 0	4 3	
15	10 4		15	2 6		15	4 4	,,	15	4 1	
30	11 5		30	2 4		30	4 2	,,	30	3 11	
45	12 9		45	2 2		45	4 0	,,	45	3 9	
4 0	14 0		4 0	2 1		4 0	3 10	,,	4 0	3 7	
15	15 6		15	2 0		15	3 8	,,	15	3 5	
30	16 8		30	1 11½		30	3 6	,,	30	3 4	
45	18 1		45	1 10		45	3 4	,,	45	3 2	
5 0	19 9		5 0	1 9		5 0	3 3	,,	5 0	3 1	N.W.
15	20 11		15	1 8		15	3 1	,,	15	2 11	
30	21 11		30	1 7		30	3 0	,,	30	2 10	
45	22 10		45	1 6		45	2 11	,,	45	2 9	
6 0	23 8		6 0	1 5		6 0	3 3	,,	6 0	2 8	N.W.
15	24 5		15	1 4		15	6 0	,,	15	2 7	
30	24 11		30	1 3		30	8 3	,,	30	2 6	
45	25 4		45	1 1½		45	10 6	,,	45	2 5	
7 0	25 7		7 0	1 1		7 0	12 3	,,	7 0	2 4	
15	25 11		15	1 0		15	13 6	,,	15	2 3	
30	25 10		30	1 0		30	14 7	,,	30	2 3	N.
45	25 7		45	0 11		45	15 5	,,	45	3 2	Deals down.
8 0	25 2		8 0	4 0		8 0	16 0	,,	8 0	3 2	Deals up.
15	24 6		15	5 0		15	16 5	,,	15	3 0	
30	23 9		30	6 1	N.	30	16 6	N.	30	3 0	
45	23 0		45	6 9		45	16 6	,,	45	3 0	
9 0	22 4		9 0	7 6		9 0	16 3	,,	9 0	3 7	N.
15	21 4		15	8 0		15	15 10	,,	15	4 11	
30	20 5		30	8 4		30	15 0	,,	30	6 3	
45	19 5		45	8 8		45	14 2	,,	45	7 6	
10 0	18 6		10 0	8 9		10 0	13 3	,,	10 0	8 7	
15	17 6		15	8 3½		15	12 7	,,	15	9 6	
30	16 6		30	8 3		30	11 10	,,	30	10 3	
45	15 4		45	7 7		45	11 3	,,	45	10 8	
11 0	14 6		11 0	7 0½		11 0	10 8	,,	11 0	10 9	N.
15	13 7		15	5 6		15	10 2	,,	15	10 4	
30	12 8		30	6 1½		30	9 8	,,	30	9 6	
45 A.M.	11 11		45 A.M.	5 11		45 A.M.	9 3	,,	45 A.M.	9 11	

May 23.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
Noon.	11 2		Noon.	5 9	N.N.E.	Noon.	8 10	N.W.	Noon.	8 5	
12 15 P.M.	10 4		12 15 P.M.	5 6½		12 15 P.M.	8 6	N.	12 15 P.M.	7 10	
30	9 6		30	5 4		30	8 2	”	30	7 4	
45	8 9		45	5 2		45	7 9	”	45	7 0	
1 0	8 2		1 0	5 0		1 0	7 5	”	1 0	6 9	N.
15	7 6		15	4 9		15	7 1	”	15	6 5	
30	7 1		30	4 6		30	6 9	”	30	6 1	
45	6 8		45	4 4		45	6 5	”	45	5 10	
2 0	6 5		2 0	4 2½		2 0	6 2	”	2 0	5 7	
15	6 6		15	4 0½		15	5 11	”	15	5 4	
30	6 10		30	3 10		30	5 8	”	30	5 1	
45	7 7		45	3 8½		45	5 5	”	45	4 10	
3 0	8 7		3 0	3 7		3 0	5 2	”	3 0	4 8	N.
15	9 8		15	3 5		15	4 11	”	15	4 6	
30	10 10		30	3 3		30	4 8	”	30	4 3	
45	12 0		45	3 1		45	4 6	”	45	4 0	
4 0	13 5		4 0	3 0		4 0	4 4	”	4 0	3 10	
15	14 6		15	2 10½		15	4 2	”	15	3 8	
30	15 9		30	2 9		30	4 0	”	30	3 7	
45	16 11		45	2 7½		45	3 10	”	45	3 6	N.
5 0	18 1		5 0	2 6		5 0	3 8	”	5 0	3 4	
15	19 5		15	2 4½		15	3 6	”	15	3 2	
30	20 9		30	2 3		30	3 4	”	30	3 0	
45	21 9		45	2 1½		45	3 3	”	45	2 11	
6 0	22 10		6 0	2 0		6 0	3 2	”	6 0	2 10	N.
15	23 8		15	1 11		15	4 7	N.W.	15	2 9	
30	24 5		30	1 10		30	7 5	”	30	2 8	
45	24 9		45	1 9		45	9 2	”	45	2 6	
7 0	25 2		7 0	1 8		7 0	11 1	”	7 0	2 5	
15	25 4		15	1 6½		15	12 7	”	15	2 4	
30	25 6		30	1 5		30	13 10	”	30	2 3	
45	25 5		45	1 4		45	14 11	”	45	2 3	
8 0	25 2		8 0	1 3		8 0	15 7	”	8 0	2 2	N.
15	24 8		15	4 3		15	15 11	”	15	2 1	
30	23 11		30	5 5		30	16 1	”	30	2 1	
45	23 1		45	6 3		45	16 2	”	45	2 0	
9 0	22 2		9 0	7 1		9 0	16 2	”	9 0	2 0	
15	21 5		15	7 9		15	15 11	N.	15	3 7	
30	20 6		30	8 0		30	15 3	”	30	4 8	
45	19 6		45	8 5		45	14 4	”	45	6 1	
10 0	18 9		10 0	8 6		10 0	13 6	”	10 0	7 4	Calm.
15	17 9		15	8 6		15	12 8	”	15	8 6	
30	16 9		30	8 3		30	11 11	”	30	9 7	
45	15 8		45	7 7		45	11 3	”	45	10 2	
11 0	14 7		11 0	6 11		11 0	10 8	”	11 0	10 7	
15	13 9		15	6 5		15	10 1	”	15	10 2	
30	12 10		30	6 1		30	9 7	”	30	9 9	
45 P.M.	12 0		45 P.M.	5 9		45 P.M.	9 2	”	45 P.M.	9 3	

May 24.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	11 2		12 0 A.M.	5 6	N.N.E.	12 0 A.M.	8 9	N.	12 0 A.M.	8 8	
15	10 5		15	5 3		15	8 5	”	15	8 1	N.W.
30	9 7		30	5 0		30	8 1	”	30	7 6	
45	8 9		45	4 10		45	7 9	”	45	7 2	
1 0	7 10		1 0	4 8		1 0	7 5	”	1 0	6 11	
15	7 6		15	4 5		15	7 1	”	15	6 8	
30	6 10		30	4 3½		30	6 9	”	30	6 4	
45	6 4		45	4 1		45	6 5	”	45	6 0	
2 0	5 10		2 0	3 10		2 0	6 2	”	2 0	5 9	
15	5 8		15	3 8		15	5 11	”	15	5 6	Calm.
30	5 7		30	3 6		30	5 8	”	30	5 3	
45	5 11		45	3 4		45	5 5	”	45	4 11	
3 0	6 9		3 0	3 2		3 0	5 2	”	3 0	4 8	
15	7 9		15	3 0		15	4 11	”	15	4 5	
30	9 0		30	2 10		30	4 8	”	30	4 3	
45	10 1		45	2 8		45	4 6	”	45	4 2	
4 0	11 5		4 0	2 6		4 0	4 4	”	4 0	4 0	
15	12 6		15	2 5		15	4 2	”	15	3 10	
30	13 8		30	2 4		30	4 0	”	30	3 8	
45	14 10		45	2 3		45	3 10	”	45	3 6	
5 0	16 3		5 0	2 2		5 0	3 9	”	5 0	3 4	
15	17 5		15	2 1		15	3 8	”	15	3 2	
30	18 9		30	1 11		30	3 7	”	30	3 1	
45	20 0		45	1 10		45	3 5	”	45	3 0	
6 0	21 0		6 0	1 9		6 0	3 3	”	6 0	2 11	
15	22 3		15	1 8		15	3 1	N.N.W.	15	2 10	
30	23 0		30	1 7		30	3 3	”	30	2 9	
45	23 10		45	1 6		45	5 4	”	45	2 7	
7 0	24 6		7 0	1 5		7 0	7 10	”	7 0	2 6	N.
15	24 11		15	1 4½		15	9 7	”	15	2 5	
30	25 3		30	1 3		30	11 7	”	30	2 9	Deals down.
45	25 6		45	1 1½		45	12 10	”	45	2 10	
8 0	25 8		8 0	1 0		8 0	13 10	”	8 0	3 0	
15	25 5		15	1 0		15	15 0	”	15	2 8	Deals up.
30	25 1		30	1 0		30	15 9	”	30	2 5	
45	24 5		45	4 6		45	16 1	”	45	2 3	
9 0	23 9		9 0	5 6		9 0	16 3	”	9 0	2 1	
15	22 11		15	6 3		15	16 3	”	15	2 0	
30	22 1		30	7 1		30	16 1	”	30	2 0	
45	21 0		45	7 8		45	15 7	”	45	3 11	
10 0	20 0		10 0	8 0		10 0	14 10	”	10 0	5 0	
15	18 11		15	8 5		15	13 10	”	15	6 5	
30	18 0		30	8 3		30	13 0	”	30	7 11	
45	17 0		45	8 3		45	12 2	”	45	8 11	
11 0	16 0		11 0	7 11		11 0	11 6	”	11 0	9 10	
15	14 11		15	7 3		15	10 11	”	15	10 5	
30	14 0		30	6 6		30	10 3	”	30	10 7	S.W.
45 A.M.	12 11		45 A.M.	6 1		45 A.M.	9 9	”	45 A.M.	10 3	

May 24.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
Noon.	11 11		Noon.	5 9	N.E.	Noon.	9 3	N.N.W.	Noon.	9 7	
12 15 P.M.	11 2		12 15 P.M.	5 6½		12 15 P.M.	8 10	E.	12 15 P.M.	8 10	
30	10 3		30	5 4		30	8 6	,,	30	8 3	
45	9 4		45	5 2		45	8 1	,,	45	7 5	N.W.
1 0	8 6		1 0	5 0		1 0	7 9	,,	1 0	7 2	
15	7 9		15	4 10		15	7 4	,,	15	6 11	
30	7 0		30	4 7	E.	30	7 0	,,	30	6 7	
45	6 3		45	4 5		45	6 9	,,	45	6 4	
2 0	5 8		2 0	4 2½		2 0	6 5	,,	2 0	6 1	
15	5 1		15	4 0		15	6 1	,,	15	5 10	
30	4 8		30	3 10		30	5 10	,,	30	5 7	
45	4 5		45	3 8		45	5 7	,,	45	5 3	
3 0	4 7		3 0	3 6½		3 0	5 4	,,	3 0	5 0	S.
15	5 1		15	3 4½		15	5 1	,,	15	4 9	
30	6 1		30	3 3		30	4 11	,,	30	4 6	
45	7 2		45	3 1½		45	4 8	,,	45	4 4	
4 0	8 3		4 0	2 11		4 0	4 6	,,	4 0	4 2	
15	9 6		15	2 10		15	4 4	,,	15	4 0	
30	10 7		30	2 8½		30	4 2	,,	30	3 10	
45	11 11		45	2 6		45	4 0	,,	45	3 8	
5 0	13 1		5 0	2 4		5 0	3 10	,,	5 0	3 6	Calm.
15	14 6		15	2 3		15	3 8	,,	15	3 4	
30	15 9		30	2 2		30	3 6	,,	30	3 2	
45	17 0		45	2 0½		45	3 4	,,	45	3 1	
6 0	18 3		6 0	1 11		6 0	3 3	,,	6 0	3 0	
15	19 6		15	1 9½		15	3 2	W.S.W.	15	2 11	
30	20 0		30	1 8		30	3 0	,,	30	2 10	
45	21 9		45	1 7		45	2 10	,,	45	2 9	
7 0	22 6		7 0	1 6	S.	7 0	2 9	,,	7 0	2 8	S.W.
15	23 3		15	1 5		15	4 0	,,	15	2 7	
30	23 10		30	1 4		30	6 7	,,	30	2 5	
45	24 3		45	1 3		45	8 9	,,	45	2 3	
8 0	24 6		8 0	1 2		8 0	10 8	,,	8 0	2 2	
15	24 9		15	1 1		15	12 0	,,	15	2 2	
30	24 10		30	1 0½		30	13 3	,,	30	2 1	
45	24 8		45	1 0		45	14 2	,,	45	2 1	
9 0	24 4		9 0	0 11		9 0	14 9	S.W.	9 0	2 0	S.W.
15	23 9		15	3 9		15	15 2	,,	15	2 0	
30	23 2		30	5 0		30	15 5	,,	30	2 0	
45	22 4		45	5 8		45	15 5	,,	45	1 11	
10 0	21 6		10 0	6 1		10 0	15 4	,,	10 0	1 11	
15	20 8		15	6 8		15	14 11	,,	15	3 0	Calm.
30	19 9		30	7 2		30	14 2	,,	30	4 2	
45	18 9		45	7 5		45	13 4	,,	45	5 4	
11 0	17 10		11 0	7 8		11 0	12 6	,,	11 0	6 7	
15	16 6		15	7 3		15	11 8	,,	15	7 9	
30	15 10		30	7 0		30	10 11	,,	30	8 8	
45 P.M.	14 10		45 P.M.	6 11		45 P.M.	10 4	,,	45 P.M.	9 8	

May 25.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	13 10		12 0 A.M.	6 4	S.	12 0 A.M.	9 11	S.W.	12 0 A.M.	10 5	
15	13 0		15	6 0		15	9 6	N.W.	15	9 11	
30	12 0		30	5 9		30	9 0	,,	30	9 7	
45	11 0		45	5 6		45	8 7	,,	45	9 2	
1 0	10 3		1 0	5 2		1 0	8 3	,,	1 0	8 7	
15	9 6		15	5 0		15	7 9	,,	15	7 9	
30	8 8		30	4 9½		30	7 5	,,	30	7 2	
45	8 0		45	4 6		45	7 0	,,	45	6 6	
2 0	7 4		2 0	4 4		2 0	6 9	,,	2 0	6 2	
15	6 8		15	4 1		15	6 5	,,	15	5 11	
30	6 1		30	3 10		30	6 1	,,	30	5 7	
45	5 7		45	3 7½		45	5 10	,,	45	5 3	
3 0	5 4		3 0	3 5		3 0	5 7	,,	3 0	5 0	W
15	5 4		15	3 3		15	5 4	,,	15	4 10	
30	5 9		30	3 1		30	5 1	,,	30	4 7	
45	6 9		45	2 11		45	4 11	,,	45	4 5	
4 0	7 10		4 0	2 9		4 0	4 8	,,	4 0	4 3	
15	9 0		15	2 7		15	4 6	,,	15	4 1	
30	10 5		30	2 6	W.	30	4 4	,,	30	3 11	
45	11 8		45	2 5		45	4 1	,,	45	3 9	
5 0	12 8		5 0	2 3		5 0	3 11	,,	5 0	3 7	S.W.
15	13 10		15	2 2		15	3 9	,,	15	3 6	
30	15 4		30	2 1		30	3 7	,,	30	3 3	
45	16 5		45	2 0		45	3 5	,,	45	3 2	
6 0	17 7		6 0	1 10	N.W.	6 0	3 3	,,	6 0	3 0	S.W.
15	19 0		15	1 9		15	3 2	,,	15	2 11	
30	20 8		30	1 7½		30	3 1	,,	30	2 10	
45	21 10		45	1 6		45	3 0	,,	45	2 9	W.
7 0	22 9		7 0	1 5		7 0	2 11	,,	7 0	2 7	
15	23 8		15	1 4		15	3 1	,,	15	2 6	
30	24 5		30	1 3		30	5 8	,,	30	2 9	Deals [down.
45	25 1		45	1 2		45	8 1	,,	45	2 11	
8 0	25 6		8 0	1 1½		8 0	10 0	,,	8 0	2 7	Deals up.
15	25 10		15	1 1		15	12 0	,,	15	2 6	
30	26 2		30	1 0		30	13 3	,,	30	2 4	
45	26 4		45	0 11		45	14 6	,,	45	2 2	
9 0	26 2		9 0	0 10		9 0	15 3	,,	9 0	2 1	N.
15	25 9		15	3 8		15	16 0	,,	15	2 0	
30	25 4		30	4 11		30	16 5	,,	30	1 11	
45	24 6		45	5 10		45	16 7	,,	45	1 10	
10 0	23 8		10 0	6 8		10 0	16 9	,,	10 0	1 10	
15	22 11		15	7 5		15	16 7	,,	15	1 10	
30	22 1		30	8 0		30	16 1	,,	30	3 6	
45	21 2		45	8 4½		45	15 3	,,	45	5 0	
11 0	20 3		11 0	8 8		11 0	14 3	,,	11 0	6 6	N.W.
15	19 3		15	8 9½		15	13 6	,,	15	7 11	
30	18 4		30	8 9		30	12 7	,,	30	8 11	
45 A.M.	17 3		45 A.M.	8 2		45 A.M.	11 10	,,	45 A.M.	10 0	

May 25.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
Noon.	16 1		Noon.	7 5	N.W.	Noon.	11 2	N.W.	Noon.	10 6	N.W.
12 15 P.M.	15 0		12 15 P.M.	6 9		12 15 P.M.	10 8	,,	12 15 P.M.	10 9	
30	14 0		30	6 3		30	10 0	,,	30	10 5	
45	13 2		45	6 0		45	9 8	,,	45	9 9	
1 0	12 4		1 0	5 9		1 0	9 3	,,	1 0	9 2	
15	11 5		15	5 7		15	8 11	,,	15	8 6	
30	10 8		30	5 5		30	8 5	,,	30	7 10	
45	9 10		45	5 3		45	8 1	,,	45	7 5	
2 0	9 1		2 0	5 0		2 0	7 9	,,	2 0	7 1	
15	8 6		15	4 9		15	7 5	,,	15	6 8	
30	7 10		30	4 7		30	7 1	,,	30	6 5	N.
45	7 4		45	4 5		45	6 10	,,	45	6 1	
3 0	6 10		3 0	4 3		3 0	6 7	E.	3 0	5 10	
15	6 6		15	4 1		15	6 3	,,	15	5 6	
30	6 4		30	3 11		30	6 0	,,	30	5 3	
45	6 5		45	3 9		45	5 9	,,	45	5 1	
4 0	7 1		4 0	3 7½		4 0	5 6	,,	4 0	4 10	
15	7 9		15	3 5		15	5 3	,,	15	4 7	
30	8 10		30	3 3		30	5 0	,,	30	4 5	
45	9 10		45	3 1		45	4 9	,,	45	4 3	N.E.
5 0	11 2		5 0	3 0		5 0	4 7	,,	5 0	4 1	
15	12 4		15	2 10		15	4 5	,,	15	3 11	
30	13 4		30	2 9		30	4 3	,,	30	3 9	
45	14 6		45	2 7		45	4 1	,,	45	3 7	
6 0	15 9		6 0	2 5	N.W.	6 0	3 11	,,	6 0	3 5	
15	17 0		15	2 3		15	3 9	,,	15	3 3	
30	18 4		30	2 1½		30	3 7	,,	30	3 1	
45	19 6		45	2 0½		45	3 6	,,	45	3 0	
7 0	20 6		7 0	2 0		7 0	3 4	,,	7 0	2 11	
15	21 9		15	1 10½		15	3 2	,,	15	2 9	
30	22 7		30	1 9		30	3 0	,,	30	2 7	
45	23 6		45	1 8		45	4 0	,,	45	2 6	
8 0	24 0		8 0	1 6½		8 0	6 6	,,	8 0	2 5	N.
15	24 7		15	1 6		15	8 9	,,	15	2 4	
30	25 0		30	1 5		30	10 5	,,	30	2 3	
45	25 5		45	1 4		45	12 2	,,	45	2 2	
9 0	25 7		9 0	1 3		9 0	13 4	,,	9 0	2 2	
15	25 8		15	1 2½		15	14 3	,,	15	2 1	
30	25 7		30	1 2		30	15 3	,,	30	2 0	
45	25 2		45	4 0		45	15 10	,,	45	2 0	
10 0	24 9		10 0	5 0		10 0	16 1	,,	10 0	1 11	
15	24 0		15	5 10		15	16 2	,,	15	1 10	
30	23 3		30	6 8		30	16 2	,,	30	1 10	
45	22 7		45	7 3		45	16 1	,,	45	3 0	
11 0	21 8		11 0	7 8		11 0	15 8	,,	11 0	4 4	N.
15	21 0		15	8 0		15	14 10	,,	15	5 5	
30	20 2		30	8 3		30	14 0	,,	30	6 10	
45 P.M.	19 0		45 P.M.	8 4		45 P.M.	13 2	,,	45 P.M.	8 0	

May 26.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	18 0		12 0 A.M.	8 0	N.	12 0 A.M.	12 4	E.	12 0 A.M.	9 0	
15	17 3		15	7 6		15	11 8	N.	15	9 9	
30	16 1		30	6 10		30	11 1	,,	30	10 3	
45	15 2		45	6 4		45	10 6	,,	45	10 6	
1 0	14 3		1 0	6 0		1 0	9 11	,,	1 0	10 2	N.
15	13 5		15	5 9		15	9 7	,,	15	9 6	
30	12 7		30	5 7		30	9 2	,,	30	8 10	
45	11 9		45	5 5		45	8 9	,,	45	8 2	
2 0	11 0		2 0	5 3		2 0	8 5	,,	2 0	7 9	
15	10 6		15	5 1		15	8 1	,,	15	7 4	
30	9 10		30	4 11		30	7 9	,,	30	7 0	
45	9 3		45	4 9		45	7 5	,,	45	6 8	
3 0	8 9		3 0	4 7		3 0	7 1	,,	3 0	6 4	
15	8 4		15	4 5		15	6 10	,,	15	6 0	
30	8 1		30	4 3		30	6 7	,,	30	5 9	
45	7 10		45	4 0½		45	6 4	,,	45	5 6	
4 0	8 1		4 0	3 10		4 0	6 0	,,	4 0	5 3	N.W.
15	8 7		15	3 8		15	5 8	,,	15	5 0	
30	9 4		30	3 6		30	5 4	,,	30	4 9	
45	10 4		45	3 4		45	5 1	,,	45	4 6	
5 0	11 6		5 0	3 2		5 0	4 10	N.W.	5 0	4 3	
15	12 4		15	3 0		15	4 8	,,	15	4 1	
30	13 5		30	2 11		30	4 6	,,	30	3 11	
45	14 6		45	2 10		45	4 4	,,	45	3 9	
6 0	15 5		6 0	2 8	N.	6 0	4 2	,,	6 0	3 7	
15	16 6		15	2 7		15	4 0	N.N.W.	15	3 6	N.
30	17 6		30	2 5		30	3 10	,,	30	3 5	
45	18 9		45	2 4		45	3 8	,,	45	3 4	
7 0	19 11		7 0	2 2		7 0	3 6	,,	7 0	3 2	
15	21 0		15	2 1		15	3 5	,,	15	3 0	
30	22 0		30	2 0		30	3 3	,,	30	2 11	
45	22 11		45	1 11		45	3 8	,,	45	2 10	
8 0	23 7		8 0	1 9		8 0	5 2	,,	8 0	2 9	N.
15	24 2		15	1 8		15	7 3	,,	15	2 8	
30	24 7		30	1 7		30	9 1	N.	30	2 7	
45	25 0		45	1 6		45	11 0	,,	45	2 6	
9 0	25 2		9 0	1 5		9 0	12 5	,,	9 0	2 5	
15	25 5		15	1 4		15	13 6	,,	15	2 3	
30	25 4		30	1 3		30	14 4	,,	30	2 2	
45	25 1		45	1 2		45	15 0	,,	45	2 1	
10 0	24 8		10 0	4 1		10 0	15 6	,,	10 0	2 1	N.
15	23 10		15	5 0		15	15 8	N.N.E.	15	2 0	
30	23 3		30	6 0		30	15 9	,,	30	1 11	
45	22 4		45	6 7½		45	15 9	,,	45	1 10	
11 0	21 5		11 0	7 1		11 0	15 5	,,	11 0	3 3	
15	20 7		15	7 6		15	14 8	,,	15	4 6	
30	19 10		30	7 9		30	13 10	,,	30	5 10	
45 A.M.	19 1		45 A.M.	8 0		45 A.M.	13 0	,,	45 A.M.	7 1	

May 26.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
Noon.	18 2		Noon.	8 1	N.	Noon.	12 4	N.N.E.	Noon.	8 2	
12 15 P.M.	17 0		12 15 P.M.	7 8½		12 15 P.M.	11 7	N.	12 15 P.M.	9 0	
30	16 0		30	6 10½		30	11 0	,,	30	9 9	
45	15 0		45	6 5½		45	10 6	,,	45	10 0	N.E.
1 0	14 0		1 0	6 1		1 0	9 11	,,	1 0	9 11	
15	13 2		15	5 9		15	9 6	,,	15	9 5	
30	12 5		30	5 6		30	9 1	,,	30	8 9	
45	11 6		45	5 3½		45	8 9	,,	45	8 1	
2 0	10 10		2 0	5 1½		2 0	8 4	,,	2 0	7 6	
15	9 11		15	5 0		15	7 11	,,	15	7 0	
30	9 2		30	4 9½		30	7 7	,,	30	6 7	N.
45	8 5		45	4 7½		45	7 3	,,	45	6 4	
3 0	7 9		3 0	4 6		3 0	7 0	,,	3 0	6 0	
15	7 4		15	4 4		15	6 9	,,	15	5 8	
30	6 8		30	4 2		30	6 5	,,	30	5 5	
45	6 3		45	4 0		45	6 2	,,	45	5 3	
4 0	5 10		4 0	3 10		4 0	5 11	,,	4 0	5 0	
15	5 7		15	3 8½		15	5 8	,,	15	4 9	N.
30	5 7		30	3 6¾		30	5 5	,,	30	4 6	
45	5 11		45	3 5		45	5 2	,,	45	4 3	
5 0	6 5		5 0	3 4½		5 0	5 0	,,	5 0	4 0	
15	7 3		15	3 2		15	4 10	,,	15	3 10	
30	8 2		30	3 1		30	4 8	,,	30	3 8	
45	9 3		45	2 10		45	4 5	,,	45	3 6	
6 0	10 3		6 0	2 8½	N.	6 0	4 3	,,	6 0	3 4	
15	11 4		15	2 7		15	4 1	N.E.	15	3 3	
30	12 6		30	2 6		30	3 11	,,	30	3 2	N.
45	13 5		45	2 4½		45	3 9	,,	45	3 1	
7 0	14 6		7 0	2 3		7 0	3 7	,,	7 0	3 0	
15	15 8		15	2 1½		15	3 5	,,	15	2 9	
30	16 10		30	2 0		30	3 3	,,	30	2 7	
45	17 10		45	1 11		45	3 2	,,	45	2 6	
8 0	18 10		8 0	1 10		8 0	3 0	,,	8 0	2 5	
15	19 10		15	1 9		15	2 10	,,	15	2 4	
30	20 9		30	1 8		30	2 9	,,	30	2 3	
45	21 7		45	1 6½		45	2 10	,,	45	2 2	
9 0	22 2		9 0	1 5		9 0	4 3	,,	9 0	2 1	
15	22 8		15	1 4		15	6 9	,,	15	2 1	
30	23 0		30	1 3		30	8 4	,,	30	2 0	
45	23 3		45	1 2		45	9 10	,,	45	2 0	
10 0	23 4		10 0	1 1		10 0	11 0	,,	10 0	2 0	N.
15	23 5		15	1 0		15	11 11	,,	15	1 11	
30	23 4		30	0 11		30	12 7	N.N.E.	30	1 11	
45	23 1		45	0 10		45	13 2	,,	45	1 10	
11 0	22 8		11 0	2 11		11 0	13 7	,,	11 0	1 10	
15	22 0		15	3 10		15	13 9	,,	15	1 10	
30	21 4		30	5 0		30	13 11	,,	30	1 9	
45 P.M.	20 8		45 P.M.	5 7		45 P.M.	13 11	,,	45 P.M.	1 9	

May 27.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	19 10		12 0 A.M.	6 0	N.W.	12 0 A.M.	13 7	N.N.E.	12 0 A.M.	2 5	
15	19 2		15	6 4		15	13 0	N.E.	15	3 4	
30	18 3		30	6 8		30	12 5	,,	30	4 5	
45	17 4		45	6 11		45	11 8	,,	45	5 6	
1 0	16 5		1 0	7 1		1 0	11 2	,,	1 0	6 6	Calm.
15	15 6		15	7 1		15	10 6	,,	15	7 2	
30	14 6		30	6 10		30	10 0	,,	30	7 9	
45	13 7		45	6 2		45	9 6	,,	45	8 3	
2 0	12 9		2 0	5 7		2 0	9 1	,,	2 0	8 5	
15	12 0		15	5 3		15	8 9	,,	15	8 1	
30	11 2		30	4 11½		30	8 4	,,	30	7 6	
45	10 7		45	4 8½		45	7 11	,,	45	6 11	
3 0	9 9		3 0	4 4		3 0	7 7	,,	3 0	6 5	
15	9 2		15	4 1		15	7 3	,,	15	6 0	
30	8 6		30	3 10½		30	7 0	,,	30	5 9	
45	7 10		45	3 8		45	6 9	,,	45	5 6	Calm.
4 0	7 7		4 0	3 6¾		4 0	6 5	,,	4 0	5 3	
15	7 2		15	3 5½		15	6 2	,,	15	5 0	
30	6 10		30	3 3½		30	5 10	,,	30	4 10	
45	6 10		45	3 1		45	5 7	,,	45	4 7	
5 0	7 2		5 0	3 0		5 0	5 4	,,	5 0	4 4	
15	7 8		15	2 10		15	5 1	,,	15	4 1	
30	8 9		30	2 9		30	4 10	,,	30	3 10	
45	9 9		45	2 7		45	4 7	,,	45	3 7	
6 0	10 10		6 0	2 5	N.W.	6 0	4 4	,,	6 0	3 5	
15	11 10		15	2 3		15	4 2	N.W.	15	3 3	
30	12 8		30	2 1½		30	4 0	,,	30	3 2	
45	13 11		45	2 1		45	3 10	,,	45	3 1	
7 0	14 9		7 0	1 11½		7 0	3 8	,,	7 0	3 0	W.
15	15 9		15	1 10		15	3 6	,,	15	2 11	
30	16 8		30	1 9		30	3 4	,,	30	2 10	
45	17 9		45	1 8		45	3 3	,,	45	2 9	[down.
8 0	19 0		8 0	1 7		8 0	3 1	,,	8 0	3 0	Deals
15	20 0		15	1 6		15	2 11	,,	15	2 8	Deals up.
30	21 0		30	1 4½		30	2 10	,,	30	2 6	
45	21 0		45	1 3		45	2 11	,,	45	2 5	
9 0	22 7		9 0	1 2		9 0	4 4	,,	9 0	2 3	
15	23 2		15	1 1		15	6 2	,,	15	2 2	
30	23 7		30	1 0		30	7 11	,,	30	2 1	
45	23 10		45	0 11		45	9 6	,,	45	2 0	
10 0	24 1		10 0	0 10		10 0	10 11	,,	10 0	1 11	W.
15	24 2		15	0 9		15	12 0	,,	15	1 11	
30	24 1		30	0 8½		30	12 9	,,	30	1 10	
45	23 9		45	0 8		45	13 5	,,	45	1 9	
11 0	23 5		11 0	2 0	W.	11 0	13 10	,,	11 0	1 8	
15	22 10		15	3 7		15	14 1	,,	15	1 7	
30	22 3		30	4 3		30	14 3	,,	30	1 6	
45 A.M.	21 5		45 A.M.	4 11		45 A.M.	14 3	,,	45 A.M.	1 6	

May 27.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
Noon.	20 8		Noon.	5 6	W.	Noon.	14 0	N.W.	Noon.	1 6	
12 15 P.M.	19 10		12 15 P.M.	5 9		12 15 P.M.	13 8	,,	12 15 P.M.	3 0	
30	19 1		30	6 0		30	12 8	,,	30	4 0	
45	18 2		45	6 4		45	11 10	,,	45	4 11	
1 0	17 4		1 0	6 6		1 0	11 1	,,	1 0	6 0	W.
15	16 3		15	6 3		15	10 7	,,	15	6 11	
30	15 4		30	6 1		30	10 1	,,	30	7 9	
45	14 4		45	5 6		45	9 7	,,	45	8 3	
2 0	13 7		2 0	4 11½		2 0	9 1	,,	2 0	8 5	
15	12 8		15	4 9½		15	8 7	,,	15	8 3	
30	11 10		30	4 7½		30	8 2	,,	30	7 7	
45	11 0		45	4 5		45	7 9	,,	45	7 0	
3 0	10 3		3 0	4 3		3 0	7 5	,,	3 0	6 6	W.
15	9 8		15	4 2	W.N.W.	15	7 2	,,	15	6 0	
30	8 11		30	4 0		30	6 11	,,	30	5 7	
45	8 3		45	3 10		45	6 7	,,	45	5 3	
4 0	7 8		4 0	3 8		4 0	6 3	,,	4 0	5 0	
15	7 2		15	3 6		15	6 0	,,	15	4 9	
30	6 8		30	3 5		30	5 9	,,	30	4 6	
45	6 4		45	3 3		45	5 6	,,	45	4 4	
5 0	6 2		5 0	3 1		5 0	5 3	,,	5 0	4 2	W.
15	6 5		15	3 0		15	5 0	,,	15	4 0	
30	6 8		30	2 11		30	4 10	,,	30	3 10	
45	7 3		45	2 9		45	4 8	,,	45	3 8	
6 0	8 0		6 0	2 6	W.N.W.	6 0	4 5	,,	6 0	3 6	
15	8 9		15	2 5		15	4 3	,,	15	3 4	N.
30	9 8		30	2 4		30	4 0	,,	30	3 2	
45	10 6		45	2 3		45	3 10	,,	45	3 0	
7 0	11 6		7 0	2 2		7 0	3 8	,,	7 0	2 11	
15	12 6		15	2 0		15	3 6	,,	15	2 9	
30	13 9		30	1 11		30	3 4	,,	30	2 7	
45	14 8		45	1 10		45	3 2	E.	45	2 6	
8 0	15 8		8 0	1 9		8 0	3 1	,,	8 0	2 4	N.
15	16 8		15	1 8		15	2 11	,,	15	2 3	
30	17 11		30	1 7		30	2 10	,,	30	2 1	
45	18 11		45	1 6		45	2 9	,,	45	2 0	
9 0	19 10		9 0	1 5		9 0	2 8	,,	9 0	2 0	
15	20 9		15	1 4		15	2 7	,,	15	2 0	
30	21 7		30	1 3		30	3 2	N.E.	30	1 11	
45	22 3		45	1 2		45	4 6	,,	45	1 11	
10 0	22 7		10 0	1 1		10 0	6 3	,,	10 0	1 10	
15	23 0		15	0 11		15	8 1	,,	15	1 10	
30	23 4		30	0 9½		30	9 7	,,	30	1 9	
45	23 6		45	0 8		45	10 8	,,	45	1 9	
11 0	23 8		11 0	0 7½		11 0	11 7	,,	11 0	1 8	N.
15	23 7		15	0 7		15	12 3	N.	15	1 8	
30	23 6		30	0 6½		30	13 0	,,	30	1 7	
45 P.M.	23 2		45 P.M.	0 6		45 P.M.	13 5	,,	45 P.M.	1 7	

May 28.—1864.

Hull.				Gainsborough.				Goole.				Naburn Lock.			
Time.	Tide.		Wind.	Time.	Tide.		Wind.	Time.	Tide.		Wind.	Time.	Tide.		Wind.
h m	ft.	in.		h m	ft.	in.		h m	ft.	in.		h m	ft.	in.	
12 0 A.M.	22	8		12 0 A.M.	1	6	N.	12 0 A.M.	13	9	N.	12 0 A.M.	1	6	
15	22	2		15	2	3		15	13	11	N.W.	15	1	6	
30	21	7		30	2	11		30	14	1	,,	30	1	5	
45	20	10		45	3	6		45	13	10	,,	45	1	5	
1 0	20	4		1 0	4	0		1 0	13	4	,,	1 0	2	11	N.W.
15	19	7		15	4	5		15	12	5	,,	15	3	10	
30	18	8		30	4	10		30	11	11	,,	30	4	9	
45	17	9		45	5	4		45	11	2	,,	45	5	9	
2 0	17	0		2 0	5	9		2 0	10	8	,,	2 0	6	6	
15	16	0		15	6	0		15	10	1	,,	15	7	5	
30	15	1		30	5	10		30	9	7	,,	30	7	11	
45	14	3		45	5	6		45	9	2	,,	45	8	3	
3 0	13	6		3 0	5	0		3 0	8	8	,,	3 0	8	4	
15	12	9		15	4	9		15	8	3	,,	15	7	10	
30	12	0		30	4	6		30	7	11	,,	30	7	2	
45	11	4		45	4	3		45	7	7	,,	45	6	6	
4 0	10	9		4 0	4	0		4 0	7	4	,,	4 0	5	11	N.W.
15	10	2		15	3	10		15	7	0	,,	15	5	7	
30	9	8		30	3	9		30	6	8	,,	30	5	4	
45	9	2		45	3	8		45	6	5	,,	45	5	2	
5 0	8	10		5 0	3	7		5 0	6	2	,,	5 0	5	0	
15	8	8		15	3	6		15	5	11	,,	15	4	10	
30	8	7		30	3	4		30	5	8	,,	30	4	7	
45	8	9		45	3	2		45	5	5	,,	45	4	4	
6 0	9	3		6 0	3	0		6 0	5	2	,,	6 0	4	1	
15	9	9		15	2	10½		15	5	0	N.N.W.	15	3	11	
30	10	6		30	2	9		30	4	10	,,	30	3	9	
45	11	5		45	2	8		45	4	8	,,	45	3	8	
7 0	12	2		7 0	2	6		7 0	4	5	,,	7 0	3	7	N.W.
15	12	10		15	2	4		15	4	3	,,	15	3	6	
30	13	9		30	2	2		30	4	0	,,	30	3	4	
45	14	9		45	2	1		45	3	10	,,	45	3	2	
8 0	15	6		8 0	2	0		8 0	3	8	,,	8 0	3	0	
15	16	6		15	1	11	E.N.E.	15	3	6	,,	15	2	10	
30	17	4		30	1	10		30	3	4	,,	30	2	8	
45	18	8		45	1	8		45	3	3	,,	45	2	7	
9 0	19	6		9 0	1	7		9 0	3	1	,,	9 0	2	6	
15	20	5		15	1	6		15	3	0	,,	15	2	5	
30	21	3		30	1	5		30	3	6	,,	30	2	4	
45	21	0		45	1	4		45	4	8	,,	45	2	3	
10 0	22	5		10 0	1	2		10 0	5	9	,,	10 0	2	2	N.W.
15	22	11		15	1	0		15	7	4	,,	15	2	1	
30	23	5		30	1	0		30	8	10	,,	30	2	0	
45	23	8		45	0	11		45	10	1	,,	45	2	0	
11 0	23	10		11 0	0	10		11 0	11	2	,,	11 0	1	11	
15	23	10		15	0	9		15	12	0	,,	15	1	10	
30	23	9		30	0	8		30	12	8	,,	30	1	9	
45 A.M.	23	4		45 A.M.	0	7		45 A.M.	13	4	,,	45 A.M.	1	8	

May 28.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
Noon.	22 10		Noon.	2 6	E.N.E.	Noon.	13 9	N.N.W.	Noon.	1 7	
12 15 P.M.	22 4		12 15 P.M.	3 4½		12 15 P.M.	14 0	,,	12 15 P.M.	1 6	
30	21 8		30	4 0		30	14 1	,,	30	1 6	
45	21 1		45	4 7		45	14 1	,,	45	1 10	
1 0	20 4		1 0	5 0½		1 0	13 10	,,	1 0	3 0	N.W.
15	19 8		15	5 6		15	13 9	,,	15	3 10	
30	18 9		30	5 10		30	12 6	,,	30	4 6	
45	17 10		45	6 1		45	11 10	,,	45	5 9	
2 0	16 11		2 0	6 3		2 0	11 2	,,	2 0	6 8	
15	16 0		15	6 3		15	10 8	,,	15	7 6	
30	15 2		30	5 10		30	10 1	,,	30	8 1	
45	14 5		45	5 5		45	9 7	,,	45	8 5	
3 0	13 6		3 0	5 0		3 0	9 2	,,	3 0	8 5	W.
15	12 9		15	4 9		15	8 9	,,	15	8 2	
30	12 0		30	4 6		30	8 4	,,	30	7 7	
45	11 3		45	4 5		45	8 0	,,	45	7 1	
4 0	10 6		4 0	4 3		4 0	7 8	,,	4 0	6 6	
15	9 10		15	4 1		15	7 4	,,	15	6 1	
30	9 2		30	3 11		30	7 1	,,	30	5 10	
45	8 6		45	3 9		45	6 10	,,	45	5 7	
5 0	8 0		5 0	3 7½		5 0	6 7	,,	5 0	5 2	W.
15	7 5		15	3 6		15	6 4	,,	15	4 11	
30	7 2		30	3 3½		30	6 1	,,	30	4 8	
45	6 10		45	3 2		45	5 10	,,	45	4 5	
6 0	6 8		6 0	3 0		6 0	5 7	,,	6 0	4 3	
15	6 8		15	2 10½		15	5 3	,,	15	4 1	
30	6 11		30	2 9½		30	5 0	,,	30	4 0	W.
45	7 5		45	2 7½		45	4 9	,,	45	3 9	
7 0	8 2		7 0	2 6		7 0	4 7	,,	7 0	3 6	
15	8 10		15	2 4½		15	4 5	,,	15	3 5	
30	9 7		30	2 3		30	4 3	,,	30	3 3	
45	10 6		45	2 1½		45	4 0	,,	45	3 1	
8 0	11 6		8 0	2 0½	W.	8 0	3 10	,,	8 0	3 0	
15	12 3		15	1 11		15	3 8	,,	15	2 10	
30	13 3		30	1 10		30	3 7	,,	30	2 8	
45	14 3		45	1 9		45	3 6	,,	45	2 7	
9 0	15 0		9 0	1 7½		9 0	3 4	,,	9 0	2 6	W.
15	15 11		15	1 6		15	3 2	,,	15	2 5	
30	17 0		30	1 4½		30	3 0	,,	30	2 4	
45	17 10		45	1 3½		45	2 11	,,	45	2 3	
10 0	18 7		10 0	1 2½		10 0	2 9	,,	10 0	2 1	
15	19 5		15	1 2		15	2 8	,,	15	2 0	
30	20 2		30	1 1½		30	2 8	,,	30	1 11	
45	20 9		45	1 1		45	3 4	,,	45	1 10	
11 0	21 4		11 0	1 0	N.	11 0	4 5	,,	11 0	1 10	W.
15	21 8		15	0 11		15	5 5	,,	15	1 9	
30	21 11		30	0 10		30	6 10	,,	30	1 8	
45 P.M.	22 1		45 P.M.	0 9		45 P.M.	8 1	,,	45 P.M.	1 7	

May 29.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	22 2		12 0 A.M.	0 8	N.	12 0 A.M.	9 3	N.N.W.	12 0 A.M.	1 7	
15	22 3		15	0 8		15	10 3	N.W.	15	1 6	
30	22 1		30	1 10½		30	10 8	,,	30	1 6	
45	21 10		45	2 8		45	11 3	,,	45	1 5	
1 0	21 7		1 0	3 4		1 0	11 7	,,	1 0	1 5	
15	21 1		15	3 11		15	12 0	,,	15	1 5	
30	20 6		30	4 4		30	12 3	,,	30	1 4	
45	19 11		45	4 8½		45	12 4	,,	45	1 4	
2 0	19 4		2 0	5 2½		2 0	12 2	,,	2 0	1 4	
15	18 7		15	5 4		15	11 10	,,	15	2 2	
30	17 10		30	5 6		30	11 3	,,	30	2 9	
45	17 1		45	5 6		45	10 9	,,	45	3 6	W.S.W.
3 0	16 2		3 0	5 2		3 0	10 2	,,	3 0	4 0	
15	15 2		15	4 10		15	9 8	,,	15	4 9	
30	14 5		30	4 7		30	9 2	,,	30	5 5	
45	13 7		45	4 4		45	8 8	,,	45	6 0	
4 0	12 11		4 0	4 2		4 0	8 3	,,	4 0	6 5	
15	12 3		15	4 0		15	7 10	,,	15	6 8	
30	11 7		30	3 10		30	7 6	,,	30	6 6	
45	11 0		45	3 8		45	7 2	,,	45	6 1	
5 0	10 5		5 0	3 6		5 0	6 10	,,	5 0	5 9	
15	9 10		15	3 4		15	6 6	,,	15	5 4	
30	9 11		30	3 2		30	6 3	,,	30	5 0	
45	8 9		45	3 0½		45	6 0	,,	45	4 8	
6 0	8 6		6 0	2 11	N.	6 0	5 9	,,	6 0	4 5	
15	8 4		15	2 9½		15	5 6	N.	15	4 1	N.
30	8 3		30	2 7		30	5 4	,,	30	3 11	
45	8 5		45	2 6		45	5 2	,,	45	3 8	
7 0	8 11		7 0	2 4		7 0	5 0	,,	7 0	3 6	
15	9 7		15	2 3		15	4 10	,,	15	3 4	
30	10 7		30	2 2		30	4 8	,,	30	3 2	
45	11 7		45	2 1		45	4 5	N.N.E.	45	3 0	
8 0	12 6		8 0	2 0		8 0	4 2	,,	8 0	2 10	N.
15	13 4		15	1 10		15	4 0	,,	15	2 8	
30	14 2		30	1 8½		30	3 10	,,	30	2 7	
45	15 1		45	1 7		45	3 8	,,	45	2 6	
9 0	15 10		9 0	1 6		9 0	3 6	,,	9 0	2 5	
15	16 9		15	1 5½		15	3 4	,,	15	2 4	
30	17 7		30	1 4		30	3 3	,,	30	2 3	
45	18 7		45	1 3		45	3 2	,,	45	2 2	
10 0	19 5		10 0	1 2		10 0	3 1	,,	10 0	2 1	N.
15	20 4		15	1 1½		15	2 11	,,	15	2 0	
30	21 1		30	1 0		30	3 3	,,	30	1 11	
45	21 11		45	0 11		45	4 3	,,	45	1 10	
11 0	22 5		11 0	0 10		11 0	5 3	,,	11 0	1 8	
15	22 10		15	0 9		15	6 7	N.	15	1 7	
30	23 3		30	0 8½		30	8 1	,,	30	1 6	
45 A.M.	23 6		45 A.M.	0 8		45 A.M.	9 3	,,	45 A.M.	1 5	

May 29.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
Noon.	23 8		Noon.	0 7	N.	Noon.	10 6	N.	Noon.	1 5	
12 15 P.M.	23 9		12 15 P.M.	0 6		12 15 P.M.	11 7	N.N.E.	12 15 P.M.	1 4	
30	23 8		30	0 5		30	12 2	,,	30	1 3	
45	23 5		45	0 5		45	12 11	,,	45	1 3	
1 0	23 0		1 0	1 10		1 0	13 4	,,	1 0	1 3	N.
15	22 6		15	3 0		15	13 10	,,	15	1 3	
30	21 10		30	3 9		30	14 1	,,	30	1 3	
45	21 3		45	4 5		45	14 1	,,	45	1 5	
2 0	20 7		2 0	4 10½		2 0	13 11	,,	2 0	2 1	
15	19 10		15	5 2		15	13 6	,,	15	2 8	
30	19 0		30	5 6		30	12 9	,,	30	3 5	
45	18 2		45	5 10		45	12 1	,,	45	4 3	
3 0	17 2		3 0	6 0		3 0	11 6	,,	3 0	5 3	N.
15	16 5		15	6 1		15	11 0	,,	15	6 3	
30	15 6		30	5 11		30	10 3	,,	30	7 0	
45	14 9		45	5 5		45	9 8	,,	45	7 6	
4 0	14 0		4 0	5 1		4 0	9 3	,,	4 0	8 0	
15	13 4		15	4 9	W.	15	8 10	,,	15	7 10	
30	12 6		30	4 6½		30	8 6	,,	30	7 7	
45	11 10		45	4 5½		45	8 1	,,	45	7 1	
5 0	11 2		5 0	4 3½		5 0	7 9	,,	5 0	6 6	N.
15	10 7		15	4 1½		15	7 5	,,	15	6 0	
30	10 2		30	4 0		30	7 1	,,	30	5 7	
45	9 6		45	3 11		45	6 10	,,	45	5 3	
6 0	9 0		6 0	3 9	W.	6 0	6 7	,,	6 0	5 0	
15	8 6		15	3 7		15	6 4	N.W.	15	4 10	
30	8 1		30	3 5		30	6 0	,,	30	4 8	
45	7 9		45	3 3		45	5 9	,,	45	4 5	
7 0	7 7		7 0	3 1½		7 0	5 7	,,	7 0	4 2	Calm.
15	7 5		15	3 0		15	5 4	,,	15	4 0	
30	7 6		30	2 10½		30	5 1	,,	30	3 10	
45	7 8		45	2 9		45	4 11	N.	45	3 8	
8 0	8 2		8 0	2 7		8 0	4 9	,,	8 0	3 6	
15	8 8		15	2 5		15	4 6	,,	15	3 4	
30	9 4		30	2 3		30	4 3	,,	30	3 2	
45	10 2		45	2 1½		45	4 1	N.E.	45	3 0	
9 0	10 11		9 0	2 0		9 0	3 11	,,	9 0	2 10	
15	11 10		15	1 10½		15	3 9	,,	15	2 8	
30	12 10		30	1 9		30	3 7	,,	30	2 6	Calm.
45	13 8		45	1 8		45	3 5	,,	45	2 4	
10 0	14 8		10 0	1 7		10 0	3 3	,,	10 0	2 3	
15	15 8		15	1 6		15	3 1	,,	15	2 2	
30	16 6		30	1 5		30	3 0	,,	30	2 1	
45	17 6		45	1 4		45	2 10	,,	45	2 0	
11 0	18 4		11 0	1 3½		11 0	2 9	,,	11 0	1 11	
15	19 0		15	1 3		15	2 7	,,	15	1 10	
30	19 8		30	1 2		30	2 6	,,	30	1 9	
45 P.M.	20 6		45 P.M.	1 1		45 P.M.	3 1	,,	45 P.M.	1 8	Calm.

May 30.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	21 2		12 0 A.M.	1 0	S.W.	12 0 A.M.	4 0	N.E.	12 0 A.M.	1 7	
15	21 6		15	0 11		15	5 1	S.W.	15	1 6	
30	21 10		30	0 10		30	6 6	,,	30	1 6	
45	22 1		45	0 9		45	7 10	,,	45	1 5	
1 0	22 2		1 0	0 8		1 0	8 11	,,	1 0	1 5	
15	22 4		15	0 7		15	9 11	,,	15	1 5	
30	22 4		30	0 6		30	10 8	,,	30	1 4	
45	22 2		45	0 5		45	11 2	,,	45	1 4	
2 0	21 11		2 0	1 3½		2 0	11 8	,,	2 0	1 4	
15	21 7		15	1 11		15	12 0	,,	15	1 3	
30	21 2		30	2 7		30	12 3	,,	30	1 3	
45	20 8		45	3 1		45	12 6	,,	45	1 3	
3 0	20 2		3 0	3 6		3 0	12 6	,,	3 0	1 3	
15	19 6		15	3 11		15	11 9	,,	15	1 6	
30	18 9		30	4 2		30	11 3	,,	30	2 0	
45	17 10		45	4 5		45	10 8	,,	45	2 10	
4 0	16 10		4 0	4 8		4 0	10 2	,,	4 0	3 8	
15	16 0		15	4 9		15	9 8	,,	15	4 3	
30	15 2		30	4 9		30	9 2	,,	30	5 0	
45	14 4		45	4 8		45	8 8	,,	45	5 7	
5 0	13 7		5 0	4 5		5 0	8 2	,,	5 0	6 3	
15	12 11		15	4 1		15	7 8	,,	15	6 7	S.W.
30	12 4		30	3 9		30	7 5	,,	30	6 9	
45	11 8		45	3 7		45	7 2	,,	45	6 7	
6 0	11 0		6 0	3 6		6 0	6 11	,,	6 0	6 3	
15	10 5		15	3 5		15	6 8	W.	15	5 10	
30	9 11		30	3 2		30	6 5	,,	30	5 6	
45	9 5		45	3 0		45	6 3	,,	45	5 1	W.
7 0	9 1		7 0	2 11		7 0	6 0	,,	7 0	4 9	
15	8 9		15	2 9		15	5 9	,,	15	4 6	
30	8 7		30	2 8		30	5 6	,,	30	4 4	
45	8 6		45	2 7		45	5 3	,,	45	4 2	
8 0	8 8		8 0	2 6	W.	8 0	5 0	,,	8 0	4 0	
15	8 11		15	2 5		15	4 10	,,	15	3 10	
30	9 6		30	2 3		30	4 8	,,	30	3 8	
45	10 3		45	2 2		45	4 6	,,	45	3 6	
9 0	10 10		9 0	2 1		9 0	4 4	,,	9 0	3 3	W.
15	11 9		15	2 0		15	4 1	,,	15	3 0	
30	12 8		30	1 10		30	3 11	W.S.W.	30	2 10	
45	13 6		45	1 8		45	3 9	,,	45	2 9	
10 0	14 4		10 0	1 7		10 0	3 7	,,	10 0	2 8	
15	15 1		15	1 5		15	3 5	,,	15	2 7	
30	16 2		30	1 3½		30	3 3	,,	30	2 6	
45	17 1		45	1 2½		45	3 1	,,	45	2 4	
11 0	17 10		11 0	1 1¾		11 0	2 11	,,	11 0	2 3	W.
15	18 8		15	1 0½		15	2 10	,,	15	2 2	
30	19 6		30	0 11½		30	2 8	,,	30	2 1	
45 A.M.	20 4		45 A.M.	0 10¾		45 A.M.	2 8	,,	45 A.M.	2 0	

May 30.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
Noon.	20 11		Noon.	0 9½		Noon.	3 5	W.S.W.	Noon.	1 11	
12 15 P.M.	21 6		12 15 P.M.	0 8		12 15 P.M.	4 3	N.W.	12 15 P.M.	1 10	
30	22 0		30	0 7		30	5 3	,,	30	1 9	W.
45	22 5		45	0 6		45	6 10	,,	45	1 8	
1 0	22 8		1 0	0 5½		1 0	8 5	,,	1 0	1 7	
15	22 9		15	0 4½		15	9 3	,,	15	1 7	
30	22 11		30	0 3½		30	10 3	,,	30	1 6	
45	22 8		45	0 2½		45	11 0	,,	45	1 6	
2 0	22 6		2 0	0 1½		2 0	11 5	,,	2 0	1 5	
15	22 2		15	0 0½		15	11 11	,,	15	1 5	
30	21 8		30	0 9	S.W.	30	12 3	,,	30	1 4	
45	21 2		45	2 0		45	12 6	,,	45	1 4	
3 0	20 6		3 0	2 6½		3 0	12 8	,,	3 0	1 4	
15	19 10		15	3 1		15	12 7	,,	15	1 4	
30	19 1		30	3 6		30	12 2	,,	30	1 6	
45	18 4		45	3 11½		45	11 7	,,	45	2 7	
4 0	17 6		4 0	4 3		4 0	11 2	,,	4 0	3 4	
15	16 8		15	4 6		15	10 5	,,	15	3 11	S.W.
30	15 8		30	4 7½		30	9 11	,,	30	4 8	
45	14 8		45	4 9		45	9 4	,,	45	5 6	
5 0	13 11		5 0	4 8		5 0	8 10	,,	5 0	6 3	
15	13 0		15	4 3		15	8 5	,,	15	6 6	
30	12 5		30	3 9½		30	8 0	,,	30	6 10	
45	11 9		45	3 7½		45	7 8	,,	45	6 10	
6 0	11 1		6 0	3 6	S.W.	6 0	7 4	,,	6 0	6 6	
15	10 5		15	3 4		15	7 0	,,	15	6 0	
30	9 8		30	3 2½		30	6 9	,,	30	5 8	
45	9 1		45	3 1½		45	6 6	,,	45	5 4	S.W.
7 0	8 6		7 0	3 0		7 0	6 3	,,	7 0	5 0	
15	7 11		15	2 9½		15	5 11	,,	15	4 8	
30	7 6		30	2 9		30	5 8	,,	30	4 4	
45	7 1		45	2 7½		45	5 5	,,	45	4 1	
8 0	6 9		8 0	2 6		8 0	5 2	,,	8 0	3 10	
15	6 6		15	2 4		15	4 11	,,	15	3 8	
30	6 5		30	2 2½		30	4 9	,,	30	3 6	
45	6 7		45	2 1		45	4 7	,,	45	3 4	
9 0	6 10		9 0	2 0		9 0	4 5	,,	9 0	3 2	S.W.
15	7 6		15	1 10		15	4 2	,,	15	3 0	
30	8 3		30	1 8½		30	4 0	,,	30	2 10	
45	9 0		45	1 7		45	3 10	,,	45	2 9	
10 0	9 7		10 0	1 6		10 0	3 8	,,	10 0	2 8	
15	10 5		15	1 5		15	3 6	,,	15	2 7	
30	11 6		30	1 4		30	3 4	,,	30	2 6	
45	12 4		45	1 3		45	3 2	,,	45	2 5	
11 0	13 3		11 0	1 2		11 0	3 0	,,	11 0	2 4	
15	14 3		15	1 1		15	2 11	,,	15	2 3	
30	15 3		30	1 0		30	2 9	,,	30	2 2	S.W.
45 P.M.	16 2		45 P.M.	1 0		45 P.M.	2 8	,,	45 P.M.	2 0	

May 31.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	16 11		12 0 A.M.	0 11	S.W.	12 0 A.M.	2 7	N.W.	12 0 A.M.	1 11	
15	17 10		15	0 10		15	2 6	N.N.W.	15	1 10	
30	18 10		30	0 9		30	2 5	,,	30	1 9	
45	19 9		45	0 8		45	2 3	,,	45	1 8	
1 0	20 5		1 0	0 7		1 0	2 6	,,	1 0	1 7	S.W.
15	21 1		15	0 6		15	3 5	,,	15	1 6	
30	21 7		30	0 5½		30	4 4	,,	30	1 5	
45	21 11		45	0 4¾		45	6 0	,,	45	1 4	
2 0	22 2		2 0	0 3¼		2 0	7 5	,,	2 0	1 4	
15	22 4		15	0 2		15	8 7	,,	15	1 4	
30	22 6		30	0 1		30	8 8	,,	30	1 4	
45	22 7		45	0 0¾		45	10 6	,,	45	1 3	
3 0	22 6		3 0	0 0½		3 0	11 3	,,	3 0	1 3	
15	22 5		15	0 8	N.	15	11 8	,,	15	1 3	
30	22 0		30	1 10		30	12 0	,,	30	1 2	
45	21 7		45	2 6		45	12 4	,,	45	1 2	
4 0	21 0		4 0	3 0½		4 0	12 7	,,	4 0	1 2	
15	20 6		15	3 4½		15	12 8	,,	15	1 2	
30	19 9		30	3 8		30	12 5	,,	30	1 2	
45	18 10		45	3 10		45	12 0	,,	45	1 9	
5 0	18 2		5 0	4 0		5 0	11 6	,,	5 0	2 6	N.W.
15	17 9		15	4 3		15	10 11	,,	15	3 2	
30	16 5		30	4 6	N.E.	30	10 3	,,	30	3 8	
45	15 7		45	4 9		45	9 9	,,	45	4 7	
6 0	14 9		6 0	4 7	N.E.	6 0	9 3	,,	6 0	5 5	
15	14 0		15	4 3		15	8 10	,,	15	6 0	
30	13 3		30	3 11		30	8 5	,,	30	6 6	
45	12 6		45	3 8		45	8 0	,,	45	6 10	
7 0	11 11		7 0	3 6		7 0	7 7	,,	7 0	6 8	N.W.
15	11 3		15	3 4		15	7 3	,,	15	6 5	
30	10 8		30	3 3		30	6 11	,,	30	6 0	
45	10 1		45	3 2		45	6 8	,,	45	5 8	
8 0	9 8		8 0	3 0		8 0	6 4	,,	8 0	5 4	
15	9 3		15	2 10		15	6 1	,,	15	5 0	
30	8 11		30	2 8		30	5 10	,,	30	4 9	
45	8 10		45	2 6		45	5 7	,,	45	4 6	
9 0	8 9		9 0	2 4		9 0	5 4	,,	9 0	4 3	
15	8 11		15	2 2		15	5 1	,,	15	4 0	
30	9 6		30	2 1		30	4 11	,,	30	3 9	
45	10 0		45	2 0		45	4 9	,,	45	3 6	
10 0	10 9		10 0	2 0		10 0	4 6	,,	10 0	3 4	N.W.
15	11 8		15	2 0		15	4 4	,,	15	3 3	
30	12 7		30	1 9½		30	4 1	,,	30	3 1	
45	13 6		45	1 8		45	3 11	,,	45	3 0	
11 0	14 4		11 0	1 7		11 0	3 9	,,	11 0	2 11	
15	15 4		15	1 6		15	3 7	,,	15	2 10	
30	16 3		30	1 5		30	3 5	,,	30	2 9	
45 A.M.	17 2		45 A.M.	1 4		45 A.M.	3 3	,,	45 A.M.	2 7	

May 31.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
Noon.	18 2		Noon.	1 3½	N.	Noon.	3 1	N.N.W.	Noon.	2 6	
12 15 P.M.	19 2		12 15 P.M.	1 1½		12 15 P.M.	2 11	E.S.E.	12 15 P.M.	2 5	
30	20 1		30	1 0½		30	2 9	,,	30	2 4	
45	20 11		45	1 0		45	2 11	,,	45	2 3	
1 0	21 7		1 0	0 10½		1 0	3 10	,,	1 0	2 2	N.E.
15	22 3		15	0 9½		15	4 11	,,	15	2 1	
30	22 10		30	0 8		30	6 8	,,	30	2 0	
45	23 5		45	0 7½		45	7 11	,,	45	1 11	
2 0	23 9		2 0	0 6		2 0	9 0	,,	2 0	1 10	
15	24 0		15	0 5½		15	10 7	,,	15	1 10	
30	24 3		30	0 4		30	11 8	,,	30	1 9	
45	24 4		45	0 3		45	12 10	,,	45	1 9	
3 0	24 2		3 0	0 1½		3 0	13 2	,,	3 0	1 8	
15	23 9		15	1 9		15	13 8	,,	15	1 7	
30	23 3		30	2 3		30	14 0	,,	30	1 7	
45	22 9		45	3 0½		45	14 3	,,	45	1 6	S.E.
4 0	22 2		4 0	3 10		4 0	14 6	,,	4 0	1 6	
15	21 6		15	4 7		15	14 7	S.E.	15	2 2	
30	20 9		30	5 2		30	14 3	,,	30	3 0	
45	19 11		45	5 6		45	13 7	,,	45	3 9	
5 0	19 0		5 0	5 11		5 0	13 1	,,	5 0	4 9	
15	17 11		15	6 2½		15	12 5	,,	15	5 8	
30	17 1		30	6 4½		30	11 9	,,	30	6 6	
45	16 4		45	6 6		45	11 1	,,	45	7 6	
6 0	15 6		6 0	6 2		6 0	10 6	,,	6 0	8 3	
15	14 9		15	5 9		15	10 0	,,	15	8 6	
30	13 11		30	5 3		30	9 7	,,	30	8 11	
45	13 3		45	4 10		45	9 3	,,	45	8 8	
7 0	12 6		7 0	4 7½		7 0	8 10	,,	7 0	8 2	S.E.
15	11 9		15	4 6		15	8 6	,,	15	7 8	
30	11 1		30	4 3½		30	8 2	,,	30	7 1	
45	10 5		45	4 2		45	7 10	,,	45	6 7	
8 0	9 10		8 0	4 0		8 0	7 6	,,	8 0	6 3	
15	9 2		15	3 11		15	7 2	,,	15	5 11	
30	8 5		30	3 8		30	6 10	,,	30	5 8	
45	8 2		45	3 6½		45	6 7	,,	45	5 5	
9 0	7 10		9 0	3 5		9 0	6 3	,,	9 0	5 2	
15	7 7		15	3 3½		15	6 0	,,	15	4 11	S.E.
30	7 5		30	3 2		30	5 9	,,	30	4 8	
45	7 4		45	3 0		45	5 6	,,	45	4 5	
10 0	7 6		10 0	2 10½		10 0	5 3	,,	10 0	4 3	
15	7 11		15	2 9		15	5 1	,,	15	4 1	
30	8 5		30	2 7½		30	4 10	,,	30	3 11	
45	9 2		45	2 6		45	4 8	,,	45	3 9	
11 0	9 11		11 0	2 5		11 0	4 5	,,	11 0	3 7	
15	10 8		15	2 4		15	4 3	,,	15	3 5	
30	11 7		30	2 3		30	4 1	,,	30	3 3	S.E.
45 P.M.	12 6		45 P.M.	2 1		45 P.M.	3 11	,,	45 P.M.	3 2	

June 1.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	13 8		12 0 A.M.	2 0	W.	12 0 A.M.	3 9	S.E.	12 0 A.M.	3 1	
15	14 6		15	1 10½		15	3 7	S.	15	3 0	
30	15 7		30	1 9		30	3 5	,,	30	2 10	
45	16 7		45	1 8		45	3 4	,,	45	2 9	
1 0	17 6		1 0	1 7		1 0	3 3	,,	1 0	2 8	S.E.
15	18 4		15	1 6		15	3 2	,,	15	2 7	
30	19 2		30	1 4½		30	3 0	,,	30	2 5	
45	20 3		45	1 3		45	2 10	,,	45	2 4	
2 0	20 9		2 0	1 2		2 0	2 11	,,	2 0	2 3	
15	21 5		15	1 0½		15	3 3	,,	15	2 1	
30	21 11		30	0 11		30	5 0	,,	30	1 11	
45	22 5		45	0 10		45	6 8	,,	45	1 10	
3 0	22 8		3 0	0 9		3 0	8 3	,,	3 0	1 9	
15	22 10		15	0 8		15	9 6	,,	15	1 8	
30	22 11		30	0 7		30	10 4	,,	30	1 7	
45	23 0		45	0 6		45	11 2	,,	45	1 6	
4 0	23 10		4 0	0 5		4 0	11 11	,,	4 0	1 6	Calm.
15	22 8		15	0 4½		15	12 3	,,	15	1 6	
30	22 4		30	0 3		30	12 8	,,	30	1 6	
45	21 10		45	2 5	N.W.	45	12 11	N.W.	45	1 6	
5 0	21 3		5 0	3 3		5 0	13 1	,,	5 0	1 5	
15	20 7		15	3 8		15	13 1	,,	15	1 5	
30	19 10		30	4 1		30	12 9	,,	30	1 5	
45	19 0		45	4 8		45	12 1	,,	45	2 9	
6 0	18 3		6 0	4 11	N.W	6 0	11 8	,,	6 0	3 8	
15	17 3		15	5 2		15	11 1	,,	15	4 6	
30	16 5		30	5 3		30	10 6	,,	30	5 3	
45	15 7		45	5 3		45	9 10	,,	45	6 1	
7 0	14 8		7 0	4 11		7 0	9 5	,,	7 0	6 8	
15	13 11		15	4 7		15	9 0	,,	15	7 1	S.W.
30	13 0		30	4 3		30	8 7	,,	30	7 6	
45	12 3		45	4 0		45	8 2	,,	45	7 6	
8 0	11 5		8 0	3 10		8 0	7 9	,,	8 0	7 2	
15	10 9		15	3 9		15	7 5	,,	15	6 8	
30	10 1		30	3 8		30	7 1	,,	30	6 1	
45	9 5		45	3 6		45	6 10	,,	45	5 10	
9 0	9 0		9 0	3 5		9 0	6 6	,,	9 0	5 6	W.
15	8 6		15	3 3		15	6 3	,,	15	5 1	
30	8 2		30	3 1½		30	6 0	,,	30	4 10	
45	7 10		45	3 0		45	5 9	,,	45	4 7	
10 0	7 8		10 0	2 10½		10 0	5 6	,,	10 0	4 4	
15	7 9		15	2 9		15	5 3	,,	15	4 2	
30	8 0		30	2 6		30	5 0	,,	30	4 0	
45	8 8		45	2 4½		45	4 10	,,	45	3 10	W.
11 0	9 4		11 0	2 3		11 0	4 7	,,	11 0	3 8	
15	10 2		15	2 1½		15	4 5	,,	15	3 6	
30	11 1		30	2 0		30	4 2	,,	30	3 4	
45 A.M.	11 11		45 A.M.	1 10¾		45 A.M.	4 0	,,	45 A.M.	3 2	

June 1.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
Noon.	12 8		Noon.	1 9½		Noon.	3 10	N.W.	Noon.	3 0	
12 15 P.M.	13 10		12 15 P.M.	1 8½		12 15 P.M.	3 8	,,	12 15 P.M.	2 11	
30	14 10		30	1 7		30	3 6	,,	30	2 10	
45	16 0		45	1 6		45	3 4	,,	45	2 9	W.
1 0	17 0		1 0	1 4½		1 0	3 2	,,	1 0	2 8	
15	18 1		15	1 4		15	3 0	,,	15	2 7	
30	18 11		30	1 2¾		30	2 10	,,	30	2 6	
45	20 0		45	1 0¾		45	2 9	,,	45	2 5	
2 0	20 10		2 0	1 0	W.	2 0	2 8	,,	2 0	2 4	
15	21 7		15	0 10½		15	3 0	,,	15	2 3	W.
30	22 2		30	0 10		30	4 8	,,	30	2 2	
45	22 8		45	0 9		45	5 10	,,	45	2 1	
3 0	23 2		3 0	0 8½		3 0	7 6	,,	3 0	2 0	
15	23 5		15	0 7¼		15	8 11	,,	15	1 10	
30	23 7		30	0 6		30	10 3	,,	30	1 9	W.
45	23 8		45	0 5		45	11 7	,,	45	1 8	
4 0	23 7		4 0	0 4		4 0	12 2	,,	4 0	1 7	
15	23 5		15	0 3½		15	12 10	,,	15	1 7	
30	22 11		30	0 3½		30	13 3	,,	30	1 7	
45	22 5		45	2 6		45	13 8	,,	45	1 7	
5 0	21 8		5 0	3 6		5 0	13 10	,,	5 0	1 6	
15	21 0		15	4 0½		15	13 11	,,	15	1 5	
30	20 4		30	4 7		30	13 8	,,	30	1 5	
45	19 6		45	5 0		45	13 2	,,	45	2 4	
6 0	18 9		6 0	5 4½	N.W.	6 0	12 7	,,	6 0	3 6	
15	17 10		15	5 7½		15	12 0	,,	15	4 3	
30	16 11		30	6 0		30	11 5	,,	30	5 0	W.
45	16 1		45	6 0½		45	10 9	,,	45	5 11	
7 0	15 2		7 0	5 11		7 0	10 1	,,	7 0	6 10	
15	14 3		15	5 6		15	9 8	,,	15	7 6	
30	13 6		30	5 0		30	9 3	,,	30	7 11	
45	12 8		45	4 7½		45	8 9	,,	45	8 1	
8 0	11 11		8 0	4 4		8 0	8 4	,,	8 0	7 10	
15	11 1		15	4 2		15	8 0	,,	15	7 3	W.
30	10 4		30	4 0½		30	7 9	,,	30	6 9	
45	9 8		45	3 10½		45	7 5	,,	45	6 3	
9 0	9 0		9 0	3 9		9 0	7 1	,,	9 0	5 11	
15	8 4		15	3 8		15	6 10	,,	15	5 7	
30	7 9		30	3 6		30	6 7	,,	30	5 3	Calm.
45	7 3		45	3 4		45	6 4	,,	45	5 0	
10 0	6 10		10 0	3 2½		10 0	6 1	,,	10 0	4 9	
15	6 6		15	3 0½		15	5 10	,,	15	4 6	
30	6 3		30	2 11		30	5 7	,,	30	4 3	
45	6 3		45	2 9½		45	5 4	,,	45	4 0	
11 0	6 7		11 0	2 8		11 0	5 1	,,	11 0	3 10	
15	7 1		15	2 6		15	4 10	,,	15	3 8	
30	7 10		30	2 5		30	4 8	,,	30	3 6	Calm.
45 P.M.	8 9		45 P.M.	2 3½		45 P.M.	4 5	,,	45 P.M.	3 4	

June 2.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	9 8		12 0 A.M.	2 2	N.	12 0 A.M.	4 3	N.W.	12 0 A.M.	3 3	
15	10 6		15	2 0½		15	4 0	,,	15	3 1	
30	11 9		30	1 11		30	3 10	,,	30	2 11	
45	12 9		45	1 9½		45	3 8	,,	45	2 9	
1 0	13 9		1 0	1 8		1 0	3 6	,,	1 0	2 8	Calm.
15	14 10		15	1 7		15	3 4	,,	15	2 6	
30	15 11		30	1 5¾		30	3 2	,,	30	2 5	
45	17 0		45	1 4½		45	3 0	,,	45	2 4	
2 0	18 0		2 0	1 2¾		2 0	2 11	,,	2 0	2 3	
15	19 1		15	1 1¼		15	2 10	,,	15	2 2	
30	20 0		30	1 0		30	2 9	,,	30	2 1	
45	21 0		45	0 11		45	2 8	,,	45	2 0	
3 0	21 9		3 0	0 10		3 0	3 0	,,	3 0	1 11	
15	22 5		15	0 9		15	4 8	,,	15	1 10	
30	22 11		30	0 8		30	6 6	,,	30	1 9	
45	23 4		45	0 7		45	8 6	,,	45	1 8	
4 0	23 7		4 0	0 6		4 0	9 9	,,	4 0	1 7	
15	23 10		15	0 5		15	11 2	,,	15	1 7	
30	23 11		30	0 4		30	12 1	,,	30	1 7	
45	23 11		45	0 3		45	12 9	,,	45	1 6	
5 0	23 8		5 0	0 3		5 0	13 5	,,	5 0	1 6	
15	23 4		15	1 10		15	13 10	,,	15	1 6	
30	22 10		30	3 3		30	14 1	,,	30	1 5	
45	22 2		45	4 0		45	14 3	,,	45	1 5	
6 0	21 7		6 0	4 6	N.	6 0	14 4	,,	6 0	1 5	N.W.
15	20 10		15	5 3		15	14 3	N.E.	15	1 5	
30	20 1		30	5 7		30	13 10	,,	30	2 6	
45	19 4		45	5 11		45	13 2	,,	45	3 5	
7 0	18 5		7 0	6 3		7 0	12 5	,,	7 0	4 9	
15	17 6		15	6 5		15	11 9	,,	15	5 9	
30	16 8		30	6 6		30	11 1	,,	30	6 8	
45	15 7		45	6 3		45	10 7	E.N.E.	45	7 6	
8 0	14 9		8 0	5 11	E.	8 0	10 1	,,	8 0	8 0	E.
15	13 10		15	5 3		15	9 7	,,	15	8 6	
30	13 0		30	4 11		30	9 2	,,	30	8 6	
45	12 3		45	4 9		45	8 9	,,	45	8 2	
9 0	11 6		9 0	4 5		9 0	8 5	,,	9 0	7 8	
15	10 9		15	4 3		15	8 1	,,	15	7 3	
30	10 1		30	4 2		30	7 9	,,	30	6 9	N.E.
45	9 5		45	4 0		45	7 5	,,	45	6 3	
10 0	8 10		10 0	3 11		10 0	7 1	,,	10 0	5 10	
15	8 3		15	3 9		15	6 10	,,	15	5 7	
30	7 10		30	3 6½		30	6 6	,,	30	5 4	
45	7 5		45	3 4½		45	6 2	,,	45	5 1	
11 0	7 3		11 0	3 3		11 0	5 11	,,	11 0	4 10	
15	7 2		15	3 2		15	5 8	,,	15	4 7	E.
30	7 5		30	3 0		30	5 5	,,	30	4 5	
45 A.M.	8 0		45 A.M.	2 10½		45 A.M.	5 2	,,	45 A.M.	4 2	

June 2.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
Noon.	8 10		Noon.	2 9	E.	Noon.	4 11	E.N.E.	Noon.	4 0	
12 15 P.M.	9 10		12 15 P.M.	2 7½		12 15 P.M.	4 9	E.	12 15 P.M.	3 10	
30	10 11		30	2 6		30	4 6	,,	30	3 8	
45	11 11		45	2 4½		45	4 4	,,	45	3 6	
1 0	12 11		1 0	2 3		1 0	4 2	,,	1 0	3 4	
15	14 0		15	2 1¼		15	4 0	E.S.E.	15	3 2	
30	15 2		30	1 11½		30	3 10	,,	30	3 1	
45	16 3		45	1 10		45	3 8	,,	45	3 0	E.
2 0	17 2		2 0	1 9		2 0	3 6	,,	2 0	2 10	
15	18 3		15	1 8		15	3 4	,,	15	2 9	
30	19 6		30	1 6¾		30	3 2	,,	30	2 8	
45	20 7		45	1 5		45	3 0	,,	45	2 7	
3 0	20 6		3 0	1 3½		3 0	2 10	,,	3 0	2 6	
15	22 6		15	1 2		15	3 8	,,	15	2 5	E.
30	23 3		30	1 1		30	5 6	,,	30	2 4	
45	23 10		45	1 0½		45	7 6	,,	45	2 3	
4 0	24 2		4 0	1 0		4 0	9 4	,,	4 0	2 1	
15	24 5		15	0 10¾		15	10 10	,,	15	2 0	
30	24 8		30	0 9½		30	12 2	,,	30	1 11	
45	24 10		45	0 8½		45	13 6	,,	45	1 10	
5 0	24 10		5 0	0 7½		5 0	14 2	,,	5 0	1 10	E.
15	24 5		15	0 6½		15	14 8	,,	15	1 10	
30	23 11		30	3 3		30	15 2	,,	30	1 9	
45	23 2		45	4 5		45	15 4	,,	45	1 8	
6 0	22 6		6 0	5 0	E.	6 0	15 5	,,	6 0	1 8	
15	21 9		15	5 9½		15	15 5	,,	15	1 7	
30	21 0		30	6 3		30	15 1	,,	30	2 11	
45	20 1		45	6 7		45	14 6	,,	45	3 11	
7 0	19 4		7 0	7 0		7 0	13 9	,,	7 0	5 0	E.
15	18 5		15	7 4½		15	13 0	,,	15	6 4	
30	17 6		30	7 5		30	12 4	,,	30	7 6	
45	16 6		45	7 4½		45	11 7	,,	45	8 4	
8 0	15 6		8 0	6 9½		8 0	11 0	,,	8 0	9 0	
15	14 7		15	6 3		15	10 6	,,	15	9 6	
30	13 9		30	5 8½		30	10 1	,,	30	9 8	
45	12 10		45	5 4		45	9 7	,,	45	9 4	
9 0	12 2		9 0	5 1		9 0	9 3	,,	9 0	8 9	Calm.
15	11 4		15	4 10		15	8 11	,,	15	8 2	
30	10 7		30	4 8		30	8 6	,,	30	7 6	
45	9 10		45	4 6½		45	8 2	,,	45	7 0	
10 0	9 2		10 0	4 4½		10 0	7 10	,,	10 0	6 7	
15	8 7		15	4 2½		15	7 7	,,	15	6 3	
30	7 11		30	4 1		30	7 3	,,	30	6 0	
45	7 5		45	3 11		45	7 0	,,	45	5 9	
11 0	7 0		11 0	3 8½		11 0	6 8	,,	11 0	5 6	Calm.
15	6 8		15	3 7		15	6 5	,,	15	5 3	
30	6 6		30	3 6		30	6 1	,,	30	5 0	
45 P.M.	6 7		45 P.M.	3 4		45 P.M.	5 10	,,	45 P.M.	4 9	

June 3.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	7 0		12 0 A.M.	3 2	E.	12 0 A.M.	5 7	E.S.E.	12 0 A.M.	4 6	
15	7 8		15	3 0		15	5 4	,,	15	4 4	
30	8 6		30	2 10		30	5 2	,,	30	4 2	
45	9 5		45	2 8		45	5 0	,,	45	4 0	
1 0	10 5		1 0	2 6		1 0	4 10	,,	1 0	3 10	Calm.
15	11 6		15	2 4½		15	4 7	,,	15	3 8	
30	12 6		30	2 3		30	4 4	,,	30	3 6	
45	13 8		45	2 1½		45	4 2	,,	45	3 4	
2 0	14 7		2 0	2 0		2 0	4 0	,,	2 0	3 2	
15	15 9		15	1 10½		15	3 10	,,	15	3 0	
30	16 10		30	1 9		30	3 8	,,	30	2 10	
45	17 10		45	1 7½		45	3 6	,,	45	2 8	
3 0	19 0		3 0	1 6		3 0	3 4	,,	3 0	2 7	
15	20 2		15	1 5		15	3 2	,,	15	2 6	
30	21 2		30	1 4		30	3 0	,,	30	2 5	
45	22 1		45	1 3		45	3 2	,,	45	2 4	
4 0	22 9		4 0	1 2		4 0	4 8	,,	4 0	2 3	
15	23 4		15	1 1		15	6 9	,,	15	2 2	
30	23 9		30	1 0		30	8 8	,,	30	2 1	
45	24 1		45	0 11		45	10 2	,,	45	2 0	
5 0	24 4		5 0	0 10		5 0	11 7	,,	5 0	1 11	
15	24 5		15	0 9		15	12 9	,,	15	1 10	
30	24 5		30	0 8		30	13 8	,,	30	1 9	
45	24 2		45	0 7		45	14 2	,,	45	1 8	
6 0	23 9		6 0	2 0	E.	6 0	14 7	,,	6 0	1 7	
15	23 2		15	4 0		15	14 9	S.E.	15	1 6	
30	22 6		30	4 8		30	14 11	,,	30	1 6	
45	21 10		45	5 7		45	14 11	,,	45	1 5	
7 0	21 1		7 0	5 10		7 0	14 9	,,	7 0	1 5	E.
15	20 3		15	6 3		15	14 3	S.	15	3 1	
30	19 4		30	6 6		30	13 5	,,	30	4 0	
45	18 6		45	6 9		45	12 7	,,	45	5 4	
8 0	17 6		8 0	7 0		8 0	12 0	,,	8 0	6 6	
15	16 5		15	7 0		15	11 4	,,	15	7 6	
30	15 6		30	6 6		30	10 8	,,	30	8 3	
45	14 7		45	6 2		45	10 2	,,	45	8 10	
9 0	13 9		9 0	5 7		9 0	9 9	,,	9 0	9 1	
15	12 10		15	5 3		15	9 3	,,	15	9 0	
30	12 0		30	4 11		30	8 10	S.S.E.	30	8 6	
45	11 2		45	4 9		45	8 6	,,	45	7 10	
10 0	10 5		10 0	4 7	N.E.	10 0	8 2	,,	10 0	7 5	N.W.
15	9 8		15	4 5½		15	7 10	,,	15	6 9	
30	8 11		30	4 3		30	7 6	,,	30	6 3	
45	8 2		45	4 1		45	7 2	,,	45	5 10	
11 0	7 7		11 0	3 11	S.	11 0	6 10	,,	11 0	5 6	
15	7 1		15	3 9		15	6 6	,,	15	5 3	
30	6 8		30	3 7		30	6 3	,,	30	5 0	
45 A.M.	6 5		45 A.M.	3 5½		45 A.M.	6 0	,,	45 A.M.	4 10	

June 3.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	W
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
Noon.	6 3		Noon.	3 3½		Noon.	5 9	S.S.E.	Noon.	4 7	
12 15 P.M.	6 6		12 15 P.M.	3 1½		12 15 P.M.	5 6	E.S.E.	12 15 P.M.	4 5	
30	7 0		30	3 0		30	5 3	,,	30	4 3	
45	7 10		45	2 10½		45	5 0	,,	45	4 0	
1 0	8 10		1 0	2 9		1 0	4 9	,,	1 0	3 9	E.
15	9 10		15	2 7		15	4 6	,,	15	3 6	
30	11 0		30	2 5		30	4 4	,,	30	3 4	
45	12 2		45	2 3		45	4 2	,,	45	3 3	
2 0	13 3		2 0	2 1½		2 0	4 0	,,	2 0	3 2	
15	14 4		15	2 0½		15	3 10	,,	15	3 1	
30	15 6		30	1 11		30	3 8	,,	30	3 0	
45	16 8		45	1 10		45	3 6	,,	45	2 11	
3 0	17 11		3 0	1 8		3 0	3 4	,,	3 0	2 10	
15	19 2		15	1 7½	N.	15	3 2	,,	15	2 8	
30	20 4		30	1 7		30	3 0	,,	30	2 7	
45	21 5		45	1 6¼		45	2 11	,,	45	2 6	
4 0	22 3		4 0	1 4½		4 0	2 10	,,	4 0	2 5	E.
15	23 1		15	1 3		15	3 11	,,	15	2 4	
30	23 9		30	1 2		30	6 7	,,	30	2 3	
45	24 3		45	1 1		45	8 5	,,	45	2 2	
5 0	24 7		5 0	1 0		5 0	9 10	,,	5 0	2 0	
15	24 10		15	1 0½		15	11 8	,,	15	1 10	
30	24 11		30	0 10		30	12 11	,,	30	1 9	
45	25 0		45	0 9		45	13 10	,,	45	1 8	
6 0	24 10		6 0	0 8½	N.E.	6 0	14 7	,,	6 0	1 6	
15	24 4		15	3 0		15	15 1	,,	15	1 6	
30	23 9		30	4 0		30	15 5	,,	30	1 5	
45	23 1		45	5 2		45	15 7	,,	45	1 5	
7 0	22 4		7 0	5 10		7 0	15 7	,,	7 0	1 5	
15	21 6		15	6 3		15	15 6	,,	15	1 5	
30	20 8		30	6 9		30	15 0	E.	30	3 3	
45	19 8		45	7 0½		45	14 3	,,	45	4 6	
8 0	18 11		8 0	7 4½		8 0	13 7	,,	8 0	5 6	
15	17 11		15	7 6½		15	12 8	,,	15	7 0	
30	17 0		30	7 6		30	12 0	,,	30	8 1	
45	15 11		45	7 0		45	11 4	,,	45	8 11	
9 0	15 1		9 0	6 8		9 0	10 9	,,	9 0	9 7	Calm.
15	14 1		15	6 0		15	10 3	,,	15	9 10	
30	13 3		30	5 8		30	9 10	,,	30	9 7	
45	12 5		45	5 4½		45	9 5	,,	45	9 0	
10 0	11 7		10 0	5 0½		10 0	9 0	,,	10 0	8 4	
15	10 9		15	4 10½		15	8 8	,,	15	7 9	
30	10 0		30	4 9		30	8 4	,,	30	7 2	
45	9 2		45	4 7		45	8 0	,,	45	6 9	
11 0	8 6		11 0	4 5		11 0	7 8	,,	11 0	6 4	
15	7 10		15	4 2½		15	7 4	,,	15	6 0	
30	7 3		30	4 0½		30	7 1	,,	30	5 9	Calm.
45 P.M.	6 9		45 P.M.	3 10½		45 P.M.	6 9	,,	45 P.M.	5 6	

June 4.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	6 4		12 0 A.M.	3 8½	N.E.	12 0 A.M.	6 6	E.	12 0 A.M.	5 3	
15	6 2		15	3 6		15	6 2	N.W.	15	5 0	
30	6 1		30	3 3½		30	5 10	,,	30	4 9	
45	6 5		45	3 1½		45	5 7	,,	45	4 7	
1 0	7 1		1 0	2 11½		1 0	5 4	,,	1 0	4 5	Calm.
15	8 0		15	2 10		15	5 1	,,	15	4 3	
30	9 0		30	2 8½		30	4 11	,,	30	4 1	
45	10 2		45	2 7		45	4 9	,,	45	3 11	
2 0	11 2		2 0	2 5½		2 0	4 6	,,	2 0	3 9	
15	12 3		15	2 4½		15	4 4	,,	15	3 7	
30	13 5		30	2 3		30	4 2	,,	30	3 5	
45	14 7		45	2 1½		45	4 0	,,	45	3 3	
3 0	15 9		3 0	2 0		3 0	3 10	W.N.W.	3 0	3 1	
15	16 11		15	1 10½		15	3 8	,,	15	2 11	
30	18 1		30	1 9		30	3 6	,,	30	2 9	
45	19 4		45	1 8		45	3 4	,,	45	2 7	
4 0	20 6		4 0	1 7		4 0	3 2	,,	4 0	2 5	
15	21 6		15	1 5½		15	3 0	,,	15	2 4	
30	22 5		30	1 4½		30	3 2	,,	30	2 3	
45	23 2		45	1 3½		45	4 9	,,	45	2 2	
5 0	23 8		5 0	1 2½		5 0	6 11	,,	5 0	2 1	
15	24 2		15	1 1½		15	8 10	W.	15	2 0	
30	24 6		30	1 0½		30	10 10	,,	30	1 11	
45	24 9		45	1 0		45	12 2	,,	45	1 10	
6 0	24 10		6 0	0 11	N.E.	6 0	13 2	,,	6 0	1 10	
15	24 10		15	0 10		15	14 0	S.W.	15	1 9	
30	24 6		30	0 10		30	14 7	,,	30	1 8	
45	23 11		45	3 6		45	15 0	,,	45	1 7	
7 0	23 5		7 0	4 3		7 0	15 3	,,	7 0	1 6	
15	22 8		15	5 3		15	15 5	,,	15	1 6	
30	21 11		30	6 0		30	15 5	,,	30	1 5	
45	21 1		45	6 5		45	15 1	,,	45	2 4	
8 0	20 3		8 0	6 9		8 0	14 6	W.S.W.	8 0	3 10	
15	19 4		15	7 2		15	13 8	,,	15	5 0	
30	18 5		30	7 3		30	12 10	,,	30	6 1	
45	17 6		45	7 5		45	12 0	,,	45	7 3	W.
9 0	16 6		9 0	7 1		9 0	11 4	,,	9 0	8 2	
15	15 5		15	6 5		15	10 10	,,	15	8 11	
30	14 6		30	6 1		30	10 3	,,	30	9 4	
45	13 6		45	5 9		45	9 9	W.	45	9 6	
10 0	12 9		10 0	5 4		10 0	9 4	,,	10 0	9 7	
15	11 10		15	5 0½		15	8 11	,,	15	9 2	
30	11 0		30	4 11		30	8 6	,,	30	8 1	
45	10 2		45	4 9		45	8 2	W.N.W.	45	7 7	
11 0	9 5		11 0	4 6½		11 0	7 10	,,	11 0	6 11	
15	8 8		15	4 5		15	7 6	,,	15	6 5	
30	8 0		30	4 3		30	7 3	,,	30	6 0	
45 A.M.	7 4		45 A.M.	4 1		45 A.M.	6 11	,,	45 A.M.	5 9	

June 4.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
Noon.	6 9		Noon.	3 10½		Noon.	6 8	W.N.W.	Noon.	5 6	
12 15 P.M.	6 2		12 15 P.M.	3 9		12 15 P.M.	6 4	N.W.	12 15 P.M.	5 3	
30	5 10		30	3 7	W.N.W.	30	6 0	,,	30	5 0	
45	5 8		45	3 4½		45	5 9	,,	45	4 9	
1 0	5 8		1 0	3 3½		1 0	5 6	,,	1 0	4 6	W.
15	6 2		15	3 1½		15	5 3	,,	15	4 3	
30	7 0		30	3 0		30	5 0	,,	30	4 1	
45	8 0		45	2 9½		45	4 9	,,	45	3 10	
2 0	9 1		2 0	2 8		2 0	4 6	,,	2 0	3 8	
15	10 3		15	2 7		15	4 4	,,	15	3 6	
30	11 5		30	2 6		30	4 2	,,	30	3 4	
45	12 8		45	2 4½		45	4 0	,,	45	3 2	W.
3 0	13 10		3 0	2 3		3 0	3 10	,,	3 0	3 1	
15	15 1		15	2 1½		15	3 8	,,	15	3 0	
30	16 3		30	2 0		30	3 6	,,	30	2 11	
45	17 7		45	1 10½		45	3 4	,,	45	2 10	
4 0	18 9		4 0	1 9		4 0	3 2	,,	4 0	2 9	
15	20 2		15	1 8		15	3 1	,,	15	2 8	
30	21 3		30	1 7		30	3 0	,,	30	2 7	W.
45	22 3		45	1 6		45	2 11	,,	45	2 6	
5 0	23 1		5 0	1 4½		5 0	3 4	,,	5 0	2 5	
15	23 9		15	1 3		15	5 6	,,	15	2 4	
30	24 4		30	1 2¾		30	8 3	,,	30	2 3	
45	24 4		45	1 1		45	10 1	,,	45	2 2	
6 0	24 11		6 0	1 0	N.W.	6 0	11 8	,,	6 0	2 0	
15	25 2		15	1 0		15	12 11	,,	15	1 11	
30	25 2		30	1 0		30	14 3	,,	30	1 10	
45	24 11		45	0 11		45	14 9	,,	45	1 9	W.
7 0	24 6		7 0	2 9		7 0	15 3	,,	7 0	1 8	
15	23 10		15	4 0		15	15 6	,,	15	1 7	
30	23 2		30	5 0		30	15 8	,,	30	1 6	
45	22 3		45	5 9		45	15 8	,,	45	1 5	
8 0	21 6		8 0	6 3½		8 0	15 6	,,	8 0	1 5	
15	20 7		15	6 10		15	14 11	,,	15	3 1	
30	19 9		30	7 2		30	14 2	,,	30	4 6	
45	18 9		45	7 5½		45	13 2	,,	45	5 7	
9 0	18 0		9 0	7 7½		9 0	12 6	,,	9 0	6 10	
15	16 11		15	7 7		15	11 9	,,	15	8 1	
30	15 11		30	7 3		30	11 1	,,	30	9 0	
45	14 11		45	6 6		45	10 6	,,	45	9 8	
10 0	14 1		10 0	6 2		10 0	10 0	,,	10 0	9 11	
15	13 2		15	5 8		15	9 6	,,	15	9 5	
30	12 3		30	5 3		30	9 1	,,	30	8 8	
45	11 4		45	5 1		45	8 8	,,	45	8 1	
11 0	10 6		11 0	4 11		11 0	8 4	,,	11 0	7 6	S.W.
15	9 9		15	4 8½		15	8 0	,,	15	7 0	
30	9 1		30	4 6½		30	7 8	,,	30	6 6	
45 P.M.	8 4		45 P.M.	4 4		45 P.M.	7 4	,,	45 P.M.	6 1	

June 5.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	7 9		12 0 A.M.	4 2	N.W.	12 0 A.M.	7 0	N.W.	12 0 A.M.	5 10	
15	7 3		15	4 0		15	6 9	,,	15	5 7	
30	6 8		30	3 10½		30	6 5	,,	30	5 4	
45	6 4		45	3 8		45	6 2	,,	45	5 1	
1 0	6 1		1 0	3 5½		1 0	5 10	,,	1 0	4 10	
15	6 2		15	3 3		15	5 6	,,	15	4 7	
30	6 7		30	3 1½		30	5 3	,,	30	4 5	
45	7 6		45	3 0		45	5 0	,,	45	4 2	
2 0	8 5		2 0	2 11		2 0	4 9	,,	2 0	4 0	
15	9 5		15	2 10		15	4 7	,,	15	3 10	
30	10 6		30	2 8½		30	4 5	,,	30	3 8	
45	11 9		45	2 7½		45	4 3	,,	45	3 6	
3 0	12 10		3 0	2 6		3 0	4 1	,,	3 0	3 4	
15	14 0		15	2 5		15	3 11	,,	15	3 2	
30	15 1		30	2 3½		30	3 9	,,	30	3 0	
45	16 4		45	2 2		45	3 7	,,	45	2 10	
4 0	17 6		4 0	2 0½		4 0	3 5	,,	4 0	2 8	
15	18 8		15	1 10		15	3 3	,,	15	2 6	
30	19 11		30	1 9		30	3 1	,,	30	2 5	
45	21 0		45	1 8		45	3 0	,,	45	2 4	W.
5 0	22 0		5 0	1 7		5 0	2 11	,,	5 0	2 3	
15	22 10		15	1 6		15	3 8	,,	15	2 2	
30	23 6		30	1 5		30	6 2	,,	30	2 1	
45	24 2		45	1 4		45	8 0	W.N.W.	45	2 0	
6 0	24 7		6 0	1 2½	W.S.W.	6 0	9 8	,,	6 0	1 11	
15	24 10		15	1 1½		15	11 4	W.	15	1 10	
30	25 1		30	1 0½		30	12 8	,,	30	1 9	
45	25 2		45	0 11		45	13 7	,,	45	1 8	
7 0	24 11		7 0	0 10½		7 0	14 5	,,	7 0	1 7	
15	24 7		15	0 9½		15	15 0	W.S.W.	15	1 6	
30	24 0		30	3 8		30	15 5	,,	30	1 5	
45	23 3		45	4 6		45	15 7	,,	45	1 4	
8 0	22 7		8 0	5 7	W. by S.	8 0	15 8	,,	8 0	1 3	
15	21 8		15	6 3		15	15 6	,,	15	1 3	
30	20 10		30	6 7		30	15 1	,,	30	2 6	S.W.
45	19 11		45	7 0		45	14 3	,,	45	3 8	
9 0	19 0		9 0	7 3		9 0	13 6	,,	9 0	5 6	
15	18 1		15	7 6		15	12 8	,,	15	6 8	
30	17 2		30	7 7		30	11 11	,,	30	7 10	
45	16 1		45	7 5		45	11 4	,,	45	8 9	
10 0	15 2		10 0	6 9		10 0	10 8	,,	10 0	9 3	
15	14 3		15	6 2		15	10 1	,,	15	9 6	
30	13 4		30	5 8		30	9 7	,,	30	9 5	
45	12 4		45	5 4		45	9 2	,,	45	8 11	
11 0	11 6		11 0	5 0		11 0	8 9	,,	11 0	8 3	
15	10 9		15	4 10		15	8 5	,,	15	7 8	
30	9 11		30	4 8½		30	8 1	,,	30	7 2	
45 A.M.	9 2		45 A.M.	4 7		45 A.M.	7 9	,,	45 A.M.	6 6	

June 5.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
Noon.	8 4		Noon.	4 4	W.S.W.	Noon.	7 5	W.S.W.	Noon.	6 1	S.W.
12 15 P.M.	7 8		12 15 P.M.	4 2		12 15 P.M.	7 1	S.W.	12 15 P.M.	5 10	
30	7 0		30	4 0½		30	6 9	,,	30	5 6	
45	6 5		45	3 10		45	6 5	,,	45	5 4	
1 0	5 10		1 0	3 8½		1 0	6 2	,,	1 0	5 2	
15	5 5		15	3 7½		15	5 11	,,	15	4 9	
30	5 3		30	3 5¼		30	5 7	,,	30	4 7	
45	5 3		45	3 3¼		45	5 4	,,	45	4 5	
2 0	5 9		2 0	3 1½		2 0	5 1	,,	2 0	4 2	S.W.
15	6 7		15	3 0		15	4 10	,,	15	4 0	
30	7 7		30	2 10½		30	4 7	,,	30	3 9	
45	8 8		45	2 9		45	4 5	,,	45	3 7	
3 0	9 9		3 0	2 7		3 0	4 3	,,	3 0	3 5	
15	10 11		15	2 4		15	4 1	,,	15	3 3	
30	12 2		30	2 3		30	3 11	,,	30	3 1	
45	13 4		45	2 1½		45	3 9	,,	45	2 11	
4 0	14 6		4 0	2 0		4 0	3 7	,,	4 0	2 9	S.W.
15	15 11		15	1 11		15	3 5	,,	15	2 8	
30	17 2		30	1 9½		30	3 3	,,	30	2 7	
45	18 5		45	1 8½		45	3 1	,,	45	2 6	
5 0	19 8		5 0	1 7		5 0	3 0	,,	5 0	2 5	
15	20 9		15	1 6		15	2 11	,,	15	2 3	
30	21 9		30	1 4½		30	2 9	,,	30	2 2	
45	22 6		45	1 3		45	2 8	,,	45	2 1	
6 0	23 4		6 0	1 2½	S.W.	6 0	4 5	,,	6 0	2 0	
15	24 0		15	1 1¼		15	7 0	,,	15	1 11	
30	24 4		30	1 0		30	9 0	,,	30	1 10	
45	24 7		45	0 11½		45	11 0	,,	45	1 9	
7 0	24 8		7 0	0 11		7 0	12 5	,,	7 0	1 8	
15	24 9		15	0 10		15	13 4	,,	15	1 7	
30	24 6		30	0 9		30	14 1	,,	30	1 7	
45	24 1		45	0 8½		45	14 9	,,	45	1 7	
8 0	23 7		8 0	2 4		8 0	15 0	,,	8 0	1 6	
15	22 10		15	4 1		15	15 1	,,	15	1 6	
30	22 2		30	5 0		30	15 2	,,	30	1 5	
45	21 3		45	5 8½		45	15 0	,,	45	1 5	
9 0	20 6		9 0	6 1		9 0	14 6	,,	9 0	1 5	S.
15	19 7		15	6 7½		15	13 9	,,	15	3 6	
30	18 7		30	6 11		30	12 11	,,	30	5 3	
45	17 8		45	7 0		45	12 2	,,	45	6 6	
10 0	16 9		10 0	7 1½		10 0	11 5	,,	10 0	7 6	
15	15 8		15	6 8		15	10 10	,,	15	8 4	
30	14 9		30	6 3		30	10 4	,,	30	8 10	
45	13 9		45	5 10		45	9 10	,,	45	9 1	
11 0	12 11		11 0	5 6		11 0	9 4	,,	11 0	9 0	S.
15	12 1		15	5 2		15	8 11	,,	15	8 6	
30	11 2		30	4 10		30	8 6	,,	30	7 10	
45 P.M.	10 4		45 P.M.	4 7		45 P.M.	8 2	,,	45 P.M.	7 3	

June 6.—1864.

Hull.			Gainsborough.			Goole.			Naburn Lock.		
Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.	Time.	Tide.	Wind.
h m	ft. in.		h m	ft. in.		h m	ft. in.		h m	ft. in.	
12 0 A.M.	9 7		12 0 A.M.	4 4	S.	12 0 A.M.	7 10	S.W.	12 0 A.M.	6 8	
15	8 10		15	4 1		15	7 6	N.W.	15	6 3	
30	8 2		30	3 11		30	7 2	,,	30	5 10	
45	7 7		45	3 9		45	6 10	,,	45	5 6	
1 0	7 0		1 0	3 7		1 0	6 6	,,	1 0	5 3	
15	6 6		15	3 5		15	6 2	,,	15	5 0	
30	6 2		30	3 3		30	5 11	,,	30	4 9	
45	6 0		45	3 1		45	5 7	,,	45	4 6	
2 0	6 1		2 0	2 11½		2 0	5 4	,,	2 0	4 3	
15	6 8		15	2 10		15	5 1	,,	15	4 0	W.
30	7 6		30	2 8½		30	4 10	,,	30	3 9	
45	8 8		45	2 7		45	4 7	,,	45	3 7	
3 0	9 10		3 0	2 5½		3 0	4 5	,,	3 0	3 5	
15	11 1		15	2 4		15	4 3	,,	15	3 3	
30	12 3		30	2 2½		30	4 1	W.	30	3 1	
45	13 3		45	2 1		45	3 11	,,	45	2 11	
4 0	14 4		4 0	1 11½		4 0	3 9	,,	4 0	2 9	
15	15 7		15	1 10		15	3 7	,,	15	2 7	
30	16 9		30	1 9		30	3 5	,,	30	2 6	
45	18 0		45	1 8		45	3 3	,,	45	2 5	
5 0	19 3		5 0	1 7		5 0	3 1	,,	5 0	2 4	
15	20 6		15	1 5½		15	2 11	,,	15	2 3	
30	21 7		30	1 4		30	2 10	,,	30	2 2	
45	22 8		45	1 3		45	2 9	,,	45	2 1	
6 0	23 4		6 0	1 2½		6 0	4 0	,,	6 0	2 0	
15	24 1		15	1 2		15	6 0	,,	15	1 11	
30	24 7		30	1 1		30	8 3	,,	30	1 10	
45	24 11		45	1 0		45	10 3	,,	45	1 9	
7 0	25 2		7 0	0 11		7 0	12 0	,,	7 0	1 8	W.
15	25 5		15	0 10		15	13 3	,,	15	1 8	
30	25 5		30	0 9		30	14 0	,,	30	1 7	
45	25 0		45	0 8		45	14 9	,,	45	2 6	Deals [down.
8 0	24 7		8 0	0 7	W.N.W.	8 0	15 4	,,	8 0	2 3	
15	23 11		15	4 2		15	15 7	,,	15	1 9	
30	23 2		30	5 1½		30	15 9	W.N.W.	30	1 7	
45	22 5		45	5 9		45	15 7	,,	45	1 6	Deals up
9 0	21 6		9 0	6 5		9 0	14 9	,,	9 0	1 5	
15	20 7		15	6 11		15	13 11	,,	15	3 1	
30	19 8		30	7 2		30	13 1	,,	30	4 6	W.
45	18 9		45	7 5		45	12 4	,,	45	5 6	
10 0	17 10		10 0	7 8		10 0	11 7	,,	10 0	6 9	
15	16 10		15	7 8		15	10 11	,,	15	7 11	
30	15 10		30	7 1		30	10 4	,,	30	8 7	
45	14 10		45	6 7		45	9 10	,,	45	9 2	
11 0	14 0		11 0	6 0		11 0	9 4	,,	11 0	9 6	W
15	13 1		15	5 5		15	8 11	,,	15	9 4	
30	12 3		30	5 3		30	8 7	,,	30	8 11	
45 A.M.	11 5		45 A.M.	5 1		45 A.M.	8 3	,,	45 A.M.	8 2	

Deep-sea Dredging on the Coasts of Northumberland and Durham, in 1864. *Reported by* George S. Brady.

The following Report is intended to embrace notices only of the more interesting captures of the present year. Next year we hope to be able to lay before the section a general account of the results which have been obtained during the three years in which our dredging has been assisted by the grants of the British Association.

In the course of the summer, eight days have been spent in dredging—*two* of these on the Durham coast, and *six* off the northern shores of Northumberland. The weather, on the whole, was good, or at least such as not to put a stop to our operations, except during the two days spent on the Durham coast, on both of which we were unfortunately driven into harbour by violent gales rising suddenly and unexpectedly.

The Mollusca obtained this year are very poor, aud afford little to remark upon, the only species new to the district being *Chiton albus*, L., of which a single specimen was dredged off Holy Island. Some of the sand-covered Ascidians taken on the Durham coast require further examination. Two fine examples of *Stylifer Turtoni* were dredged off Holy Island, adherent to an *Echinus pictus.* With reference to this species, it may be mentioned that, though the dredges were put down, as we thought, on the very spot where we obtained, last year, abundance of *Echinus neglectus* (in some cases with Stylifers attached), this time not one specimen of the *Echinus* came up. There must have been plenty of it within a few yards of the dredge; for the nature of the locality, almost close beneath the cliffs of one of the Farne Islands, precluded the possibility of any great error in this respect.

Amongst stalk-eyed Crustacea the following deserve notice:—*Atelecyclus heterodon, Pagurus cuanensis, P. Hyndmanni*, and *P. ferrugineus, Crangon Allmani, C. spinosus, C. nanus*, and *C. fasciatus. Pagurus ferrugineus* and *Crangon fasciatus* are new to the district. The most important Amphipoda are the following: —*Lysianassa Costæ, Anonyx Holböllii, Haploops tubicola, Monoculodes carinatus, Westwoodilla cæcula, Protomedeia Whitei, Œdiceros parvimanus, Urothoë marinus, Dexamine vedlomensis, Calliope bidentata* (undescribed), *Eusirus Helvetiæ, Heiscladus longicaudatus, Cheirocratus Mantis* and *Unciola planipes*, the two last named being new species, descriptions of which, by the Rev. A. M. Norman, are appended to this Report. Of Ostracoda, besides *Cythere contorta* and *C. avena*, the following new species, also described by Mr. Norman, were taken:—*Cythere latissima, C. guttata, C. multifora, C. lævata, C. declivis, C. Bradii, Cythereis dunelmensis*, and *C. limicola.* A new Pycnogon, *Nymphon ruber*, Hodge, was got on the Durham coast, and is described in the Appendix. Thirty-two species of Echinodermata were obtained, and amongst them several species of great interest. Off Dunstanbro' were taken three specimens of *Antedon rosaceus*, a very rarely noticed inhabitant of our district, and several remarkably fine examples of *Ophiopholis aculeata.* A small *Echinus* exhibited by Mr. Norman at the Manchester Meeting of the British Association, and called by him *E. neglectus*, var. β, was taken abundantly. This, however, has claims to be regarded as a distinct species, and will be described by Mr. Norman from his Shetland specimens under the name of *Echinus pictus.* A single fine specimen of *Echinocardium pennatifidum*, Norman *, was dredged off Holy Island. This is the more interesting as the specimen

* This is the species described by the late Mr. Barrett from Shetland under the name of *Amphidetus gibbosus*, Agassiz (Ann. & Mag. Nat. Hist. 2nd ser. vol. xix. p. 33, pl. 7. fig. 2). It is not, however, Agassiz's species.

taken by Mr. Barrett, in Shetland, from which alone the species has been recognized as British, appears to have been lost. Three or four specimens of *Psolus squamatus* were taken off Holy Island.

Amongst Polyzoa, Mr. Alder reports the following as being new to the coast:—*Lepralia annulata* and *Tubulipora lobulata*. *Bugula Murrayana* was abundant, and appears to be pretty nearly confined to the east coast. Among Hydrozoa the most interesting captures were *Tubiclava cornucopiæ* (a new species lately described by Mr. Norman from specimens taken in Shetland), *Plumularia myriophyllum*, a rare species new to this coast, and *Halecium labrosum*.

Several fine Sponges were obtained off Dunstanbro', but these and the Foraminifera have not yet been examined.

Appendix.

Nymphon ruber, Hodge (nov. sp.).

"Body moderately stout. Lateral abdominal processes distant, once and a half as long as broad. Rostrum short, stout, not equal in length to the first joint of the footjaws. Palpi equal in length to the first joint of the footjaws. Legs long, furnished with strong spines: first and third joints equal; second as long as both; fourth longer than first; fifth longer than fourth; sixth longer than fifth. Tarsus as long as, or slightly longer than hand, with a strong spine at joint on the inner side. Hand slightly curved, with four large spines and a few hairs along the margin. Claw about half the length of the hand; auxiliary claws more than half the length of claw. Colour of body bright red; limbs banded with red."

Subfam. *Gammarides*, Bate & Westwood.

Genus *Cheirocratus* (χεὶρ, κράτος), Norman (nov. gen.).

Superior antennæ having a secondary appendage, shorter than the inferior. First gnathopods not subchelate; second subchelate and very large. Last pair of pereiopods very long. Telson deeply and widely cleft.

Cheirocratus Mantis, Norman (n. sp.).

Eyes irregularly round, of moderate size, placed between the bases of the antennæ. *Superior antennæ* not longer than four first segments of the body; the first joint of the peduncle much thicker than, but not quite so long as, the second; third joint half the length of the second: filament consisting of about twenty articulations, scarcely, if at all, longer than the peduncle. *Inferior antennæ* (imperfect in the typical specimen) having the peduncle greatly developed, the end of the penultimate joint reaching to half the length of the filament of the superior antennæ; the olfactory denticle is large, and there is a small spine on the lower side of the termination of the third joint. *First gnathopods* not subchelate; the propodos 3–4 times as long as broad; dactylos scarcely curved, broad, furnished with numerous short spines on the posterior margin. *Second gnathopods* having a long basis, which gradually widens towards the distal extremity, and is fringed anteriorly with very long simple hairs, and posteriorly with a few short and very minute hairs; carpus triangular, widening towards the extremity to receive the very large propodos, but not produced either above or below; propodos as long as the first three segments of the body, about two and a half times as long as broad, widest at the commencement of the palm, which is very oblique, occupies half the length of the propodos, and is furnished with three large tooth-like processes; dactylos strong, much curved, rather more than half the length of the palm, and having the inner margin simple. The basis of the last three pereiopods is about twice as long as broad, the anterior margin furnished with strong (spine-like) hairs, the posterior with very minute and slender hairs set in little notches. *Posterior pereiopods* very long, and having the propodos greatly developed and flat. The first pair of uropods extend considerably beyond the second; the last pair were mutilated. *Telson* so deeply and widely excavated in the centre as to appear double until closely examined, each portion having an obliquely truncate extremity terminating in spines. Lateral margins of 2nd and 3rd segments of pleon fringed with hairs, and produced posteriorly into a spine-like point. Fourth segment of pleon dorsally produced into two or three spines. Fifth segment having two dorsal spines on either side of the central line. Coxæ of all the legs shallow.

Genus *Unciola*, Say.

Superior antennæ with a minute secondary appendage; filaments of both pairs of antennæ multiarticulate. First gnathopods subchelate; second not subchelate. Telson squamiform, simple. Last uropods double-branched, very minute, scarcely longer than peduncle of the preceding pair, tipped with small spines. First two pairs of uropods having their branches truncate at the end, and furnished with strong spines.

Unciola planipes, Norman (n. sp.).

Superior antennæ with first joint of peduncle not so long as the second, and slightly longer than the third; filament (17-jointed) equal in length to the peduncle; secondary appendage very minute, consisting of a single joint only, and not longer than the first joint of the filament. *Inferior antennæ* with the peduncle equal in length to that of the superior, but the filament only half the length. First joint of peduncle much shorter than the second, which is of the same length as the third. *Head* rostrated. *First gnathopods* subchelate, beset on each margin with tufts of simple hairs; propodos slightly longer than the carpus (which has the distal angle rounded, and of equal width with the articulating propodos), somewhat ovate, and having the palm very oblique and undefined; dactylos simple, gently curved. *Second gnathopods* not subchelate; carpus and propodos much flattened, and fringed with thick-set hairs; dactylos small, springing from the inferior half of the truncated apex of the propodos, and immersed in a dense tuft of hair which springs from the upper portion of the distal extremity and from the sides of the propodos. *Dactyli* of the posterior pereiopods large and falciform, margined within with a row simple spines. *Body* very slender, and coxæ of all the legs very small; posterior lateral angles of first three abdominal segments produced into conspicuous teeth. No trace of an eye. Posterior uropods very minute, scarcely as long as the telson.

Cythere latissima, Norman (n. sp.).

Peach-stone-formed or shortly ovate, with a short central posterior projecting process; greatest height subcentral; length to breadth as one and a half to one; excessively tumid and gibbous. The ventral margins of the valves are produced into a conspicuous keel, on either side of which the carapace is extremely broad, the valves being projected directly outwards in the form of a strong ridge which externally bends outwards and downwards so as to reach below the level of the margin of the valves. The tumidity of the carapace in this part is excessive, and from thence the valves slope rapidly to the dorsal margin. End view triangular. Carapace white, opaque, punctate. Length one-third of a line.

Cythere guttata, Norman (n. sp.).

Ovate or peach-stone-shaped, slightly produced to a central point behind; greatest height and greatest tumidity before the centre; very tumid. Dorsal margin nearly straight in the centre, suddenly sloping posteally, and forming in conjunction with the infero-posteal similarly suddenly sloping margin a small truncated projection. Ventral margin slightly waved. Anterior extremity broadly rounded. Carapace excavated with large cells, which have a somewhat concentric arrangement. Length a quarter of a line.

Cythere multifora, Norman (n. sp.).

Oblongo-ovate, of nearly equal height throughout; length to breadth as two and a half to one; abruptly swollen immediately above the margin of the valves, and thence sloping to the dorsal margin. Dorsal and ventral margins nearly straight and subparallel; both extremities rounded. Dorsal view prismoidal (parallel-sided, with conical extremities). Carapace excavated with large, deep cells, which leave the interstices standing out in the form of an elegant network. Junction of the valves keeled. Length one-fourth of a line.

Cythere lævata, Norman (n. sp.).

Oblongo-ovate, highest before the middle at the commencement of the supero-anteal slope; length to breadth as one and three-quarters to one; moderately convex. Ventral margin slightly concave on the anterior half, and convex posteriorly; dorsal margin nearly straight, the anterior slope the longer. Anterior extremity well rounded, gradually arched into the superior margin above, more suddenly rounded below. Posterior extremity slightly produced centrally; the superior and inferior slopes nearly equal. Lucid spots consisting of four oblong impressions in a transverse line, and a semicircular spot in front. Carapace white, smooth, polished, with a few small scattered punctures; valves bordered by a keel-like fillet, which is more conspicuous behind. Length not one-third of a line.

Cythere declivis, Norman (n. sp.).

Subtriangular, closely resembling a miniature *Mytilus edulis* in form; highest before the middle; length to breadth as about one and three-quarters to one; subcompressed. Ventral margin slightly (rarely considerably) incurved in the centre; dorsal margin anteriorly well arched, but sloping rapidly from about the middle towards the posterior extremity. Anterior end wide and well rounded; posterior extremity narrow, rounded. Lucid spots consisting of four, placed close together in a transverse curved line (of which the lowest is the largest, and each of those above smaller than its predecessor); and in front of these a large comma-formed spot, apparently formed by the coalescence of two. Ventral view cuneiform, moderately convex behind, much compressed in front; juncture of the valves impressed. Carapace white, translucent, smooth, but marked with conspicuous opaque-white, scattered punctures; anterior margin with radiating rib-like markings. Length not quite one-third of a line.

Cythere Bradii, Norman (n. sp.).

Oblongo-ovate, of nearly equal height throughout; length to breadth as two and a half to one; very tumid. Ventral margin nearly straight, very slightly incurved a little before the middle; dorsal margin subparallel to ventral, having a nearly equal slope at the two extremities, the anterior of which is well and equally rounded, while the posterior, which is slightly the wider of the two, and a little more produced below, has the dorsal curve much longer than the ventral. Lucid spots consisting of a transverse row of four placed close to each other, and two others at some distance in advance of these, and separated from each other. Dorsal view elongated ovate. End view nearly round. Hinge-margin crenulated throughout its length. Carapace white, smooth, but studded with scattered opaque-white punctures. Length half a line.

Cythereis Dunelmensis, Norman (n. sp.).

Oblong. Dorsal and ventral margins straight, but not parallel, gradually inclining towards each other from the broad, well-rounded anterior extremity to the rectangularly truncate posterior end. Surface of valves excavated with cells, the interstices between which stand out as a network. Carapace margined in front by a row of bead-like spines; posteal extremity of ventral margin bearing four large, semierect, flattened, linguiform processes; other parts of the surface are also armed with small spines, conspicuous among which is a tubercular spine at the anterior extremity of the hinge-line. Length half a line.

Cythereis limicola, Norman (n. sp.).

Oblong, short; greatest height at the commencement of the antero-dorsal slope; length to breadth as one and three-quarters to one; subcompressed. Ventral margin straight; dorsal having a long anterior slope from the highest point, and a gradual downward inclination from the same point posteriorwards. Anterior extremity wide, rounded; posterior extremity rather narrower and subtruncate. Carapace having a greatly elevated longitudinal rib a little within the ventral margin, from the anterior extremity of which about three smaller ribs or crenations proceed divergingly to the front of the valve; there are also two nodular humps placed side by side near the posterior termination of the hinge-margin. Length about one-fourth of a line.

An Account of Meteorological and Physical Observations in Nine Balloon Ascents made in the years 1863 *and* 1864 (*in continuation of thirteen made in the year* 1862 *and first part of* 1863), *under the auspices of the Committee of the British Association for the Advancement of Science, by* James Glaisher, *F.R.S., at the request of the Committee, consisting of Colonel Sykes, the Astronomer Royal, Lord Wrottesley, Sir D. Brewster, Sir J. Herschel, Dr. Lloyd, Admiral FitzRoy, Dr. Lee, Dr. Robinson, Mr. Gassiot, Mr. Glaisher, Prof. Tyndall, Dr. Fairbairn, and Dr. W. A. Miller.*

The Committee on Balloon Experiments was appointed last year for the following purposes:—

1st. To examine the electrical condition of the air at different heights.

2nd. To verify the law of the decrease of temperature, and to compare the constants in different states of the atmosphere.

With respect to the first of these objects, no progress whatever has been made in the past year, with the exception of preparing an instrument and apparatus for the investigation.

At the request of the Committee Mr. Fleeming Jenkin kindly undertook to superintend the construction of the instrument best adapted for the purpose, but it unfortunately happens that no flame or fire of any kind can be admitted into the car of the balloon for fear of igniting the gas, and this instrument, which was furnished a little before the end of the year 1863, was constructed to be used with fire. It therefore had to be altered so that it could be used with water, but is not yet quite in a state for observation.

It happens unfortunately that electrical experiments in balloons necessitate the use of one constant flow of water, and occasionally of two flowing at the same time, just below the car of the balloon.

The Committee felt that the presence of water but little removed from the instruments, if exercising no influence when the balloon was rising, might exercise such an influence on the balloon falling and passing through the just moistened atmosphere as to throw a very considerable doubt on some of the experiments, particularly on those relating to the humidity of the air (a primary object of research), that I was requested to defer taking them, that no doubt might rest on the results, till our knowledge on this subject was much increased.

The Committee consider that the general laws on the humidity of the air have now so advanced, that electrical experiments may now be included, providing that such observations can be made with safety to ourselves.

With respect to the second of these objects, viz. verifying the law of the decrease of temperature in different states of the atmosphere. The Committee considered that this would be best attained by taking as many observations as possible, at times in the year and at times in the day at which no experiments had been made, for the purpose of determining whether *the laws which hold good at one time in the year, hold good at other times in the year,* and also to determine whether the laws which hold good at noon, apply equally well at all other times in the day.

The Committee at all times have pressed on me the importance of magnetic observations in the higher regions of the atmosphere, the Astronomer Royal suggesting the use of a horizontal magnet, and taking the times of its vibration at different elevations, a method which is seldom practicable, owing to the balloon almost constantly revolving on its own axis. To obviate the effect of this, Dr. Lloyd suggested the use of a dipping-needle placed horizontal when on the ground by means of a magnet adjustible above it, so that when in the balloon the deviation from horizontality might be readily noticed, and which deviation would be independent of the revolving motion of the balloon, and could thus be noticed at any instant.

I have been unable to attempt the latter method, as Dr. Lloyd wished some experiments to be made before the instrument should be constructed.

At Newcastle a very general wish was expressed by the Members of the Council that I should not ascend to heights exceeding 4 or 5 miles. To this I readily consented, because for the most part, from the preceding experiments, all the observations above 5 miles could have been inferred from those made below 5 miles; and there was another reason, that the balloon, after the many rough descents, had become, in Mr. Coxwell's opinion, too unsafe for extreme high ascents.

I have therefore no report to give upon any extreme high elevation attained during the past year, yet new facts and new physical conditions have become known in some of the nine ascents upon which I have to speak.

§ 1. Instruments and Apparatus.

The instruments used were for the most part the same in construction with those of the two preceding years, consisting of mercurial and aneroid barometers; Daniell's and Regnault's hygrometers; maximum and minimum thermometers, blackened bulb thermometers, both free and enclosed in vacuum tubes; Herschel's actinometer;—all these instruments have been frequently in the hands of Mr. Zambra, who superintended their replacement when broken, and their perfect order at all times; two spectroscopes, one lent by the Astronomer Royal, the other by Mr. Simms; a magnet for horizontal vibration; large caoutchouc bags, furnished by Professor Tyndall, for collecting air at high elevations, ozone-papers, &c.

In all the highest ascents both a mercurial and an aneroid barometer (the one which was used on the ascent of September 5, 1862), and which was found to read in close accordance with the mercurial barometer to very low readings, were used; in the ascents to moderate elevations, the same aneroid was used alone, it being examined both before and after the ascents, with the mercurial barometer, and occasionally with the mercurial barometer when placed in an exhausted receiver under an air-pump.

§ 2. Observing Arrangements

Were precisely similar to those in previous years; viz. in the high ascents, a board was placed across the car which carried the several instruments, so placed as to be readily read by myself, seated at one end of the car, with my face towards Mr. Coxwell; in the other ascents, when a smaller number of instruments were used, they were placed upon a board projecting beyond the car, easily read by myself standing at one end, with my back to Mr. Coxwell.

Circumstances of the Ascents, and General Observations.

The ascents to April 6 were made by the same balloon as all the preceding ascents; those on June 13, 20, and 27 by a new and larger balloon, and that on August 29 by the old balloon.

Ascent from Newcastle, August 31, 1863.—The situation of Newcastle, as regards the Tyne and the sea, is such as to cause anxiety in respect to any balloon ascent from there.

The balloon left the earth at $6^h\ 12^m$ p.m.; the wind was North; in 4 minutes we were over the High-Level Bridge, at an elevation of 1800 feet; we passed over Gateshead at $6^h\ 21^m$, being 1 mile from the earth, and in 10 minutes afterwards the height of $1\frac{3}{4}$ mile was reached.

We continued nearly at this level for some little time, and then began our downward journey; passed into cloud at $6^h\ 54^m$ at the height of 1600 feet, out of it at 1800 feet, in cloud again at 2000 feet, then turned to descend, passing again through clouds at 1900 feet. At $6^h\ 57^m$ we saw Durham Cathedral, and reached the ground at 5 minutes past seven at Pittington, near Durham.

The colours of the clouds observed in this ascent are very remarkable:—

At $6^h\ 32^m\ 30^s$, at 7912 feet high, the colours of the clouds in the east opposite to the sun were as follows:—the upper layer brown; next below bluish black, then a darker bluish black; lower still, a thin layer of white cumulo-stratus, next a greenish brown resting on uniform white rocky clouds.

At $6^h\ 35^m\ 30^s$, at 7329 feet, the colours of the clouds in the west, or under the sun, were as follows:—the upper layer was brown, the second dark blue, under which was a whitish-greyish black resting on uniform white rocky cumulus clouds.

At $6^h 37^m 10^s$, at the height of 6981 feet, the colours of the clouds in the south were:—the top layer brown, under which was bluish brown, then rocky-brown cumulostratus, below bluish black resting on a base of rocky cumulus.

At $6^h 43^m$, peaks after peaks, apparently rising up to our level, and clearly defined against the sky; cloud with a little red in it not opposite to the sun.

At $6^h 54^m 10^s$, at the height of 1580 feet, colours of clouds were as follows: —top layer deep greenish blue; next bluish black, below green rocky clouds, then slightly rocky cumulus clouds.

Ascent from Wolverhampton, September 29, 1863.—The gas used on this occasion was specially prepared in the month of July, as a high ascent was arranged to have taken place before the Meeting of the Association last year, but circumstances prevented it, and the Directors of the Gas Works had most obligingly devoted a gasometer to our use from July to September, much to their own inconvenience.

The balloon was filled the preceding day, and watched all night. On leaving, Lord Wrottesley quietly said, "Beware of the Wash," at the same time pressing my hand, and repeating, "Beware of the Wash; I fear that is your direction." We left the earth at $7^h 43^m$ a.m. with a cloudy sky and a south-west wind. At $7^h 52^m$, at the height of 3000 feet, the sun's disk was seen, and the earth was obscured by mist.

At $8^h 4^m$, at the height of 6000 feet, clouds were situated both above and below; at $8^h 18^m$, at the height of 8200 feet, there were two layers of clouds below us, and very dense clouds still far above.

When at 11,000 feet clouds were still a mile higher; there was a beautiful sea of cloud below with a blue tinge over its surface, and the peeps of the earth as seen through the breaks in the clouds were beautiful, having a purple hue; when at 13,000 feet, clouds were still at a higher elevation, and after this they began to dissipate; and at $9^h 38^m$, at 14,000 feet, the sun shone brightly, and we thought we might gradually approach a height of 5 miles, and remain in the higher regions till after noon, so that I might make a series of actinometer and blackened bulb observations; but, to our deep regret, at $9^h 48^m$ we found ourselves moving directly for the Wash, as seen through a break in the lower clouds, at an estimated distance of 10 miles only, and we were compelled to begin our descent; at $10^h 19^m$, at the height of 3000 feet, we saw by the bending of the trees that a gale of wind from the south was blowing on the earth, and we had a rough descent, being drawn over hedges, across fields and ditches; indeed so strong was the wind that the balloon was torn from top to bottom, and was very much injured, but it was only by the almost destruction of the balloon that its course was stopped; we ourselves escaped with slight injuries.

Ascent from the Crystal Palace, October 9, 1863.—The balloon left the Crystal Palace at $4^h 29^m$ p.m.; in 4 minutes it was 2500 feet high; at $4^h 46^m$ was 7300 feet, and directly over London Bridge, at which height with one glance the vast number of buildings comprising the whole of London could be seen, some so plainly that the plans of their inner courts could have easily been drawn; in this situation it was difficult to persuade oneself that that small building directly under us was the Cathedral of St. Paul's; we then gradually descended to 2300 feet at $5^h 15^m$, ascended to 3600 feet by $5^h 24^m$, and descended again to 1500 feet by $5^h 36^m$; ascended to 8600 feet by 6^h, and reached the earth by 6^h 40^m at Pirton Grange on the boundaries of Hertford and Bedford.

Ascent from Woolwich Arsenal, January 12, 1864.—The Secretary of State for War, the Right Hon. Earl de Grey and Ripon, having kindly granted permission to the Committee of the British Association to avail themselves of the facilities afforded in the Royal Arsenal, Woolwich, for future balloon ascents for scientific purposes, the ascent took place from there. The ascent was intended to have been made on December 21, the day of the winter solstice, and from this time to the end of the year the balloon was frequently partially inflated: on December 30 it was filled, but its completion was at too late an hour to ascend; it was left filled in the care of watchmen, but a strong wind arose at night, and it was driven against a gasometer, and so injured as to require repairing, and it was not till January 12 that we succeeded.

The balloon on this day left the earth at 2^h 7^m p.m.; in 3 minutes the height of 1500 feet was attained; at 2^h 14^m we crossed the Tilbury Railway line, and in 7 minutes afterwards we were over Hainault Forest; at 2^h 26^m 3000 feet was reached; the first mile was passed at 2^h 32^m, the second at 3^h 24^m, and the height of 12,000 feet was attained by 3^h 31^m. The balloon then began to descend and touched the ground at 4^h 10^m, at Lakenheath Warren, near Brandon, the descent not having taken one-half the time of ascent.

On the earth the wind was S.E.; at the height of 1300 feet we entered a strong S.W. current; we continued in this current till we reached a height of 4000 feet, when the wind changed to the south; and after some little time we determined upon ascending. At the height of 8000 feet the wind changed to S.S.W.; at the height of 4000 feet the wind changed to S.S.E.; at 11,000 feet we met with fine granular snow; passed through snow on descending till we were within 8000 feet of the earth; entered clouds at 7000 feet, and passed out of them at about 6000 feet into mist.

Ascent from Woolwich Arsenal, April 6, 1864.—This ascent was intended to be made as near March 21 as possible; but although frequent attempts were made, it was not till April 6 that we succeeded.

The balloon left Woolwich on this day at 4^h 7^m p.m., with a south-east wind; in 9 minutes, when at the height of 3000 feet, we crossed over the River Thames, ascending very evenly at the rate of 1000 feet in little more than 3 minutes, till 11,000 feet was attained at 4^h 37^m, and descended at about the same rate till within 1500 feet of the earth, when the rapidity of the descent was checked, reaching the ground at 5^h 25^m, on the outskirts of a pine plantation in Wilderness Park, near Sevenoaks, in Kent.

Our course in this ascent was most remarkable; having first passed over the River Thames into Essex, we must have repassed and moved in a directly opposite direction, and continued thus till we approached the earth, when we again moved in the same direction as at first.

After the great injury to the balloon on September 29, in addition to the numbers of repairs that it had previously needed, it was not, when again repaired, in such a condition as (in Mr. Coxwell's opinion) to be quite safe to ourselves for extreme high ascents; and after those of January 12 and April 6, having been made at a time of year that any balloon would be most severely tested, Mr. Coxwell determined, before venturing again with myself to any great elevation, to build a new balloon.

This he did, and one of a capacity capable of containing 10,000 cubic feet more than the old one, so that, if need be, two observers could ascend together to the height of 5 miles.

A new balloon, however, needs trying in low ascents till it proves to be gas-tight, before it can be used for great elevations.

Ascent from the Crystal Palace, June 13, 1864.—On this ascent the balloon left the grounds of the Crystal Palace at 7 o'clock. The sky was cloudless, and the air perfectly clear, excepting in the direction of London.

An elevation of 1000 feet was reached in $1\frac{1}{4}$ minute; 3000 feet was attained at $7^h\ 8^m$, when the balloon turned to descend, and passed down to 2300 feet by $7^h\ 13^m$; on reascending, 3400 feet was gained at $7^h\ 20^m$; after taking a slight dip, it again ascended to 3550 feet (the highest point) by $7^h\ 28^m$; then descended to 2500 feet, and after several small ascents, began the downward journey at $7^h\ 50^m$ from the height of 2800 feet, reaching the ground at East Horndon, 5 miles from Brentwood, at $8^h\ 14^m$.

Ascent from Derby, June 20, 1864.—The balloon left Derby at 17 minutes past 6^h p.m.; at $6^h\ 30^m$ the height of 1000 feet was reached, the next 1000 feet being passed in half a minute; then ascended less rapidly; cloud was entered at $6^h\ 26^m$, 3600 feet being gained, and 4000 feet at $6^h\ 30^m$; descended to 2700 feet by $6^h\ 36^m$, being over Ilkeston; Nottingham, and its race-course were visible at $6^h\ 41^m$; we then reascended to 4300 feet at $6^h\ 50^m$; on descending, passed over Southwell at $6^h\ 56^m$, and touched the ground at $7^h\ 16^m$ on a farm at Norwell Woodhouse, near Newark.

Ascent from the Crystal Palace, June 27, 1864.—The balloon left the grounds of the Crystal Palace at $6^h\ 33\frac{1}{2}^m$; the sky was cloudy, and the wind was blowing from the West.

At $6^h\ 38^m$, when 1000 feet from the earth, we crossed over Penge, reached 1500 feet high at $6^h\ 43^m$, descended to 800 feet by $6^h\ 48^m$, being over Shortlands; ascended to 1200 feet by $6^h\ 52^m$, being over Hayes Common; remained at about this elevation for 8 minutes, descended about 300 feet, and then ascended to 4200 feet by $7^h\ 16^m$; descended 1000 feet slowly, and reascended to the height of 5000 feet by $7^h\ 42^m$; began to descend, passing over the left of Tonbridge, near the village of Hudlow, and over the Medway on reaching 2400 feet at $8^h\ 8^m$; we then ascended 1200 feet, and began to descend again at $8^h\ 15^m$, passing between Hawkhurst and Cranbrook; were within 600 feet of the earth at $8^h\ 55^m$, being nearly over Tenterden; we then reascended, and in 13 minutes had attained an elevation of 6000 feet, and reached the earth at $9^h\ 21^m$ in Romney Marsh, about half a mile from Cheyne Court, 4 miles from Lydd, and 5 miles from the coast.

These several trial trips of the new balloon were made, and it had gradually become gas-tight, and capable of any work required, when at Leicester, I regret to say, it was destroyed with all its appurtenances.

One would scarcely believe it possible that such an act could take place in the centre of England in the present day, but it was so destroyed, and effectually stopped all the prearranged experiments. The Mayor of Leicester has presided over meetings for the purpose of collecting subscriptions to assist Mr. Coxwell to rebuild a new balloon, which I hope will help to remove the stigma now resting upon Leicester; and I trust the Foresters will also help to remove the stain now resting upon them; for if not the act of the Foresters themselves, it was at one of their gatherings, under their superintendence, and the destruction of the balloon was not, so far as I can learn, attempted to be stopped by those Foresters present.

Mr. Coxwell then had recourse to the old balloon, which he had repaired as best he could, and the next and last ascent of which I have to speak took place.

Ascent from the Crystal Palace, August 29, 1864.—At $4^h\ 6^m\ 30^s$ the balloon rose from the Crystal Palace, passing the first 3000 feet in 4 minutes, after which it did not rise so rapidly. At $4^h 36^m$, at the height of 11,000 feet, it was over Lewisham; at $4^h 42^m$ nearly stationary; over Charlton at $4^h 46^m$, and Woolwich at $4^h 50^m$ when at the height of 13,500 feet. It then began to descend; was over Erith at $5^h 9^m$, moving quickly, crossed over the river at $5^h 18^m$, and reached the ground at $6^h 32^m$ at Wybridge, near Rainham, in Essex.

§ 3. Description of the Table of Observations.

All the meteorological observations taken during the ascents are contained in Table I.

Column 1 contains the times at which the observations were made. Column 2 contains observations of the siphon barometer corrected for temperature and index error. Column 3 contains the readings of the thermometer attached to the barometer. Column 4 contains the readings of an aneroid barometer. Column 5 contains the height above the level of the sea, as reduced from the barometric readings in column 2 on the days the siphon barometer was used, and from column 4 on other days, by the formula of Baily, checked at intervals by that of Laplace, which is as follows:—

$$Z=\log\left(\frac{h}{h'}\right)\times 60159\left(1+\frac{t+t'-64}{900}\right)\left(1+0{\cdot}002837\cos 2\,\mathrm{L}\right)\left(1+\frac{z+52251}{20886900}\right),$$

where Z is the height required, and h, h', t and t' the height of the barometer corrected for temperature, and the temperature of the air at the lower and upper stations respectively, L the latitude. The temperature of the air for the position of the balloon has been derived from the readings in column 10, when such have been taken, otherwise from column 6. Columns 6 to 9 contain the observations with the dry- and wet-bulb thermometers free, and the deduced dew-point. Column 10 contains the readings of a gridiron thermometer. Columns 11 to 14 contain the observations with the dry- and wet-bulb thermometers aspirated, and the deduced dew-point. Columns 15 and 16 contain the direct dew-point observations with Daniell's and Regnault's hygrometers. When numbers are entered in columns 15 and 16 with "no dew" affixed to them, it is meant that the temperature of the hygrometer has been lowered to the degree stated, but that no dew has been deposited. Column 17 contains the readings of a very delicate blackened bulb thermometer fully exposed to the sun's rays.

The Astronomer Royal had observations made every 10 minutes at the Royal Observatory, Greenwich, on five days of ascents; Lord Wrottesley had observations made by Mr. Hough at Wrottesley Observatory on the ascent from Wolverhampton; E. J. Lowe, Esq., had observations made at Beeston Observatory for the ascents at Wolverhampton and Derby; and observations were made at my house at Blackheath by Messrs. Yair and Howe on June 27 and August 29.

In calculating the height of the balloon, the observations made at the Philosophical Society's Rooms, Newcastle, have been employed for August 31; those at Wrottesley for September 29; those at the Royal Observatory for October 9, 1863, January 12, April 6, June 13, and June 27, 1864; those at Nottingham for June 20; and those at Blackheath for August 29, 1864.

The height of Greenwich above the mean sea-level=159 feet.
The height of Wrottesley above the mean sea-level=531 feet.
The height of Newcastle above the mean sea-level=121 feet.
The height of Nottingham above the mean sea-level=174 feet.
The height of Blackheath above the mean sea-level=160 feet.

TABLE I.—Meteorological Observations made in the Fourteenth

References to Notes.	Time.	Siphon Barometer.		Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther.	
		Reading corrected and reduced to 32° Fahr.	Att. Therm.			Dry.	Wet.
	h m s	in.	°	in.	feet.	°	°
	6 0 0 p.m.	29·70	......	......	ground	64·0	60·0
	6 6 0 „	29·70	......	......	ground	64·0	60·0
	6 7 0 „	29·70	......	......	ground	64·0	60·0
(1)	6 12 0 „	29·55	......	......	196	56·0	54·0
(2)	6 13 0 „	29·30	......	......	422	56·0	53·5
(3)	6 13 30 „	......	......	......	(650)		
(4)	6 13 40 „						
	6 14 0 „	28·80	......	......	874	55·5	53·0
	6 14 20 „	28·64	......	......	1,109	54·2	52·1
(5)	6 14 30 „	28·50	......	......	1,145	53·5	51·2
(6)	6 14 40 „	......	......	......	(1,262)		
(7)	6 15 0 „	......	......	......	(1,496)		
(8)	6 15 40 „	27·70	......	......	1,963	51·5	49·0
	6 16 0 „	27·40	......	......	2,270	50·5	48·5
	6 17 0 „	27·00	......	......	2,670	50·5	47·2
(9)	6 17 40 „	......	......	......	(2,737)		
	6 18 0 „	26·90	......	......	2,770	47·8	45·1
	6 18 30 „	26·42	......	......	3,263	47·2	44·0
	6 18 40 „	26·00	......	......	3,694	46·0	42·1
	6 18 50 „	25·92	......	......	3,778	45·2	41·1
	6 19 0 „	25·55	......	......	4,167	45·2	40·5
	6 20 0 „	25·30	......	......	4,425	45·0	40·5
	6 20 20 „	25·10	......	......	4,632	43·5	38·8
(10)	6 20 30 „	24·85	......	......	4,907	43·0	38·2
	6 20 40 „	24·48	......	......	5,403	42·0	37·1
	6 21 10 „	24·00	......	......	5,844	40·0	35·5
(11)	6 21 30 „	23·50	......	......	6,404	37·0	32·5
	6 22 0 „	23·30	......	......	6,627	35·5	30·5
	6 22 30 „	23·00	......	......	6,963	35·0	29·0
	6 23 0 „	22·95	......	......	7,022	34·5	29·0
(12)	6 23 30 „	22·90	......	......	7,080	34·0	28·5
	6 24 0 „	22·70	......	......	7,315	34·0	28·7
	6 24 10 „	22·65	......	......	7,374	33·9	28·5
	6 25 0 „	22·50	......	......	7,549	33·5	27·8
(13)	6 25 40 „	......	......	......	(7,629)		
(14)	6 27 0 „	22·30	......	......	7,790	34·0	28·5
	6 27 50 „	22·30	......	......	7,790	34·0	28·5
	6 28 0 „	22·20	......	......	7,912	34·0	28·5
	6 28 30 „	22·20	......	......	7,912	34·0	28·5
	6 29 0 „	22·20	......	......	7,912	34·0	28·5
	1.	2.	3.	4.	5.	6.	7.

NOTES AND

(1) Left the earth a few seconds earlier.
(2) Over suburbs of Newcastle.
(3) Heard people shouting.
(4) Over Manors railway station.
(5) Entering cloud.
(6) Above clouds.
(7) Over the Tyne; cumulus below in detached masses.

(8) Tynemouth very clear; cumulus and scud far below; sun shining beautifully on the balloon; over Newcastle; lower clouds moving apparently faster than we are; railway whistle heard; can see an island in the Tyne higher up than Newcastle; hear loud buzzing noise.

(9) Passing over the High Level Bridge. Can see masts of ships in Tyne; cumulus in white heaps on our level; sun shining on some clouds and not on others; can see fields and houses through distant break in clouds; gas cloudy.

Balloon Ascent, from Newcastle, August 31, 1863.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
4·0	56·7	64·0	......	......	......	......	57·0		
4·0	56·7	64·0							
4·0	56·7	63·8							
2·0	52·1								
2·5	51·1								
2·5	50·6								
2·1	50·0								
2·3	48·5	53·5							
2·5	46·4	......	......	......	......	......	......	......	52·0
2·0	46·4	......	......	......	......	......	48·0		
3·3	43·7								
2·7	42·3	47·8							
3·2	40·4	......	......	......	......	......	45·0		
3·9	37·6								
4·1	36·4								
4·7	35·0	......	......	......	......	......	......	......	46·0
4·5	35·3								
4·7	33·7	......	......	......	......	......	34·0		
4·8	32·4								
4·9	31·1	......	......	......	......	......	......	......	42·5
4·5	29·6	40·0	......	......	......	......	30·0		
4·5	26·1								
5·0	22·5	......	......	......	......	......	25·0		
6·0	19·4								
5·5	19·3								
5·5	18·0								
5·3	19·4	......	......	......	......	......	......	......	37·0
5·4	19·0	34·0	......	......	......	......	22·0		
5·7	17·1								
5·5	18·8								
5·5	18·8								
5·5	18·8	......	......	......	......	......	19·5		
5·5	18·8	34·0	......	......	......	......	20·0		
5·5	18·8								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

General Remarks.

(10) No ozone; cumulus in beautiful hills. Over Gateshead; balloon full; cirrocumulus above us at angles of 45° and 75°; cumulus far above, the same as on July 21st, 1862.

(11) Cirrus above; balloon quite full; gas coming out; opened valve; Tyne visible almost to its source; clouds piled up in heaps around, above, and below us, peak upon peak; a very dark cloud with a little blue in it.

(12) Wind blowing in our faces; clouds piled up in heaps around us; blue sky above us; opened valve.

(13) Undoing the grapnel; cirrus, cirrocumulus, and a blackish-brown stratus above; clouds of all shapes and sizes; masses of cumulus in distorted forms.

(14) Let grapnel down; can see Newcastle.

TABLE I.—Meteorological Observations made in the Fourteenth

References to Notes.	Time.	Siphon Barometer. Reading corrected and reduced to 32° Fahr.	Siphon Barometer. Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther- Dry.	Dry and Wet Ther- Wet.
	h m s	in.	°	in.	feet.	°	°
	6 29 30 p.m.	22·10	......	......	8,033	34·0	28·5
(1)	6 29 50 „	......	......	......	(8,033)		
	6 31 0 „	22·10	......	......	8,033	34·0	28·5
	6 32 0 „	22·20	......	......	7,912	34·0	28·5
(2)	6 32 30 „	22·20	......	......	7,912	34·0	28·5
	6 33 0 „	22·35	......	......	7,770	35·0	30·0
(3)	6 33 30 „	......	......	......	(7,696)		
	6 34 0 „	22·45	......	......	7,621	36·0	32·0
(4)	6 35 0 „	......	......	......	(7,480)		
	6 35 30 „	22·70	......	......	7,327	36·5	32·0
	6 36 0 „	22·90	......	......	7,124	37·2	33·1
(5)	6 37 0 „	23·00	......	......	7,022	38·0	33·5
	6 37 10 „	......	......	......	(6,980)		
(6)	6 37 30 „	23·10	......	......	6,898	38·5	34·2
(7)	6 38 30 „	23·32	......	......	6,626	38·3	34·2
	6 39 0 „	23·50	......	......	6,404	38·2	34·2
	6 40 0 „	23·65	......	......	6,233	38·5	34·2
	6 40 10 „	23·70	......	......	6,176	38·5	34·5
	6 42 0 „	23·95	......	......	5,891	38·2	35·1
	6 42 30 „	24·40	......	......	5,389	38·5	35·0
(8)	6 43 0 „	24·40	......	......	5,389	38·5	35·0
	6 43 30 „	24·55	......	......	5,235	38·5	34·8
(9)	6 44 20 „	......	......	......	(4,927)		
(10)	6 44 30 „	24·92	......	......	4,865	39·0	36·1
(11)	6 45 0 „	25·00	......	......	4,784	39·5	37·2
(12)	6 45 30 „	25·30	......	......	4,452	39·5	37·1
(13)	6 46 0 „	25·50	......	......	4,231	40·5	37·8
(14)	6 46 15 „	25·70	......	......	4,009	41·5	38·5
(15)	6 47 0 „	25·90	......	......	3,787	42·1	40·5
(16)	6 47 10 „	......	......	......	(3,685)		
	6 47 30 „	26·20	......	......	3,480	42·1	40·8
	6 48 0 „	26·41	......	......	3,264	42·8	41·2
	6 48 10 „	26·65	......	......	3,018	43·1	42·8
(17)	6 48 20 „	26·71	......	......	2,957	43·8	42·1
(18)	6 48 30 „	......	......	......	(2,908)		
	6 49 0 „	26·90	......	......	2,762	44·1	43·0
	6 49 30 „	27·20	......	......	2,466	45·2	44·1
	6 49 45 „	27·35	......	......	2,317	45·2	45·0
	1.	2.	3.	4.	5.	6.	7.

(1) Cricket ground at Newcastle, the place we left, visible; rainbow seen between lower cumulus and upper clouds; sense of warmth; small patches of cirrus.

(2) Can see rainbow again; over cumulus in rocky heaps; sun shining on us; can see Newcastle through break in clouds. Colour of clouds opposite to the sun: Top (1) brown stratus; (2) bluish-black stratus; (3) darker bluish-black stratus; (4) thin layer of white cumulostratus; (5) greenish-brown stratus; (6) uniform rocky clouds forming the base of everything. (3) Blue sky above; wind felt in our face.

(4) Uniform rocky clouds below us. Colour of clouds under the sun: Top (1) brown stratus; (2) dark-blue stratus; (3) whitish-greyish black stratus; (4) uniform rocky cumulus.

(5) Perfectly quiet; cumuli visible, apparently resting on the earth. Colour of clouds opposite to the sun: Top (1) brown stratus; (2) bluish-brown stratus; (3) rocky brown cumulostratus; (4) bluish-black stratus; (5) uniform base of rocky cumulus.

(6) Losing sight of the sun; beautiful gilded edge of clouds visible; travelling along over a line of railway in the direction of Durham; wind gentle; no ozone; can see fields with sheaves of corn through a break in the clouds.

Balloon Ascent, from Newcastle, August 31, 1863.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
5·5	18·8								
5·5	18·8								
5·5	18·8	......	......	......	......	......	19·5	......	37·0
5·5	18·8								
5·0	22·0								
4·0	26·0	......	......	......	......	......	......	......	39·0
3·5	25·3								
4·1	27·3								
4·5	27·4	38·0	......	......	......	......	28·0	......	39·0
4·3	28·4	......	......	......	......	......	......	......	38·2
4·1	28·6								
4·0	28·8								
4·3	28·4								
4·0	29·0								
3·1	31·0	......	......	......	......	......	31·5		
3·5	30·3	......	......	......	......	......	......	......	39·0
3·5	30·3								
3·7	29·8								
2·9	32·2	39·2							
2·3	34·3								
2·4	34·0								
2·7	34·8								
3·0	33·7	41·6	......	......	......	......	35·0	......	42·0
1·6	38·5								
1·3	39·2	......	......	......	......	......	....	......	42·5
1·6	40·9								
0·3	42·4								
1·7	40·3								
1·1	41·7								
1·1	42·8	45·4	......	......	......	......	43·0		
0·2	44·8								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(7) Edge of cumulus and brownish cloud tinged by the sun. The tops of the peaks of the rocky clouds on nearly the same level as ourselves; saw struggling bits of cloud between the upper and lower stratum.

(8) Peaks after peaks of cloud (apparently) rising up on every side so much as to greatly confine the view; car hanging rather on one side; cloud with a little red in it, not opposite to the sun.

(9) Gas clearing; valve faintly seen.

(10) In basin of clouds; higher on three sides than on the fourth.

(11) Gas clearer; netting visible.

(12) Getting into cloud.

(13) Clouds appear to be rising.

(14) In basin of cloud; misty.

(15) In cloud; gas clearer still, but not quite clear.

(16) In white mist or cloud; blue above; can see earth clearly, with the river; over a railway; can see two trains.

(17) Over heaps of smoking lime; can see Lambdon Castle with its woods; scaffolding poles visible surrounding it.

(18) Heavy leaden sky above; layers of detached clouds below.

Table I.—Meteorological Observations made in the Fourteenth

References to Notes.	Time.	Siphon Barometer. Reading corrected and reduced to 32° Fahr.	Siphon Barometer. Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther- Dry.	Dry and Wet Ther- Wet.
	h m s	in.	°	in.	feet.	°	°
(1)	6 50 0 p.m.	......	......	......	(2,061)		
(2)	6 50 10 "	27·78	......	......	1,891	46·8	46·2
	6 51 0 "	27·95	......	......	1,724	47·2	46·8
	6 51 10 "	28·25	......	......	1,434	47·8	47·0
	6 51 30 "	28·50	......	......	1,193	48·2	47·5
	6 52 0 "	28·70	......	......	1,003	49·0	48·2
(3)	6 53 0 "	28·85	......	......	859	49·8	49·0
	6 53 10 "	28·90	......	......	812	......	......
	6 53 20 "	28·90	......	......	812	50·5	50·0
	6 53 30 "	28·75	......	......	1,050	51·0	50·0
(4)	6 54 0 "	28·40	......	......	1,287	51·0	50·5
(5)	6 54 10 "	28·10	......	......	1,580	50·5	50·5
	6 54 20 "	27·90	......	......	1,775	50·5	49·8
	6 54 30 "	27·72	......	......	1,954	50·5	48·9
(6)	6 55 0 "	27·65	......	......	2,024	49·8	48·5
	6 55 30 "	27·68	......	......	1,995	50·0	48·0
(7)	6 56 0 "	......	......	......	(1,793)		
(8)	6 56 30 "	......	......	......	(1,597)		
(9)	6 57 30 "	28·50	......	......	1,200	50·5	50·0
	6 58 0 "	28·53	......	......	1,171	50·5	50·0
	6 58 30 "	28·80	......	......	909	51·0	50·0
(10)	6 59 0 "	28·90	......	......	840	53·0	52·5
(11)	6 59 30 "	29·10	......	......	704	53·2	52·4
(12)	7 0 0 "	29·20	......	......	635	53·5	52·5
	7 1 0 "	29·25	......	......	600	53·7	52·5
	7 3 0 "	29·35	......	......	531	53·8	
(13)	7 5 0 "				ground		
	7 15 0 "	......	......	......	ground	53·5	
	7 29 0 "	......	......	......	ground	53·5	

Meteorological Observations made in the Fifteenth

References to Notes.	Time.	Siphon Barometer. Reading	Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry.	Wet.
	6 0 0 a.m.	......	......	29·58	ground.		
	7 12 0 "	29·436	56·5	......	ground.	44·2	43·8
	7 33 0 "	29·427	......	29·55	ground.	47·2	46·0
(14)	7 36 0 "	29·459	......	29·55	ground.	47·5	45·5
	7 42 0 "	29·483	......	29·55	ground.	48·0	46·1
	7 43 0 "	29·176	......	......	731	47·0	45·1
	7 45 0 "	29·018	......	......	879	46·0	44·2
(15)	7 46 0 "	28·791	......	28·85	1,092	45·2	44·1
	7 46 30 "	28·644	......	28·72	1,270	45·1	43·8
(16)	7 47 0 "	28·247	......	28·30	1,853	45·1	43·0
	1.	2.	3.	4.	5.	6.	7.

(1) A uniform stratum of cloud above. (2) Can see Castle clearly; sheep visible.
(3) Gas clearing; over thin wood; can see small village or hamlet.
(4) In clouds; valve opened; can see the sky, of a greenish colour.
(5) Above clouds. Colour of clouds: Top (1) deep greenish blue; (2) bluish black; (3) green rocky clouds; (4) slightly rocky clouds. (6) In clouds again.
(7) In clouds; descending rapidly; cannot see earth.
(8) Descending slowly; profound silence; in white mist; gas beautifully clear.

Balloon Ascent, from Newcastle, August 31, 1863.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
0·6	45·4	......	......	......	......	......	45·0		
0·4	46·3								
0·8	46·1	48·0							
0·7	46·7	......	......	......	......	......	......	......	48·5
0·8	47·3								
0·8	48·1								
......	......	......	......	......	......	......	48·0		
0·5	45·5	50·5							
1·0	49·0								
0·5	50·0	......	......	......	......	......	50·0		
0·0	50·5								
0·7	48·2	......	......	......	......	......	49·0		
1·6	47·2								
1·3	47·1								
2·0	45·9	......	......	......	......	......	46·5	......	51·0
0·5	49·5	......	......	......	......	......	50·0		
0·5	49·5	......	......	......	......	......	50·0		
1·0	49·0								
0·5	52·0								
0·8	51·6	......	......	......	......	......	51·0		
1·0	51·5								
1·2	51·3								

Balloon Ascent, from Wolverhampton, September 29, 1863.

0·4	43·4	44·6	44·5	43·5	1·0	42·4	43·5		
1·2	44·7								
2·0	43·4								
1·9	44·1	48·0							
1·9	43·0								
1·8	42·2								
1·1	42·9								
1·3	41·2								
2·1	40·7	45·2							
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(9) Can see earth faintly; can hear children's voices; can see furnaces and tramways; Durham Minster in sight on a hill; Leamside Junction visible.

(10) Going towards hills beyond Leamside. (11) Crossed the North-Eastern Railway.

(12) Over tramway. (13) On the ground near Pittington.

(14) Cloudy sky; wind S.W.

(15) Misty all round; east clearest.

(16) Can see the top of a high hill; query the Wrekin.

TABLE I.—Meteorological Observations made in the Fifteenth

References to Notes.	Time.	Siphon Barometer.		Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther-	
		Reading corrected and reduced to 32° Fahr.	Att. Therm.			Dry.	Wet.
	h m s	in.	°	in.	feet.	°	°
(1)	7 47 50 a.m.	28·049	49·0	......	2,129	44·9	43·0
	7 50 0 „	27·849	49·0	......	2,197	44·8	43·0
(2)	7 52 0 „	26·950	49·0	27·00	2,870	42·0	41·1
	7 52 30 „	26·451	49·0	26·50	3,278	41·5	39·0
	7 54 0 „	26·154	48·0	26·20	3,685	40·0	37·5
(3)	7 55 0 „	......	......	......	(3,811)	38·5	36·5
	7 56 0 „	25·859	46·0	......	3,938	38·0	35·8
(4)	7 57 0 „	......	......	25·70	(4,398)	37·5	35·0
(5)	7 59 0 „	24·619	42·5	24·75	5,314	35·2	32·2
(6)	8 0 0 „	24·469	42·5	24·42	5,473	33·8	31·1
(7)	8 1 0 „	24·270	42·0	......	5,789	33·0	30·4
(8)	8 2 0 „	23·972	......	24·00	6,000	32·2	29·8
(9)	8 2 30 „	23·873	41·0				
(10)	8 3 0 „	23·783	......	23·81	6,117	31·5	29·0
(11)	8 4 0 „	23·674	40·5	......	6,321	31·3	......
(12)	8 4 30 „	......	......	......	(6,375)	31·0	29·2
(13)	8 5 0 „	23·496	40·0	23·52	6,429	30·5	29·0
(14)	8 6 0 „	23·528	......	23·55	6,385	30·0	28·5
(15)	8 6 30 „	23·529	39·0	......	6,385	30·5	28·7
(16)	8 7 0 „	23·531	......	23·55	6,385	29·0	27·8
(17)	8 8 0 „						
(18)	8 9 0 „	23·382	37·0	23·40	6,647	29·5	27·8
(19)	8 10 0 „	23·362	37·0	......	6,659	29·3	27·5
	8 11 0 „	23·103	36·5	23·12	6,966	29·0	27·1
(20)	8 11 30 „	22·884	36·0	22·85	7,201	28·5	26·0
(21)	8 12 0 „	22·734	36·0	......	7,436	28·0	25·7
(22)	8 13 0 „	22·485	36·0	22·50	7,671	27·2	25·0
(23)	8 14 0 „	22·387	35·0	......	7,806	26·0	24·1
	8 15 0 „	22·188	34·5	......	8,024	26·0	24·0
(24)	8 16 0 „	22·109	34·0	22·12	8,041	26·0	24·0
(25)	8 18 0 „	21·999	......	22·01	8,259	27·0	25·1
	8 19 0 „	21·909	......	......	8,364	26·5	24·8
(26)	8 20 0 „	21·840	34·0	21·85	8,446	26·2	24·8
	8 20 30 „	......	......	......	(8,475)	......	......
(27)	8 21 0 „	21·790	......	......	8,504	25·0	32·0
(28)	8 21 30 „	21·690	33·5	......	8,621	25·0	32·0
(29)	8 22 0 „	21·590	33·0	21·50	8,726	24·5	32·0
(30)	8 22 30 „	......	......	......	(8,726)	......	......
	8 23 0 „	21·511	33·0	21·48	8,819	23·5	......
(31)	8 24 0 „	21·192	......	......	9,193	21·5	
(32)	8 25 0 „	21·142	33·5	......	9,252	21·3	
	1.	2.	3.	4.	5.	6.	7.

(1) Assisted Mr. Coxwell in lowering the grapnel.
(2) Sun faint. (3) Misty over the earth.
(4) The sun is not visible. (5) The lines from B to G visible; sky spectrum.
(6) Jerks in the balloon; the line F is beautifully defined; cannot see A, and can just see G; sky spectrum.
(7) No ozone by paper. (8) No sun; no ozone by powder.
(9) Mist in straight lines in places, and spread out in other places; very misty on the earth everywhere. (10) Valve opened. (11) Gas cloudy.
(12) Clouds above and below. (13) Clouds very high above us.
(14) B to G; sky spectrum. (15) Sand out.
(16) Fine view to the E.; no sun. (17) Gas heavy; sand out.
(18) Gleam of light.

Balloon Ascent, from Wolverhampton, September 29, 1863.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
1·9	40·8	......	......	......	......	......	41·0		
1·8	40·9	......	45·0	43·0	2·0	40·7			
0·9	40·0	......	......	......	......	......	......	......	43·0
2·5	35·9	41·5	......	......	......	......	35·5		
2·5	34·2						[no dew.		
2·0	33·7	......	......	......	......	......	38·0		
2·2	32·8								
2·5	31·6	37·5	37·5	35·2	2·3	32·1			
3·0	27·5	......	......	......	......	......	......	......	36·0
2·7	28·6	......	......	......	......	......	......	......	34·2
2·6	25·2	......	......	......	......	......	26·0		
2·4	24·4								
2·5	22·9	......	......	......	......	......	......	......	32·0
......	......	......	......	......	......	......	......	......	31·8
1·8	24·3								
1·5	25·9	......	......	......	......	......	26·5	......	31·5
1·5	23·8	......	......	......	......	......	......	......	31·0
1·8	25·7								
1·2	23·4	......	......	......	......	......	21·0		
1·7	24·7	......	......	......	......	......	21·0		
1·8	21·3	29·5							
1·9	20·2	......	......	......	......	......	20·5		
2·5	19·2	......	......	......	......	......	......	......	29·2
2·3	16·2								
2·2	15·2	......	......	......	......	......	......	......	28·1
1·9	14·4								
2·0	13·8	26·2							
2·0	13·8	......	......	......	......	......	15·0		
1·9	16·4	......	27·0	24·8	2·2	14·7			
1·7	16·7								
1·4	17·9	......	26·5	24·6	1·9	15·5	......	......	27·2
......	......	......	......	......	......	......	15·0		
......	......	25·0							
......	......	......	......	......	......	......	15·5		
......	......	24·0							
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(19) Balloon is quite full, and on examination appeared to be quite sound.
(20) Faint gleams of light. (21) Cannot get any dew on Regnault's hygrometer.
(22) Gun heard. (23) Over a town; can see two spires.
(24) Apparently moving more south.
(25) Dense clouds above us, very high indeed; there are two layers below us.
(26) A very winding canal. (27) Temperature of gas 29°·0 in neck of balloon.
(28) Temperature of gas in balloon $29\frac{1}{2}$°. (29) Gas clearing a little.
(30) No sun here, but is shining on the landscape over a large space about 30 miles distant, which appears very bright in contrast with all around.
(31) Many clouds apparently on the ground; twelve cumuli in a patch.
(32) Detached cumuli apparently resting on the ground, like huge swans in some places, in others as if there had been a simultaneous discharge of heavy ordnance; three distinct layers of cloud.

Table I.—Meteorological Observations made in the Fifteenth

References to Notes.	Time.	Siphon Barometer.		Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther-	
		Reading corrected and reduced to 32° Fahr.	Att. Therm.			Dry.	Wet.
	h m s	in.	°	in.	feet.	°	°
(1)	8 27 0 ,,	21·090	34·0	21·00	9,310	21·0	......
(2)	8 28 0 ,,	20·895	31·0	20·90	9,563	21·5	21·5
	8 29 30 ,,	20·547	30·0	......	10,005	21·1	18·5
(3)	8 30 0 ,,	......	......	......	(10,300)	......	......
(4)	8 32 0 ,,	20·002	27·5	20·00	10,646	18·1	14·2
	8 33 0 ,,	19·902	27·3	19·90	10,785	17·2	14·1
	8 34 0 ,,	19·802	27·2	......	10,924	17·0	13·9
(5)	8 34 40 ,,	......	......	......	(11,082)		
(6)	8 35 0 ,,	19·702	27·2	19·70	11,062	17·5	14·2
	8 36 0 ,,	......	......	......	......	......	......
	8 37 0 ,,	......	......	......	(11,075)	17·5	14·1
	8 38 0 ,,	19·552	26·8	......	11,082	16·2	14·1
	8 39 0 ,,	19·523	26·0	......	11,127	16·5	14·2
(7)	8 40 0 ,,	19·303	......	19·30	11,592	16·2	14·0
(8)	8 41 0 ,,	19·253	26·0	......	11,654	16·0	14·0
(9)	8 42 0 ,,	19·105	......	19·10	11,857	16·0	14·0
	8 43 0 ,,	18·905	......	......	12,113	15·5	14·8
(10)	8 44 0 ,,	18·756	......	18·70	12,305	13·8	12·5
(11)	8 44 30 ,,	18·705	......	......	12,416	12·2	11·5
(12)	8 45 0 ,,	18·705	......	......	12,416	13·0	12·1
	8 46 0 ,,	......	......	......	(12,415)	......	......
(13)	8 46 30 ,,	......	......	......	(12,415)		
	8 47 0 ,,	18·706	24·5	18·70	12,414	14·2	......
	8 48 0 ,,	18·606	24·5	18·60	12,800	13·0	
	8 48 30 ,,	......	......	......	......	......	......
(14)	8 49 0 ,,	18·506	24·5	......	12,857	16·2	15·0
	8 50 0 ,,	18·507	24·0	18·50	12,857		
(15)	8 51 0 ,,	18·307	24·0	......	12,972	16·0	
	8 52 0 ,,	18·357	24·0	......	12,900	16·0	......
(16)	8 52 30 ,,	......	......	......	(12,800)	......	......
	8 53 0 ,,	18·560	......	......	12,666	17·8	......
(17)	8 54 0 ,,	18·633	......	18·62	12,533	17·8	17·0
(18)	8 54 30 ,,	18·714	......	......	12,818		
(19)	8 55 0 ,,	......	......	......	12,818	17·5	16·9
(20)	8 57 0 ,,	18·548	18·0	18·50	12,704	17·5	......
(21)	8 58 0 ,,	18·618	......	......	12,593	17·5	16·9
	8 59 0 ,,	18·318	......	18·30	12,926	14·0	13·5
(22)	9 0 0 ,,	18·318	......	18·30	12,926	11·5	11·5
	9 1 0 ,,	18·315	......	......	12,926	11·8	11·5
(23)	9 1 15 ,,	......	......	......	12,926	......	......
(24)	9 1 30 ,,	18·315	......	18·30	12,926	12·5	12·0
	1.	2.	3.	4.	5.	6.	7.

(1) A faint sun; the liquid in the actinometer did not move at all; wind below apparently.
(2) A faint sun; examined everywhere with small spectroscope; the spectrum the same as on the earth.
(3) Looks like a beautiful garden at places from 20 to 30 miles distant, upon which the sun is shining brightly; in some places the sun is shining on beautifully curved clouds.
(4) Gleam of sun.
(5) Beautiful bed of clouds; beautiful blue tinge over clouds.
(6) Clouds a mile above us at least.
(7) Passing a large town; query Nottingham or Ashby de la Zouch.
(8) Ozone powders = 4; dotted clouds.
(9) Ice on water.
(10) Moving straight for the Wash.
(11) No sun.
(12) Image of the sun faint.
(13) Gun heard.
(14) Clouds above.
(15) Clouds far above us, at least a mile.

Balloon Ascent, from Wolverhampton, September 29, 1863.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
......	......	21·2							
......	......	......	......	......	......	......	......	......	23·0
2·6	0·7								
......	......	......	......	......	......	......	5·0		
3·9	−14·0	......	......	......	......	......	......	......	18·4
3·1	− 9·4								
3·1	− 9·7	17·2							
3·3	−10·9	17·5							
......	......	......	......	......	......	......	6·0		
3·4	−11·8								
2·1	− 2·0								
2·3	− 3·4								
2·2	− 2·7	......	......	......	......	......	2·5		
2·0	− 1·4	......	......	......	......	......	3·0		
2·0	− 1·4	16·0							
0·7	9·5								
1·3	2·4								
0·7	6·1	......	......	......	......	......	5·0	......	12·5
0·9	5·0								
......	......	......	......	......	......	......	7·0		
......	......	......	......	......	......	......	......	......	16·5
......	......	......	......	......	......	......	4·5	......	17·0
1·2	5·8	......	......	......	......	......	......	......	16·2
......	......	16·0							
......	......	......	......	......	......	......	13·5		
......	......	......	......	......	......	......	10·5	......	20·0
0·8	11·0	......	......	......	......	......	......	......	19·5
0·6	12·5								
......	......	......	......	......	......	......	12·5	......	20·9
0·6	12·5	......	......	......	......	......	13·0		
0·5	11·5	......	......	......	......	......	13·5		
0·0	11·5	......	......	......	......	......	11·0	......	13·0
0·3	9·2								
......	......	......	......	......	......	......	11·1		
0·5	8·1	12·8							
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(16) Stratus clouds, some on our level, and some at a higher elevation.
(17) The actinometer reading decreased on exposing the chamber of the instrument.
(18) A very great variety of clouds.
(19) Stratus on our level; sixteen distinct cumuli resting apparently on the earth; like the smoke on discharging ordnance; dark shadow on the ground.
(20) Beautiful tinge of blue.
(21) Seas of white rocky cloud; mist; patches of light on the earth.
(22) Smoke streaming up to a height of 1½ mile; counted forty separate cumuli, apparently resting on the earth.
(23) Gas clear; examined balloon internally for holes or rents.
(24) Gas clear; examined the balloon internally for rents; the dome of the balloon appeared greatly increased in size; does looking through a volume of gas apparently enlarge objects?

TABLE I.—Meteorological Observations made in the Fifteenth

References to Notes.	Time.	Siphon Barometer.		Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther-	
		Reading corrected and reduced to 32° Fahr.	Att. Therm.			Dry.	Wet.
	h m s	in.	°	in.	feet.	°	°
(1)	9 2 0 a.m.	18·265	......	......	12,975		
(2)	9 3 0 „	18·215	......	18·20	13,025	15·0	14·5
(3)	9 4 0 „	18·215	......	......	13,025	15·0	14·8
(4)	9 5 0 „	18·215	......	18·20	13,025	15·0...	14·8
(5)	9 7 0 „	18·215	......	......	13,030	15·0	......
	9 8 0 „	18·215	......	......	13,160	16·0	......
(6)	9 9 0 „	......	......	......	......	......	......
(7)	9 10 0 „	18·105	......	......	13,279	15·1	14·5
(8)	9 10 30 „	18·065	......	......	13,321	15·0	14·5
	9 11 0 „	......	......	......	......	......	......
(9)	9 11 15 „	......	......	......	(13,602)		
(10)	9 12 0 „	17·815	.....	......	13,882	14·5	14·0
	9 12 30 „						
(11)	9 13 0 „	17·645	24·0	......	14,218	13·1	......
(12)	9 14 0 „	17·663	24·0	......	14,096	12·8	12·4
	9 15 0 „	17·713	24·0	17·70	13,791	12·2	11·2
(13)	9 16 0 „	17·713	24·0	......	13,805	14·5	
	9 17 0 „	......	......	......	......	14·5	27·0
(14)	9 18 0 „						
(15)	9 20 0 „	17·613	......	......	13,695	1·0	......
(16)	9 22 0 „	17·613	......	......	13,695	8·0	
(17)	9 23 0 „	17·613	......	......	13,695	7·2	......
(18)	9 24 0 „	......	......	......	(13,738)	......	......
(19)	9 25 0 „	17·513	......	......	13,982	5·0	
	9 27 0 „	17·513	21·0	......	13,982	3·5	......
	9 28 0 „	17·643	21·0	......	13,807	3·0	......
(20)	9 29 0 „	17·513	20·0	......	13,982	2·5	2·0
	9 31 0 „	16·514	19·0	......	15,517	2·0	1·0
(21)	9 32 0 „	16·013	......	......	16,284	1·2	0·2
(22)	9 33 0 „	15·815	18·0	......	16,590	0·0	......
	9 34 0 „	17·317	......	......	14,295		
	9 35 0 „	17·417	......	17·30	14,235	4·5	......
	9 36 0 „	17·417	......	......	14,219	7·5	......
(23)	9 38 0 „	17·517	18·0	17·50	14,175	6·0	5·9
(24)	9 40 0 „	......	......	......	......	......	......
(25)	9 41 0 „	17·417	......	......	14,203	5·5	......
(26)	9 43 0 „	17·618	......	17·60	13,897	6·0	4·9
(27)	9 44 0 „	17·618	17·5	......	13,897		
	1.	2.	3.	4.	5.	6.	7.

(1) Shadow of cloud upon mist very fine; earth has a violet colour.
(2) Sun bringing mist up vertically.
(3) The sun was shining; the increase of scale reading in one minute by the actinometer was 5 divisions.
(4) Clouds above; a bright sun; actinometer increased 4 divisions in one minute.
(5) Clouds above us still; the sun was bright; actinometer increased 7 divisions in one minute, and fell 3 divisions in the shade in one minute.
(6) Stratus on our level.
(7) Crossing a river; query Trent.
(8) Sand out; suspect the direction of the wind changed here.
(9) A shrill whistle up the balloon was followed by a ringing sound for 10 seconds, afterwards passing down the balloon.
(10) The air is very nearly saturated; clouds above us still.
(11) Sun shining; spectrum everywhere.
(12) B to G; F very distinct; sky spectrum.
(13) Water applied to Wet-bulb Thermometer; no ozone paper coloured anywhere.
(14) Sun shining on Gridiron Thermometer.

Balloon Ascent, from Wolverhampton, September 29, 1863.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
0·5	10·4	......	......	......	......	......	......	......	15·0
0·2	13·3	......	......	......	......	......	14·0		
0·2	13·3								
......	......	......	......	......	......	......	7·2	......	16·5
......	......	......	......	......	......	......	......	......	19·0
......	......	......	......	......	......	......	11·5		
0·6	9·8	......	......	......	......	......	12·0		
0·5	10·6								
......	......	......	......	......	......	......	13·0		
0·5	10·1	......	......	......	......	......	11·5		
......	......	......	......	......	......	......	......	......	13·1
0·4	9·3	13·0							
1·0	3·5	......	......	......	......	......	11·1	......	12·2
......	......	......	......	......	......	......	0·0		
......	......	......	......	......	......	......	......	......	10·0
......	......	......	......	......	......	......	− 4·0		
......	......	......	......	......	......	......	− 7·0		
......	......	......	......	......	......	......	−10·0	......	6·0
0·5									
......	......	......	......	......	......	......	−10·0	......	4·6
1·0	......	......	......	......	......	......	−10·0		
......	......	......	......	......	......	......	......	......	3·0
......	......	......	......	......	......	......	− 1·2		
......	......	......	......	......	......	......	5·0	......	10·0
0·1	......	......	......	......	......	......	4·5	......	8·5
......	......	......	......	......	......	......	4·0		
......	......	5·0	......	......	......	......	4·5		
1·1	......	......	......	......	......	......	− 3·0	......	8·5
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(15) Blue sky; actinometer increased 5 divisions in one minute.
(16) Sun spectrum H clear, dark beyond. (17) Sun spectrum A clear.
(18) Many lines in sun spectrum.
(19) Lines clear and numerous in the sun spectrum, extending from A to beyond H.
(20) Filled bag with air.
(21) Opened valve, gas expanding rapidly; filled bags with air; saw outline of coast through a break in the clouds from N. of Yarmouth and to the West.
(22) Opened valve.
(23) Sun shining brightly; increase of 7 divisions in the actinometer scale in one minute.
(24) The sun spectrum extended from A to far beyond H, and was very beautiful.
(25) Packed up Regnault's Hygrometer; opened valve; gas expanding rapidly.
(26) Line H in the spectrum clear and vivid; beautiful ring on black bulb of Hygrometer; packed up Dry and Wet aspirated.
(27) The sun spectrum very vivid and very long, H made up of fine lines; moving directly towards the Wash.

Table I.—Meteorological Observations made in the Fifteenth

References to Notes.	Time.	Siphon Barometer.		Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther-	
		Reading corrected and reduced to 32° Fahr.	Att. Therm.			Dry.	Wet.
	h m s	in.	°	in.	feet.	°	°
(1)	9 45 0 a.m.	17·468	......	......	14,224	9·0	7·5
	9 46 0 „	......	......	......	14,190	9·3	8·2
(2)	9 47 0 „	17·418	......	......	14,155	9·5	8·6
(3)	9 48 0 „	17·318	......	17·30	14,308	11·5	11·0
(4)	9 49 0 „	17·518	......	......	14,031	13·0	12·3
	9 49 30 „	......	......	......	......	13·9	13·2
	9 50 0 „	17·117	......	17·00	13,175	14·1	13·5
(5)	9 52 0 „	17·117	......	17·10	13,175	15·1	14·1
	9 54 0 „	17·318	......	......	14,459	13·1	12·6
	9 55 0 „	17·518	......	......	14,347	13·2	12·1
(6)	9 56 0 „	17·718	......	......	13,947	13·5	11·9
	9 56 30 „	......	......	......	(13,947)	13·5	11·0
(7)	9 57 0 „	17·718	......	......	13,947	13·2	11·0
(8)	9 57 30 „	17·818	......	17·80	13,747	13·2	10·5
	9 58 0 „	18·118	......	......	13,332	14·1	11·0
	9 58 30 „						
	9 59 0 „	18·619	......	......	12,642	17·0	14·5
	10 0 0 „	18·719	......	18·70	12,504	17·2	15·0
	10 1 0 „	18·919	......	......	12,225	17·5	15·0
	10 1 30 „	19·069	......	......	12,030	17·2	14·5
	10 2 0 „	19·210	23·0	19·20	11,834	17·5	
	10 3 0 „	......	......	......	(10,964)	19·5	16·1
(9)	10 3 30 „	19·210	......	20·20	10,534	21·0	16·5
	10 4 0 „	20·410	......	......	10,284	22·0	17·8
	10 4 30 „	20·660	......	20·65	10,084	23·2	18·1
(10)	10 5 0 „	20·909	24·0	20·90	9,671	23·0	19·0
	10 5 30 „	......	......	......	(9,425)	......	......
	10 6 0 „	21·309	......	......	9,179	25·2	20·5
	10 6 30 „	21·509	......	......	8,933	26·0	21·0
	10 7 0 „	21·909	......	21·90	8,439	26·5	21·0
	10 7 30 „	22·109	......	......	8,209	27·0	21·1
	10 8 0 „	22·659	......	......	7,626	29·0	24·5
(11)	10 9 0 „	22·809	......	......	7,396	31·0	26·8
(12)	10 11 0 „	24·398	29·5	......	5,613	34·5	30·9
	10 13 0 „	24·888	......	......	5,078	35·2	30·9
	10 13 30 „	25·492	......	......	......	36·0	31·1
(13)	10 14 0 „	......	32·0	25·50	4,438	37·2	31·1
	10 15 0 „	25·992	......	......	3,933	39·2	33·0
	10 15 30 „	26·391	......	......	3,529	39·5	33·0
	10 16 0 „	26·689	33·0	......	3,224	41·2	23·5
(14)	10 17 0 „	27·007	34·0	......	2,828	42·0	33·8
	10 19 0 „	27·881	......	......	2,039	47·0	37·5
(15)	10 19 10 „	27·981	......	......	1,881		
	10 20 0 „	27·979	......	......	1,881	48·0	40·0
	10 21 0 „	27·777	......	......	1,717	48·0	40·5
(16)	10 23 0 „	28·471	......	......	1,469	50·0	45·0
(17)	10 30 0 „	......	......	......	ground.		
	1.	2.	3.	4.	5.	6.	7.

(1) Gun again heard. (2) Can see 50 miles of coast well.

(3) Supposed to be about 10 miles from the mouth of the Wash; we cannot go higher, but must descend.

(4) An increase of 8 divisions in the reading of the actinometer in one minute, in full rays of the sun.

(5) An increase of 7 divisions in the reading of the actinometer in one minute, in full rays of the sun, and then of 8 divisions in one minute.

(6) Wash obscured by second layer of clouds. (7) No ozone. (8) Ozone powder = 8.

(9) A railway seen. (10) Balloon collapsing. (11) Sun warm.

Balloon Ascent, from Wolverhampton, September 29, 1863.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
1·5	......	......	......	......	......	......	− 3·0		
1·1	......	......	......	......	......	......	− 2·0		
0·9	......	......	......	......	......	......	......	......	12·0
0·5	7·2	11·5	......	......	......	......	8·0		
0·7	6·9	......	......	......	......	......	8·0	......	17·1
0·7	7·8	......	......	......	......	......	......	......	19·0
0·6	8·9	......	......	......	......	......	......	......	18·9
1·0	6·4	......	......	......	......	......	7·0	......	18·9
0·5	8·8	......	......	......	......	......	......	......	15·2
1·1	3·6	......	......	......	......	......	......	......	15·0
1·6	− 0·5	......	......	......	......	......	0·0	......	17·2
2·5	− 8·4	13·8							
2·2	− 6·0	......	......	......	......	......	− 3·0	......	17·5
2·7	−10·4	13·5							
3·1	−13·0	......	......	......	......	......	......	......	19·0
2·5	− 4·7	......	......	......	......	......	......	......	21·0
2·2	− 1·7	......	......	......	......	......	− 6·0		
2·5	− 4·0	17·5							
2·7	− 6·0								
3·4	− 8·7	20·0	......	......	......	......	−10·0		
4·5	−14·4	......	......	......	......	......	......	......	25·2
4·2	− 9·9	......	......	......	......	......	......	......	27·0
5·1	−13·9								
4·0	− 6·1	......	......	......	......	......	......	......	28·5
......	......	......	......	......	......	......	− 5·0		
4·7	− 5·5	......	......	......	......	......	......	......	29·5
5·0	− 4·0	......	......	......	......	......	......	......	30·0
5·5	− 6·9	......	......	......	......	......	− 5·0		
5·9	− 5·9	......	......	......	......	......	......	......	31·9
4·5	8·2	29·0							
4·2	15·5	31·5							
3·6	24·9	......	......	......	......	......	25·0	......	39·0
4·3	24·1								
4·9	23·8	......	......	......	......	......	......	......	39·1
6·1	22·5								
6·2	24·9								
6·5	24·6	......	......	......	......	......	25·0		
7·7	23·8	......	......	......	......	......	......	......	49·2
8·2	23·7	......	......	......	......	......	......	......	49·0
9·5	26·8	......	......	......	......	......	......	......	53·0
8·0	31·2								
7·5	32·3								
5·0	39·7								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(12) The readings of the actinometer increased 20 divisions in one minute in full rays of the sun.

(13) Packed up Aneroid Barometer; trees are bending before the wind; there seems to be a gale below.

(14) Packed up Daniell's Hygrometer; the reading of the actinometer increased 25 div. in one minute, and again 25 divisions in one minute; can hear the barking of a dog.

(15) The wind rough.

(16) Packed up all the instruments; on the ground at Temple Bruer, 6 miles from Sleaford.

(17) The increase of the actinometer in one minute was 48 divisions

TABLE I.—Meteorological Observations made in the Sixteenth

References to Notes.	Time.	Siphon Barometer. Reading corrected and reduced to 32° Fahr.	Siphon Barometer. Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther- Dry.	Dry and Wet Ther- Wet.
	h m s	in.	°	in.	feet.	°	°
(1)	3 0 0 p.m.	......	......	29·34			
	3 30 0 ,,	29·35	......	29·29			
	4 0 0 ,,	......	......	29·30	......	53·8	48·6
(2)	4 5 0 ,,	......	......	......	......	53·0	49·2
	4 27 0 ,,	......	......	29·23	......	54·5	49·2
	4 28 30 ,,	......	......	29·32			
(3)	4 29 0 ,,						
	4 29 30 ,,	......	......	29·12	426	53·0	47·9
	4 30 0 ,,	......	......	28·70	845	52·0	46·8
(4)	4 30 30 ,,	......	......	28·42	899	50·0	45·5
(5)	4 31 0 ,,	......	......	27·92	1,573	48·2	44·1
	4 31 40 ,,	......	......	27·70	1,748	47·8	43·0
	4 31 50 ,,	......	......	27·60	1,887	47·4	42·8
	4 32 0 ,,	......	......	27·50	1,984	46·8	42·5
	4 32 15 ,,	......	......	27·35	2,131	46·0	42·0
(6)	4 32 30 ,,	......	......	27·20	2,279	45·2	41·1
	4 32 45 ,,	......	......	27·08	2,399	44·8	40·5
(7)	4 33 0 ,,	......	......	27·00	2,474	43·5	40·0
(8)	4 33 30 ,,	......	......	26·42	3,060	42·0	38·4
(9)	4 34 0 ,,	......	......	25·80	3,700	41·0	37·2
	4 34 30 ,,	......	......	25·70	3,805	40·8	36·8
	4 35 0 ,,	......	......	25·62	3,878	40·5	36·5
(10)	4 35 30 ,,	......	......	25·40	4,114	39·2	35·6
(11)	4 36 0 ,,	......	......	25·20	4,219	37·5	33·0
(12)	4 37 0 ,,	......	......	......	(5,200)	......	......
(13)	4 37 30 ,,	......	......	23·95	5,672	34·2	31·5
(14)	4 38 0 ,,	......	......	24·10	5,499	33·0	30·5
	4 38 30 ,,	......	......	24·00	5,605	32·5	29·7
	4 39 0 ,,	......	......	23·90	5,717	32·0	29·5
(15)	4 39 30 ,,	......	......	23·40	6,277	31·5	28·2
	4 39 45 ,,	......	......	23·31	6,378	31·3	28·4
(16)	4 40 0 ,,	......	......	23·20	6,506	31·2	28·5
	4 40 30 ,,	......	......	23·10	6,619	31·2	28·5
(17)	4 41 0 ,,	......	......	23·00	6,732	31·0	28·5
(18)	4 41 30 ,,	......	......	22·95	6,796	31·5	28·7
	4 42 0 ,,	......	......	22·75	7,030	31·8	28·9
	4 42 30 ,,						
(19)	4 43 0 ,,	......	......	22·62	7,184	31·0	27·1
	4 43 30 ,,	......	......	22·60	7,193	30·5	27·1
(20)	4 44 0 ,,	......	......	22·60	7,193	29·5	27·1
(21)	4 45 0 ,,	......	......	22·55	7,252	29·2	27·1
(22)	4 46 0 ,,	......	......	22·52	7,303	29·0	27·1
(23)	4 46 30 ,,	......	......	22·50	7,310	30·0	27·1
(24)	4 47 0 ,,	......	......	22·55	7,267	31·5	27·2
	1.	2.	3.	4.	5.	6.	7.

(1) Clear sky generally; fine wind S.E.
(2) Both the Gridiron Thermometer and the Blackened Bulb Thermometer were broken just before leaving.
(3) Left the earth.
(4) A very rapid decline of temperature.
(5) Sky cloudless except near the horizon.
(6) Golden sunset; colours very intense.
(7) Sand out.
(8) Rising quickly.
(9) Wind changed from S.E. to S.
(10) Temperature falling quickly again.
(11) The Thames visible to its mouth.
(12) The mouth of the Thames visible, and surrounding coast.
(13) The sea beyond the mouth of the Thames visible.
(14) Gas like smoke on coming out of the lower valve or neck of balloon.

Balloon Ascent, from the Crystal Palace, October 9, 1863.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
5·2	43·5								
3·8	46·0								
5·3	44·1								
5·1	42·8								
5·2	41·5								
4·5	40·7								
4·1	39·6								
4·8	37·7								
4·6	37·7								
4·3	37·7								
4·0	37·4								
4·1	36·4								
4·3	35·6								
3·5	35·9								
3·6	33·9								
3·8	32·4								
4·0	31·8								
4·0	31·4								
3·6	30·8								
4·5	26·8								
......	......	......	......	......	......	......	29·0		
2·7	26·9								
2·5	25·5	......	......	......	......	......	......	26·0	
2·8	23·8								
2·5	24·2								
3·3	20·0								
2·9	21·0								
2·7	22·3	......	......	......	......	......	......	22·0	
2·7	21·7								
2·5	22·2	......	......	......	......	......	22·2		
2·8	21·8	......	......	......	......	......	......	21·0	
2·9	22·0								
3·9	16·9	......	......	......	......	......	......	20·0	
3·4	17·2								
2·4	19·1								
2·1	19·8	......	......	......	......	......	20·0		
1·9	20·2								
2·9	18·0	......	......	......	......	......	......	19·0	
4·3	16·5								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(15) Over London; the roar of London deep.
(16) Roar of London loud and continuous. (17) The river Thames like a canal.
(18) London looks very fine indeed. (19) Nearly over London Bridge.
(20) The sunset is gorgeous; rose-coloured cumuli extending from near the place of the sun to the S. and N.; white cumuli in the E.; no clouds except near the horizon.
(21) The ships in the Thames appear long and narrow, and steamboats like moving toys.
(22) The Docks distinct and very clear.
(23) Can see the inner court of the Bank; St. Paul's looks very small; all streets in the city are distinctly visible; Milbank Prison and Oxford Street seen very clearly.
(24) Over the Thames.

TABLE I.—Meteorological Observations made in the Sixteenth

References to Notes.	Time.	Siphon Barometer.		Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther-	
		Reading corrected and reduced to 32° Fahr.	Att. Therm.			Dry.	Wet.
	h m s	in.	°	in.	feet.	°	°
(1)	4 48 0 p.m.	......	......	22·69	7,087	30·0	27·2
(2)	4 49 0 ,,	......	......	23·00	6,731	30·5	27·2
(3)	4 50 0 ,,	......	......	23·15	6,557	31·0	27·5
	4 51 0 ,,	......	......	23·60	6,310	31·7	28·0
	4 52 30 ,,	......	......	24·00	5,600	32·0	29·2
(4)	4 52 45 ,,	......	......	24·15	5,433	32·5	29·5
	4 53 0 ,,	......	......	24·50	5,052	33·0	29·8
	4 53 30 ,,	......	......	25·55	3,928	33·2	30·0
	4 54 0 ,,	......	......	24·70	4,835	34·0	30·5
	4 55 0 ,,	......	......	25·10	2,409	34·8	30·7
(5)	4 55 10 ,,	......	......	25·20	4,302	34·8	31·2
	4 56 0 ,,	......	......	25·40	4,095	35·5	32·0
	4 57 0 ,,	......	......	25·55	4,024	36·0	32·0
	4 57 30 ,,	......	......	25·70	3,783	36·5	32·5
	4 57 45 ,,	......	......	25·80	3,679	37·0	33·0
	4 58 0 ,,	......	......	25·80	3,679	37·0	33·0
	4 58 30 ,,	......	......	25·80	3,679	37·0	33·1
	4 59 0 ,,	......	......	25·85	3,548	37·0	33·2
	5 0 0 ,,	......	......	26·20	3,268	38·0	34·2
	5 1 0 ,,	......	......	26·42	3,046	38·7	35·1
	5 1 30 ,,	......	......	......	(3,043)	......	......
(6)	5 2 0 ,,	......	......	26·42	3,040	39·0	35·1
(7)	5 3 0 ,,	......	......	26·40	3,067	39·2	35·5
(8)	5 4 0 ,,	......	......	26·38	3,087	39·0	35·1
	5 4 30 ,,	......	......	26·35	3,125	39·2	35·1
	5 4 45 ,,	......	......	......	(3,220)	......	......
	5 5 0 ,,	......	......	26·15	3,323	39·5	35·5
(9)	5 6 0 ,,	......	......	26·15	3,330	39·2	35·5
	5 6 30 ,,	......	......	26·15	3,323	39·5	35·5
(10)	5 7 0 ,,	......	......	26·20	3,272	39·2	35·1
(11)	5 8 0 ,,	......	......	26·31	3,159	39·0	35·5
(12)	5 10 0 ,,	......	......	26·60	2,863	39·5	36·0
	5 11 0 ,,	......	......	26·70	2,765	40·5	36·1
(13)	5 12 0 ,,	......	......	26·80	2,665	40·5	37·0
(14)	5 13 0 ,,	......	......	26·75	2,715	41·0	37·8
	5 14 0 ,,	......	......	27·08	2,386	42·0	38·5
	5 14 15 ,,	......	......	27·14	2,327	42·0	39·2
	5 14 30 ,,	......	......	27·14	2,327	42·0	39·0
(15)	5 15 0 ,,	......	......	27·10	2,369	42·5	39·1
	5 16 0 ,,	......	......	26·85	2,629	42·0	38·5
	5 17 0 ,,	......	......	26·72	2,750	42·5	38·1
	5 18 0 ,,	......	......	26·60	2,870	42·0	37·5
	5 19 0 ,,	......	......	26·55	2,920	41·5	37·0
	5 20 0 ,,	......	......	26·35	3,121	41·0	36·8
	5 20 30 ,,	......	......	26·20	3,275	40·7	36·2
(16)	5 21 0 ,,	......	......	26·15	3,323	40·5	36·1
	5 22 0 ,,	......	......	26·10	3,368	40·0	36·0
	1.	2.	3.	4.	5.	6.	7.

(1) Roar of London deep; some blue smoke of London seen curving upward.
(2) Mist towards the S. of London, bounded by straight lines.
(3) All the S. of London is bounded by mist mixed with smoke, all N. of London clear.
(4) Leaving London.
(5) The wet thermometer reading is increasing more rapidly than the dry bulb.
(6) Nearly over Tottenham.

Balloon Ascent, from the Crystal Palace, October 9, 1863.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
2·8	18·0								
3·3	17·7	......	......	......	......	......	20·0		
3·5	18·1								
3·7	19·5								
2·8	22·7	......	......	......	......	......	......	21·0	
3·0	23·1								
3·2	23·4	......	......	......	......	......	22·0		
3·2	23·6								
3·5	24·4								
4·1	24·2	......	......	......	......	......	......	24·0	
3·6	25·3	......	......	......	......	......	26·0		
3·5	26·6								
4·0	26·0	......	......	......	......	......	......	26·0	
4·0	26·6								
4·0	27·3								
4·0	27·3	......	......	......	......	......	28·0		
3·9	27·5						[dew off.		
3·8	27·7	......	......	......	......	......	27·5		
3·8	29·0	......	......	......	......	......	......	29·0	
3·6	30·3							[dew off.	
......	......	......	......	......	......	......	......	30·0	
3·9	29·9								
3·7	30·6								
3·9	29·9								
4·1	29·6	......	......	......	......	......	25·5		
......	......	......	......	......	......	......	......	25·0	
4·0	30·2								
3·7	30·6								
4·0	30·2								
4·1	29·6	......	......	......	......	......	26·0		
3·5	30·8								
3·5	31·4								
4·4	30·4								
3·5	32·5								
3·2	33·7								
3·5	34·2								
2·8	35·7								
3·0	35·3								
3·4	34·9	......	......	......	......	......	28·5		
3·5	34·2								
4·4	32·7								
4·5	32·0								
4·5	31·4								
4·2	31·5								
4·5	30·2	......	......	......	......	......	28·0		
4·4	30·4								
4·0	30·8								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(7) Noise of London still heard.
(8) Beautiful golden sunset.
(9) Changed direction of motion.
(10) A faint spectrum on all sides.
(11) Misty over the land.
(12) Misty; sky blue.
(13) Over New River; two miles from Tottenham.
(14) Entered another current; moving N.W.
(15) Beautiful sunset.
(16) S.E. current.

TABLE I.—Meteorological Observations made in the Sixteenth

References to Notes.	Time.	Siphon Barometer.		Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther-	
		Reading corrected and reduced to 32° Fahr.	Att. Therm.			Dry.	Wet.
	h m s	in.	°	in.	feet.	°	°
(1)	5 22 30 p.m.	......	......	26·10	3,368	39·5	36·2
	5 24 0 ,,	......	......	26·33	3,590	39·5	36·1
(2)	5 25 0 ,,	......	......	26·40	3,382	39·8	36·5
	5 25 30 ,,	......	......	26·56	2,905	40·5	36·2
	5 25 45 ,,	......	......	26·65	2,905	40·5	36·5
	5 26 0 ,,	......	......	26·91	2,554	41·0	37·1
	5 27 0 ,,	......	......	27·05	2,386	41·5	37·8
	5 28 0 ,,	......	......	27·20	2,268	42·0	39·1
	5 29 0 ,,	......	......	27·40	2,072	43·0	40·5
	5 30 0 ,,	......	......	27·45	2,042	43·0	41·0
	5 31 0 ,,	......	......	27·50	1,976	43·8	41·5
	5 31 30 ,,	......	......	27·50	1,970	44·0	42·1
	5 32 15 ,,	......	......	27·50	1,958	43·5	42·1
(3)	5 32 30 ,,	......	......	27·50	1,930	44·0	42·5
	5 33 30 ,,	......	......	27·55	1,890	44·0	42·5
	5 34 0 ,,	......	......	27·60	1,877	44·0	42·5
	5 34 30 ,,	......	......	27·65	1,827	44·0	42·5
	5 35 0 ,,	......	......	27·75	1,831	44·5	42·8
	5 35 30 ,,	......	......	27·85	1,633	44·2	43·1
	5 36 0 ,,	......	......	27·90	1,586	44·5	43·2
	5 36 30 ,,	......	......	28·00	1,490	44·8	43·6
	5 37 0 ,,	......	......	27·70	1,782	44·8	43·6
	5 38 0 ,,	......	......	27·55	1,927	45·0	43·4
	5 39 0 ,,	......	......	27·35	2,120	45·2	43·1
	5 40 0 ,,	......	......	27·35	2,124	45·0	43·1
	5 41 0 ,,	......	......	26·92	2,552	44·2	43·0
	5 42 0 ,,	......	......	26·85	2,619	43·0	41·5
(4)	5 42 15 ,,	......	......	26·56	2,910	42·5	38·5
	5 42 30 ,,	......	......	26·30	3,174	41·5	37·5
(5)	5 43 0 ,,	......	......	26·15	3,326	41·0	37·2
	5 43 15 ,,	......	......	26·00	3,476	39·5	36·0
	5 43 30 ,,	......	......	25·75	3,735	39·2	35·0
	5 44 0 ,,	......	......	25·72	3,762	38·5	33·0
	5 45 0 ,,	......	......	25·30	4,318	37·8	32·5
	5 45 30 ,,	......	......	25·25	4,259	37·2	35·1
	5 46 0 ,,	......	......	25·25	4,303	37·2	35·0
	5 46 30 ,,	......	......	25·00	4,584	37·0	35·2
	5 47 0 ,,	......	......	24·75	4,786	36·6	32·5
	5 48 0 ,,	......	......	24·60	4,949	36·0	31·5
	5 48 30 ,,	......	......	24·50	5,052	36·0	31·5
	5 49 0 ,,	......	......	24·30	5,263	35·0	31·8
	5 49 30 ,,	......	......	24·20	5,377	34·2	31·0
	5 49 45 ,,	......	......	23·80	5,813	33·0	30·8
(6)	5 50 0 ,,	......	......	23·55	6,091	32·5	28·2
	5 51 0 ,,	......	......	23·10	6,310	31·2	27·5
	5 52 0 ,,	......	......	22·75	6,992	29·8	
	5 53 0 ,,	......	......	22·40	7,305	29·2	25·2
	5 54 0 ,,	......	......	22·20	7,633	28·5	
	5 55 0 ,,	......	......	22·10	7,755	28·5	24·5
	5 55 30 ,,	......	......	21·90	7,988	28·1	24·5
	1.	2.	3.	4.	5.	6.	7.

(1) Direction N.W.
(2) The western sky is magnificent; the eastern sky is dotted with fine cumuli.
(3) A thin mist.

Balloon Ascent, from the Crystal Palace, October 9, 1863.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
3·3	31·8								
3·4	31·6								
3·3	32·2								
4·3	30·6								
4·0	31·4	......	......	......	......	......	31·5		
3·9	32·2	......	......	......	......	......	33·5		
3·7	33·2	......	......	......	......	......	34·0		
2·9	35·5								
2·5	37·5	......	......	......	......	......	36·0		
2·0	38·6	......	......	......	......	......	38·5		
2·3	38·8	......	......	......	......	......	40·0		
1·9	39·8								
1·4	41·0								
1·5	40·7	......	......	......	......	......	40·0		
1·5	40·7								
1·5	40·7								
1·5	40·7	......	......	......	......	......	40·0		
1·7	40·7								
1·1	41·8								
1·3	41·4	......	......	......	......	......	41·0		
1·2	42·1								
1·2	42·1	......	......	......	......	......	43·0		
1·6	41·5								
2·1	40·7	......	......	......	......	......	......	41·0	
1·9	40·9	......	......	......	......	......	41·0		
1·2	41·6								
1·5	37·5								
4·0	33·5								
4·0	32·5								
3·8	32·4	......	......	......	......	......	33·0		
3·5	31·4								
4·2	29·5								
5·5	25·6								
5·3	34·2								
2·1	32·1								
2·2	32·0								
1·8	32·7								
4·1	26·5								
4·5	24·7								
4·5	24·7								
3·2	26·7								
3·2	25·4								
2·2	26·4								
4·3	19·0								
3·7	17·6								
4·0	10·7								
4·0	9·1								
3·6	9·7								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(4) Sudden dryness.
(5) Too dark to observe either Daniell's or Regnault's hygrometers after this time.
6) Earth looks dark.

TABLE I.—Meteorological Observations made in the Sixteenth

References to Notes.	Time.	Siphon Barometer. Reading corrected and reduced to 32° Fahr.	Siphon Barometer. Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther- Dry.	Dry and Wet Ther- Wet.
	h m s	in.	°	in.	feet.	°	°
	5 56 0 p.m.	......	......	21·80	8,108	28·0	24·1
(1)	5 56 30 „	......	......	21·60	8,354	28·0	24·0
(2)	5 57 0 „	......	......	21·55	8,416	27·5	23·5
	5 58 0 „	......	......	21·50	8,467	27·0	23·0
	5 59 0 „	......	......	21·40	8,499	27·0	23·0
(3)	6 0 0 „	......	......	21·30	8,714	26·5	23·0

Meteorological Observations made in the Seventeenth

References to Notes.	Time.	Siphon Barometer. Reading corrected and reduced to 32° Fahr.	Siphon Barometer. Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther- Dry.	Dry and Wet Ther- Wet.
(4)	2 5 0 p.m.	30·110	......	30·11	......	42·0	39·3
(5)	2 6 0 „	......	......	......	......	......	......
(6)	2 7 0 „	......	......	......	......	......	......
	2 8 0 „	29·856	45·0	29·90	......	41·5	39·0
(7)	2 8 30 „	29·717	45·0	......	368	......	......
(8)	2 9 0 „	29·409	44·5	......	655	40·0	38·2
(9)	2 10 0 „	28·679	44·5	......	1,328	38·5	37·2
(10)	2 10 30 „	28·389	44·3	28·42	1,598	39·5	38·1
(11)	2 11 0 „	28·469	44·3	......	1,518	39·7	38·3
(12)	2 11 30 „	28·560	44·0	28·60	1,436	40·0	38·5
	2 12 0 „	28·610	43·7	28·65	1,390	41·5	39·5
	2 12 30 „	28·871	43·5	28·90	1,148	41·5	39·5
	2 13 0 „	28·713	43·0	......	1,336	41·0	39·5
	2 13 30 „	28·593	43·0	28·60	1,733	41·5	39·5
(13)	2 14 0 „	28·383	43·0	......	1,773	41·7	39·8
(14)	2 15 0 „	28·313	43·0	28·34	1,787	42·0	40·1
(15)	2 15 30 „	28·243	43·0	......	1,801	42·5	40·3
	2 16 0 „	28·163	43·0	......	1,816	43·0	40·5
	2 16 30 „	......	......	......	(1,860)	......	......
(16)	2 17 0 „	28·073	43·0	28·11	1,903	43·2	41·0
	2 18 0 „	27·963	43·0	......	2,010	44·0	43·1
(17)	2 19 0 „	27·763	43·0	......	2,204	44·0	41·5
(18)	2 20 0 „	27·314	43·0	......	2,639	44·0	41·2
	2 21 0 „	27·264	43·0	27·31	2,687	44·0	41·1
(19)	2 21 30 „	27·213	44·0	27·25	2,735	44·0	41·2
(20)	2 23 0 „	27·173	44·0	......	2,775	44·0	41·0
(21)	2 23 45 „	27·223	44·0	......	(2,670)	......	......
	2 24 0 „	27·262	44·0	......	2,689	44·2	41·0
	2 25 0 „	26·262	44·5	27·30	2,689	44·5	41·0
	2 26 0 „	26·943	44·0	......	3,005	44·5	40·8
(22)	2 27 0 „	26·663	44·0	......	3,282	43·5	39·5
	2 28 0 „	26·266	......	......	3,675	42·2	38·1
	1.	2.	3.	4.	5.	6.	7.

(1) Too dark to read well. (2) Not sure of decimals in thermometer readings.

(3) Can scarcely take this reading; could not read after this; came down at $6^h 30^m$ at Pirton Grange, on the boundary of the counties of Hertford and Bedford; from 6^h I was watching the increasing darkness of the earth; the earth began to get dark at half-past 5 o'clock; it continuously increased.

(4) Cloudy; overcast; misty; thick. (5) Great deposit on Regnault's Hygrometer.

(6) Balloon left the earth. (7) Over the river.

(8) Changing direction towards S.W. (9) Moving directly down the river.

(10) The wind below is S.E. (11) We are now going N.E.

Balloon Ascent, from the Crystal Palace, October 9, 1863.

...mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
3·9	8·1								
4·0	7·6								
4·0	4·9								
4·0	4·6								
4·0	4·6								
3·5	6·1								

Balloon Ascent, from the Royal Arsenal, Woolwich, January 12, 1864.

8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
2·7	36·0	42·0	......	......	......	......	35·0	......	41·8
......	......	......	......	......	......	......	......	35·0	
......	......	......	41·7	39·2	2·5	36·1	[dew off.		
2·5	35·9	......	......	......	......	......	36·5		
......	......	......	......	......	......	......	......	......	40·0
1·8	35·9	39·5	......	......	......	......	......	......	39·5
1·3	35·4								
1·4	36·3								
1·4	36·4								
1·5	36·6								
2·0	37·1								
2·0	37·1								
1·5	37·7	40·3	......	......	......	......	......	......	41·0
2·0	37·1								
1·9	37·4								
1·9	37·7								
2·2	37·5								
2·5	37·5	43·6	......	......	......	......	......	......	43·5
......	......	......	......	......	......	......	39·0		
2·2	38·4								
0·9	42·0	......	44·0	43·1	0·9	42·0			
2·5	38·5	......	44·2	42·1	3·1	37·5	......	37·0	
2·8	37·9	44·0	44·0	41·2	2·8	37·9	......	......	44·0
2·9	37·7	44·0	44·0	41·0	3·0	37·5	......	......	44·0
2·8	37·9	44·1	......	......	......	......	......	......	44·1
3·0	37·5	......	44·0	41·0	3·0	37·5	......	......	44·0
......	......	......	......	......	......	......	......	37·5	
3·2	37·3	......	......	......	......	......	......	......	44·0
3·5	37·0	44·5	......	......	......	......	......	......	45·0
3·7	36·4	......	......	......	......	......	......	......	44·7
4·0	34·7	......	......	......	......	......	......	......	43·0
4·1	33·1								

(12) Sensibly warm. (13) Mist. Crossing Tilbury line; off the river.
(14) Higher; moving more easterly; crossing Tilbury railway again.
(15) Quite warm.
(16) Mr. Norris from this time noted the first appearance of dew on the hygrometer.
(17) Still S.W. wind; going N.E. (18) Cloudy.
(19) Crossing Hainault Forest; in fog; all ponds covered with ice; the earth looks dull.
(20) Calm and warm to sense.
(21) Going due N.E; cannot go high with this wind.
(22) Gas let out; the earth looks dull and bare.

TABLE I.—Meteorological Observations made in the Seventeenth

References to Notes.	Time.	Siphon Barometer. Reading corrected and reduced to 32° Fahr.	Siphon Barometer. Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther- Dry.	Dry and Wet Ther- Wet.
	h m s	in.	°	in.	feet.	°	°
	2 28 30 p.m.	26·119	......	......	3,821	41·5	36·2
(1)	2 30 0 „	25·890	......	......	4,044	38·0	33·5
	2 31 0 „	24·972	......	......	5,001	36·2	33·1
	2 31 15 „	......	......	......	(5,200)	36·0	32·2
(2)	2 32 30 „	24·575	......	24·60	5,401	34·2	31·5
	2 33 0 „	24·397	39·0	24·40	5,610	33·2	31·5
	2 34 0 „	24·088	......	......	5,924	32·2	31·1
	2 34 30 „	23·880	......	23·90	6,144	31·5	30·5
	2 35 0 „	23·681	37·5	23·70	6,364	31·0	......
	2 36 0 „	23·601	......	23·62	6,453	30·6	29·2
	2 37 0 „	23·531	......	......	6,516	30·2	......
(3)	2 37 30 „	23·282	......	......	6,802	29·2	......
	2 39 0 „	23·232	......	23·25	6,844	29·2	......
	2 40 0 „	23·283	......	......	......	29·8	......
	2 41 0 „	23·493	......	23·40	6,678	30·0	30·0
(4)	2 41 30 „	23·433	36·0	......	6,650	29·5	27·1
(5)	2 43 0 „	23·385	......	......	6,692	29·2	27·1
(6)	2 44 0 „	......	......	......	(6,790)	29·4	......
	2 45 0 „	23·187	......	......	6,885		
(7)	2 46 0 „	......	......	......	(6,885)		
(8)	2 46 10 „	23·187	35·0	23·20	6,885		
	2 47 0 „	23·087	35·0	23·10	6,984	30·8	29·0
(9)	2 47 15 „	......	......	......	(7,006)	30·7	29·0
(10)	2 47 30 „	23·037	......	......	7,029		
	2 48 0 „	22·967	35·0	......	7,118	30·7	27·8
	2 49 0 „	22·937	......	......	7,089	31·1	29·0
	2 50 0 „	22·738	......	......	7,277	31·0	28·5
	2 51 0 „	22·608	34·5	......	7,448	30·5	26·5
	2 52 0 „	22·488	34·2	......	7,602	29·2	25·0
	2 52 30 „	22·438	34·0	......	7,666	29·2	24·5
(11)	2 53 0 „	22·398	34·0	......	7,730	28·5	24·0
	2 54 0 „	22·388	......	23·40	7,741	......	......
(12)	2 55 0 „	22·438	......	......	7,666	29·2	27·0
(13)	2 56 0 „	22·489	......	22·50	7,614	29·2	27·1
(14)	2 57 0 „	22·889	......	......	7,044	30·5	27·2
	2 58 0 „	22·089	......	......	8,148	30·5	27·5
	2 59 0 „	23·039	34·0	23·05	6,768	30·5	27·1
(15)	3 0 0 „	22·439	......	......	7,666	29·1	25·1
	3 1 0 „	22·439	......	......	7,666	28·5	24·5
(16)	3 2 0 „	22·293	32·0	......	7,931	27·2	23·1
(17)	3 3 0 „	22·143	32·0	......	8,086	27·2	23·1
(18)	3 4 0 „	22·043	......	......	8,189	27·2	23·5
	3 5 0 „	21·993	......	......	8,230	27·0	23·5
	3 5 30 „	......	......	......	(8,288)	......	......
(19)	3 6 0 „	21·944	31·5	......	8,346	26·5	23·7
(20)	3 8 0 „	21·595	31·0	21·60	8,766	26·0	22·5
	3 9 0 „	21·485	31·0	......	8,894	25·5	22·6
	1.	2.	3.	4.	5.	6.	7.

(1) Sudden change of temperature and direction.
(2) Going N.; wind S.
(3) The wind below is S.E.
(4) Cloudy; gas opake.
(5) Can see Chelmsford.
(6) Can hear machinery in action.
(7) Can hear steam-ploughing and a thrashing-machine.
(8) Can see up balloon now; gas not quite transparent.
(9) Can just see the Thames south of us; going N. still.

Balloon Ascent, from the Royal Arsenal, Woolwich, January 12, 1864.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
5·3	29·5	41·5	......	......	......	......	......	......	41·5
4·5	27·4	......	......	......	......	......	......	27·5	
3·1	28·5								
3·8	26·5	......	......	......	......	......	......	26·1	
2·7	27·3								
1·7	28·8	......	......	......	......	......	......	29·5	
1·1	29·3	32·0	......	......	......	......	......	......	32·0
1·0	30·1	31·0	......	......	......	......	......	......	32·7
......	......	......	......	......	......	......	......	26·2	
......	......	......	......	......	......	......	......	11·5	
......	......	29·2	......	......	......	......	......	11·5	
......	......	......	......	......	......	......	......	......	29·8
......	......	30·0	......	......	......	......	......	......	30·0
......	......	29·3	......	......	......	......	......	9·5	29·3
......	......	......	......	......	......	......	......	9·0	
......	......	30·7	......	......	......	......	......	......	30·7
......	......	31·0							
......	......	31·0	......	......	......	......	......	......	31·0
......	......	......	......	......	......	......	......	4·5	
4·2	9·8	......	......	......	......	......	......	6·0	
4·7	7·5								
4·5	6·7								
......	......	......	......	......	......	......	......	......	29·0
2·2	19·3								
2·1	20·6	......	......	......	......	......	......	......	29·2
3·3	17·6	......	......	......	......	......	......	......	30·5
3·0	18·8	......	......	......	......	......	......	......	30·5
3·4	17·2								
4·0	10·6	......	......	......	......	......	......	11·2	
4·0	9·0								
4·1	4·2	......	27·2	22·2	5·0	−0·8	......	......	28·0
4·1	4·2	......	......	......	......	......	......	......	27·5
3·7	6·5	......	......	......	......	......	15 no dew	......	27·2
3·5	7·4								
......	......	......	......	......	......	......	......	5·0	
2·8	10·2	......	......	......	......	......	......	......	26·5
3·5	4·7	26·0	......	......	......	......	......	......	26·0
2·9	7·2	......	25·5	22·8	2·7	8·5			
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(10) Can hear people's voices.
(11) We are very warm.
(12) Can see Blackwater; estimated distance from coast twenty miles.
(13) Going N. still; determined to go higher.
(14) Ozone = 1.
(15) Colder current.
(16) In another current.
(17) Going N.N.E.; wind S.S.W.
(18) Could not get Daniell lower than 15°.
(19) Ozone = 1.
(20) Iodine paper slightly coloured in 5 minutes.

Table I.—Meteorological Observations made in the Seventeenth

References to Notes.	Time.	Siphon Barometer.		Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther-	
		Reading corrected and reduced to 32° Fahr.	Att. Therm.			Dry.	Wet.
	h m s	in.	°	in.	feet.	°	°
(1)	3 10 0 p. m.	21·296	30·5	......	9,104	24·5	21·2
(2)	3 11 0 „	21·295	31·0	......	9,105	23·0	19·5
	3 12 0 „	21·197	......	......	9,217	22·8	
	3 13 0 „	21·097	......	......	9,327	21·5	ice.
(3)	3 14 0 „	21·001	......	......	9,437	20·5	25·0
(4)	3 15 0 „	21·001	28·0	......	9,437	20·5	25·0
	3 15 30 „	20·951	28·0	......	9,500	20·5	19·0
(5)	3 16 0 „	20·951	28·0	20·95	9,500	20·5	17·5
	3 16 30 „	20·951	28·0	20·95	9,500	20·5	18·4
(6)	3 17 0 „	20·921	......	......	9,536	21·0	18·5
	3 17 30 „	20·902	27·5	20·90	9,560	21·0	18·7
(7)	3 18 0 „	20·882	......	......	9,586	21·0	18·5
(8)	3 19 0 „	20·702	......	......	9,822	20·0	18·5
(9)	3 20 0 „	20·402	......	......	10,017	17·5	16·2
(10)	3 21 0 „	20·352	......	......	10,090	17·2	15·0
	3 21 20 „	20·355	26·0	20·35	10,090	17·2	15·0
(11)	3 21 40 „	20·205	......	......	10,319	16·2	14·1
	3 22 0 „	20·155	......	......	10,394	15·9	13·8
	3 22 30 „	20·105	......	20·10	10,469	15·5	13·1
	3 23 0 „	20·105	25·0	20·10	10,469	15·0	13·0
	3 24 0 „	20·005	......	......	10,619	14·0	11·0
(12)	3 25 0 „	19·606	......	......	11,016	13·2	11·1
(13)	3 26 0 „	19·406	......	19·40	11,278	12·1	9·4
	3 27 0 „	19·386	......	......	11,429	11·5	9·2
	3 27 30 „	19·307	......	19·30	11,533	11·1	9·2
(14)	3 28 0 „	19·209	......	......	11,664	11·2	9·1
	3 29 0 „	19·209	......	......	11,664	11·1	9·0
(15)	3 29 30 „	19·160	......	......	11,708	11·0	8·7
(16)	3 29 45 „	19·110	......	......	11,761	11·0	8·7
	3 30 30 „	19·060	......	......	......	11·2	8·5
	3 31 30 „	19·012	......	......	11,897	11·0	8·3
(17)	3 32 0 „	19·112	......	......	11,774	13·2	12·5
(18)	3 33 0 „	19·313	......	......	11,528		
	3 34 0 „	19·313	......	......	11,528	14·5	13·8
(19)	3 35 0 „	19·433	......	......	11,353		
	3 35 30 „	19·663	......	......	11,071	15·0	13·8
(20)	3 36 0 „	19·714	......	......	11,007		
(21)	3 36 30 „	19·814	......	......	10,879		
	3 37 0 „	19·914	......	......	10,751	16·0	14·0
	3 37 30 „	19·964	......	......	10,697	16·0	15·2
	3 38 0 „	20·064	......	......	10,561	16·2	15·8
	3 38 15 „	20·365	......	20·25	10,289	16·2	16·0
	3 38 30 „	20·316	20·0	20·30	10,221	16·2	16·0
	3 39 0 „	20·416	......	20·40	10,085	16·2	16·0
	3 39 10 „	20·466	20·0	20·45	10,017	16·2	16·0
(22)	3 39 20 „	20·536	20·0	20·50	9,921	16·5	16·3
	1.	2.	3.	4.	5.	6.	7.

(1) Ozone = 1.
(2) Applied water to wet-bulb thermometer.
(3) On a level with Harwich or Colchester.
(4) Regnault failed; misty.
(5) Ozone = 1; Iodine = 1.
(6) Ozone = 1; Iodine paper = 1.
(7) Regnault's Hygrometer will not act.
(8) Cloudy.
(9) Cold to sense; changed direction; wind S.S.E.
(10) Regnault difficult to work and to get dew deposited.
(11) Over Newmarket.

Balloon Ascent, from the Royal Arsenal, Woolwich, January 12, 1864.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
° 3·3	° + 2·4	° 24·5	°	°	°	°	°	°	° 24·5
3·5	− 0·5	......	23·0	19·8	3·2	−0·2			
......	......	......	......	......	......	......	......	......	20·5
1·5	+ 8·6	......	20·0	19·2	0·8	13·5	......	......	20·5
3·0	− 3·5	......	20·5	17·0	3·5	−7·5	−2·0	−2·0	20·5
2·1	+ 3·8	......	20·5	18·5	2·0	4·5	......	......	20·5
2·5	1·3								
2·3	2·9	......	......	......	......	......	......	......	21·0
2·5	1·3	......	21·0	18·5	2·5	1·5	......	......	21·0
1·5	7·8	......	20·0	18·5	2·5	1·5	......	......	20·0
1·3	+ 6·4								
2·2	− 1·7	......	......	......	......	......	.....	......	17·2
2·2	− 1·7	......	......	......	......	......	−2·0	......	17·1
2·1	− 2·1	......	......	......	......	......	......	......	16·2
2·1	− 2·4								
2·4	− 5·4	15·2	......	......	......	......	......	......	15·2
2·0	− 2·5	15·0	......	......	......	......	......	......	15·0
3·0	−12·2	......	......	......	......	......	......	......	14·0
2·1	− 5·2								
2·7	−11·5								
2·3	− 8·6								
1·9	− 5·5								
2·1	− 7·2	......	11·2	9·1	2·1	......	0·0		
2·1	− 7·3								
2·3	− 7·4								
2·3	− 7·4								
2·7	−12·5								
2·7	−12·7								
0·7	+ 7·1								
0·7	8·3								
1·2	+ 4·5								
2·0	− 1·4								
0·8	+ 9·0								
0·4	14·3								
0·2	14·5	......	......	......	......	......	......	......	16·5
0·2	14·5	......	......	......	......	......	......	......	16·2
0·2	14·5	......	......	......	......	......	......	......	16·2
0·2	14·5	......	......	......	......	......	......	......	16·2
0·2	14·8	......	......	......	......	......	......	......	16·5
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(12) Hoar-frost on ropes and all round the neck of the balloon in long fringes.
(13) Earth nearly obscured. (14) Filled one air-bag; Regnault failed again.
(15) Fine snow under us.
(16) Filled the second bag with air; can rise no higher. (17) Snow granular.
(18) Repeated application of ether to Daniell's Hygrometer was not followed by the usual deposition of dew on the blackened bulb. (19) Rabbits heavy and dull.
(20) Snow fine and thin. (21) Dog whining. (22) Snow still granular.

TABLE I.—Meteorological Observations made in the Seventeenth

References to Notes.	Time.	Siphon Barometer.		Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther-	
		Reading corrected and reduced to 32° Fahr.	Att. Therm.			Dry.	Wet.
	h m s	in.	°	in	feet.	°	°
(1)	3 39 30 p.m.	20·836	20·0	......	9,516	16·8	16·5
	3 39 45 „	20·916	20·0	......	9,408	17·2	17·0
	3 40 0 „	21·016	......	......	9,273	18·0	18·0
	3 40 30 „	21·065	......	21·05	9,316	18·0	18·0
(2)	3 41 0 „	21·215	......	21·20	9,199	18·5	18·3
	3 41 15 „	21·265	......	21·25	9,156		
(3)	3 41 30 „	21·415	......	21·40	9,026	20·0	19·8
	3 41 45 „	21·515	......	21·55	8,939	21·0	20·5
	3 42 30 „	21·714	......	21·70	8,765	21·0	20·5
	3 44 0 „	21·444	......	......	8,904	21·8	21·5
	3 44 30 „	22·213	22·0	......	7,993	22·5	22·0
(4)	3 45 0 „	22·433	22·0	......	7,732	22·5	22·0
(5)	3 47 0 „	22·723	......	......	7,447	23·2	22·9
(6)	3 47 30 „	22·863	......	......	7,226	24·0	24·0
	3 47 45 „	22·963	......	......	7,136	24·2	24·0
(7)	3 48 0 „	23·113	22·0	......	6,967	24·5	24·4
(8)	3 49 0 „	23·414	......	......	6,640	25·2	25·1
(9)	3 49 30 „	23·713	......	......	6,313	26·0	25·8
	3 50 0 „	23·813	......	......	6,204	26·2	26·0
(10)	3 50 30 „	23·962	......	......	6,040	26·5	26·0
	3 51 0 „	24·062	......	......	5,932	26·9	26·8
	3 51 30 „	24·161	......	......	5,824	27·0	26·8
	3 52 0 „	24·311	......	......	5,670	27·6	27·3
	3 52 30 „	24·360	24·0	......	5,619	28·1	27·9
	3 53 0 „	24·509	......	......	5,465	28·5	28·3
	3 53 30 „	24·588	......	......	5,384	29·1	28·8
(11)	3 54 0 „	24·687	......	......	5,284	29·2	29·0
	3 54 30 „	24·827	......	......	5,142	30·3	30·3
	3 55 0 „	25·306	......	......	4,636	31·0	30·7
	3 55 30 „	25·206	......	......	4,739	31·2	31·1
	3 56 0 „	25·804	27·0	......	4,121		
	3 56 15 „	......	......	......	(4,183)	31·5	31·2
	3 56 30 „	25·703	27·0	......	4,224	32·2	30·8
	3 57 0 „	25·951	28·0	......	3,973	32·5	32·0
	3 58 0 „	......	......	......	(3,703)	34·2	32·0
	3 59 0 „	26·500	......	......	3,433	36·0	
(12)	4 0 0 „	26·550	......	......	3,384	36·2	
(13)	4 0 30 „	26·779	......	......	3,159		
(14)	4 1 0 „	26·849	......	......	3,091	37·2	......
	4 1 15 „	26·984	......	......	2,953	37·5	
	4 1 30 „	27·122	29·5	......	2,821	38·0	
	4 2 0 „	27·445	......	......	2,451	38·5	38·5
	4 2 30 „	27·511	32·0	......	2,384	39·2	38·5
	4 3 0 „	27·811	32·2	......	2,096	39·8	39·2
	4 3 30 „	28·089	33·0	......	1,878	40·8	40·0
(15)	4 4 0 „	28·188	33·5	......	1,807	41·0	40·5
	4 5 0 „	28·586	......	......	1,415	40·0	39·0
	4 7 0 „	28·633	......	......	1,366	40·0	39·5
	1.	2.	3.	4.	5.	6.	7.

(1) I am redder than usual, and my eyes are suffused. Mr. Norris is reddish blue.
(2) Note-book covered with snow. The ether is not good.
(3) Clouds below us; very dense cloud above us.
(4) Above cloud; the view is beautiful. Line of cloud due N. and S.
(5) Line of cloud remarkably well defined.

Balloon Ascent, from the Royal Arsenal, Woolwich, January 12, 1864.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
0·3	14·3	......	......	......	......	......	......	......	16·8
0·2	15·5	......	......	......	......	......	......	......	17·2
0·0	18·0	......	......	......	......	......	......	......	18·2
0·0	18·0	......	......	......	......	......	......	......	18·2
0·2	16·9	......	......	......	......	......	......	......	18·5
0·2	18·4								
0·5	17·1	......	......	......	......	......	......	......	21·0
0·5	17·1	......	......	......	......	......	......	......	21·0
0·3	19·6								
0·5	18·9	......	......	......	......	......	......	......	22·5
0·5	18·9								
0·3	21·1	......	......	......	......	......	......	......	23·2
0·0	24·0								
0·2	22·9								
0·1	23·9								
0·1	24·6								
0·2	24·8								
0·2	25·1								
0·5	23·7								
0·1	26·4								
0·2	25·9								
0·3	26·0								
0·2	27·1								
0·2	27·6	......	......	......	......	......	......	......	28·5
0·3	27·8								
0·2	28·4								
0·0	30·3	......	......	......	......	......	......	......	30·5
0·3	29·9								
0·1	30·8								
0·3	30·5								
1·4	27·7								
0·5	31·0								
2·2	28·2								
......	......	......	......	......	......	......	......	......	37·5
0·0	38·5								
0·7	37·6								
0·6	38·5								
0·8	39·0								
0·5	39·9								
1·0	36·5								
0·5	37·6								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(6) About entering cloud. (7) In cloud.
(8) Out of cloud. (9) Cannot tell where we are. (10) Very misty.
(11) Ozone = 1. (12) Applied water to the Wet-bulb; forest of pines.
(13) Can see a circle of trees. (14) Villages scarce.
(15) Cannot see two miles ahead.

TABLE I.—Meteorological Observations made in the Seventeenth

References to Notes.	Time.	Siphon Barometer. Reading corrected and reduced to 32° Fahr.	Siphon Barometer. Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther- Dry.	Dry and Wet Ther- Wet.
	h m s	in.	°	in.	feet.	°	°
	4 8 0 p.m.	28·581	......	......	1,420	39·8	38·0
(1)	4 8 30 „	28·680	......	......	1,324	40·0	39·5
	4 9 0 „	28·498	......	......	1,514	40·4	39·8
(2)	4 9 20 „						
	4 9 30 „	29·977	......	......	ground.	41·8	40·7
	Meteorological Observations made in the Eighteenth						
(3)	....	30·204	......	30·24	......	46·2	43·1
	3 20 0 p.m.	30·204	......	30·24	......	47·0	44·2
	4 7 0 „	30·114	......	30·19	......	46·0	42·5
	4 8 0 „	30·114	......	30·19	......	46·0	42·5
	4 9 0 „	30·094	......	30·17	......	45·7	
	4 9 10 „	......	......	......	......	45·5	
	4 9 30 „	29·875	......	......	320	45·5	42·0
	4 9 40 „	29·604	45·5	29·65	557	44·8	41·5
(4)	4 10 10 „	29·274	......	......	867	42·0	38·7
	4 11 30 „	28·876	......	......	1,219		
	4 12 0 „	28·658	45·0	......	1,400	40·8	37·2
	4 13 0 „	28·258	45·0	28·25	1,749		
(5)	4 14 0 „	27·879	......	28·00	2,161	37·8	36·1
(6)	4 14 30 „	27·762	......	27·73	2,170	36·5	35·5
(7)	4 15 0 „	27·564	......	......	2,469	36·0	35·2
(8)	4 16 0 „	27·245	42·5	27·25	2,775	......	......
(9)	4 16 30 „	26·817	42·0	......	3,194	34·5	33·2
(10)	4 16 45 „						
	4 17 0 „	26·649	......	26·68	3,362		
(11)	4 18 0 „	26·490	......	26·51	3,507	33·1	32·5
(12)	4 19 0 „	26·152	40·5	26·15	3,884	......	......
(13)	4 19 30 „						
(14)	4 20 0 „	25·873	......	......	4,260	33·0	32·1
(15)	4 20 30 „	25·724	39·5	25·70	4,404	34·2	32·2
	4 22 0 „	25·175	......	......	4,873	36·0	34·1
(16)	4 23 0 „	24·825	......	24·85	5,251	36·2	35·2
	4 25 0 „	24·296	......	24·31	5,827	36·0	34·5
(17)	4 25 30 „	......	......	......	(6,163)	......	......
	4 26 0 „	23·696	......	......	6,500	34·2	33·1
(18)	4 26 30 „	......	......	......	(6,627)		
(19)	4 27 30 „	23·378	39·0	23·40	6,882	38·5	37·2
(20)	4 28 0 „	23·001	......	......	7,281		
	4 29 0 „	22·834	......	22·85	7,493	40·2	36·0
(21)	4 30 0 „	22·329	......	22·35	8,083	39·0	33·1
	4 32 0 „	21·898	......	21·92	8,594	35·6	30·5
	4 34 0 „	21·678	......	......	8,854	34·2	30·0
(22)	4 34 30 „	21·487	......	21·51	9,090	34·5	29·1
	1.	2.	3.	4.	5.	6.	7.

(1) Can scarcely see to read; very misty.
(2) On the ground at Lakenheath Warren, near Brandon. Never saw the sun, and there was therefore no opportunity for using the actinometer, polariscope, or spectroscope.
(3) The sky uniformly cloudy; no sun; objects misty in the distance; wind S.E.
(4) Very misty. (5) Entered a W.S.W. current. (6) Misty; entering cloud.
(7) Moving down the river. (8) Over the edge of the river on the Essex side.
(9) In cloud. (10) Getting lighter. (11) The goat uneasy; fog wetting.

Balloon Ascent, from the Royal Arsenal, Woolwich, January 12, 1864.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
1·8	35·7								
0·5	37·6								
0·6	39·0								
1·1	38·8								

Balloon Ascent, from the Royal Arsenal, Woolwich, April 6, 1864.

8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
3·1	39·6	......	......	......	......	......	42·5		
2·8	41·0								
3·5	38·5								
3·5	38·5	......	......	......	......	......	40·0		
3·5	37·9								
3·3	37·7								
3·3	34·6	41·8	......	......	......	......	......	......	43·0
3·6	32·6								
1·7	33·8								
1·0	34·0	......	......	......	......	......	......	35·0	
0·8	33·9								
......	......	34·5	......	......	......	......	......	......	35·9
1·3	31·0								
0·6	31·5	......	......	......	......	......	32·0		
......	......	32·0	......	......	......	......	......	......	34·1
0·9	30·3								
2·0	28·7	33·3	......	......	......	......	......	......	35·5
1·9	31·2								
1·0	33·4	34·2	......	......	......	......	......	......	38·1
1·5	32·2	34·8	......	......	......	......	......	33·2	36·2
......	......	......	......	......	......	......	32·7		
1·1	28·5	35·5	......	......	......	......	......	......	34·8
1·3	35·4	......	......	......	......	......	......	33·0	
4·2	30·6	36·0	......	......	......	......	......	......	42·1
5·9	25·3	......	......	......	......	......	......	25·0	
5·1	22·6	......	36·1						
4·2	22·6	36·0	......	......	......	......	......	......	35·1
5·4	20·0	......	......	......	......	......	......	18·2	

(12) Much lighter. (13) In mist; can see the sun's outline.
(14) Two layers of cloud. (15) Goat less uneasy.
(16) Can see a very large oval in the cloud, with balloon in the centre; no prismatic colours; no break in the clouds. (17) Gas clearer. (18) Immense halo upon the cloud.
(19) Shadow of balloon on clouds; very fine; blue sky.
(20) Beautiful sound heard when closing the valve.
(21) Can feel wind pressing against us. (22) Sun warm.

TABLE I.—Meteorological Observations made in the Eighteenth

References to Notes.	Time.	Siphon Barometer. Reading corrected and reduced to 32° Fahr.	Siphon Barometer. Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther- Dry.	Dry and Wet Ther- Wet.
	h m s	in.	°	in.	feet.	°	°
	4 35 0 p.m.	21·276	......	......	9,378	34·5	27·2
	4 36 0 „	20·676	......	20·72	10,155	35·2	27·5
	4 36 30 „	20·177	......	20·20	10,805	36·0	27·8
(1)	4 37 0 „	19·976	......	20·00	11,075	36·5	
(2)	4 37 30 „						
	4 38 0 „	20·026	......	......	10,987	39·0	29·2
	4 38 + „	......	......	......	(10,730)	......	......
	4 39 0 „	20·474	......	20·50	10,470	43·0	33·8
	4 39 + „	......	......	......	(10,300)	......	......
	4 39 10 „	20·673	43·0	......	10,240		
	4 40 0 „	20·873	......	20·90	10,010	46·0	35·1
	4 40 30 „	20·972	......	21·00	9,895	46·1	35·0
(3)	4 41 0 „	21·271	44·0	......	9,513	46·2	35·1
	4 42 0 „	21·967	45·0	......	8,642	46·8	37·1
	4 43 0 „	22·676	......	......	7,783	......	......
	4 44 0 „	22·744	46·0	......	7,696	47·2	37·8
	4 44 + „	......	......	......	(7,610)	......	......
	4 44 30 „	22·764	......	22·80	7,524	46·2	37·1
	4 46 0 „	22·564	......	......	7,869	46·0	36·5
	4 46 30 „	22·514	......	......	7,947	46·0	37·5
(4)	4 47 0 „	22·564	......	......	7,553	46·0	37·5
	4 47 30 „	22·981	48·0	......	7,410	46·2	38·5
	4 48 0 „	23·309	48·0	23·38	7,036	46·2	38·4
	4 50 0 „	......	......	......	......	......	......
(5)	4 50 30 „	24·060	......	......	6,153	44·0	37·8
(6)	4 51 0 „	24·537	......	......	5,536	43·8	38·3
	4 52 0 „	24·906	......	25·00	5,213	43·0	38·0
	4 52 30 „	25·955	......	......	4,163	42·2	38·0
	4 53 0 „	......	......	......	(4,049)	......	......
	4 53 30 „	......	......	......	(3,935)	......	......
	4 54 0 „	26·254	......	......	3,821	41·0	38·0
(7)	4 54 30 „	26·654	......	......	3,405	41·0	37·1
	4 54 45 „	26·773	......	......	3,280	40·4	36·8
(8)	4 55 0 „	26·953	......	......	3,071	39·9	36·5
	4 56 0 „	27·153	......	......	2,881	39·1	36·0
	4 56 30 „	27·352	......	......	2,691	39·5	36·2
	4 58 0 „	28·250	......	......	1,836	39·8	37·1
	4 59 0 „	28·670	......	......	1,437	40·0	37·8
	4 59 30 „	28·949	......	......	1,163	40·6	38·1
	5 0 0 „	29·049	......	29·10	1,069	41·5	38·6
	5 1 0 „	29·099	......	......	1,024	41·8	38·7
	5 2 0 „	29·149	......	......	979	41·9	38·8
	5 3 0 „	29·268	......	......	869	42·0	38·7
	5 4 0 „	29·468	......	......	725	42·9	39·4
	5 5 0 „	29·628	......	......	545	43·5	39·9
	5 6 0 „	29.678	......	......	497	45·0	41·2
	5 7 0 „	29·748	......	......	416	45·8	
(9)	5 25 0 „	29·828	48·1	29·85	ground.	47·0	42·2
	1	2.	3.	4.	5.	6.	7.

(1) A rent in the balloon; very high up. (2) Very warm.
(3) Heard railway trains. (4) Valve opened.

Balloon Ascent, from the Royal Arsenal, Woolwich, April 6, 1864.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
7·3	15·0								
7·7	15·2								
8·2	15·5	34·0	......	......	......	......	......	......	41·0
9·8	16·3								
......	......	......	......	......	......	......	......	16·0	
9·2	22·7	......	......	......	......	......	......	......	48·5
......	......	......	......	......	......	......	23·0		
10·9	22·7	48·5						[no dew	
11·1	22·4	......	......	......	......	......	......	35·0	
11·1	22·5								
9·7	26·2	......	......	......	......	......	......	......	51·0
......	......	......	......	......	......	......	......	......	52·0
9·4	26·2	22·7							
......	......	......	......	......	......	......	26·0		
9·1	26·7	......	......	......	......	......	......	......	53·0
9·5	25·6	......	......	......	......	......	......	......	53·0
8·5	27·8	......	......	......	......	......	......	......	53·0
8·5	27·8								
7·7	29·6	......	......	......	......	......	......	......	54·0
7·8	29·5	......	......	......	......	......	......	24·5	53·7
......	......	......	......	......	......	......	25·0		
6·2	30·4	......	......	......	......	......	......	......	47·0
5·5	31·6								
5·0	32·0								
4·2	32·9								
......	......	......	......	......	......	......	34·0		
......	......	......	......	......	......	......	......	35·0	
3·0	34·2	41·0	......	......	......	......	......	......	41·0
3·9	32·2								
3·6	32·2								
3·4	32·0								
3·1	31·9								
3·3	31·8	......	......	......	......	......	34·0		
2·7	33·6								
2·2	34·9								
2·5	34·9								
2·9	34·9								
3·1	34·8								
3·1	35·0								
3·3	34·6								
3·5	35·2								
3·6	35·5								
3·8	36·8								
4·8	36·8	47·0	......	......	......	......	37·0	37·5	43·6
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(5) Entered cloud and lost sight of sun.
(6) Stratus clouds on our level.
(7) We are over water.
(8) Raining.
(9) On the ground in Wilderness Park.

TABLE I.—Meteorological Observations made in the Nineteenth

References to Notes.	Time.	Siphon Barometer. Reading corrected and reduced to 32° Fahr.	Siphon Barometer. Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther- Dry.	Wet.
	h m s	in.	°	in.	feet.	°	°
(1)	6 58 0 p.m.	......	......	29·30	......	61·5	52·5
	7 0 0 ,,	......	......	29·30	......	61·8	51·7
	7 0 10 ,,	......	......	29·25	317	60·0	51·0
	7 0 20 ,,	......	......	29·13	491	59·1	50·1
	7 0 30 ,,	......	......	28·92	691	59·2	50·1
	7 1 0 ,,	......	......	28·75	885	59·1	50·0
(2)	7 1 30 ,,	......	......	28·47	1,155	58·2	50·2
	7 2 0 ,,	......	......	28·36	1,265	57·2	48·2
	7 2 10 ,,	......	......	28·15	1,437	56·8	48·1
	7 2 30 ,,	......	......	27·95	1,635	56·0	48·1
	7 2 45 ,,	......	......	27·90	1,685	55·5	48·1
	7 3 15 ,,	......	......	27·61	1,982	54·1	46·5
	7 4 0 ,,	......	......	27·45	2,132	54·2	47·1
(3)	7 5 0 ,,	......	......	27·30	2,282	54·0	47·1
	7 5 20 ,,	......	......	27·18	2,301	52·5	47·1
	7 5 55 ,,	......	......	27·05	2,530	52·2	46·1
	7 6 0 ,,	......	......	26·95	2,630	52·1	46·1
	7 6 30 ,,	......	......	26·80	2,780	52·1	46·2
	7 7 0 ,,	......	......	26·74	2,840	52·5	45·7
	7 7 15 ,,	......	......	26·70	2,880	(52·2)	......
	7 7 30 ,,	......	......	26·70	2,880	52·0	45·5
	7 8 0 ,,	......	......	26·56	3,031	51·5	45·0
	7 9 0 ,,	......	......	26·65	2,937	51·0	45·1
	7 10 0 ,,	......	......	26·75	(2,630)	(51·7)	......
	7 10 30 ,,	......	......	27·05	2,530	52·5	45·6
	7 11 0 ,,	......	......	27·05	2,520	52·5	46·0
(4)	7 11 30 ,,	......	......	27·20	2,380	52·8	45·9
	7 12 0 ,,	......	......	......	(2,330)	(53·3)	......
	7 12 30 ,,	......	......	27·20	2,280	53·8	46·6
	7 13 0 ,,	......	......	27·15	2,327	52·8	46·0
	7 13 30 ,,	......	......	27·13	2,337	51·5	45·2
	7 14 0 ,,	......	......	27·05	2,522	51·0	45·0
	7 14 30 ,,	......	......	26·95	2,604	50·5	44·8
(5)	7 15 0 ,,	......	......	26·87	2,694	50·2	44·2
	7 16 0 ,,	......	......	26·70	2,854	49·0	43·5
	7 16 30 ,,	......	......	26·56	3,004	48·2	43·5
	7 17 0 ,,	......	......	......	(3,055)	......	......
	7 17 30 ,,	......	......	26·47	3,106	47·2	42·6
(6)	7 18 0 ,,	......	......	......	(3,234)		
	7 18 10 ,,	......	......	26·30	3,276	46·8	42·5
	7 18 40 ,,	......	......	26·32	3,296	46·9	42·0
	7 19 0 ,,	......	......	......	(3,337)	(46·7)	......
	7 20 0 ,,	......	......	26·13	3,461	46·6	42·1
(7)	7 21 0 ,,	......	......	26·35	3,291	46·5	42·1
	7 22 0 ,,	......	......	26·33	3,307		
	7 22 30 ,,	......	......	26·33	3,307	47·2	44·1
	7 23 0 ,,	......	......	26·35	3,327	47·2	44·1
(8)	7 23 30 ,,	......	......	26·35	3,327	47·2	44·0
	7 25 0 ,,	......	......	26·24	3,407	48·0	44·1
	1.	2.	3.	4.	5.	6.	7.

(1) Cloudless; horizon misty; moon bright; left the earth.
(2) London misty; apparently going over the Isle of Dogs.
(3) Sun on water dazzling in the direction of London.
(4) Sun bright.
(5) In a line with Charlton.

Balloon Ascent, from the Crystal Palace, Sydenham, June 13, 1864.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
9·0	44·7	......	......	......	......	......	......	44·0	
10·1	43·1								
9·0	43·1								
9·0	42·1								
9·1	41·9								
9·1	41·9								
8·0	43·0								
9·0	40·0								
8·7	44·1								
7·9	40·7								
7·4	43·0								
7·6	39·0	......	......	......	......	......	......	40·5	
7·1	40·1								
6·9	40·3								
5·4	41·6								
6·1	39·9								
6·0	40·0								
5·9	40·2								
6·8	38·8								
......	......	......	......	......	......	......	......	......	53·0
6·5	38·9								
6·5	39·8	......	......	......	......	......	......	38·5	
5·9	39·0								
......	......	......	......	......	......	......	......	......	53·0
6·9	38·5								
6·5	39·5								
6·9	39·0	......	......	......	......	......	......	......	55·5
......	......	......	......	......	......	......	......	......	56·0
7·2	39·6								
6·8	39·2								
6·3	38·8								
6·0	38·8								
5·7	38·9								
6·0	37·8								
5·5	37·5								
4·7	38·3								
......	......	......	......	......	......	......	......	35·0	
4·6	37·4	......	......	......	......	......	......	......	47·5
4·3	37·7								
4·9	36·5								
......	......	......	......	......	......	......	......	......	46·3
4·5	37·0	......	......	......	......	......	......	37·5	
4·4	38·4								
3·1	40·9								
3·1	40·9								
3·2	41·0	......	......	......	......	......	......	40·0±	
3·9	39·8								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(6) In a line with Woolwich.

(7) Heard a gun fired on Woolwich Common. Report heard 10 seconds after seeing the flash.

(8) Lowering grapnel. Gas transparent.

TABLE I.—Meteorological Observations in the Nineteeth

References to Notes.	Time.	Siphon Barometer.		Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther-	
		Reading corrected and reduced to 32° Fahr.	Att. Therm.			Dry.	Wet.
	h m s	in.	°	in.	feet.	°	°
	7 26 0 p.m.	......	......	26·17	3,459	48·2	44·2
	7 27 0 "	......	......	26·15	3,463	48·5	44·1
	7 27 30 "	......	......	26·06	3,536	47·0	41·2
(1)	7 28 30 "	......	......	26·05	3,543	47·1	41·1
	7 29 0 "	......	......	26·05	3,543	47·0	41·0
(2)	7 30 0 "	......	......	26·05	3,543	46·0	40·5
(3)	7 31 0 "	......	......	26·13	3,517	46·0	40·5
	7 32 0 "	......	......	......	(3,445)	......	......
	7 32 30 "	......	......	26·27	3,409	47·0	41·8
	7 32 45 "	......	......	26·35	3,349	48·2	43·0
	7 33 0 "	......	......	26·70	3,097	49·0	44·2
	7 34 0 "	......	......	26·87	2,755	51·2	45·0
	7 35 0 "	......	......	26·90	2,680	51·1	44·5
	7 36 0 "	......	......	27·05	2,527	51·0	44·8
	7 36 30 "	......	......	27·05	2,527	51·1	45·5
(4)	7 37 30 "	......	......	26·94	2,740	50·5	45·0
	7 38 0 "	......	......	26·90	2,782	50·2	45·0
	7 38 10 "	......	......	......	(2,790)	......	......
(5)	7 39 0 "	......	......	26·85	2,834	49·5	44·2
	7 39 30 "	......	......	26·83	2,854	50·2	45·0
	7 40 0 "	......	......	26·85	2,834	51·0	45·1
	7 42 0 "	......	......	26·87	2,812	51·8	45·7
	7 43 0 "	......	......	26·94	2,740	51·8	45·8
	7 44 0 "	......	......	......	(2,683)	52·0	46·0
	7 45 0 "	......	......	27·05	2,625	51·9	46·0
	7 46 0 "	......	......	......	(2,550)	(52·0)	......
	....	......	......	27·20	2,470	52·0	46·1
	7 46 30 "	......	......	......	......	......	......
	7 47 30 "	......	......	26·95	2,629	51·0	45·5
	7 48 0 "	......	......	26·89	2,689	51·0	45·0
	7 49 0 "	......	......	26·83	2,740	51·5	45·2
	7 49 30 "	......	......	26·75	2,823	51·8	45·0
	7 50 0 "	......	......	26·65	2,927	51·5	46·0
	7 50 30 "	......	......	26·56	3,017	51·0	46·2
	7 51 0 "	......	......	26·55	3,027	......	......
	7 52 0 "	......	......	26·53	3,053	49·2	43·0
	7 52 30 "	......	......	26·83	2,753	49·0	43·4
	7 53 0 "	......	......	26·95	2,613	49·0	44·0
	7 54 0 "	......	......	27·20	2,363	50·5	46·0
	7 55 0 "	......	......	27·40	2,003	51·7	47·6
	7 56 0 "	......	......	27·65	1,923	53·0	50·0
	7 58 0 "	......	......	27·77	1,807	53·2	50·0
	8 0 0 "	......	......	27·85	1,726	53·5	50·0
(6)	8 2 0 "	......	......	28·35	1,238	53·5	50·0
(7)	8 14 0 "	......	......	29·49	ground.	53·3	49·1
	8 15 0 "	......	......	29·50		54·0	50·0
	1.	2.	3.	4.	5.	6.	7.

(1) Mist in horizon all round.
(2) Going towards Erith.
(3) Erith Church nearly under us.
(4) Over the river bank at 7h 36m 51s.

Balloon Ascent, from the Crystal Palace, Sydenham, June 13, 1864.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
4·0	36·8								
4·4	39·3								
5·8	34·7								
6·0	34·4								
6·0	34·3								
5·5	34·2								
5·5	34·2								
......	......	......	......	......	......	......	......	35·0	
5·2	35·9								
5·2	37·3	......	......	......	......	......	......	......	48·5
4·8	39·0								
6·2	38·6								
6·6	37·7								
6·2	38·3								
5·6	39·7								
5·5	39·4								
5·2	39·5								
......	......	......	......	......	......	......	......	39·5	
5·3	38·5								
5·2	39·5								
5·9	39·0								
6·1	39·5								
6·0	39·7								
6·0	39·9								
5·9	40·0								
......	......	......	......	......	......	......	......	39·5	
5·9	40·1								
......	......	......	......	......	......	......	......	......	52·0
5·5	39·8								
6·0	38·8								
6·3	38·4								
6·8	38·1								
5·5	40·4								
4·8	41·2								
......	......	......	......	......	......	......	......	39·0	
6·2	36·3								
5·6	37·3								
5·0	38·6								
4·5	41·3								
4·1	43·4								
3·0	47·0								
3·2	46·8								
3·5	46·6								
3·5	46·6								
4·2	44·9								
4·0	46·1								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(5) Over the river bank on Essex side at 7^h 38^m 36^s, therefore the river was crossed in 1^m 35^s.
(6) Packed up the instruments.
(7) On the ground at East Hendon, five miles from Brentwood.

TABLE I.—Meteorological Observations made in the Twentieth

References to Notes.	Time.	Siphon Barometer. Reading corrected and reduced to 32° Fahr.	Siphon Barometer. Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther- Dry.	Dry and Wet Ther- Wet.
	h m s	in.	°	in.	feet.	°	°
(1)	4 10 0 p.m.	......	......	29·91	......	66·8	59·5
(2)	5 15 0 „	......	......	......	......	65·8	58·9
	6 10 0 „	......	......	29·88	......	66·0	60·0
	....	......	......	......	......	66·5	59·5
(3)	6 17 0 „	......	......	29·86	......	65·0	60·0
	6 17 30 „	......	......	29·56	511	65·0	58·0
(4)	6 18 0 „	......	......	29·28	772	63·2	57·1
	6 18 20 „	......	......	29·01	1,022		
(5)	6 18 30 „	......	......	28·95	1,082	62·1	56·1
(6)	....	......	......	......	......	60·9	55·5
(7)	6 19 0 „	......	......	28·56	1,462	60·5	55·0
(8)	6 19 30 „	......	......	......	(1,582)	(59·0)	......
(9)	6 19 45 „						
(10)	6 20 0 „	......	......	28·23	1,702	58·2	54·1
	6 20 30 „	......	......	28·01	2,006	58·2	54·1
	6 21 0 „	......	......	27·91	2,106	58·2	54·0
	6 21 30 „	......	......	27·84	2,236	58·2	53·1
(11)	6 22 0 „	......	......	27·36	2,696	55·5	52·0
(12)	6 22 20 „						
(13)	6 23 0 „	......	......	27·27	2,786	54·5	51·0
(14)	6 24 0 „	......	......	26·96	3,086	54·0	51·0
(15)	6 24 30 „	......	......	26·81	3,214	54·0	51·0
(16)	6 25 0 „	......	......	......	(3,375)	53·0	50·6
(17)	6 26 0 „	......	......	26·34	3,696	52·0	50·0
	6 26 30 „						
	6 27 0 „	......	......	26·11	3,978	52·5	50·2
	6 27 30 „	......	......	26·05	4,038	52·2	50·2
	6 28 0 „	......	......	26·01	4,068	51·7	50·2
	6 28 10 „	......	......	25·97	4,082	51·2	49·7
	6 28 30 „	......	......	25·95	4,102	51·2	49·7
(18)	6 29 0 „	......	......	25·95	4,102	51·2	49·2
(19)	6 30 0 „	......	......	25·93	4,122	51·2	49·5
	6 30 30 „	......	......	25·97	4,082	51·2	49·5
(20)	6 31 0 „	......	......	26·04	4,006	51·2	49·2
	6 32 0 „	......	......	26·19	3,841	51·2	49·2
	6 33 0 „	......	......	26·77	3,242	52·0	50·0
	6 34 0 „	......	......	26·81	3,202	52·2	50·5
(21)	6 35 0 „	......	......	27·01	3,002	52·8	50·1
(22)	6 35 15 „	......	......	27·16	2,840		
	6 36 0 „	......	......	27·26	2,740	53·5	51·2
	6 36 30 „	......	......	27·26	2,740	53·5	51·5
	6 36 40 „	......	......	......	(2,740)		
(23)	6 37 0 „	......	......	27·26	2,740	54·0	52·0
	1.	2.	3.	4.	5.	6.	7.

(1) In Mr. Webster's garden, wind W.
(2) In Mr. Webster's garden, wind W.S.W.; cloudy.
(3) Left the earth.
(4) Passing over Derby.
(5) Moving due E.; cloudy sky. Over the railway.
(6) Going towards Mansfield.
(7) Over the Derwent; misty all round.
(8) Over meadows.
(9) The car has turned half round since leaving the earth; can see people as specs.
(10) Can see sheep; scud above; cannot see people in the fields; gas very nearly clear.
(11) Lowering the grapnel; wind felt in the face; can only see people on the roads.
(12) Four miles from Derby.
(13) Derby in mist.
(14) Gas thick and cloudy issuing from the valve; clouds under us.

Balloon Ascent, from Derby, June 20, 1864.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therm. (aspirated.)				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
7·3	53·2	......	......	......	......	......	......	45·0	
6·9	53·5	......	......	......	......	......	......	......	66·0
6·0	55·1								
7·0	53·9								
5·0	55·9								
7·0	52·3								
6·1	51·9								
6·0	50·9								
5·4	50·8								
5·5	50·2								
......	......	......	......	......	......	......	......	48·1	59·0
4·1	50·4								
4·1	50·4	......	......	......	......	......	......	......	58·2
4·2	50·2								
5·1	48·4	......	......	......	......	......	......	......	58·3
3·5	48·6								
3·5	47·6	......	......	......	......	......	......	48·3	
3·0	48·1								
3·0	48·1								
2·4	48·0								
2·0	48·0								
2·3	47·9	......	......	......	......	......	......	48·0	
2·0	48·2								
1·5	48·7								
1·5	48·1								
1·5	48·1								
2·0	47·1								
1·7	47·7								
1·7	47·7								
2·0	47·1	......	......	......	......	......	......	48·0	
2·0	47·1								
2·0	48·0								
1·7	48·8								
2·7	47·2								
2·3	48·9								
2·0	49·5								
2·0	50·0								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(15) Clouds around us; gas issuing from the neck of the balloon; earth misty.

(16) Entering cloud.

(17) In a white cloud; fog; can see nothing; clouds blacker above than below; gas muddy looking; warm.

(18) Can hear watch ticking plainly.

(19) Heard a railway train.

(20) At 6^h 31^m 30^s at 3938 feet. Mr. Goodchild's pulsations were 90 in a minute; Mr. Allport's the same; Master Glaisher's 86; Mr. Jackson's and Mr. Coxwell's 94; Mr. Glaisher's 96; Mr. Knight's 110; and Mr. Bourne's 112.

Over Ilkeston, or about 10 miles from Derby; saw ten furnaces, &c.; counted ten bridges over the river.

(21) Gas clear; heard shouting; can see men, sheep, &c.

(22) Gas bright.

(23) Can see Nottingham.

TABLE I.—Meteorological Observations made in the Twentieth

References to Notes.	Time.	Siphon Barometer. Reading corrected and reduced to 32° Fahr.	Siphon Barometer. Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther- Dry.	Dry and Wet Ther- Wet.
	h m s	in.	°	in.	feet.	°	°
	6 37 30 p.m.	......	......	27·26	2,740	54·0	52·1
	6 38 0 „	......	......	27·18	2,820	53·9	51·2
	6 39 0 „	......	......	27·11	2,890	54·0	52·0
	6 39 30 „	......	......	27·06	2,940	54·0	51·7
(1)	6 40 0 „	......	......	27·01	2,990	53·9	51·5
	6 40 30 „	......	......	27·01	2,990	54·0	51·5
(2)	6 41 0 „	......	......	26·95	3,050	54·0	51·5
	6 42 0 „	......	......	26·88	3,120	54·0	51·5
(3)	6 43 0 „	......	......	26·78	3,237	54·0	51·5
(4)	6 44 0 „	......	......	26·47	3,549	53·5	52·0
(5)	6 45 0 „	......	......	26·36	3,669	53·0	50·5
(6)	6 45 10 „						
	6 45 30 „	......	......	26·27	3,758	52·2	49·5
	6 46 0 „	......	......	26·26	3,768	51·0	50·0
(7)	6 46 30 „						
	6 47 0 „	......	......	26·27	3,759	51·5	50·0
(8)	6 47 30 „	......	......	......	(3,886)		
	6 48 0 „	......	......	26·02	4,013	50·7	49·8
	6 49 0 „	......	......	25·91	4,123	50·2	49·2
	6 49 30 „	......	......	25·81	4,230	50·0	49·2
	6 50 0 „	......	......	25·78	4,271	49·2	49·2
	6 50 30 „	......	......	25·78	4,271	49·2	49·2
(9)	6 51 0 „	......	......	25·78	4,271	49·2	49·2
(10)	6 51 30 „	......	......	......	(4,276)	......	......
	6 52 0 „	......	......	25·77	4,280	49·5	49·0
	6 52 30 „	......	......	......	(4,255)	......	
	6 53 0 „	......	......	25·81	4,230	49·5	48·2
	6 53 30 „	......	......	25·81	4,230	49·5	48·1
(11)	6 54 0 „	......	......	25·86	4,180	49·5	48·1
(12)	6 54 30 „	......	......	25·91	4,130	49·2	48·1
	6 54 45 „	......	......	25·91	4,130	49·3	48·1
(13)	6 55 30 „	......	......	26·07	4,080	49·5	48·1
(14)	6 56 0 „	......	......	26·56	3,390	51·2	49·5
(15)	6 56 30 „						
(16)	6 57 0 „	......	......	26·68	3,360	51·5	50·0
	6 57 30 „	......	......	26·84	3,187	52·0	51·5
	6 58 0 „	......	......	27·27	2,696	57·5	53·2
	6 59 0 „	......	......	27·28	2,688	58·0	54·8
	7 0 0 „	......	......	27·56	2,493	58·0	55·0
	7 1 0 „	......	......	28·01	2,088	59·3	54·8
	7 2 0 „	......	......	28·78	1,388	60·4	56·2
	7 3 0 „	......	......	28·96	1,061	61·8	57·5
(17)	7 16 0 „						
	7 25 0 „	......	......	29·58	......	64·6	58·5
	7 30 0 „	......	......	29·78	......	64·0	58·2
	1.	2.	3.	4.	5.	6.	7.

(1) Gas clear.

(2) Nottingham race-course and Burford seen. Gas coming out fast from the neck of the balloon. Nottingham appeared covered with smoke; moving towards Sherwood Forest.

(3) Over railway. (4) Mist below; can see the earth clearly.

(5) Black mist below.

(6) Lost sight of the earth on entering cloud; clouds apparently blacker below than above; gas getting cloudy. (7) Can hear sounds.

(8) Gas much cloudier; lighter; gas coming out of the neck of the balloon; light all round; gas thick. (9) Heard a gun; still in cloud.

Balloon Ascent, from Derby, June 20, 1864.

mometers (free).		Gridiron Thermo-meter.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicaee Blackened Bulb Ther-mometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
1·9	50·2								
2·7	48·5	......	......	......	......	......	......	48·0	
2·0	50·0								
2·3	49·5								
2·4	49·1								
2·5	49·1								
2·5	49·1								
2·5	49·1								
2·5	49·1								
1·5	50·5								
2·5	48·0								
2·7	46·7								
1·0	49·0								
1·5	48·5								
0·9	48·8								
1·0	48·1								
0·8	48·3								
0·0	49·2	......	......	......	......	......	......	49·0	
0·0	49·2								
0·0	49·2								
0·5	48·5								
......	......	......	......	......	......	......	......	47·5	
1·3	46·8								
1·4	46·6								
1·4	46·6								
1·1	46·8								
1·2	46·8								
1·4	46·6								
1·7	47·7	......	......	......	......	......	......	47·0	
1·5	48·5								
0·5	51·0								
4·3	49·3								
3·2	52·0								
3·0	52·3								
4·5	51·0								
4·2	52·6								
4·3	53·9								
6·1	53·4								
5·8	53·9								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(10) The number of pulsations per minute were as follows:—Mr. Coxwell, 94; Mr. Bourne, 98; Mr. Goodchild, 86; Mr. Allport, 84; Mr. Jackson, 96; Mr. Knight, 90.
(11) Valve opened; slight wind against the face.
(12) Can hear a church-clock striking; clouds darker.
(13) Can see the earth; over fields.
(14) Earth clear; can see the edges of the clouds; cannot see people.
(15) Can see people; over a park; going over Southwell.
(16) Over Nottingham and Lincoln Railway; see sun faintly.
(17) On the ground at Nowell Woodhouse, about 9 miles from Newark.

TABLE I.—Meteorological Observations made in the Twenty-first

References to Notes.	Time.	Siphon Barometer. Reading corrected and reduced to 32° Fahr.	Siphon Barometer. Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther- Dry.	Dry and Wet Ther- Wet.
	h m s	in.	°	in.	feet.	°	°
(1)	6 31 0 p.m.	......	......	29·75	ground	63·1	55·5
	6 33 0 „	......	......	29·75	ground	64·0	56 +
	6 33 30 „	......	......	29·75	ground	63·0	54·0
	6 34 0 „	......	......	29·67	432	61·5	52·0
(2)	6 34 30 „	......	......	29·64	484	62·0	52·1
	6 34 45 „	......	......	29·61	514	60·1	51·2
	6 35 0 „	......	......	29·51	610	60·1	51·3
	6 35 50 „	......	......	29·38	719	59·5	51·2
(3)	6 37 0 „	......	......	29·21	865	58·5	50·2
(4)	6 38 0 „	......	......	29·08	970	58·0	50·0
(5)	6 38 30 „	......	......	28·98	1,054	57·8	50·0
	6 39 0 „	......	......	28·88	1,138	57·2	49·5
	6 40 0 „	......	......	28·81	1,188	57·2	50·0
	6 42 0 „	......	......	28·56	1,493	56·8	50·0
	6 42 30 „	......	......	29·55	1,497	56·5	50·0
(6)	6 43 0 „	......	......	28·55	1,497	56·2	49·8
	6 47 0 „	......	......	29·18	891	57·0	51·0
(7)	6 48 0 „	......	......	29·24	840	57·2	51·5
(8)	6 48 30 „	......	......	29·35	750	57·8	51·9
	6 49 0 „	......	......	29·36	747	57·9	52·0
	6 49 10 „	......	......	29·40	717	...	......
	6 49 20 „	......	......	29·38	714	58·0	51·5
(9)	6 49 30 „	......	......	29·37	713	57·8	51·2
(10)	6 50 0 „	......	......	29·24	841	57·5	50·9
(11)	6 50 30 „	......	......	29·17	903		
	6 51 30 „	......	......	......	(980)	57·2	50·5
(12)	6 52 0 „	......	......	29·05	1,019	57·0	50·3
(13)	6 53 0 „	......	......	28·74	1,309	56·2	50·0
(14)	6 54 30 „	......	......	28·45	1,589	55·5	48·9
	6 54 45 „	......	......	28·41	1,621	55·2	48·9
(15)	6 56 0 „	......	......	28·38	1,660	55·2	48·2
	6 56 30 „	......	......	28·37	1,670	54·9	48·2
	6 59 30 „	......	......	28·81	1,188	55·0	49·2
	7 1 0 „	......	......	29·06	950	55·2	49·2
	7 1 30 „	......	......	28·98	1,004	56·0	49·5
(16)	7 2 0 „	......	......	28·86	1,134	55·9	49·0
(17)	7 2 30 „	......	......	28·64	1,370	55·2	49·2
(18)	7 3 0 „	......	......	28·56	1,460	55·0	48·5
(19)	7 3 30 „	......	......	28·51	1,514	54·5	48·0
(20)	7 4 0 „	......	......	28·45	1,578	54·0	47·8
	7 4 30 „	......	......	28·31	1,714	53·2	46·8
(21)	7 5 0 „	......	......	28·05	1,979	52·7	46·1
	7 5 30 „	......	......	28·00	2,026	52·2	46·1
	1.	2.	3.	4.	5.	6.	7.

(1) Sky cloudy; cirrocumulus; wind N.N.W. (2) Misty.
(3) Over Penge. (4) Going towards Bromley.
(5) Over Chatham and Dover line of railway.
(6) The number of pulsations per minute were as follows:—Mr. E. Atkinson, 78; Mr. Glaisher, 104; Mr. Ingelow, 108; Mr. Collins, 108; and Mr. Woodroffe, 120.
(7) Over Shortlands.
(8) Can see the fountains playing at the Crystal Palace.
(9) See New Church at Bromley. (10) Passing south of Bromley.
(11) Thirty vibrations of horizontal magnet in 48 seconds.
(12) On a level with Bromley.

Balloon Ascent, from the Crystal Palace, June 27, 1864.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
7·6	49·1	......	......	......	......	......	......	45·6	
......	49·4								
9·0	46·4								
9·5	43·7								
9·9	43·6								
8·9	43·4								
8·8	43·5	......	......	......	......	......	......	......	59·2
8·3	43·9	......	......	......	......	......	......	......	59·0
8·3	42·8	......	......	......	......	......	......	......	58·0
8·0	42·8								
7·8	43·0	......	......	......	......	......	......	......	57·0
7·7	42·5								
7·2	43·4								
6·8	43·8								
6·5	44·0	......	......	......	......	......	......	......	55·0
6·4	43·8								
6·0	45·5								
5·7	46·3								
5·9	46·7								
5·9	46·7								
......	...	......	......	......	......	......	......	......	56·8
6·5	43·8								
6·6	45·3								
6·6	45·1								
6·7	44·5								
6·7	44·2	......	......	......	......	......	......	......	55·9
6·2	44·8								
6·6	43·7								
6·3	42·9								
7·0	41·5								
6·7	43·2								
5·8	43·6								
6·0	43·4								
6·5	43·4								
6·9	42·5								
6·0	43·4								
6·5	42·2								
6·5	41·7	......	......	......	......	......	......	......	54·0
6·6	41·7	......	......	......	......	......	......	......	53·5
6·4	40·4								
6·6	39·6								
6·1	39·9								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(13) Going over Hayes Common.
(14) Crystal Palace looks well.
(15) The number of respirations per minute were as follows:—Mr. Collins, 11; Mr. Coxwell, 15; Mr. J. and Mr. E. Atkinson, both 17; Mr. Ingelow, 18; Mr. Glaisher, 18½; Mr. Woodroffe, 19; and Mr. Ellis, 20. Mr. Collins repeated the experiments and found them still the same.
(16) Ozone-paper tinged to 1; ozone-powder coloured to 2.
(17) Can feel wind in the face.
(18) Passing down the Sevenoaks road.
(19) Moving S.E.
(20) Sun at edge of cloud.
(21) Sun visible.

Table I.—Meteorological Observations made in the Twenty-first

References to Notes.	Time.	Siphon Barometer.		Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther-	
		Reading corrected and reduced to 32° Fahr.	Att. Therm			Dry.	Wet.
	h m s	in.	°	in.	feet.	°	°
	7 6 0 p.m.	......	......	27·97	2,057	52·2	46·1
(1)	7 6 30 „	......	......	27·75	2,295	51·5	46·0
	7 7 30 „	......	......	27·41	2,603	50·5	45·1
	7 8 0 „	......	......	27·36	2,648	49·5	45·0
	7 9 0 „	......	......	27·08	2,941	49·6	45·0
	7 9 30 „	......	......	27·00	3,021	49·2	45·2
	7 10 0 „	......	......	26·91	3,111	49·5	45·2
	7 10 30 „	......	......	26·81	3,202	49·5	45·1
	7 10 45 „	......	......	26·56	3,454	48·4	43·5
	7 11 0 „	......	......	26·27	3,767	46·9	43·0
	7 11 30 „	......	......	26·17	3,831	46·5	42·1
	7 12 0 „	......	......	26·11	3,871	46·2	42·1
	7 13 0 „	......	......	26·01	3,965	45·9	42·1
	7 14 0 „	......	......	25·96	4,017	45·5	42·1
	7 15 0 „	......	......	25·88	4,086	44·2	41·1
	7 16 0 „	......	......	25·91	4,131	43·1	40·5
	7 17 0 „	......	......	25·91	4,131	43·0	40·0
(2)	7 18 0 „	......	......	26·00	4,040	43·0	40·5
	7 18 30 „	......	......	26·06	3,985	43·1	40·5
	7 19 0 „	......	......	26·11	3,845	......	......
	7 19 20 „	......	......	26·25	3,795	43·1	40·5
	....	......	......	26·26	3,790	43·9	41·0
	7 20 0 „	......	......	26·37	3,680	44·0	42·0
	7 20 30 „	......	......	26·41	3,640	44·1	41·9
	....	......	......	26·41	3,640	44·2	42·1
(3)	7 21 0 „	......	......	26·46	3,590		
	7 22 0 „	......	......	26·51	3,511	44·8	42·1
(4)	7 22 15 „	......	......	26·54	3,487	44·5	43·1
	7 22 30 „	......	......	26·57	3,453	43·2	42·1
	7 24 0 „	......	......	26·57	3,453	45·2	42·5
	7 25 0 „	......	......	26·61	3,423	45·9	43·0
(5)	7 26 0 „	......	......	26·71	3,322	47·2	......
(6)	7 26 30 „	......	......	26·73	3,302	47·2	44·5
	7 27 0 „	......	......	26·76	3,277	47·5	45·0
	7 28 0 „	......	......	26·85	3,187	47·5	44·1
(7)	7 29 0 „	......	......	26·86	3,197	47·8	44·2
	7 30 0 „	......	......	26·90	3,119	47·5	43·7
	7 31 0 „	......	......	26·81	3,209	47·2	42·1
(8)	7 32 0 „	......	......	26·61	3,415	47·0	42·2
	7 33 0 „	......	......	26·48	3,527	47·0	42·2
(9)	7 34 0 „	......	......	26·44	3,561	46·5	42·1
(10)	7 34 30 „	......	......	......	(3,734)		
(11)	7 35 0 „	......	......	26·06	3,907	43·0	41·3
	7 35 30 „	......	......	25·86	4,191	42·8	41·5
(12)	7 36 0 „	......	......	25·78	4,270	43·0	42·0
(13)	7 37 0 „	......	......	25·61	4,467	43·0	42·0
	7 38 0 „	......	......	25·41	4,661	43·7	41·5
	7 39 0 „	......	......	25·36	4,716	43·0	41·3
	1.	2.	3.	4.	5.	6.	7.

(1) Near New Bromley. (2) Golden tinge over water. (3) Sun again seen.
(4) Thirty vibrations of horizontal magnet was observed in 49·1 seconds.
(5) Sun shining on Blackened Bulb Thermometer.
(6) Can see Farningham; passing Madamscourt Hill.
(7) Thirty vibrations of horizontal magnet was observed in 49 seconds.

Balloon Ascent, from the Crystal Palace, June 27, 1864.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
6·1	39·9								
5·5	41·2								
5·4	40·3								
4·5	40·2								
4·6	40·1								
4·0	40·9								
4·3	40·6								
4·4	40·4								
3·9	38·1								
3·9	38·6								
4·4	37·1								
4·1	37·4	......	......	......	......	......	......	39·2	45·0
3·8	37·7								
3·4	38·2								
3·1	37·5								
2·6	37·4								
3·0	36·4	......	......	......	......	......	......	34·5	
2·5	37·4								
2·6	37·4								
......	......	......	......	......	......	......	......	......	42·0
2·6	37·4								
2·9	37·6								
2·0	39·6								
2·2	39·3								
2·1	39·6								
2·7	38·8								
1·4	41·3								
1·1	40·8								
2·7	39·4								
2·9	39·7								
......	......	......	......	......	......	......	......	......	45·0
2·7	41·5								
2·5	42·2								
3·4	42·4								
3·6	40·2								
3·8	39·4								
5·1	36·4								
4·8	36·8								
4·8	36·8								
4·4	37·1								
1·7	39·2								
1·3	40·2								
1·0	40·8								
1·0	40·8								
2·2	38·8								
1·7	39·2								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(8) Thirty vibrations of horizontal magnet was observed in 48·9 seconds.
(9) Sevenoaks on our level. (10) Crossing Sevenoaks line.
(11) Can see Knoll House.
(12) Ozone by paper was coloured to 2, that by powder 3.
(13) Thirty vibrations of horizontal magnet was observed in 49·2 seconds.

TABLE I.—Meteorological Observations made in the Twenty-first

References to Notes.	Time.	Siphon Barometer. Reading corrected and reduced to 32° Fahr.	Siphon Barometer. Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther- Dry.	Dry and Wet Ther- Wet.
	h m s	in.	°	in.	feet.	°	°
	7 39 30 p.m.	......	......	25·28	4,796	44·1	40·2
(1)	7 40 0 „	......	......	25·18	4,898	42·9	41·2
	7 41 0 „	......	......	25·18	4,898	42·8	41·0
	7 41 30 „	......	......	25·18	4,898	42·2	40·5
	7 42 0 „	......	......	25·26	4,816	41·9	39·8
	7 42 30 „	......	......	25·28	4,796	42·2	39·9
	7 42 45 „	......	......	25·36	4,722	41·9	38·5
(2)	7 43 0 „	......	......	25·38	4,699	41·2	38·5
(3)	7 44 0 „	......	......	25·45	4,597	41·2	38·5
(4)	7 44 30 „	......	......	25·45	4,597	40·2	37·8
(5)	7 45 0 „	......	......	25·38	4,699	40·2	37·8
(6)	7 46 0 „	......	......	25·36	4,692	40·2	37·8
	7 48 0 „	......	......	25·45	4,597	40·9	38·2
	7 49 0 „	......	......	25·55	4,492	40·9	38·2
(7)	7 49 20 „	......	......	25·57	4,471	41·0	38·2
(8)	7 49 30 „	......	......	25·57	4,471	41·0	38·2
	7 50 0 „	......	......	25·68	4,357	41·0	38·2
(9)	7 51 0 „	......	......	25·91	4,115	41·2	38·5
(10)	7 52 30 „	......	......	26·06	3,958	42·0	38·2
(11)	7 53 0 „	......	......	......	(3,958)	42·0	38·0
	7 53 30 „	......	......	26·06	3,958	42·0	38·9
(12)	7 53 45 „	......	......	26·06	3,958	41·9	39·0
(13)	7 54 0 „	......	......	26·06	3,958	41·9	39·2
	7 54 30 „	......	......	26·08	3,936	41·9	39·0
	7 55 30 „	......	......	26·06	3,958	41·9	39·0
	7 56 0 „	......	......	26·06	3,958	41·5	39·5
(14)	7 56 30 „	......	......	26·08	3,936	41·5	39·0
(15)	7 57 30 „	......	......	......	(3,686)		
	7 58 0 „	......	......	26·36	3,637	41·9	39·5
(16)	7 58 30 „	......	......	26·41	3,588	42·0	39·2
	7 59 0 „	......	......	26·45	3,547	41·9	39·8
(17)	8 0 0 „	......	......	26·48	3,604	41·9	39·8
(18)	8 0 30 „	......	......	26·55	3,450	42·1	39·8
(19)	8 1 0 „	......	......	26·66	3,343	42·1	40·0
	8 1 30 „	......	......	26·76	3,244	42·5	40·0
	8 2 30 „	......	......	26·86	3,144	42·5	40·5
(20)	8 3 0 „	......	......	26·96	3,044	42·5	40·5
(21)	8 3 30 „	......	......	27·01	2,994	43·0	41·0
(22)	8 4 0 „	......	......	27·26	2,744	43·5	41·0
	8 5 0 „	......	......	27·31	2,694	44·0	41·5
(23)	8 6 0 „	......	......	27·41	2,594	44·5	42·0
(24)	8 7 0 „	......	......	27·56	2,440	44·9	42·0
	8 8 0 „	......	......	27·58	2,409	44·9	42·0
	1.	2.	3.	4.	5.	6.	7.

(1) Over the Weald of Kent; temperature of gas in balloon 55°.
(2) Very misty; no object at any distance can be seen.
(3) Thirty vibrations of horizontal magnet in 49·2 seconds.
(4) The sky clear and light blue; detached cumuli.
(5) Heard dog barking; passing to the left of Tunbridge.
(6) Thirty vibrations of horizontal magnet in 49 seconds.
(7) Very misty. (8) Very misty.
(9) Ozone paper coloured to 3, powder to 4.
(10) Can see Tunbridge Wells to the right and S. of us.
(11) Can hear voices, but see no one on the earth.

Balloon Ascent, from the Crystal Palace, June 27, 1864.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
3·9	35·6	......	......	......	......	......	......	......	41·5
1·7	39·1								
1·8	38·8								
1·7	38·4								
2·1	37·1								
2·3	37·0								
3·4	34·3								
2·7	35·1								
2·7	35·1								
2·4	34·7								
2·4	34·7								
2·4	34·7								
2·7	34·7								
2·7	34·7								
2·8	34·7								
2·8	34·7								
2·8	34·7								
2·7	35·1								
3·8	33·5								
4·0	33·1	......	......	......	......	......	......	......	41·5
3·1	35·0								
2·9	35·4								
2·7	35·9								
2·9	35·4								
2·9	35·4								
2·0	37·0								
2·5	36·9								
2·4	36·6								
2·8	35·7								
2·1	37·1								
2·1	37·1								
2·3	36·9								
2·1	37·4								
2·5	37·0								
2·0	38·0								
2·0	38·0								
2·0	38·6	......	......	......	......	......	......	......	44·0
2·5	38·0								
2·5	38·5								
2·5	39·0								
2·9	38·6								
2·9	38·6								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(12) The sun at edge of cloud. (13) Near village of Hadlow.
(14) Nearly over the Medway.
(15) Thirty vibrations of horizontal magnet in 49 seconds.
(16) We are changing our direction. (17) Heard a gun.
(18) Can see main line of the South-Eastern Railway; a train coming towards us.
(19) Can see people. (20) Belt across the sun apparently on our level.
(21) Can see two horses, and a man leading them.
(22) Thirty vibrations of horizontal magnet in 48·7 seconds.
(23) Heard a gun; can see three trains.
(24) Can just see the edge of the sun.

TABLE I.—Meteorological Observations made in the Twenty-first

References to Notes.	Time.	Siphon Barometer. Reading corrected and reduced to 32° Fahr.	Siphon Barometer. Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther- Dry.	Dry and Wet Ther- Wet.
	h m s	in.	°	in.	feet.	°	°
(1)	8 8 30 p.m.	......	......	27·46	2,529	45·0	42·2
(2)	8 9 30 „	......	......	27·06	2,929	45·2	42·3
	8 10 0 „	......	......	26·76	3,229	44·8	42·5
	8 11 0 „	......	......	26·66	3,329	44·8	42·0
	8 14 0 „	......	......	26·51	3,479	43·9	41·5
	8 15 0 „	......	......	26·41	3,579	43·5	41·0
(3)	8 15 30 „	......	......	26·41	3,579	43·5	41·0
	8 16 0 „	......	......	26·41	3,579	43·3	41·0
(4)	8 17 0 „	......	......	26·56	3,444	43·1	40·5
(5)	8 18 0 „	......	......	26·66	3,340	43·0	40·1
	8 19 0 „	......	......	26·71	3,288	43·1	40·5
	8 20 0 „	......	......	26·76	3,236	43·2	40·5
	8 20 30 „	......	......	27·01	2,978	43·5	40·8
	8 20 45 „	......	......	27·01	2,978	43·5	41·5
	8 21 0 „	......	......	27·01	2,978	43·5	41·2
	8 22 0 „	......	......	27·11	2,878	43·8	41·2
(6)	....	......	......	27·16	2,828	44·0	41·5
	8 23 0 „	......	......	27·16	2,828	44·0	42·0
	8 24 0 „	......	......	27·26	2,720	44·2	42·0
(7)	8 25 0 „	......	......	27·27	2,710	44·5	42·2
	8 26 0 „	......	......	27·56	2,434	45·2	43·2
	8 27 0 „	......	......	27·66	2,337	45·0	43·0
	8 27 30 „	......	......	27·71	2,289	45·9	43·0
	8 28 0 „	......	......	27·76	2,241	46·0	43·9
(8)	8 28 20 „	......	......	27·78	2,221	46·0	43·5
	8 28 30 „	......	......	27·81	2,199	46·2	44·0
	8 29 0 „	......	......	27·96	2,151	46·2	44·0
(9)	8 29 30 „	......	......	28·01	2,003	47·0	44·1
	8 29 45 „	......	......	28·06	1,955	47·0	44·1
	8 30 0 „	......	......	28·08	1,937	47·2	44·2
	8 30 15 „	......	......	28·08	1,937	47·1	44·2
	8 30 30 „	......	......	28·15	1,910	47·5	44·2
	8 31 0 „	......	......	28·18	1,831	47·5	44·2
(10)	8 32 0 „	......	......	28·18	1,831	47·7	44·7
	8 32 30 „	......	......	28·16	1,884	47·9	44·6
	8 32 45 „	......	......	28·16	1,884	48·0	44·5
(11)	8 33 0 „	......	......	28·11	1,936	48·2	44·7
(12)	8 33 30 „	......	......	28·06	1,988	48·2	44·9
	8 34 0 „	......	......	27·95	2,098	47·8	44·5
	8 35 30 „	......	......	27·88	2,168	47·8	44·2
(13)	8 36 0 „	......	......	27·84	2,208	47·9	44·0
	8 36 30 „	......	......	27·78	2,268	47·8	44·0
	8 37 0 „	......	......	27·76	2,288	47·6	44·0
	8 37 30 „	......	......	27·68	2,322	47·6	44·2
	8 38 0 „	......	......	27·66	2,337	47·2	43·9
	8 38 15 „	......	......	27·64	2,348	47·2	43·9
	8 38 30 „	......	......	27·64	2,348	47·2	44·0
(14)	8 39 0 „	......	......	27·66	2,337	47·2	43·7
	1.	2.	3.	4.	5.	6.	7.

(1) Heard the whistle of a train.
(2) Sixteen vibrations of horizontal magnet in 26·5 seconds.
(3) Lowered grapnel; clear sky above.
(4) Going over Goudhurst. (5) Sunset.
(6) We are passing between Hawkhurst and Cranbrook.

Balloon Ascent, from the Crystal Palace, June 27, 1864.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
2·8	38·9								
2·9	38·9								
2·3	38·8								
2·8	38·7								
2·4	38·6								
2·5	38·0								
2·5	38·0								
2·3	38·3								
2·6	37·4								
2·9	38·6								
2·6	37·4								
2·7	37·3								
2·7	37·6								
2·0	39·2								
2·3	38·4								
2·6	38·1								
2·5	38·5								
2·0	39·6								
2·2	39·4								
2·3	39·4								
2·0	40·9								
2·0	40·7								
2·9	39·7								
2·1	41·5								
2·5	40·6								
2·2	41·5								
2·2	41·5								
2·9	40·8								
2·9	40·8								
3·0	40·8								
2·9	40·9								
3·3	40·5								
3·3	40·5								
3·0	41·4								
3·3	40·9								
3·5	40·6								
3·5	40·8								
3·3	41·2								
3·3	40·8								
3·6	40·2								
3·9	39·7								
3·8	39·8								
3·6	40·0								
3·4	40·4								
3·3	40·2								
3·3	40·2								
3·2	40·4								
3·5	39·8								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(7) Thirty vibrations of horizontal magnet in 48·5 seconds.
(8) Cranbrook very distinct. (9) Sounds very distinctly heard.
(10) The country is very beautiful indeed.
(11) A bell heard with a clear sound. (12) The shades of evening are coming over.
(13) Over Tenterden. (14) Heard a gun.

TABLE I.—Meteorological Observations made in the Twenty-first

References to Notes.	Time.	Siphon Barometer. Reading corrected and reduced to 32° Fahr.	Siphon Barometer. Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther- Dry.	Dry and Wet Ther- Wet.
	h m s	in.	°	in.	feet.	°	°
	8 39 30 p.m.	......	......	27·66	2,337	47·2	43·5
	8 39 45 „	......	......	27·66	2,337	47·2	43·5
	8 40 0 „	......	......	27·81	2,187	47·0	43·5
	8 41 0 „	......	......	27·86	2,136	47·0	43·6
	8 41 30 „	......	......	27·91	2,086	47·0	43·7
	8 42 0 „	......	......	27·94	2,056	47·3	43·9
	8 42 30 „	......	......	28·01	1,986	47·2	43·9
(1)	8 43 0 „	......	......	28·16	1,836	47·0	44·0
	8 43 30 „	......	......	28·21	1,786	47·2	44·5
	8 44 0 „	......	......	28·28	1,716	47·5	45·1
	8 44 30 „	......	......	28·28	1,716	47·8	44·8
(2)	8 45 0 „	......	......	28·35	1,668	48·2	44·5
	8 45 30 „	......	......	28·36	1,678	48·5	45·2
	8 46 0 „	......	......	28·41	1,628	48·7	45·1
	8 47 0 „	......	......	28·42	1,618	48·9	45·5
(3)	8 48 0 „	......	......	......	(1,478)	49·1	
	8 50 0 „	......	......	28·84	1,198	49·0	45·5
(4)	8 51 0 „	......	......	28·91	1,114	49·0	44·2
	8 51 30 „	......	......	28·91	1,114	49·0	44·0
	8 52 0 „	......	......	28·98	1,030	49·0	43·9
	8 52 30 „	......	......	29·06	944	49·0	43·5
	8 53 0 „	......	......	29·06	944	49·0	43·2
	8 54 0 „	......	......	29·21	770	49·0	43·5
	8 54 15 „	......	......	29·21	770	49·0	44·0
	8 54 30 „	......	......	29·26	662	49·0	44·0
	8 55 0 „	......	......	29·23	698	48·8	43·8
	8 55 30 „	......	......	29·16	772	48·9	43·5
	8 56 0 „	......	......	29·06	890	48·9	43·5
	8 56 30 „	......	......	28·91	949	48·6	43·2
	8 57 0 „	......	......	28·66	1,245	48·8	42·8
	8 57 30 „	......	......	28·56	1,363	48·5	42·3
	8 58 0 „	......	......	28·41	1,540	47·9	42·2
	8 58 30 „	......	......	28·31	1,658	47·0	42·0
	8 59 0 „	......	......	28·26	1,717	46·5	41·8
	8 59 30 „	......	......	28·16	1,843	46·0	40·6
	9 0 15 „	......	......	27·36	2,651	47·2	41·0
	9 1 0 „	......	......	27·06	2,954	47·5	42·2
	9 1 30 „	......	......	26·78	3,244	46·5	42·7
	9 2 0 „	......	......	26·81	3,214	46·7	42·5
	9 3 0 „	......	......	26·31	3,517	46·9	41·5
(5)	9 3 30 „	......	......	26·06	3,964	46·0	41·2
(6)	9 4 0 „	......	......	25·91	4,019	44·8	40·5
	.... „	......	......	25·78	4,166	44·5	
	9 6 0 „	......	......	25·06	4,956		
	9 7 0 „	......	......	24·66	5,396		
(7)	9 8 0 „	......	......	24·06	6,168		
(8)	9 21 0 „						
(9)	9 30 0 „	......	......	29·96	ground	46·5	45·2
	1.	2.	3.	4.	5.	6.	7.

(1) Gas clear. (2) Mist over marshes.
(3) Packed up the Hygrometer and Blackened Bulb Thermometer.
(4) Still over Tenterden; came within the influence of a westerly current.
(5) Difficult to read the instruments.
(6) In fog.
(7) Could not see to read the instruments.

Balloon Ascent, from the Crystal Palace, June 27, 1864.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
3·7	39·3								
3·7	39·3								
3·5	39·5								
3·4	39·7								
3·3	39·9								
3·4	40·1								
3·3	40·2								
3·0	40·6								
2·7	41·4								
2·4	43·4								
3·0	41·4								
3·7	40·4								
3·3	41·6								
3·6	41·2								
3·4	41·8								
3·5	41·7								
4·8	39·0								
5·0	38·6								
5·1	38·4								
5·5	37·5								
5·8	36·9								
5·5	37·5								
5·0	38·6								
5·0	38·6								
5·0	38·3								
5·4	37·8								
5·4	37·8								
5·4	37·3								
6·0	36·2								
6·2	35·5								
5·7	35·9								
5·0	36·4								
4·7	36·4								
5·4	34·4								
6·0	34·1								
5·3	36·3								
3·8	38·4								
4·2	37·7								
5·4	35·4								
4·8	35·7								
4·3	35·5								
1·3	43·8								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(8) On the ground at Romney Marsh, about half a mile from Cheynecourt.

(9) At the Alliance Inn, Brookland, at midnight, Mr. Coxwell's pulsations were 90 in a minute; Mr. Glaisher's 88; Mr. Collins's 94, and Mr. J. Atkinson's 74. The number of respirations per minute were—Mr. Coxwell, 18; Mr. Glaisher 17, and Mr. Collins 15. At the hour of 1^h a.m., June 28, 30 vibrations of the same horizontal magnet were observed, as follows:—in 47·2; again 47·2; again 47·2; again 46·5; and in 47·2 seconds.

TABLE I.—Meteorological Observations made in the Twenty-second

References to Notes.	Time.	Siphon Barometer. Reading corrected and reduced to 32° Fahr.	Siphon Barometer. Att. Therm.	Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther- Dry.	Dry and Wet Ther- Wet.
	h m s	in.	°	in.	feet.	°	°
	4 6 0 p.m.	......	......	29·64	ground.	72·5	57·0
(1)	4 6 20 „						
	4 7 0 „	......	......	29·54	444	72·0	57·0
	4 7 30 „	......	......	29·26	769	71·2	57·2
	4 8 0 „	......	......	28·49	1,484	71·0	56·0
	4 8 30 „	......	......	28·10	1,883	68·2	55·5
	4 9 0 „	......	......	27·54	2,433	64·5	53·0
	4 10 0 „	......	......	26·84	3,166	62·2	51·0
	4 10 30 „	......	......	26·59	3,427	61·0	49·5
	4 11 0 „	......	......	26·34	4,034	60·5	48·5
	4 11 30 „	......	......	26·09	4,644	58·5	47·2
	4 12 0 „	......	......	25·79	5,370	56·2	46·2
	4 13 0 „	......	......	25·80	5,347	55·0	46·0
(2)	4 14 0 „	......	......	25·46	4,612	52·5	47·0
	4 15 0 „	......	......	25·44	4,635	53·2	47·1
(3)	4 16 0 „	......	......	25·36	4,730	54·2	49·2
	4 17 0 „	......	......	25·29	4,808	54·3	49·2
	4 17 30 „	......	......	25·06	5,066	54·2	48·5
	4 18 0 „	......	......	24·86	5,289	54·2	48·5
(4)	4 19 0 „	......	......	24·53	5,664	54·2	51·0
(5)	4 20 0 „	......	......	24·44	5,767	54·2	48·2
	4 23 30 „	......	......	23·79	6,513	51·2	45·0
	4 24 0 „	......	......	23·49	6,858	51·2	45·0
	4 24 30 „	......	......	......	(7,008)	......	......
	4 25 0 „	......	......	23·24	7,158	51·2	44·1
	4 26 0 „	......	......	22·96	7,496	51·0	42·5
	4 26 30 „	......	......	22·89	7,578	50·2	40·5
(6)	4 27 0 „	......	......	22·54	7,994	48·9	38·9
(7)	4 28 0 „						
(8)	4 28 30 „	......	......	22·34	8,224	45·0	37·2
	4 28 45 „	......	......	22·14	8,454	44·2	37·1
	4 29 0 „	......	......	22·04	8,568	43·2	36·5
	4 29 30 „	......	......	21·92	8,719	43·2	36·0
	4 30 30 „	......	......	21·44	9,322	42·0	36·2
(9)	4 31 0 „	......	......	21·34	9,610	41·2	36·0
	4 32 0 „	......	......	20·59	10,575	41·2	36·0
	4 32 30 „	......	......	20·46	10,744	40·5	35·0
(10)	4 33 0 „	......	......	20·36	10,875	40·2	34·8
(11)	4 34 0 „	......	......	19·94	11,422	36·0	28·5
	4 36 0 „	......	......	19·64	11,813	35·5	26·2
	4 38 0 „	......	......	19·07	12,605	34·2	28·0
	4 38 20 „	......	......	......	......	......	......
	4 39 0 „	......	......	18·94	12,773	32·8	27·2
	4 39 30 „	......	......	18·82	12,954	32·8	26·2
(12)	4 39 45 „	......	......	18·84	12,924	33·2	25·5
(13)	4 42 0 „	......	......	18·34	13,675	34·2	33·5
(14)	4 44 0 „	......	......	......	......	......	......
(15)	4 45 0 „	......	......	......	(14,293)		
	1.	2.	3.	4.	5.	6.	7.

(1) Left the earth. (2) Balloon revolving once in 3 minutes. (3) No wind.
(4) Deep blue sky; horizon very misty; cirri above.
(5) Tried vibrations of a horizontal magnet, but failed.
(6) Changed direction to move west. (7) Moving quickly.
(8) Ships look small.

Balloon Ascent, from the Crystal Palace, August 29, 1864.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
15·5	45·4								
15·0	45·7								
14·0	46·7								
15·0	45·2								
12·7	45·6	......	......	......	......	......	......	......	70·0
11·5	43·6	......	......	......	......	......	......	......	64·5
11·2	41·4								
11·5	39·5								
12·0	38·0								
11·3	37·1								
10·0	36·9								
9·0	37·4								
5·5	41·5								
6·1	41·0								
5·0	44·3	......	......	......	......	......	.....	43·5	54·0
5·1	44·2								
5·7	42·9	......	......	......	......	......	......	......	54·8
5·7	42·9								
3·0	47·9								
6·0	42·3	......	......	......	......	......	......	......	52·0
6·2	38·6								
6·2	38·6								
......	......	......	......	......	......	......	......	33·0	
7·1	37·1	......	......	......	......	......	......	38·0	
8·5	33·6								
9·7	30·2	......	......	......	......	......	......	29·5	52·0
10·0	28·1								
7·8	28·1								
7·1	28·7								
6·7	28·5								
7·2	27·4								
5·8	29·0								
5·2	29·5								
5·2	29·5								
5·5	28·0								
5·4	27·8	......	......	......	......	......	......	25·0	
7·5	16·7								
9·3	12·1								
6·2	17·1								
......	......	......	......	......	......	......	......	......	35·0
5·6	16·0	......	......	......	......	......	......	12·0	35·2
6·6	13·0								
7·7	10·0								
......	......	......	......	......	......	......	......	......	42·0
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(9) Tried vibrations of horizontal magnet again, but failed.
(10) The fountains of the Crystal Palace look very small; ozone coloured to 1.
(11) Dreadnought looks small.
(12) Applied water to Wet-bulb.
(13) Fountains at the Crystal Palace small.
(14) Sun hot to the face.
(15) Thirty vibrations of a horizontal magnet in 42 seconds.

TABLE I.—Meteorological Observations made in the Twenty-second

References to Notes.	Time.	Siphon Barometer.		Aneroid Barometer, No. 2.	Height above sea-level.	Dry and Wet Ther-	
		Reading corrected and reduced to 32° Fahr.	Att. Therm.			Dry.	Wet.
	h m s	in.	°	in.	feet.	°	°
	4 46 0 p.m.	......	......	17·94	14,293	35·2	31·0
	4 47 0 ,,	......	......	17·94	14,293	35·2	30·7
(1)	4 47 30 ,,	......	......	17·92	14,317	35·5	30·5
	4 48 30 ,,	......	......	17·84	14,415	33·2	31·1
	4 49 0 ,,	......	......	17·74	14,581	33·2	31·0
	4 49 30 ,,	......	......	17·74	14,581	34·2	30·9
(2)	4 50 0 ,,	......	......	......	(14,580)		
	4 52 0 ,,	......	......	17·89	14,330	33·0	30·5
(3)	4 52 30 ,,	......	......	17·92	14,281	33·0	30·0
	4 53 0 ,,	......	......	17·94	14,248	32·3	28·1
	4 54 30 ,,	......	......	18·04	14,086	32·0	26·1
	4 55 0 ,,	......	......	......	......	......	......
	4 56 0 ,,	......	......	18·04	14,086	29·5	22·0
(4)	4 57 0 ,,	......	......	18·09	13,991	28·5	22·1
(5)	4 58 0 ,,	......	......	......	......	......	......
	4 58 30 ,,	......	......	18·14	13,895	29·0	22·0
	4 59 0 ,,	......	......	18·26	13,730	30·0	23·1
	5 0 0 ,,	......	......	18·29	13,688	31·0	22·5
	5 1 30 ,,	......	......	18·74	13,016	30·0	22·0
(6)	5 3 0 ,,	......	......	18·84	12,866	31·0	22·7
	5 7 0 ,,	......	......	20·64	9,943	34·0	28·9
	5 7 30 ,,	......	......	20·79	9,868	34·2	29·0
	5 8 0 ,,						
	5 9 0 ,,	......	......	21·05	9,740	36·2	30·2
	5 11 0 ,,	......	......	21·42	9,268	36·2	30·5
	5 11 30 ,,	......	......	21·52	9,143	37·2	30·5
	5 12 0 ,,	......	......	21·65	8,981	37·8	30·9
	5 14 0 ,,	......	......	22·34	8,146	41·2	32·0
	5 14 30 ,,	......	......	22·69	7,726	41·5	31·8
	5 15 0 ,,	......	......	22·74	7,666	41·0	31·8
	5 16 0 ,,	......	......	23·00	7,351	42·5	32·0
	5 17 0 ,,	......	......	23·29	7,018	44·2	33·5
(7)	5 17 30 ,,	......	......	23·69	6,558	45·5	38·1
	5 18 0 ,,	......	......	24·18	5,996	47·0	42·8
	5 19 0 ,,	......	......	25·26	4,815	49·5	46·2
	5 20 0 ,,	......	......	25·49	4,550	51·2	48·1
	5 21 0 ,,	......	......	25·70	4,326	52·5	48·1
	5 22 0 ,,	......	......	26·14	3,857	53·5	49·5
	5 23 0 ,,	......	......	26·74	3,225	54·2	49·1
(8)	5 25 0 ,,	......	......	26·74	3,238	58·2	49·5
	5 26 0 ,,	......	......	28·06	1,902		
	5 27 0 ,,	......	......	28·54	1,417	64·0	55·0
(9)	5 32 0 ,,	......	......	29·86	on the ground	69·0	57·2
	1.	2.	3.	4.	5.	6.	7.

(1) Ozone paper coloured to 2; 28 vibrations of a horizontal magnet in 49·5 seconds.
(2) Mr. Glaisher's pulsations were 110, and respirations 20 in a minute.
(3) Mr. Glaisher's pulsations were 97 in a minute.
(4) Field appeared 20 feet square.
(5) Nearly over Erith.

Balloon Ascent, from the Crystal Palace, August 29, 1864.

mometers (free).		Gridiron Thermometer.	Dry and Wet Therms. (aspirated).				Hygrometers.		Delicate Blackened Bulb Thermometer.
Diff.	Dew-point.		Dry.	Wet.	Diff.	Dew-point.	Daniell's. Dew-point.	Regnault's. Dew-point.	
°	°	°	°	°	°	°	°	°	°
4·2	25·3								
4·5	23·5								
5·0	22·8	......	......	......	......	......	......	......	42·0
2·1	27·0								
2·2	27·0								
3·3	25·1	......	......	......	......	......	......	......	35·5
2·5	25·5								
3·0	24·0								
4·2	18·9								
5·9	22·5								
......	3·0	......	......	......	......	......	......	......	37·0
7·5	− 2·4	......	......	......	......	......	......	− 3·0	
6·4	− 1·6								
......	......	......	......	......	......	......	......	− 3·0	
7·0	− 3·4								
6·9	+ 1·4								
8·5	− 0·4								
8·0	− 3·2								
8·3	+ 0·4	......	......	......	......	......	......	0·0	
5·1	20·0								
5·2	19·9								
6·0	21·2	......	......	......	......	......	......	20·0	
5·7	22·0	......	......	......	......	......	......	......	42·0
6·7	31·1	......	......	......	......	......	......	......	43·0
6·9	31·7								
9·2	20·5								
9·7	19·7								
9·2	20·2								
10·5	19·2	......	......	......	......	......	......	19·0	51·0
10·7	20·9								
7·4	29·6								
4·2	38·1								
3·3	43·0								
3·1	44·9								
4·4	43·6								
4·0	45·0								
5·1	44·1								
8·7	41·6								
9·0	47·5								
11·8	47·9								
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.

(6) Mr. Glaisher's pulsations here were 99; Mr. Coxwell's 102; Messrs. Norris and Cranston each 118 in one minute. The number of respirations in one minute were as follows:—Mr. Norris, 10; Mr. Glaisher, 18; and Messrs. Coxwell and Cranston each 22.

(7) Over the edge of the River Thames. (8) Sand out.

(9) On the ground at Wybridge, near Rainham, in Essex.

§ 4. Adopted Temperatures of the Air and Dew-Point, with Height, in the Fourteenth to the Twenty-second Balloon Ascents.

From all the observations of the temperature and of the dew-point in the preceding Tables, a determination was made of both elements, with the corresponding readings of the barometer and heights. Some of the numbers in the column for heights have been interpolated when either of these elements have been observed without a corresponding observation of the barometer. The numbers thus found are within brackets. The results are contained in the following Tables.

Table II.—Showing the adopted Reading of the Barometer, calculated Height above the Sea, Temperatures of the Air, Wet-bulb, and the Dew-point, in the Fourteenth to the Twenty-second Balloon Ascents.—Fourteenth Ascent.—August 31, 1863.

Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.	Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.
h m s	in.	feet.	°	°	°	h m s	in.	feet.	°	°	°
6 0 0	29·70	on the ground	64·0	60·0	56·7	6 40 0	23·65	6233	38·5	34·2	28·4
6 0	29·70		64·0	60·0	56·7	40 10	23·70	6176	38·5	34·5	29·0
7 0	29·70		64·0	60·0	56·7	42 0	23·95	5891	38·2	35·1	31·0
12 0	29·55	196	56·0	54·0	52·1	42 30	24·40	5389	38·5	35·0	30·3
13 0	29·30	422	56·0	53·5	51·1	43 0	24·40	5389	38·5	35·0	30·3
14 0	28·80	874	55·5	53·0	50·6	43 30	24·45	5339	38·5	34·8	29·8
14 20	28·64	1109	54·2	54·1	54·0	44 30	24·92	3865	39·1	36·1	32·2
14 30	28·50	1145	53·5	51·2	48·5	45 0	25·00	4784	39·5	37·2	34·3
15 40	27·70	1963	51·5	49·0	46·4	45 30	25·30	4452	39·5	37·1	34·0
16 0	27·40	2270	50·5	48·5	46·4	46 0	25·50	4231	40·5	37·8	34·8
17 0	27·00	2670	50·5	47·2	43·7	46 15	25·70	4009	41·5	38·5	33·7
18 0	26·90	2770	47·8	45·1	42·3	47 0	25·90	3787	42·1	40·5	38·5
18 30	26·42	3263	47·2	44·0	40·4	47 30	26·20	3480	42·1	40·8	39·2
18 40	26·00	3694	46·0	42·1	37·6	48 0	26·41	3264	42·8	41·2	40·9
18 50	25·92	3778	45·2	41·1	36·4	48 10	26·65	3018	43·1	42·8	42·4
19 0	25·55	4167	45·2	40·5	35·0	48 20	26·71	2957	43·8	42·1	40·3
20 0	25·30	4425	45·0	40·5	35·3	49 0	26·90	2762	44·1	43·0	41·7
20 20	25·10	4632	43·5	38·8	33·7	49 30	27·20	2466	45·3	44·1	42·9
20 30	24·85	4907	43·0	38·2	32·4	49 45	27·35	2317	45·2	45·0	44·8
20 40	24·48	5403	42·0	37·1	31·1	50 10	27·78	1803	46·8	46·2	45·2
21 10	24·00	5844	40·0	35·5	29·6	51 0	27·95	1724	47·2	46·8	46·3
21 30	23·50	6404	37·0	32·5	26·1	51 10	28·25	1434	47·9	47·0	46·1
22 0	23·30	6627	35·5	30·5	22·5	51 30	28·50	1193	48·2	47·5	46·7
22 30	23·00	6963	35·0	29·0	19·4	52 0	28·70	1003	49·0	48·2	47·3
23 0	22·95	7022	34·5	29·0	19·3	53 0	28·85	859	49·8	49·0	48·1
23 30	22·90	7080	34·0	28·5	18·0	53 10	28·90	812	....	....	48·0
24 0	22·70	7315	34·0	28·7	19·4	53 20	28·90	812	50·5	50·0	45·5
24 10	22·50	7549	33·9	28·5	19·0	53 30	28·75	1050	51·0	50·0	49·0
25 0	22·50	7549	33·5	27·8	17·1	54 0	28·40	1287	51·0	50·5	50·0
27 0	22·30	7790	34·0	28·5	18·8	54 10	28·10	1580	50·5	50·5	50·5
27 50	22·30	7790	34·0	28·5	18·8	54 20	27·90	1775	50·5	49·8	48·6
28 0	22·20	7912	34·0	28·5	18·8	54 30	27·72	1954	50·5	48·9	47·2
28 30	22·20	7912	34·0	28·5	18·8	55 0	27·65	2024	49·8	48·5	47·1
29 0	22·20	7912	34·0	28·5	18·8	55 30	27·63	1995	50·0	48·0	45·9
29 30	22·10	8033	34·0	28·5	18·8	57 30	28·50	1200	50·5	50·0	49·5
31 0	22·10	8033	34·0	28·5	18·8	58 0	28·53	1171	50·5	50·0	49·5
32 0	22·20	7912	34·0	28·5	18·8	58 30	28·80	909	51·0	50·0	49·0
32 30	22·20	7912	34·0	28·5	18·8	59 0	28·90	840	53·0	52·5	52·0
33 0	22·35	7770	35·0	30·0	22·0	59 30	29·10	704	53·2	52·4	51·6
34 0	22·45	7621	36·0	32·0	26·0	7 0 0	29·20	635	53·5	52·5	51·5
35 30	22·70	7327	36·5	32·0	25·3	1 0	29·25	600	53·7	52·5	51·3
36 0	22·90	7124	37·2	33·1	27·3	3 0	29·35	531	53·8		
37 0	23·00	7022	38·0	33·5	27·4	5 0		on the ground			
37 30	23·10	6898	38·5	34·2	28·4	15 0	....		53·5		
38 30	23·32	6626	38·3	34·2	28·6	29 0	....		53·5		
39 0	23·50	6404	38·2	34·2	28·8						

Table II. (*continued.*)—Fifteenth Ascent.—September 29, 1863.

Time of observation. A.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.
h m s	in.	feet.	°	°	°
7 12 0	29·436	on the ground	44·2	43·8	43·4
33 0	29·427	on the ground	47·2	46·0	44·7
36 0	29·459	on the ground	47·5	45·5	43·4
42 0	29·483	on the ground	48·0	46·1	44·1
43 0	29·176	731	47·0	45·1	43·0
45 0	29·018	879	46·0	44·2	42·2
46 0	28·791	1092	45·2	44·1	42·9
46 30	28·644	1270	45·1	43·8	41·2
47 0	28·247	1853	45·1	43·0	40·7
47 50	28·049	2129	44·9	43·0	40·8
50 0	27·849	2197	44·9	43·0	40·8
52 0	26·950	2870	42·0	41·1	40·0
52 30	26·451	3278	41·5	39·0	35·9
54 0	26·154	3685	40·0	37·5	34·2
55 0	....	(3811)	38·5	36·5	33·7
56 0	25·859	3938	38·0	35·8	32·8
57 0	....	(4398)	37·5	35·0	31·6
59 0	24·619	5314	35·2	32·2	27·5
8 0 0	24·469	5473	33·8	31·1	28·6
1 0	24·270	5789	33·6	30·4	25·2
2 0	23·972	6000	32·2	29·8	24·4
3 0	23·783	6117	31·5	29·0	22·9
4 0	23·674	6321	31·3		....
4 30	....	(6375)	31·0	29·2	24·3
5 0	23·496	6429	30·5	29·0	25·9
6 0	23·528	6385	30·0	28·5	23·8
6 30	23·529	6385	30·5	28·7	25·7
7 0	23·531	6385	29·0	27·8	23·4
9 0	23·382	6647	29·5	27·8	24·7
10 0	23·362	6659	29·3	27·5	21·3
11 0	23·103	6966	29·0	27·1	20·3
11 30	22·884	7201	28·5	26·0	19·2
12 0	22·734	7436	28·0	25·7	16·2
13 0	22·485	7671	27·2	25·0	15·2
14 0	22·387	7806	26·0	24·1	14·4
15 0	22·188	8024	26·0	24·0	13·8
16 0	22·109	8041	26·0	24·0	13·8
18 0	21·999	8259	27·0	25·1	16·4
19 0	21·909	8364	26·5	24·8	16·7
20 0	21·840	8446	26·2	24·8	17·9
20 30	....	(8475)	....	....	15·0
21 0	21·790	8504	25·0	32·0	
21 30	21·690	8621	25·0	32·0	
22 0	21·590	8726	24·5	32·0	
22 30	....	(8726)	....	....	15·5
23 0	21·511	8819	23·5		
24 0	21·192	9193	21·5		
25 0	21·142	9252	21·3		
27 0	21·090	9310	21·0	26·0	
28 0	20·895	9563	21·5	21·5	
29 30	20·547	10005	21·1	18·5	0·7
31 0	....	(10300)	....	....	5·0
32 0	20·002	10646	18·1	14·2	−14·0
33 0	19·902	10785	17·2	14·1	− 9·4
34 0	19·802	10924	17·0	13·9	− 9·7
35 0	19·702	11062	17·5	14·2	−10·9

Time of observation. A.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.
h m s	in.	feet.	°	°	°
8 37 0	....	(11075)	17·5	14·1	−11·8
38 0	19·552	11082	16·2	14·1	− 2·0
39 0	19·523	11127	16·5	14·2	− 3·4
40 0	19·303	11592	16·2	14·0	− 2·7
41 0	19·253	11654	16·0	14·0	− 1·4
42 0	19·105	11857	16·0	14·0	− 1·4
43 0	18·905	12113	15·5	12·5	9·5
44 0	18·756	12305	13·8	12·5	2·4
44 30	18·705	12416	12·2	11·5	6·1
45 0	18·705	12416	13·0	12·1	5·0
46 0	....	(12415)	....	....	7·0
47 0	18·706	12414	14·2		
....	18·606	12800	13·0		
....	....	....	17·0	....	4·5
49 0	18·506	12857	16·2	15·0	5·8
50 0	18·507	12857	....		
51 0	18·307	12972	16·0		
52 0	18·357	12900	16·0		
52 30	....	(12800)	....	....	13·5
53 0	18·560	12666	17·8	....	10·5
54 0	18·633	12533	17·8	17·0	11·0
54 30	18·714	11818			
....	....	....	17·5	16·9	12·5
....	....	....	....	....	12·5
57 0	18·548	12704	20·9		
58 0	18·618	12593	17·5	16·9	12·5
59 0	18·318	12926	14·0	13·5	11·5
9 0 0	18·318	12926	11·5	11·5	9·5
1 0	18·315	12926	11·8	11·5	9·2
1 15	....	....	....	....	11·1
1 30	18·315	12926	12·5	12·0	8·1
2 0	18·265	12975			
3 0	18·215	13025	15·0	14·5	10·4
4 0	18·215	13025	15·0	14·8	13·3
5 0	18·215	13025	15·0	14·8	13·3
7 0	18·215	13030	16·5	15·0	3·5
8 0	18·215	13160	16·0		
10 0	18·105	13279	15·1	14·5	9·8
10 30	18·065	13321	15·0	14·5	10·6
....	....	....	....	....	10·1
12 0	17·815	13882	14·5	14·0	11·5
13 0	17·645	14218	13·1		
14 0	17·663	14096	12·8	12·4	9·3
15 0	17·713	13791	12·2	11·2	3·5
16 0	17·713	13805	14·5		
....	....	....	14·5		
20 0	17·613	13695	1·0	....	0·0
22 0	17·613	13695	8·0		
23 0	17·613	13695	7·2		
24 0	....	(13738)	....	....	− 4·0
25 0	17·513	13982	5·0		
27 0	17·513	13982	3·5		
28 0	17·643	13807	3·0		− 7·0
29 0	17·513	13982	2·5	2·0	−10·0
31 0	17·514	15517	2·0	1·0	−10·0
32 0	16·013	16284	1·2	0·2	
33 0	15·815	16590	0·0	0·2	

Table II. (*continued.*)—Fifteenth Ascent.—September 29 (*continued*).

Time of observation. A.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.	Time of observation. A.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.
h m s	in.	feet.	°	°	°	h m s	in.	feet.	°	°	°
9 34 0	17·317	14295				10 2 0	19·210	11834	17·5		
35 0	17·417	14235	4·5	....	− 1·2	....	....	....	19·5	16·1	− 0·2
36 0	17·417	14219	7·5	....	5·0	3 30	20·210	10534	21·0	16·5	−14·4
38 0	17·517	14175	6·0	5·9	4·5	4 0	20·410	10284	22·0	17·8	− 9·9
40 0	....	....	....	....	4·0	4 30	20·660	10084	23·2	18·1	−13·9
41 0	17·417	14203	5·5	....	4·5	5 0	21·909	9671	23·0	19·0	− 6·1
43 0	17·618	13897	7·2	4·9	− 3·0	6 0	21·309	9179	25·0	20·5	− 4·3
44 0	17·618	13897				6 30	21·509	8933	26·0	21·0	− 4·0
45 0	17·468	14224	9·0	7·5	− 3·0	7 0	22·909	8439	26·5	21·0	− 6·9
46 0	....	(14190)	9·3	8·2	− 2·0	7 30	22·109	8209	27·0	21·1	− 5·9
47 0	17·418	14155	9·5	8·6	0·9	8 0	22·659	7626	29·0	24·5	+ 8·2
48 0	17·318	14308	11·5	11·5	11·5	9 0	22·809	7396	31·0	26·8	15·5
49 0	17·518	14031	13·0	12·3	6·9	11 0	24·398	5613	34·5	30·9	24·9
50 0	17·117	13175	13·9	13·2	7·8	13 0	24·888	5078	35·2	30·9	24·1
....	....	....	14·1	13·5	8·9	....	....	....	36·0	31·1	33·8
52 0	17·117	13175	15·0	14·1	6·4	14 0	25·492	4438	37·2	31·1	22·5
54 0	17·318	14459	13·1	12·6	8·8	15 0	25·992	3933	39·3	33·0	24·9
55 0	17·518	14347	13·2	12·1	3·6	15 30	26·391	3529	39·5	33·0	24·6
56 0	17·718	13947	13·5	11·9	− 0·5	16 0	26·689	3224	41·2	33·5	23·8
56 30	....	(13947)	13·5	11·0	− 8·4	17 0	27·007	2828	42·0	33·8	23·7
57 0	17·718	13947	13·2	11·0	− 6·0	19 0	27·881	2039	47·0	37·5	26·8
57 30	17·818	13747	13·2	10·5	−10·4	191 0	27·981	1881			
58 0	18·118	13332	15·1	11·0	−13·0	20 0	27·979	1881	48·0	40·0	31·2
59 0	18·619	12642	17·0	14·5	− 4·7	21 0	27·777	1717	48·0	40·5	32·3
10 0 0	18·719	12504	17·2	15·0		23 0	28·471	1469	50·0	45·0	39·7
1 0	18·919	12225	17·5	15·1	− 4·0	30 0	....	ground	53·0		
1 30	19·069	12030	17·2	14·5	− 6·0						

Sixteenth Ascent.—October 9, 1863.

Time of observation.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.	Time of observation.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.
P.M.						P.M.					
4 0 0	29·30	on the	53·8	48·6	43·5	4 41 0	23·00	6732	31·0	28·5	22·2
27 0	29·23	ground	54·5	49·2	44·1	41 30	22·95	6796	31·5	28·7	21·8
29 30	29·12	426	53·0	47·9	42·8	42 0	22·75	7030	31·8	28·9	22·0
30 0	28·70	845	52·0	46·8	41·5	43 0	22·62	7184	31·0	27·1	16·9
30 30	28·42	899	50·0	45·5	40·7	43 30	22·62	7161	30·5	27·1	17·2
31 0	27·92	1573	48·2	44·1	39·6	44 0	22·60	7193	29·5	27·1	19·1
31 40	27·70	1748	47·8	43·0	37·7	45 0	22·55	7252	29·2	27·1	19·8
31 50	27·60	1887	47·4	42·8	37·7	46 0	22·52	7303	29·0	27·1	20·2
32 0	27·50	1984	46·8	42·5	37·7	46 30	22·50	7310	30·0	27·1	18·0
32 15	27·35	2131	46·0	42·0	37·4	47 0	22·55	7267	31·5	27·2	16·5
32 30	27·20	2279	45·2	41·1	36·4	48 0	22·69	7087	30·0	27·2	18·0
32 45	27·00	2399	44·8	40·5	35·6	49 0	23·00	6731	30·5	27·2	17·7
33 0	27·00	2474	43·5	40·0	35·9	50 0	23·15	6557	31·0	27·5	18·1
33 30	26·42	3060	42·0	38·4	33·9	51 0	23·60	6310	31·7	28·0	19·5
34 0	25·80	3700	41·0	37·2	32·4	52 30	24·00	5600	32·0	29·2	22·7
34 30	25·70	3805	40·8	36·8	31·8	52 45	24·15	5433	32·5	29·5	23·1
35 0	25·62	3878	40·5	36·5	31·4	53 0	24·50	5052	33·0	29·8	23·4
35 30	25·40	4114	39·2	35·6	30·8	53 30	25·55	3928	33·2	30·0	23·6
36 0	25·20	4219	37·5	33·0	26·8	54 0	24·70	4835	34·0	30·5	24·4
37 30	23·95	5672	34·2	31·5	26·9	55 0	25·10	4409	34·8	30·7	24·2
38 0	24·10	5499	33·0	30·5	25·5	55 10	25·20	4302	34·8	31·2	25·3
38 30	24·00	5605	32·5	29·7	23·8	56 0	25·40	4095	35·5	32·0	26·6
39 0	23·90	5717	32·0	29·5	24·2	57 0	25·55	4024	36·0	32·0	26·0
39 30	23·40	6277	31·5	28·2	20·0	57 30	25·70	3783	36·5	32·5	26·6
39 45	23·31	6378	31·3	28·4	21·0	57 45	25·80	3679	37·0	33·0	27·3
40 0	23·20	6506	31·2	28·5	22·3	58 0	25·80	3679	37·0	33·0	27·3

TABLE II. (*continued.*)—SIXTEENTH ASCENT.—October 9, 1863.

Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.	Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air	Temp. of the Wet-bulb.	Temp. of the Dew-point.
h m s	in.	feet.	°	°	°	h m s	n.	feet.	°	°	°
4 58 30	25·80	3679	37·0	33·1	27·5	5 33 30	27·65	1890	45·0	42·5	40·7
59 0	25·85	3548	37·0	34·2	27·7	34 0	27·60	1877	44·0	42·5	40·7
5 0 0	26·20	3268	38·0	34·2	29·0	34 30	27·65	1827	44·0	42·5	40·7
1 0	26·42	3046	38·7	35·1	30·3	35 0	27·75	1731	44·5	42·8	40·7
2 0	26·42	3040	39·0	35·1	29·9	35 30	27·85	1633	44·2	43·1	41·8
3 0	26·40	3067	39·2	35·5	30·6	36 0	27·90	1586	44·5	43·2	41·4
4 0	26·38	3087	39·0	35·1	29·9	36 30	28·00	1490	44·8	43·6	42·1
4 30	26·35	3125	39·2	35·1	29·6	37 0	27·70	1782	44·8	43·6	42·1
5 0	26·15	3323	39·5	35·5	30·2	38 0	27·55	1927	45·0	43·4	41·5
6 0	26·15	3330	39·2	35·5	30·6	39 0	27·35	2120	45·2	43·1	40·7
6 30	26·15	3323	39·5	35·5	30·2	40 0	27·35	2124	45·0	43·1	40·9
7 0	26·20	3272	39·2	35·1	29·6	41 0	26·92	2552	44·2	43·0	41·6
8 0	26·31	3159	39·0	35·5	30·8	42 0	26·85	2619	43·0	41·5	37·5
10 0	26·60	2863	39·5	36·0	31·4	42 15	....	(2910)	42·5	38·5	33·5
11 0	26·70	2765	40·5	36·1	30·4	42 30	26·30	3174	41·5	37·5	32·5
12 0	26·80	2665	40·5	37·0	32·5	43 0	26·15	3326	41·0	37·2	32·4
13 0	26·75	2715	41·0	37·8	33·7	43 15	26·00	3476	39·5	36·0	31·4
14 0	27·08	2386	42·0	38·5	34·2	43 30	25·75	3735	39·2	35·0	29·5
14 15	27·14	2327	42·0	39·3	35·7	44 0	25·72	3762	38·5	33·0	25·6
14 30	27·14	2327	42·0	39·0	35·3	45 0	25·20	4318	37·8	32·5	34·2
15 0	27·10	2369	42·5	39·1	34·9	45 30	25·25	4259	37·2	35·1	32·1
16 0	26·85	2629	42·0	38·5	34·2	46 0	25·25	4303	37·2	35·1	32·1
17 0	26·72	2750	42·5	38·1	32·7	46 30	25·00	4584	37·2	35·2	32·1
18 0	26·60	2870	42·0	37·5	32·0	47 0	24·75	4786	36·6	32·5	26·5
19 0	26·55	2920	41·5	37·0	31·4	48 0	24·60	4949	36·0	31·8	25·5
20 0	26·35	3121	41·0	36·8	31·5	48 30	24·50	5052	36·0	31·5	24·9
20 30	26·20	3275	40·7	36·2	30·2	49 0	24·30	5263	35·0	31·8	26·7
21 0	26·15	3323	40·5	36·1	30·4	49 30	24·20	5377	34·2	31·0	25·4
22 0	26·10	3368	40·0	36·0	30·8	49 45	23·80	5813	33·0	30·8	26·4
22 30	26·10	3368	39·5	36·5	32·6	50 0	23·55	6091	32·5	28·2	19·0
24 0	26·33	3590	39·5	36·1	31·6	51 0	23·10	6310	31·2	27·5	17·6
25 0	26·00	3479	39·8	36·5	32·2	52 0	22·75	6992	29·8		
25 30	26·56	2905	40·5	36·2	30·6	53 0	22·40	7305	29·2	25·2	10·7
25 45	26·65	2905	40·5	36·5	31·4	54 0	22·20	7633	28·5	23·0	1·8
26 0	26·91	2554	41·0	37·1	32·2	55 0	22·10	7755	28·5	24·5	9·1
27 0	27·05	2386	41·5	37·8	33·2	55 30	21·90	7988	28·1	24·5	9·7
28 0	27·20	2268	42·0	39·1	35·5	56 0	21·80	8108	28·0	24·1	8·1
29 0	27·40	2072	43·0	40·5	37·5	56 30	21·60	8354	28·0	24·0	7·6
30 0	27·45	2042	43·0	41·0	38·6	57 0	21·55	8416	27·5	23·5	4·9
31 0	27·50	1976	43·8	41·5	38·8	58 0	21·50	8467	27·0	23·0	4·6
31 30	27·50	1970	44·0	42·1	39·8	59 0	21·40	8499	27·0	23·0	4·6
32 15	27·50	1958	43·5	42·1	41·0	6 0 0	21·30	8714	26·5	23·0	6·1
32 30	27·50	1930	44·0	42·5	40·7						

SEVENTEENTH ASCENT.—January 12, 1864.

2 5 0	30·110	ground	42·0	39·3	36·0	2 11 30	28·560	1436	40·0	38·5	36·6
6 0	....		....	....	35·0	12 0	28·610	1390	41·5	39·5	37·1
7 0	....		41·7	....	36·1	12 30	28·871	1148	41·5	39·5	37·1
8 0	29·856	....	41·5	39·0	35·9	13 0	28·713	1336	41·0	39·5	37·7
8 30	29·717	368				13 30	28·593	1733	41·5	39·5	37·1
9 0	29·409	655	40·0	38·2	35·9	14 0	28·383	1773	41·7	39·8	37·4
10 0	28·679	1328	38·5	37·2	35·4	15 0	28·313	1787	42·0	40·1	37·7
10 30	28·389	1598	39·5	38·1	36·3	15 30	28·243	1801	42·5	40·3	37·6
11 0	28·469	1518	39·7	38·3	36·4	16 0	28·163	1816	42·0	40·5	37·5

TABLE II. (*continued.*)—SEVENTEENTH ASCENT.—January 12 (*continued*).

Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.
h m s	in.	feet.	°	°	°
2 16 30	....	(1860)	....	....	39·0
17 0	28·073	1903	43·2	41·0	38·8
18 0	27·963	2010	44·0	43·1	42·0
19 0	27·763	2204	44·0	41·5	38·4
20 0	27·314	2639	44·0	41·2	37·9
21 0	27·263	2687	44·0	41·1	37·6
21 30	27·213	2735	44·0	41·2	37·9
23 0	27·173	2775	44·0	41·0	37·5
23 45	....	(2670)	....	....	37·5
24 0	27·262	2689	44·2	41·0	37·3
25 0	27·262	2689	44·5	41·0	37·0
26 0	26·943	3005	44·5	40·8	36·4
27 0	26·663	3282	43·5	39·5	34·7
28 0	26·266	3675	42·2	38·1	33·1
28 30	26·119	3821	41·5	36·2	29·5
30 0	25·890	4044	38·0	33·5	27·4
31 0	24·972	5001	36·2	33·1	28·5
31 15	....	(5200)	36·0	32·2	26·5
32 30	24·575	5401	34·2	31·5	27·3
33 0	24·397	5610	33·2	31·5	29·0
34 0	24·088	5924	32·2	31·1	29·3
34 30	23·880	6144	31·5	30·5	30·1
35 0	23·681	6364	31·0	....	26·2
36 0	23·601	6453	30·6	29·2	
37 0	23·531	6516	30·2	31·0	11·5
37 30	23·282	6802	29·2	30·0	11·5
39 0	23·232	6844	29·2	30·0	
41 0	23·403	6678	30·0	30·0	
41 30	23·433	6650	29·5	27·1	9·5
43 0	23·385	6692	29·2	27·1	
44 0	......	(6790)	29·4		
45 0	23·187	6885			
46 10	23·187	6885			
47 0	23·087	6984	30·8	29·0	
47 15	......	(7006)	30·7	29·0	
47 30	23·037	7029			
48 0	22·967	7118	30·7	27·8	
49 0	22·937	7089	31·1	29·0	
50 0	22·738	7277	31·0	28·5	
......	......	......	...	...	4·5
51 0	22·608	7448	30·5	26·5	
52 0	22·488	7602	29·2	25·0	6·0
52 30	22·438	7666	29·2	24·5	7·5
53 0	22·398	7730	28·5	24·0	6·7
54 0	22·388	7741			
55 0	22·438	7666	29·2	27·0	19·3
56 0	22·489	7614	29·2	27·1	20·6
57 0	22·889	7044	30·5	27·2	17·6
58 0	22·089	8148	30·5	27·5	18·8
59 0	23·039	6768			
3 0 0	22·439	7666	29·1	25·1	10·6
1 0	22·439	7666	28·5	24·5	9·0
2 0	22·293	7931	27·2	23·1	4·2
3 0	22·143	8086	27·2	23·1	4·2
4 0	22·043	8189	27·2	23·5	6·5
5 0	21·993	8230	27·0	23·5	7·4
5 30	......	(8288)	...	...	5·0
3 6 0	21·944	8346	26·5	23·7	10·2
8 0	21·595	8766	26·0	22·5	4·7
9 0	21·485	8894	25·5	22·6	7·2
10 0	21·296	9104	24·5	21·2	2·4
11 0	21·295	9105	23·0	19·5	− 0·5
12 0	21·197	9217	22·8		
13 0	21·099	9327	21·5		
14 0	21·001	9437	20·5		
15 0	21·001	9437			
15 30	20·951	9500	20·5	19·0	8·6
16 0	20·951	9500	20·5	17·5	− 3·5
16 30	20·951	9500	20·5	18·4	3·8
17 0	20·921	9536	21·0	18·5	1·3
17 30	20·902	9560	21·0	18·7	2·9
18 0	20·882	9586	21·0	18·5	1·4
19 0	20·702	9822	20·0	18·5	7·8
20 0	20·402	10017	17·5	16·2	+ 6·4
21 0	20·352	10090	17·2	15·0	− 1·7
21 20	20·352	10090	17·2	15·0	− 1·7
21 40	20·205	10319	16·2	14·1	− 2·1
22 0	20·155	10394	15·9	13·8	− 2·4
22 30	20·105	10469	15·5	13·1	− 5·4
23 0	20·105	10469	15·0	13·0	− 2·5
24 0	20·005	10619	14·0	11·0	−12·2
25 0	19·606	11016	13·2	11·1	+ 5·2
26 0	19·406	11278	12·1	9·4	− 2·8
27 0	19·386	11429	11·5	9·2	− 8·6
27 30	19·307	11533	11·1	9·2	− 5·5
28 0	19·209	11664	11·2	9·1	− 7·2
29 0	19·209	11664	11·1	9·0	− 7·3
29 30	19·160	11708	11·0	8·7	− 7·4
30 30	19·110	11761	11·0	8·7	− 7·4
31 30	19·012	11897	11·0	8·3	−12·7
32 0	19·112	11774	13·2	12·8	+ 9·8
33 0	19·313	11528			
34 0	19·313	11528	14·5	13·8	8·3
35 0	19·433	11353			
35 30	19·663	11071	15·0	13·8	4·5
36 0	19·714	11007			
36 30	19·814	10879			
37 0	19·914	10751	16·0	14·0	− 1·4
37 30	19·964	10697	16·0	15·2	+ 9·0
38 0	20·064	10561	16·2	15·8	14·3
38 15	20·265	10289	16·2	16·0	14·5
38 30	20·316	10221	16·2	16·0	14·5
39 0	20·416	10085	16·2	16·0	14·5
39 10	20·466	10017	16·2	16·0	14·5
39 20	20·536	9921	16·5	16·3	14·8
39 30	20·836	9516	16·8	16·5	14·3
39 45	20·916	9408	17·2	17·0	15·5
40 0	21·016	9273	18·0	18·0	18·0
40 30	21·065	9316	18·0	18·0	18·0
41 0	21·215	9199	18·5	18·3	16·9
41 15	21·265	9156			
41 30	21·415	9026	20·0	19·8	18·4
41 45	21·515	8939	21·0	20·5	17·1
42 30	21·714	8765	21·0	20·5	17·1

TABLE II. (*continued.*)—SEVENTEENTH ASCENT.—January 12 (*continued*).

Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.	Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.
h m s	in.	feet.	°	°	°	h m s	in.	feet.	°	°	°
3 44 0	21·444	8904	21·8	21·5	19·6	3 56 15	....	(4473)	31·5	31·2	30·5
44 30	22·213	7993	22·5	22·0	18·9	56 30	25·703	4224	32·2	30·8	27·7
45 0	22·433	7732	22·5	22·0	18·9	57 0	25·951	3973	32·5	32·0	31·0
47 0	22·733	7447	22·2	22·9	21·1	58 0	....	(3703)	34·2		
47 30	22·863	7226	24·0	24·0	24·0	59 0	26·500	3433	36·0		
47 45	22·963	7136	24·2	24·0	22·9	4 0 0	26·550	3384	36·2		
48 0	23·113	6967	24·5	24·4	23·9	0 30	26·779	3159			
49 0	23·414	6640	25·2	25·1	24·6	1 0	26·849	3091	37·2		
49 30	23·713	6313	26·0	25·8	24·8	1 15	26·989	2953	37·5		
50 0	23·813	6204	26·2	26·0	25·1	1 30	27·122	2821	38·0		
50 30	23·962	6040	26·5	26·0	23·7	2 0	27·445	2451	38·5	38·5	38·5
51 0	24·062	5932	26·9	26·8	26·4	2 30	27·511	2384	39·2	38·5	37·6
51 30	24·161	5824	27·0	26·8	25·9	3 0	27·811	2096	39·8	39·2	38·5
52 0	24·311	5670	27·6	27·3	26·0	3 30	28·089	1878	40·8	40·0	39·0
52 30	24·360	5619	28·1	27·9	27·1	4 0	28·188	1807	41·0	40·5	39·9
53 0	24·509	5465	28·5	28·3	27·6	5 0	28·586	1415	40·0	39·0	36·5
53 30	24·588	5384	29·1	28·8	27·8	7 0	28·633	1366	40·0	39·5	37·6
54 0	24·687	5284	29·2	29·0	28·4	8 0	28·581	1420	39·8	38·0	35·7
54 30	24·827	5142	30·3	30·3	30·3	8 30	28·680	1324	40·0	39·5	37·6
55 0	25·306	4636	31·0	30·7	29·9	9 0	28·498	1514	40·4	39·8	39·0
55 30	25·206	4739	31·2	31·1	30·8	9 30	29·977	ground	41·8	40·7	38·8
56 0	25·804	4121									

EIGHTEENTH ASCENT.—April 6, 1864.

3 0 0	....	on the ground	46·0	43·1	39·6	4 30 0	22·329	8083	39·0	33·1	25·3
20 0	30·204		47·0	44·2	40·8	32 0	21·898	8594	35·6	30·6	
4 7 0	30·114		46·0	42·5	38·5	34 0	21·678	8854	34·2	30·0	22·6
8 0	30·114		46·0	42·5	38·5	34 30	21·487	9090	34·5	29·1	20·0
9 0	30·094		45·7			35 0	21·276	9378	34·5	27·2	15·0
9 10	....		45·5			36 0	20·676	10155	35·2	27·5	15·2
9 30	29·875	320	45·5	42·0	37·9	36 30	20·177	10805	36·0	27·8	15·5
9 40	29·604	557	44·8	41·5	37·7	37 0	19·976	11075	36·5	..	15·5
10 10	29·274	867	42·0	38·7	34·6	38 0	20·026	10987	39·0	29·2	16·3
11 13	28·876	1219				38+	....	(10730)	..	..	16·0
12 0	28·658	1405	40·8	37·2	32·6	39 0	20·474	10470	43·0	33·8	22·7
13 0	28·258	1749				40 0	20·873	10010	46·0	35·1	22·7
14 0	27·879	2161	37·8	36·1	33·8	40 30	20·972	9895	46·1	35·0	22·4
14 30	27·862	2170	36·5	35·5	34·0	41 0	21·271	9513	46·2	35·1	22·5
15 0	27·564	2469	36·0	35·2	33·9	42 0	21·967	8642	46·8	37·1	26·2
16 0	27·245	2775				43 0	22·676	7783			
16 30	26·817	3194	34·5	33·2	31·0	44 0	22·744	7696	47·2	37·8	26·2
17 0	26·649	3362				44+	....	(7610)	..	..	26·0
18 0	26·490	3507	33·1	32·5	32·0	44 30	22·864	7524	46·2	37·1	26·7
19 0	26·152	3884	32·0			46 0	22·564	7869	46·0	36·5	25·6
20 0	25·873	4260	33·0	32·1	30·3	46 30	22·514	7947	46·0	37·5	27·8
20 30	25·724	4404	34·2	32·2	28·7	47 0	22·864	7553	46·0	37·5	27·8
22 0	25·175	4873	36·0	34·1	31·2	47 30	22·981	7410	46·2	38·5	29·6
23 0	24·825	5251	36·0	35·2	28·7	48 0	23·309	7036	46·2	38·4	29·5
25 0	24·296	5827	36·0	34·5	32·2	50 0	....	....	..	..	25·0
25 30	....	(6163)	..	..	32·7	50 30	24·060	6153	44·0	37·8	30·4
26 0	23·696	6800	34·2	33·1	28·5	51 0	24·537	5536	43·8	38·3	31·6
27 30	23·378	6882	38·5	37·2	35·4	52 0	24·906	5213	43·0	38·0	32·0
28 0	23·001	7281		..		52 30	25·955	4163	42·2	38·0	32·9
29 0	22·834	7493	40·2	36·0	30·6	53 0	....	(4049)	..	..	34·9

Table II. (*continued.*)—Eighteenth Ascent.—April 6 (*continued*).

Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.	Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.
h m s	in.	feet.	°	°	°	h m s	in.	feet.	°	°	°
4 53 30	....	(3935)	..	..	35·0	5 0 0	29·049	1069	41·5	38·6	34·9
54 0	26·254	3821	41·0	38·0	34·2	1 0	29·099	1024	41·8	38·7	34·8
54 30	26·654	3405	41·0	37·1	32·2	2 0	29·149	979	41·9	38·8	35·0
54 45	26·773	3280	40·4	36·8	32·2	3 0	29·268	869	42·0	38·7	34·6
55 0	26·953	3071	39·9	36·5	32·0	4 0	29·468	725	42·9	39·4	35·2
56 0	27·153	2881	39·1	36·0	31·9	5 0	29·628	545	43·5	39·9	35·5
56 30	27·352	2691	39·5	36·2	31·8	6 0	29·678	497	45·0	41·2	36·8
58 0	28·250	1836	39·8	37·1	33·6	7 0	29·748	ground	45·8		
59 0	28·670	1437	40·0	37·8	34·9	25 0	29·728	ground	47·0	42·2	36·8
59 30	28·949	1163	40·6	38·1	34·9						

Nineteenth Ascent.—June 13, 1864.

	29·300	....	61·5	52·5	44·7	7 21 0	26·450	3126	46·5	42·1	38·4
	29·300	....	61·8	51·7	43·1	22 0	26·330	3307	....	....	....
7 0 10	29·250	317	60·0	51·0	43·1	22 30	26·330	3307	47·2	44·1	40·9
0 20	29·130	490	59·1	50·1	42·1	23 0	26·350	3327	47·2	44·1	40·9
0 30	28·920	691	59·2	50·1	41·9	23 30	26·350	3327	47·2	44·0	41·0
1 0	28·750	885	59·1	50·0	41·9	25 0	26·240	3407	48·0	44·1	39·8
1 30	28·470	1155	58·2	50·2	43·0	26 0	26·170	3459	48·2	44·2	39·8
2 0	28·360	1265	57·2	48·2	40·0	27 0	26·150	3463	48·5	44·1	39·3
2 10	28·150	1437	56·8	48·1	44·1	27 30	26·060	3536	47·0	41·2	34·7
2 30	27·950	1635	56·0	48·1	40·7	28 30	26·050	3543	47·1	41·1	34·4
2 45	27·900	1685	55·5	48·1	43·0	29 0	26·050	3543	47·0	41·0	34·3
3 15	27·610	1982	54·1	46·5	39·0	30 0	26·050	3543	46·0	40·5	34·2
4 0	27·450	2132	54·2	47·1	40·1	31 0	26·130	3517	46·0	40·5	34·2
5 0	27·300	2282	54·0	47·1	40·3	32 0	....	(3445)	....	....	35·0
5 20	27·180	2301	54·5	47·1	41·6	32 30	26·270	3409	47·0	41·8	35·9
5 55	27·050	2530	52·2	46·1	39·9	32 45	26·350	3349	48·2	43·0	37·3
6 0	26·950	2630	52·1	46·1	40·0	33 0	26·700	3097	49·0	44·2	39·0
6 30	26·800	2780	52·1	46·2	40·2	34 0	26·870	2755	51·2	45·0	38·6
7 0	26·740	2840	52·5	45·7	38·8	35 0	26·900	2680	51·1	44·5	37·7
7 15	26·700	2880				36 0	27·050	2527	51·0	44·8	38·3
7 30	26·700	2880	52·0	45·5	38·9	36 30	27·050	2527	51·1	45·5	39·7
8 0	26·560	3031	51·5	45·0	39·8	37 30	26·940	2740	50·5	45·0	39·4
9 0	27·650	2937	51·0	45·1	39·0	38 0	26·900	2782	50·2	45·0	39·5
10 0	27·750	2630				38 10	....	(2790)	....	....	39·5
10 30	27·050	2530	52·5	45·6	38·5	39 0	26·850	2834	49·5	44·2	38·5
11 0	27·055	2520	52·5	46·0	39·5	39 30	26·830	2854	50·2	45·0	39·5
11 30	27·200	2310	52·8	45·9	39·0	40 0	26·850	2834	51·0	45·1	39·0
12 30	27·200	2280	53·8	46·6	39·6	42 0	26·870	2812	51·8	45·7	39·5
13 0	27·150	2327	52·8	46·0	39·2	43 0	26·940	2740	51·8	45·8	39·7
13 30	27·130	2337	51·5	45·2	38·8	44 0	....	(2683)	52·0	46·0	39·9
14 0	27·050	2522	51·0	45·0	38·8	45 0	27·050	2625	51·9	46·0	40·0
14 30	26·950	2604	50·5	44·0	37·2	46 0	....	(2550)	....	....	39·5
15 0	26·870	2694	50·2	44·2	37·8	....	27·200	2470	52·0	46·1	40·1
16 0	26·700	2854	49·0	43·5	37·5	47 30	26·950	2629	51·0	45·5	39·8
16 30	26·560	3004	48·2	43·5	38·3	48 0	26·890	2689	51·0	45·0	38·8
17 0	....	(3055)	....	....	35·0	49 0	26·830	2740	51·5	45·2	38·4
17 30	26·470	3106	47·2	42·6	37·0	49 30	26·750	2823	51·8	45·0	38·1
18 10	26·300	3276	46·8	42·5	37·7	50 0	26·650	2927	51·5	46·0	40·4
18 40	26·320	3296	46·9	42·0	36·5	50 30	26·560	3017	51·0	46·2	41·2
19 0	....	(3337)	....	....	46·3	51 0	26·550	3027	....	....	39·0
20 0	26·130	3461	46·6	42·1	37·0	52 0	26·530	3053	49·2	43·0	36·3

TABLE II. (*continued.*)—NINETEENTH ASCENT.—June 13 (*continued.*)

Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.	Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.
h m s	in.	feet.	°	°	°	h m s	in.	feet.	°	°	°
7 52 30	26·830	2753	49·0	43·4	37·3	8 0 0	27·850	1276	53·5	50·0	46·6
53 0	26·950	2613	49·0	44·0	38·6	2 0	28·350	1238	53·5	50·0	46·6
54 0	27·200	2363	50·5	46·0	41·3	14 0	29·490	{on the ground}	53·3	49·1	44·9
55 0	27·450	2003	51·7	47·6	43·4	15 0	29·500		54·0	50·0	46·1
56 0	27·650	1923	53·0	50·0	47·0						
58 0	27·770	1807	53·2	50·0	46·8						

TWENTIETH ASCENT.—June 20, 1864.

Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.	Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.
6 10 0	29·880	{on the ground}	66·0	60·0	55·1	6 39 0	27·110	2890	54·0	52·0	50·0
....	....		66·5	59·5	53·9	39 30	27·060	2940	54·0	51·7	49·5
17 0	29·860		65·0	60·0	55·9	40 0	27·010	2990	53·9	51·5	49·1
17 30	29·560	511	65·0	58·0	52·3	40 30	27·010	2990	54·0	51·5	49·1
18 0	29·280	772	63·2	57·1	51·9	41 0	26·950	3050	54·0	51·5	49·1
18 20	29·010	1022				42 0	26·880	3320	54·0	51·5	49·1
18 30	28·950	1082	62·1	56·1	50·9	43 0	26·780	3237	54·0	51·5	49·1
....	....	....	60·9	55·5	50·8	44 0	26·470	3549	53·5	52·0	50·5
19 0	28·560	1462	60·5	55·0	50·2	45 0	26·360	3669	53·0	50·5	48·0
19 30	....	(1582)	....	....	48·1	45 30	26·270	3758	52·2	49·5	46·7
20 0	28·230	1702	58·2	54·1	50·4	46 0	26·260	3768	51·0	50·0	49·0
20 30	28·010	2006	58·2	54·1	50·4	47 0	26·270	3759	51·5	50·0	48·5
21 0	27·910	2106	58·2	54·0	50·2	48 0	26·020	4013	50·7	49·8	48·8
21 30	27·840	2236	58·2	53·1	48·4	49 0	25·910	4123	50·2	49·2	48·1
22 0	27·360	2696	55·5	52·0	48·6	49 30	25·810	4230	50·0	49·2	48·3
23 0	27·270	2786	54·5	51·0	47·6	50 0	25·780	4271	49·2	49·2	49·2
24 0	26·960	3086	54·0	51·0	48·1	50 30	25·780	4271	49·2	49·2	49·2
24 30	26·810	3214	54·0	51·0	48·1	51 0	25·780	4271	49·2	49·2	49·2
25 0	....	(3375)	53·0	50·6	48·0	52 0	25·770	4280	49·5	49·0	48·5
26 0	26·340	3696	52·0	50·0	48·0	52 30	....	(4255)	....	....	47·5
27 0	26·110	3978	52·5	50·2	47·9	53 0	25·810	4230	49·5	48·2	46·8
27 30	26·050	4038	52·2	50·2	48·2	53 30	25·810	4230	49·5	48·1	46·6
28 0	26·010	4068	51·7	50·2	48·7	54 0	25·860	4180	49·5	48·1	46·6
28 10	25·970	4082	51·2	49·7	48·1	54 30	25·910	4130	49·2	48·1	46·8
28 30	25·950	4102	51·2	49·7	48·1	54 45	25·910	4130	49·3	48·1	46·8
29 0	25·950	4102	51·2	49·2	47·1	55 30	26·070	4080	49·5	48·1	46·6
30 0	25·930	4122	51·2	49·5	47·7	56 0	26·560	3390	51·2	49·5	47·7
30 30	25·970	4082	51·2	49·5	47·7	57 0	26·680	3360	51·5	50·0	48·5
31 0	26·040	4006	51·2	49·2	47·1	57 30	26·840	3187	52·0	51·5	51·0
32 0	26·190	3841	51·2	49·2	47·1	58 0	27·270	2696	57·5	53·2	49·3
33 0	26·770	3242	52·0	50·0	48·0	59 0	27·280	2688	58·0	54·8	52·0
34 0	26·810	3202	52·2	50·5	48·8	7 0 0	27·560	2493	58·0	55·0	52·3
35 0	27·010	3002	52·8	50·1	47·2	1 0	28·010	2088	59·3	54·8	51·0
35 15	27·160	2840				2 0	28·780	1388	60·4	56·2	52·6
36 0	27·260	2740	53·5	51·2	48·9	3 0	28·960	1061	61·8	57·5	53·9
36 30	27·260	2740	53·5	51·5	49·5	16 0	....	{ground.}	....		
37 0	27·260	2740	54·0	52·0	50·0	25 0	29·580		64·6	58·5	53·4
37 30	27·260	2740	54·0	52·1	50·2	30 0	29·780		64·0	58·2	53·9
38 0	27·180	2820	53·9	51·2	48·5						

TABLE II. (*continued*).—TWENTY-FIRST ASCENT.—June 27, 1864.

Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.	Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.
h m s	in.	feet.	°	°	°	h m s	in.	feet.	°	°	°
6 31 0	29·75	ground	63·1	55·5	49·1	7 15 0	25·88	4086	44·2	41·1	37·5
33 0	29·75		64·0	56+	49·4	16 0	25·91	4131	43·1	40·5	37·4
33 30	29·75		63·0	54·0	46·4	17 0	25·91	4131	43·0	40·0	36·4
34 0	29·67	432	61·5	52·0	43·7	18 0	26·00	4040	43·0	40·5	37·4
34 30	29·64	484	62·0	52·1	43·6	18 30	26·06	3985	43·1	40·5	37·4
34 45	29·61	514	60·1	51·2	43·4	19 0	26·11	3845			
35 0	29·51	610	60·1	51·3	43·5	19 20	26·25	3795	43·1	40·5	37·4
35 50	29·38	719	59·5	51·2	43·9	19 40	26·26	3790	43·9	41·0	37·6
37 0	29·21	865	58·5	50·2	42·8	20 0	26·37	3680	44·0	42·0	39·6
37 30	29·08	970	58·0	50·0	42·8	20 30	26·41	3640	44·1	41·9	39·3
38 0	28·98	1054	57·8	50·0	43·0	20 45	26·41	3640	44·2	42·1	39·6
39 0	28·88	1138	57·2	49·5	42·5	21 0	26·46	3590			
40 0	28·81	1188	57·2	50·0	43·4	22 0	26·51	3511	44·8	42·1	38·8
42 0	28·56	1493	56·8	50·0	43·8	22 15	26·54	3487	44·5	43·1	41·3
42 30	28·55	1497	56·5	50·0	44·0	22 30	26·57	3453	43·2	42·1	40·8
43 0	28·55	1497	56·2	49·8	43·8	24 0	26·57	3453	45·2	42·5	39·4
47 0	29·18	891	57·0	51·0	45·5	25 0	26·61	3423	45·9	43·0	41·7
48 0	29·24	840	57·2	51·5	46·3	26 0	26·71	3322	47·2		
48 30	29·35	750	57·8	51·9	46·7	26 30	26·73	3302	47·2	44·0	41·5
49 0	29·36	747	57·9	52·0	46·7	27 0	26·76	3277	47·5	45·0	42·2
49 10	29·40	717				28 0	26·85	3187	47·5	44·1	42·4
49 20	29·38	714	58·0	51·5	43·8	29 0	26·86	3197	47·8	44·2	40·2
49 30	29·37	713	57·8	51·2	45·3	30 0	26·90	3119	47·5	43·7	39·4
50 0	29·24	841	57·5	50·9	45·1	31 0	26·81	3209	47·2	42·1	36·4
50 30	29·17	903				32 0	26·61	3415	47·0	42·2	36·8
51 30	....	(980)	57·2	50·5	44·5	33 0	26·40	3527	47·0	42·2	36·8
52 0	29·05	1019	57·0	50·3	44·2	34 0	26·44	3561	46·5	42·1	37·1
53 0	28·74	1309	56·2	50·0	44·8	35 0	26·06	3907	43·0	41·3	39·2
54 30	28·45	1589	55·5	48·9	43·7	35 30	25·86	4191	42·8	41·5	40·2
54 45	28·41	1621	55·2	48·9	42·9	36 0	25·78	4270	43·0	42·0	40·8
56 0	28·38	1660	55·2	48·2	41·5	37 0	25·61	4467	43·0	42·0	40·8
56 30	28·37	1670	54·9	48·2	43·2	38 0	25·41	4661	43·7	41·5	38·8
59 30	28·81	1188	55·0	49·2	43·6	39 0	25·36	4716	43·0	41·3	39·2
7 1 0	29·06	950	55·2	49·2	43·4	39 30	25·28	4796	44·1	40·2	35·6
1 30	28·98	1004	56·0	49·5	43·4	40 0	25·18	4898	42·9	41·2	39·1
2 0	28·86	1134	55·9	49·0	42·5	41 0	25·18	4898	42·8	41·0	38·8
2 30	28·64	1370	55·2	49·2	43·4	41 30	25·18	4898	42·2	40·5	38·4
3 0	28·56	1460	35·0	48·5	42·2	42 0	25·26	4816	41·9	39·8	37·1
3 30	28·51	1514	54·5	48·0	41·7	42 30	25·28	4796	42·2	39·9	37·0
4 0	28·45	1578	54·0	47·8	41·7	42 45	25·36	4722	41·9	38·5	34·3
4 30	28·31	1714	53·2	46·8	40·4	43 0	25·38	4799	41·2	38·5	35·1
5 0	28·05	1979	52·7	46·1	39·6	44 0	25·45	4597	41·2	38·5	35·1
5 30	28·00	2026	52·2	46·1	39·9	44 30	25·45	4597	40·2	37·8	34·7
6 0	27·97	2057	52·2	46·1	39·9	45 0	25·38	4699	40·2	37·8	34·7
6 30	27·75	2295	51·5	46·0	41·2	46 0	25·36	4692	40·2	37·8	34·7
7 30	27·41	2603	50·5	45·1	40·3	48 0	25·45	4597	40·9	38·2	34·7
8 0	27·36	2648	49·5	45·0	40·2	49 0	25·55	4492	40·9	38·2	34·7
9 0	27·08	2941	49·6	45·0	40·1	49 20	25·57	4471	41·0	38·2	34·7
9 30	27·00	3021	49·2	45·2	40·9	49 30	25·57	4471	41·0	38·2	34·7
10 0	26·91	3111	49·5	45·2	40·6	50 0	25·68	4357	41·0	38·2	34·7
10 30	26·81	3202	49·5	45·1	40·4	51 0	25·91	4115	41·2	38·5	35·1
10 45	26·56	3454	48·4	43·5	38·1	52 30	26·06	3958	42·0	38·2	33·5
11 0	26·27	3767	46·9	43·0	38·6	53 0	....	(3958)	42·0	38·0	33·1
11 30	26·17	3831	46·5	42·1	37·1	53 30	26·06	3958	42·0	38·9	35·0
12 0	26·11	3871	46·2	42·1	37·4	53 45	26·06	3958	41·9	39·0	35·4
13 0	26·01	3965	45·1	42·1	37·7	54 0	26·06	3958	41·9	39·2	35·9
14 0	25·96	4017	45·5	42·1	38·2	54 30	26·08	3936	41·9	39·0	35·4

TABLE II. (*continued*).—TWENTY-FIRST ASCENT.—June 27 (*continued*).

Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.	Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.
h m s	in.	feet.	°	°	°	h m s	in.	feet.	°	°	°
7 55 30	26·06	3958	41·9	39·0	35·4	8 35 30	27·88	2168	47·8	44·2	40·2
56 0	26·06	3958	41·5	39·5	37·0	36 0	27·84	2208	47·9	44·0	39·7
56 30	26·08	3936	41·5	39·0	36·9	36 30	27·78	2268	47·8	44·0	39·8
58 0	26·36	3637	41·9	39·5	36·6	37 0	27·76	2288	47·6	44·0	40·0
58 30	26·41	3588	42·0	39·2	35·7	37 30	27·68	2322	47·6	44·2	40·4
59 0	26·45	3547	41·9	39·8	37·1	38 0	27·66	2337	47·2	43·9	40·2
8 0 0	26·48	3604	41·9	39·8	37·1	38 15	27·64	2348	47·2	43·9	40·2
0 30	26·55	3450	42·1	39·8	36·9	38 30	27·64	2348	47·2	44·0	40·4
1 0	26·66	3343	42·1	40·0	37·4	39 0	27·66	2337	47·2	43·7	39·8
1 30	26·76	3244	42·5	40·0	37·0	39 30	27·66	2337	47·2	43·5	39·3
2 30	26·86	3144	42·5	40·5	38·0	39 45	27·66	2337	47·2	43·5	39·3
3 0	26·96	3044	42·5	40·5	38·0	40 0	27·81	2187	47·0	43·5	39·5
3 30	27·01	2994	43·0	41·0	38·6	41 0	27·86	2136	47·0	43·6	39·7
4 0	27·26	2744	43·5	41·0	38·0	41 30	27·91	2086	47·0	43·7	39·9
5 0	27·31	2694	44·0	41·5	38·5	42 0	27·94	2056	47·3	43·9	40·1
6 0	27·41	2594	44·5	42·0	39·0	42 30	28·01	1986	47·2	43·9	40·2
7 0	27·56	2440	44·9	42·0	38·6	43 0	28·16	1836	47·0	44·0	40·6
8 0	27·58	2409	44·9	42·0	38·6	43 30	28·21	1786	47·2	44·5	41·4
8 30	27·46	2529	45·0	42·2	38·9	44 0	28·28	1716	47·5	45·1	43·4
9 30	27·06	2929	45·0	42·3	38·9	44 30	28·28	1716	47·8	44·8	41·4
10 0	26·76	3229	44·8	42·5	38·8	45 0	28·35	1668	48·2	44·5	40·4
11 0	26·66	3329	44·8	42·0	38·7	45 30	28·36	1678	48·5	45·2	41·6
14 0	26·51	3479	43·9	41·5	38·6	46 0	28·41	1628	48·7	45·1	41·2
15 0	26·41	3579	43·5	41·0	38·0	47 0	28·42	1618	48·9	45·5	41·8
15 30	26·41	3579	43·5	41·0	38·0	48 0	....	(1478)	49·1		
16 0	26·41	3579	43·3	41·0	38·3	50 0	28·84	1198	49·0	45·5	41·7
17 0	26·56	3444	43·1	40·5	37·4	51 0	28·91	1114	49·0	44·2	39·0
18 0	26·66	3340	43·0	40·1	38·6	51 30	28·91	1114	49·0	44·0	38·6
19 0	26·71	3288	43·1	40·5	37·4	52 0	28·98	1030	49·0	43·9	38·4
20 0	26·76	3236	43·2	40·5	37·3	52 30	29·06	944	49·0	43·5	37·5
20 30	27·01	2978	43·5	40·8	37·6	53 0	29·06	944	49·0	43·2	36·9
20 45	27·01	2978	43·5	41·5	39·2	54 0	29·21	770	49·0	43·5	37·5
21 0	27·01	2978	43·5	41·2	38·4	54 15	29·21	770	49·0	44·0	38·6
22 0	27·11	2878	43·8	41·2	38·1	54 30	29·26	662	49·0	44·0	38·6
22 30	27·16	2828	44·0	41·5	38·5	55 0	29·23	698	48·8	43·8	38·3
23 0	27·16	2828	44·0	42·0	39·6	55 30	29·16	772	48·9	43·5	37·8
24 0	27·26	2720	44·2	42·0	39·4	56 0	29·06	890	48·9	43·5	37·8
25 0	27·27	2710	44·5	42·2	39·4	56 30	28·91	949	48·6	43·2	37·3
26 0	27·56	2434	45·2	43·2	40·9	57 0	28·66	1245	48·8	42·8	36·2
27 0	27·66	2337	45·0	43·0	40·7	57 30	28·56	1363	48·5	42·3	35·5
27 30	27·71	2289	45·9	43·0	39·7	58 0	28·41	1540	47·9	42·2	35·9
28 0	27·76	2241	46·0	43·9	41·5	58 30	28·31	1658	47·0	42·0	36·4
28 20	27·78	2221	46·0	43·5	40·6	59 0	28·26	1717	46·5	41·8	36·4
28 30	27·81	2199	46·2	44·0	41·5	59 30	28·16	1843	46·0	40·6	34·4
29 0	27·96	2151	46·2	44·0	41·5	9 0 15	27·36	2651	47·2	41·0	34·1
29 30	28·01	2003	47·0	44·1	40·8	1 0	27·06	2954	47·5	42·2	36·3
29 45	28·06	1955	47·0	44·1	40·8	1 30	26·78	3244	46·5	42·7	38·4
30 0	28·08	1937	47·2	44·2	40·8	2 0	26·81	3214	46·7	42·5	37·7
30 15	28·08	1937	47·1	44·2	40·9	3 0	26·31	3517	46·9	41·5	35·5
30 30	28·15	1910	47·5	44·2	40·5	3 30	26·06	3964	46·0	41·2	35·7
31 0	28·18	1831	47·5	44·2	40·5	4 0	25·91	4019	44·8	40·5	35·5
32 0	28·18	1831	47·7	44·7	41·4	5 0	25·78	4166	44·5		
32 30	28·16	1884	47·9	44·6	40·9	6 0	25·06	4956			
32 45	28·16	1884	48·0	44·5	40·6	7 0	24·66	5396			
33 0	28·11	1936	48·2	44·7	40·8	8 0	24·06	6168			
33 30	28·06	1988	48·2	44·9	41·2	30 0	29·96	ground	46·5	45·2	43·8
34 0	27·95	2098	47·8	44·5	40·8						

TABLE II. (*continued*).—TWENTY-SECOND ASCENT.—August 29, 1864.

Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.	Time of observation. P.M.	Reading of the Barom. reduced to 32° F.	Height above the level of the sea.	Temp. of the Air.	Temp. of the Wet-bulb.	Temp. of the Dew-point.
h m s	in.	feet.	°	°	°	h m s	in.	feet.	°	°	°
4 6 0	29·64	ground	72·5	57·0	45·4	4 42 0	18·34	13675	34·2	33·5	
7 0	29·54	444	72·0	57·0	45·7	46 0	17·94	14293	35·2	31·0	25·3
7 30	29·26	769	71·2	57·2	46·7	47 0	17·94	14293	35·2	30·7	23·5
8 0	28·49	1484	71·0	56·0	45·2	47 30	17·92	14317	35·5	30·5	22·8
8 30	28·10	1883	64·2	55·5	45·6	48 30	17·84	14415	33·2	31·1	27·0
9 0	27·54	2433	64·5	53·0	43·6	49 0	17·74	14581	33·2	31·0	27·0
10 0	26·84	3166	62·2	51·0	41·4	49 30	17·74	14581	34·2	30·9	25·1
10 30	26·59	3427	61·0	49·5	39·5	52 0	17·89	14330	33·0	30·5	25·5
11 0	26·34	3632	60·5	48·5	38·0	52 30	17·92	14281	33·0	30·0	24·0
11 30	26·09	3837	58·5	47·2	37·1	53 0	17·94	14248	32·3	28·1	18·9
12 0	25·79	4412	56·2	46·2	36·9	54 30	18·04	14086	32·0	26·1	22·5
13 0	25·80	4404	55·0	46·0	37·4	55 0	....	....	....	....	3·0
14 0	25·46	4612	52·5	47·0	41·5	56 0	18·04	14086	29·5	22·0	− 2·4
15 0	25·44	4635	53·2	47·1	41·0	57 0	18·09	13991	28·5	22·1	− 1·6
16 0	25·36	4730	54·2	49·2	44·3	58 30	18·14	13895	29·0	22·0	− 3·4
17 0	25·29	4808	54·3	49·2	44·2	59 0	18·26	13730	30·0	23·1	+ 1·4
17 30	25·06	5066	54·2	48·5	42·9	5 0 0	18·29	13688	31·0	22·5	− 0·4
18 0	24·86	5289	54·2	48·5	42·9	1 30	18·74	13016	30·0	22·0	− 3·2
19 0	24·53	5664	54·2	51·0	47·9	3 0	18·84	12866	31·0	22·7	+ 0·4
20 0	24·44	5767	54·2	48·2	42·3	7 0	20·64	9943	34·0	28·9	20·0
23 30	23·79	6513	51·2	45·0	38·6	7 30	20·79	9868	34·2	29·0	19·9
24 0	23·49	6858	51·2	45·0	38·6	9 0	21·05	9740	36·2	30·2	21·2
25 0	23·24	7158	51·2	44·1	37·1	11 0	21·42	9268	36·2	30·5	22·0
26 0	22·96	7496	51·0	42·5	33·6	11 30	21·52	9143	37·2	30·5	31·1
26 30	22·89	7578	50·2	40·5	30·2	12 0	21·65	8981	37·8	30·9	31·7
27 0	22·54	7994	48·9	38·9	28·1	14 0	22·34	8146	41·2	32·0	20·5
28 30	22·34	8224	45·0	37·2	28·1	14 30	22·69	7726	41·5	31·8	19·7
28 45	22·14	8454	44·2	37·1	28·7	15 0	22·74	7666	41·0	31·8	20·2
29 0	22·04	8568	43·2	36·5	28·5	16 0	23·00	7352	42·5	32·0	19·2
29 30	21·92	8719	43·2	36·0	27·4	17 0	23·29	7018	44·2	33·5	20·9
30 30	21·44	9322	42·0	36·2	29·0	17 30	23·69	6558	45·5	38·1	29·6
31 0	21·34	9610	41·2	36·0	29·5	18 0	24·18	5996	47·0	42·8	38·1
32 0	20·59	10575	41·2	36·0	29·5	19 0	25·26	4815	49·5	46·2	43·0
32 30	20·46	10744	40·5	35·0	28·0	20 0	25·49	4550	51·2	48·1	44·9
33 0	20·36	10875	40·2	34·8	27·8	21 0	25·70	4326	52·5	48·1	43·6
34 0	19·94	11411	36·0	28·5	16·7	22 0	26·14	3857	53·5	49·5	45·0
36 0	19·64	11813	35·5	26·2	12·1	23 0	26·74	3225	54·2	49·1	44·1
38 0	19·07	12605	34·2	28·0	17·1	25 0	26·74	3238	58·2	49·5	41·6
39 0	18·94	12773	32·8	27·2	16·0	26 0	28·06	1902			
39 30	18·82	12944	32·8	26·2	13·0	27 0	28·54	1417	64·0	55·0	47·5
39 45	18·84	12924	33·2	25·5	10·0	32 0	29·86	ground	69·0	57·2	47·9

In every ascent a second thermometer has been used to check the accuracy of the readings of the dry thermometer, and the truthfulness of the temperatures shown by it; in some of the ascents a delicate blackened bulb thermometer was placed near to the place of the dry-bulb thermometer, fully exposed to the sun in cloudless skies, or to the sky at all times: the readings of this instrument were nearly identical with those of the dry-bulb thermometer in clouded states of the sky, and thus acted as an additional check. At all times one or the other, or both Regnault's and Daniell's hygrometer, have been used sufficiently often at all heights to show whether the wet-bulb thermometer was in proper action, and to check the results given by the use of the dry- and wet-bulb thermometers on the reduction of the observations.

In all cases the readings of the dry-bulb thermometer for the temperature of the air and the temperature of the dew-point, as found from the dry- and wet-bulb thermometer, have been adopted, without combination with similar results otherwise derived, excepting only when the wet-bulb failed to act either at times when the temperature of the air had just descended below the freezing-point, or just ascended above it, and when I have had occasion to apply water to the wet-bulb at such times the dew-point as found from either Daniell's or Regnault's hygrometer has been used.

§ 5. Variation of Temperature of the Air with Height.

Every reading of temperature in the preceding Tables, or the means of small groups of readings when observations have been taken in quick succession, at about the same altitude, was laid down on a diagram; all these points were joined, and a curved line was drawn passing through or near them, giving an equal weight to every point, and such that the area of the spaces between the original and adopted lines on one side of the adopted line was equal to that of the spaces on the other side of the line. The curves thus formed, for the most part, in the previous experiments have shown a gradual decrease of temperature with increase of elevation, and a gradual increase of temperature with decrease of elevation; but this was not the case this year, and I have not been able to adopt any curves for January 12 and April 6.

On the other days of experiments, a curve of assumed normal temperature has been adopted, and by comparison between the results as read from this curve, and the observations at the same elevations, the places and amount of disturbances are shown in the following Tables.

The numbers in the first column show the height in feet, beginning at the ground and increasing upwards; the numbers in the second column show the interval of time in ascending to the highest point; the notes in the third column show the circumstances of the observations; the numbers in the fourth and fifth columns the observations and the approximate normal temperatures of the air; and those in the next column the difference between the two preceding columns, or the most probable effect of the presence of cloud or mist on the temperature, or of other disturbing causes in operation.

The next group of columns is arranged similarly for the descent, and the other groups for succeeding ascents and descents.

TABLE III.—Showing the Temperature of the Air, as read off the curve drawn through the observed temperatures, and as read off the curve of most probable normal temperature, called adopted temperature, and the calculated amount of disturbance from the assumed law of decrease of temperature.

FOURTEENTH ASCENT.

1863. Height, in feet, above the mean level of the sea.	Temperature of the Air. Ascending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.	Descending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.
August 31.			°	°	°			°	°	°
8000	From 6^h 19^m to 6^h 29^m 30^s p.m.	Sun shining.	34·0	33·9	+ 0·1	From 6^h 29^m 30^s to 6^h 52^m p.m.	Cirri higher.	34·0	34·0	0·0
7000		Very dark cloud near us.	34·7	35·2	− 0·5			38·0	35·6	+ 2·4
6000			39·0	38·1	+ 0·9			38·3	37·2	+ 1·1
5000		Very cold.	42·8	41·5	+ 1·3			38·9	38·8	+ 0·1
4000			45·2	44·6	+ 0·6		In basin of clouds.	41·5	41·0	+ 0·5
3000			47·5	47·6	− 0·1		Just in clouds.	43·2	43·5	− 0·3
2000		Above cloud.	51·3	50·7	+ 0·6		Stratum of clouds above.	46·3	46·3	0·0
1000			54·9	53·9	+ 1·0			49·0	49·4	− 0·4
ground.		Entering into cloud.	64·0	64·0	0·0					
2000	From 6^h 52^m to 6^h 55^m p.m.	In clouds.	50·0	..	..	From 6^h 55^m to 7^h 5^m p.m.	In uniform mist.	50·2	50·2	0·0
1000			51·0	..	..			51·0	51·5	− 0·5
ground.			64·0	..	..			53·5	53·9	− 0·4

August 31.—The decrease of temperature within the first 200 feet of the earth in this ascent is very remarkable, no such rapid decrease having been found in any other ascent: on the ground the temperature was 64°, and by the time 200 feet was reached a decrease of 8° had taken place, the temperature at 200 feet being 56°: from this height, up to 1200 feet, there was but little change; and above this the temperature decreased from 2° to $3\frac{1}{2}$° in each succeeding 1000 feet, till 7000 feet were passed, when the balloon entered a relatively warm current of air.

On descending, but little change of temperature was experienced in passing downwards from 7000 to 5500 feet; then there was an increase of $2\frac{1}{2}$° in passing from 5000 feet to 4000 feet, and 1°·7 from 4000 feet to 3000 feet; the temperature then gradually increased to 49° at 1000 feet; at 860 feet it was 49°·8, and on descending to nearly 800 feet it was $50\frac{1}{2}$°; on reascending to 1000 feet it increased to 51°, but decreased to 50° at 2000 feet. The balloon then turned to descend, the temperature increasing to 51° on passing downwards to 1000 feet, the same temperature as in the last ascension, and to $53\frac{1}{2}$° on the ground.

TABLE III. (*continued.*)

FIFTEENTH ASCENT.

1863. Height, in feet, above the mean level of the sea.	Temperature of the Air.									
	Ascending.					Descending.				
	Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.	Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.
Sept. 29.			°	°	°			°	°	°
16000	From 7h 42m to 9h 31m 30s a.m.		1·0	1·5	− 0·5	From 9h 33m 30s to 10h 19m a.m.	Sun shining brightly.	1·6	1·6	0·0
15000		Sun shining.	2·0	4·3	− 2·3			4·8	4·8	0·0
14000			7·5	7·2	+ 0·3			7·5	7·4	+ 0·1
13000			14·5	10·5	+ 4·0			15·2	11·0	+ 4·2
12000		No sun.	14·9	13·5	+ 1·4			17·2	14·2	+ 3·0
11000		Clouds very high.	16·9	16·4	+ 0·5			20·0	17·3	+ 2·7
10000		A faint sun.	20·4	19·2	+ 1·2			22·9	20·5	+ 2·4
9000		Dense clouds above us.	23·2	22·1	+ 1·1			25·0	23·4	+ 1·6
8000			26·0	25·0	+ 1·0			28·2	26·3	+ 1·9
7000			29·0	28·1	+ 0·9		Sun warm.	31·1	29·5	+ 1·6
6000		Clouds above and below.	32·2	31·0	+ 1·1			33·2	32·6	+ 0 6
5000			35·6	34·2	+ 1·4			35·7	35·7	0·0
4000			37·8	37·2	+ 0·6			38·7	38·6	+ 0·1
3000		Sun faint.	41·8	40·2	+ 1·6			41·5	42·4	− 0·9
2000			45·0	43·3	+ 1·7			47·0	46·8	+ 0·2
1000		Misty all round.	45·5	46·5	− 1·0			..	..	..
ground.			48·0	49·9	− 1·9			..	..	..

September 29.—On leaving the earth the temperature decreased from 48° on the ground to $45\frac{1}{2}$° at 1000 feet, and to 1° at 16,000 feet; a warm current having been met with between 12,000 and 13,500 feet. On descending a warm current was passed extending from 14,000 feet to 9000 feet, and afterwards the temperature increased constantly with decrease of elevation till the ground was reached.

Table III. (*continued.*)

Sixteenth Ascent.

1863. Height, in feet, above the mean level of the sea.	Temperature of the Air. Ascending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.	Descending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.
October 9.			°	°	°			°	°	°
7000	From $4^h 27^m$ to $4^h 43^m 30^s$ p.m.	Clear sky.	31·0	30·4	+ 0·6	From $4^h 48^m$ to $5^h 1^m 30^s$ p.m.	Clear sky.	30·7	30·7	0·0
6000			31·6	32·5	− 0·9			31·7	31·7	0·0
5000			35·0	35·0	0·0			33·6	33·6	0·0
4000		Mist on land.	39·8	38·6	+ 1·2			35·8	35·9	− 0·1
3000			42·2	42·2	0·0			39·0	37·4	+ 1·6
2000			46·8	45·8	+ 1·0					
1000			49·8	50·0	− 0·2					
ground.			54·5	54·6	− 0·1					
3000			41·0	..	..	From $5^h 2^m$ to $5^h 8^m$ p.m.	A thin mist.	40·5		
2000				..	..			43·5		
8000	From $5^h 9^m$ to $5^h 55^m 45^s$ p.m.		28·5	28·5	0·0			Too dark to read the instruments.		
7000			29·8	30·3	− 0·5					
6000			32·8	32·9	− 0·1					
5000			35·5	35·5	0·0					
4000			38·0	38·4	− 0·4					
3000		Sudden dryness.	42·2	41·2	+ 1·0					
2000			44·8	43·8	+ 1·0					

October 9.—The temperature before starting from the ground on this day was 54½°, decreasing gradually on ascending till the height of 7300 feet was reached, where it was 30°; the balloon then turned to descend, and the temperature increased gradually to 42° at 2300 feet. On reascending the temperature was found to be 39½° at 3600 feet; it increased to 45° on descending to 1500 feet, and on again ascending declined to 28° at 7200 feet; the decline of temperature after this was very slight, but it became too dark to read the instruments, so that no observations were made either at the highest point reached, or during the descent to the earth.

There were neither warm nor cold currents met with on this day.

TABLE III. (*continued.*)

SEVENTEENTH ASCENT.

1864. Height, in feet, above the mean level of the sea.	Temperature of the Air. Ascending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.	Descending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.
January 12.			°	°				°	°	°
11000	From $2^h\ 8^m$ to $3^h\ 25^m$ p.m.	Fine snow.	14·1			From $3^h\ 36^m$ to $4^h\ 3^m\ 15^s$ p.m.	Snow fine and thin.	13·6		
10000			18·9					16·6		
9000		Misty.	23·6				Clouds above and below.	20·0		
8000		Colder current.	28·0				Snow.	22·9		
7000			30·8				Near cloud.	24·9		
6000			32·8				Very misty.	29·0		
5000		Cloudy.	36·4					30·0		
4000			38·2					33·0		
3000		Cloud.	44·8				Misty.	36·8		
2000		Calm and warm to sense.	43·8					39·1		
1000		Sensibly warm.	39·1							
ground.			41·5				Misty.	41·8		

EIGHTEENTH ASCENT.

1864. Height, in feet.	Ascending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.	Descending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.
April 6.										
11000	From $4^h\ 9^m\ 10^s$ to $4^h\ 37^m$ p.m.		36·5			From $4^h\ 37^m$ to $5^h\ 7^m$ p.m.		39·0		
10000		Sun warm.	35·0					44·3		
9000			34·4				Very warm.	46·2		
8000			39·0					46·2		
7000		Blue sky.	38·7					46·0		
6000			35·5				Entered cloud.	43·9		
5000			36·0					43·0		
4000			33·0					41·8		
3000		Fog wetting.	33·6					39·7		
2000		Entering clouds, misty.	37·5				Below cloud.	39·7		
1000			41·7					41·7		
ground.		Very misty.	45·5					45·8		

January 12.—The temperature of the air before starting was $41\frac{1}{2}°$; it decreased very slowly till 1300 feet was reached, a warm current was then met with, and at 3000 feet the temperature was nearly 45°, being $3\frac{1}{4}°$ higher than on the ground, and for a space of 3000 feet in height the temperature was higher than on the earth; it then gradually declined to 11° at 11,500 feet, and remained at about this degree till the highest point was reached; on descending it gradually increased with decrease of elevation, till on reaching the ground at $4^h\ 10^m$ it was 41°·8. The results on this day are so remarkable that no adopted temperature has been attempted.

April 6.—This ascent is remarkable for the small decrease of temperature with increase of elevation. The temperature of the air was $45\frac{1}{2}°$ on leaving the earth, *it did not decline at all* till after 300 feet had been passed, after which it decreased pretty gradually to 33° when 4300 feet was reached; a warm current was then entered, and the temperature increased till 7500 feet was attained, being of the same temperature as has been experienced at 1500 feet high, viz. 40°, then decreased to 34° at 8800 feet, and then increased slowly to 36½° at 11,000 feet, a temperature which had been experienced at the height of 2170 feet in ascending.

On descending the temperature increased about 5° in the first 1000 feet; remained at about that temperature till within 7000 feet of the earth, then gradually decreased to 40° at 3000 feet, remained at about this point till 1500 feet of the earth, and then increased to nearly 46° on the ground. The observed temperatures on this day are so remarkable that no adopted temperatures have been made.

TABLE III. (*continued.*)

NINETEENTH ASCENT.

1864. Height, in feet, above the mean level of the sea.	Temperature of the Air.									
	Ascending.					Descending.				
	Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.	Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.
June 13.			°	°	°			°	°	°
3000	From 7^h to 7^h 8^m p.m.	Cloudless.	51·5	51·5	0·0		Clear.	51·4	51·5	−0·1
2000			54·2	54·5	−0·3					
1000			58·8	58·5	+0·3					
ground.			61·8	61·5	+0·3					
3000			48·1	48·1	0·0			49·6	49·4	+0·2
3000			51·0	51·0	0·0	From 7^h 52^m to 8^h 14^m p.m.		49·0	49·2	−0·2
2000								51·7	51·9	−0·2
1000								54·0	53·9	+0·1
ground.								54·0	54·0	0·0

June 13.—The temperature of the air on the ground before starting was 62°, declining with increase of elevation till 3000 feet was reached, where it was 51½°; on descending the temperature was found to be 54° at 2300 feet; the balloon then reascended, the temperature declining gradually to 3100 feet, then began to increase, being 48½° at 3450 feet, but declined to 47° by passing upwards to 3540 feet; on again descending it increased evenly till at 2700 feet, it being there 51°, and remained about the same for 200 feet; on reascending the temperature scarcely differed from 51° till 3000 feet was gained, when a sudden decrease of 2° occurred in 35 feet; then began our final descent, the temperature remaining the same for 400 feet, then increased to 51½° by 2000 feet, and to 53°·2 at 1800 feet, below which there was scarcely any change till the earth was reached.

This fact of no change in the temperature of the air within 1800 feet of the earth at the time of sunset was very remarkable, for it indicated that if such be a law, the law of decrease of temperature with increase of elevation may be reversed at night for some distance from the earth.

TABLE III. (*continued.*)

TWENTIETH ASCENT.

1864. Height, in feet, above the mean level of the sea.	Temperature of the Air. Ascending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.	Descending. Between what time.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.
June 20.			°	°	°			°	°	°
4000	From $6^h\ 17^m$ to $6^h\ 31^m$ p.m.	In clouds.	52·4	51·4	+1·0	From $6^h\ 31^m$ to $6^h\ 35^m$ p.m.	In cloud.	51·2	51·1	+0·1
3000		Entering clouds	54·0	54·0	0·0		Out of cloud.	52·9	53·9	−1·0
2000			58·1	58·1	0·0					
1000		Misty.	62·4	62·4	0·0					
ground.			66·5	66·6	+0·1					
4000	From $6^h\ 41^m$ to $6^h\ 48^m$ p.m.	In clouds.	50·6	51·4	−0·8	From $6^h\ 48^m$ to $7^h\ 16^m$ p.m.	In cloud.	49·9	50·2	−0·3
3000			54·0	53·9	+1·2		Can see the earth.	54·1	54·5	−0·4
2000								61·1	59·8	+1·3
1000							Misty.	62·0	62·8	−0·8
ground.								64·6	64·7	−0·1
TWENTY-FIRST ASCENT.										
June 27.										
5000	From $6^h\ 33^m\ 30^s$ to $7^h\ 41^m$ p.m.		42·3	41·7	+0·6	From $7^h\ 41^m$ to $8^h\ 52^m$ p.m.	Very misty.	42·3	41·7	+0·6
4000			43·7	43·7	0·0			41·6	41·6	0·0
3000		Sun clear.	49·4	48·2	+1·2			42·7	44·0	−1·3
2000			52·4	52·2	+0·2			47·0	47·4	−0·4
1000		Misty.	56·7	56·9	−0·2			48·9	48·9	0·0
ground.			63·0	67·1						
4000	From $8^h\ 56^m\ 30^s$ to $9^h\ 4^m$ p.m.		45·0	44·8	+0·2					
3000			46·8	46·8	0·0					
2000			46·7	47·6	+0·9					
1000			48·5	48·5	0·0					
ground.										

June 20.—The temperature of the air on the ground before starting was 66½°, which declined very gradually to 4100 feet, where it was 51°. On descending it increased gradually till 2700 feet was reached, it then being 54°. On ascending to 4200 feet, the temperature fell to 49½°. On descending for the last time, it increased to 61° at 2000 feet, and to 64½° on the ground: this was about one hour before sunset, showing in the last 2000 feet an increase of temperature of 3°, thus showing that the usual law holds good to this time, but apparently with far less energy, as on ascending the decrease of temperature in the same space was three times as large, or 9°.

June 27—On this occasion the temperature was 63° on the ground, gradually decreasing to 1000 feet, where it was nearly 57°, then declined 1½° in 200 feet, then gradually to 2600 feet, when a comparatively warmer current was met with, the temperature declining only 1½° in the following 900 feet, decreased more rapidly in the next 600 feet, and remained nearly stationary during the following 900 feet, it being at 5000 feet rather more than 42°.

On *descending* it slightly *declined* in the first 300 feet, then increased slowly till 2000 feet, after which it was nearly stationary till within 400 feet of the earth, where it was 49°.

On reascending it declined very slowly till 4000 feet was attained, it being then 46°, after which it became too dark to read the thermometers; this was a matter of great regret, for the balloon passed above 6000 feet; the temperature was found to be $46\frac{1}{2}°$ on the ground.

TABLE III. (*continued.*)

TWENTY-SECOND ASCENT.

1864.	Temperature of the Air.									
	Ascending.					Descending.				
Height, in feet, above the mean level of the sea.	Between what times.	Circum-stances.	Ob-served temp.	Adopted temp.	Calcu-lated effect of disturb-ance.	Between what time.	Circum-stances.	Ob-served temp.	Adopted temp.	Calcu-lated effect of disturb-ance.
August 29.			°	°	°			°	°	°
15000	From 4^h 6^m 20^s to 4^h 49^m 30^s p.m.	Clear blue sky.	33·0	32·9	+0·1	From 4^h 49^m 30^s to 5^h 32^m p.m.	Clear blue sky.	33·0	32·9	+0·1
14000			34·8	33·8	+1·0			29·0	33·1	−4·1
13000			33·0	35·3	−2·3			30·7	33·7	−3·0
12000			35·1	36·8	−1·7			31·9	34·3	−2·4
11000			39·2	38·5	+0·7			32·7	34·9	−2·2
10000			41·0	41·0	0·0			33·8	36·8	−3·0
9000			42·7	43·4	−0·7			37·5	38·7	−1·2
8000			48·0	46·0	+2·0			41·2	41·2	0·0
7000			51·1	48·8	+2·3			44·3	44·0	+0·3
6000			53·4	51·7	+1·7			46·9	47·0	−0·1
5000			54·4	54·8	−0·4			49·0	50·1	−1·1
4000			57·5	58·1	−0·6			53·0	53·7	−0·7
3000			62·8	61·8	+1·0			58·5	57·4	+1·1
2000			67·4	65·8	+1·6			61·8	61·0	+0·8
1000			71·0	70·0	+1·0			65·5	65·0	+0·5
ground.			72·5	74·3	−1·8			69·0	69·0	0·0

August 29.—On the ground the temperature of the air was $72\frac{1}{2}°$; on ascending several warm and cold currents were passed through; the temperature was 33° on reaching the highest point, viz. 15,000 feet; on descending the increase of temperature to 14,000 feet was as much as 4°, having entered a cold current which continued till 9000 feet was passed; from 8000 feet the increase of temperature was very regular, and continued so till the earth was reached.

It is very clear from the numbers in the following Table, that they differ very much from those in previous years, and that they cannot be combined, or all used in deducing general laws. The ascent on August 31 was made in the evening with a partially clear sky, and the results are somewhat abnormal. Some of the numbers in January 12 and April 6 are affected by + signs, circumstances never before met with; on June 13, at sunset, no difference was found within 2000 feet of the earth; and those of June 20, made a little before sunset, and those of June 27, made a little before and after sunset, all seem to differ from the general laws as found by experiments made when the sun is situated at a good altitude.

The only experiments this year which can be combined with previous results are those of September 29 with a cloudy sky, those of October 9 and August 29, mostly with clear skies.

It is certain from the numbers in this Table that there are at times, in the higher regions of the earth's atmosphere, spaces subjected to great cold, and others to considerable heat; and from the notes made at the time of passing through clouds, that there exist some clouds of very low temperature, and some, as those of January 12, of high temperature.

The presence of such either cold or hot currents passing over the country must play an important part in all our meteorological phenomena, and must exert a great influence upon our climate.

The numbers in columns 24 and 26 show the mean results from the experiments of the year, the former when the sky was cloudy, September 29, and the latter when clear or mostly clear, on October 9 and August 29.

The numbers in column 25 show the number of experiments upon which each result in column 24 is based; at heights up to 5000 feet these vary from 13 to 22, at 6000 feet and 7000 feet to 5 and 7, and to heights exceeding 7000 feet to 4, these having been made on two days only, viz. June 26 and September 29, 1863, on which days the balloon was frequently enveloped in fog and clouds to the height of 3 and 4 miles.

The numbers in column 32 show the total number of experiments upon which the numbers in column 31 are based; they vary from 7 to 17 up to the height of 23,000 feet, and there can be but little doubt that the numbers in column 31 are very nearly true, and approximate closely to the general law. Above 24,000 feet the number of experiments are too few to speak confidently upon them, but they are in accordance with the series below this elevation.

The numbers in column 28 show the decrease of temperature at each 1000 feet increase of elevation with a cloudy sky, they differ from those in column 31, showing the decrease for the same space with a clear sky, the former being smaller, the latter up to the usual height of the cloud plane, and are nearly alike above that plane, but the observations of cloudy skies at heights exceeding 5000 and 6000 feet, are too few to place great confidence in them.

In forming the last six columns of the following Table, no use has been made of the observations taken on July 17, 1862, August 31, 1863, January 12, April 6, June 13, 20, and 27 of the year 1864. The results on all those days are abnormal; I defer studying the results on these days till I can compare them with some confidence with the general laws, which may be found to hold good at times of the year at which they were made; their study then will be profitable, and probably fruitful in yielding valuable results.

The numbers in column 30 show the average increase of elevation at every 1000 feet for a decrease of 1° with a cloudy sky; from these we see that up to 1000 feet the average space is 223, the space for each 1000 feet increasing, till at 22,000 feet it requires more than 1000 feet for a change of 1° of temperature.

TABLE IV.—Showing the decrease of Temperature

Height above the level of the sea.		August 31, 1863.			Sept. 29, 1863.		October 9, 1863.			January 12, 1864.		April 6, 1864.		June 13, 1864.	
		State of the Sky.													
		In cloud at 1000 ft. Clear above.	Cloudy below 3000 ft.	Uniform Mist.	Cloudy.		Clear.			Misty.		Cloudy.		Clear.	
From	To	Ascending.	Descending.	Descending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Descending.
ft.	ft.	°	°	°	°	°	°	°	°	°	°	°	°	°	°
28000	29000	...	...	...	...	...	...	...	...	...	...	...	...	...	...
27000	28000	...	...	...	...	...	...	...	...	...	...	...	...	...	...
26000	27000	...	...	...	...	...	...	...	...	...	...	...	...	...	...
25000	26000	...	...	...	...	...	...	...	...	...	...	...	...	...	...
24000	25000	...	...	...	...	...	...	...	...	...	...	...	...	...	...
23000	24000	...	...	...	...	...	...	...	...	...	...	...	...	...	...
22000	23000	...	...	...	...	...	...	...	...	...	...	...	...	...	...
21000	22000	...	...	...	...	...	...	...	...	...	...	...	...	...	...
20000	21000	...	...	...	...	...	...	...	...	...	...	...	...	...	...
19000	20000	...	...	...	...	...	...	...	...	...	...	...	...	...	...
18000	19000	...	...	...	...	...	...	...	...	...	...	...	...	...	...
17000	18000	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16000	17000	...	...	...	...	...	...	...	...	...	...	...	...	...	...
15000	16000	...	...	...	2·8	3·2	...	...	...	...	...	...	...	...	...
14000	15000	...	...	...	2·9	2·6	...	...	...	...	...	...	...	...	...
13000	14000	...	...	...	3·3	3·6	...	...	...	...	...	...	...	...	...
12000	13000	...	...	...	3·0	3·2	...	...	...	...	...	...	...	...	...
11000	12000	...	...	...	2·9	3·1	...	...	...	...	...	...	...	...	...
10000	11000	...	...	...	2·8	3·2	...	...	...	4·8	4·0	−1·5	5·3	...	...
9000	10000	...	...	...	2·9	2·9	...	...	...	4·7	3·4	−0·6	1·9	...	...
8000	9000	...	...	...	2·9	2·9	...	...	...	4·4	2·9	+4·6	0·0	...	...
7000	8000	1·3	1·6	...	3·1	3·2	...	...	1·8	2·8	2·0	−0·3	−0·2	...	...
6000	7000	2·9	1·6	...	2·9	3·1	2·1	1·0	2·6	2·0	4·1	−3·2	−2·1	...	...
5000	6000	2·4	1·6	...	3·2	3·1	2·5	1·9	2·6	3·6	3·0	+0·5	−0·9	...	...
4000	5000	3·1	2·2	...	3·0	2·9	3·6	2·3	2·9	1·8	3·8	−3·0	−1·2	...	...
3000	4000	3·0	2·5	...	3·0	3·8	3·6	...	2·8	+6·6	2·3	+0·6	−2·1	...	...
2000	3000	3·1	2·8	...	3·1	4·4	3·6	...	2·6	−1·0	...	3·9	0·0	3·0	2·7
1000	2000	3·2	3·1	1·3	3·2	5·0	4·2	...	...	−4·7	...	4·2	+2·0	4·0	2·0
0	1000	9·1	...	2·4	3·4	5·1	4·6	...	...	+2·4	...	3·8	+4·1	3·0	0·1
No. of Col.		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.

in every 1000 feet of elevation up to 29,000 feet.

June 20, 1864.				June 27, 1864.			Aug. 29, 1864.		Mean.				General Means (omitting July 17, 1862, Aug. 31, 1863, Jan. 12, April 6, June 13, 20, 27, 1864).					
State of the Sky.																		
Cloudy.				Partially Clear.			Clear.						Cloudy.			Clear.		
Ascending.	Descending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Ascending.	Descending.	Cloudy.	Number of experiments.	Clear.	Number of experiments.	Mean.	Number of experiments.	Space passed for a decline of 1°.	Mean.	Number of experiments.	Space passed for a decline of 1°.
°	°	°	°	°	°	°	°	°	°		°	°	°		feet.	°		feet.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0·8	1	1250
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0·9	1	1111
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1·0	1	1000
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1·0	1	1000
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1·1	2	909
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1·3	2	771
...	...	...	...	...	...	...	...	...	...	...	...	...	0·8	2	1250	1·0	4	1000
...	...	...	...	...	...	...	...	...	...	...	...	...	0·8	2	1250	1·1	7	911
...	...	...	...	...	...	...	...	...	...	...	...	...	1·1	2	911	1·2	7	833
...	...	...	...	...	...	...	...	...	...	...	...	...	0·9	2	909	1·3	7	771
...	...	...	...	...	...	...	...	...	...	...	...	...	1·4	2	715	1·5	7	666
...	...	...	...	...	...	...	...	...	...	...	...	...	1·3	2	771	1·7	7	588
...	...	...	...	...	...	...	...	...	...	...	...	...	1·2	2	833	1·9	7	526
...	...	...	...	...	...	...	...	...	3·0	2	...	2	2·1	4	477	2·2	9	455
...	...	...	...	...	...	...	0·9	0·2	2·8	2	0·5	2	2·0	4	500	1·7	9	588
...	...	...	...	...	...	...	1·5	0·6	3·4	2	1·0	2	2·3	4	435	2·0	11	500
...	...	...	...	...	...	...	1·5	0·6	3·1	2	1·0	2	2·2	4	455	2·2	11	455
...	...	...	...	...	...	...	2·0	0·6	3·0	2	1·3	2	2·2	4	455	2·3	11	435
...	...	...	...	...	...	...	2·2	1·9	3·0	2	2·0	2	2·2	4	455	2·6	13	385
...	...	...	...	...	...	...	2·4	1·9	2·9	2	2·2	2	2·2	4	455	2·4	12	417
...	...	...	...	...	...	...	2·6	2·5	2·9	2	2·6	2	2·2	4	455	2·5	12	400
...	...	...	...	...	...	...	2·8	2·8	3·2	2	2·5	3	2·4	4	417	2·7	12	371
...	...	...	...	...	...	...	2·9	3·0	3·0	2	2·3	5	2·7	5	371	2·5	15	401
...	...	...	...	...	...	...	3·2	3·1	3·2	2	2·7	5	3·2	7	313	2·6	17	385
...	...	...	...	2·0	−0·1	...	3·2	3·6	3·0	2	3·1	5	3·3	13	303	2·9	12	345
2·6	2·8	1·4	4·3	4·0	+2·4	2·0	3·7	3·7	3·4	2	3·5	4	3·4	20	295	3·3	12	304
4·1	...	...	5·3	4·0	1·4	0·8	4·0	3·6	3·8	2	3·5	4	3·7	22	271	3·8	11	264
4·3	...	...	3·0	4·7	1·5	0·9	4·2	4·0	4·1	2	4·1	3	3·6	21	278	4·7	9	213
4·2	...	...	1·9	1·9	0·2	...	4·3	4·0	4·3	2	4·3	3	4·5	17	223	6·2	9	162
15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.

In the last column of Table IV. the same results are shown for clear, or nearly clear skies, and they show that a change of 1° takes place for an average increase of 162 feet; this space gradually increasing to 1000 feet at 23,000 feet.

By comparing the numbers in columns 30 and 33 together, the different spaces required to be passed through for a decline of 1° of temperature in the two states of the sky will be readily seen: up to 23,000 feet it is necessary to pass through a much larger change of elevation with a cloudy sky for a decline of 1° of temperature than with a clear sky.

Cloudy Sky.

By adding together successively the numbers in column 28, we shall find the whole decrease of temperature from the earth to the different elevations; the results with a cloudy sky are as follows:—

feet	feet		°		feet.
From 0 to	1,000	the decrease was	4·5,	or 1° on the average of	223
,,	2,000	,,	8·1	,,	247
,,	3,000	,,	11·8	,,	255
,,	4,000	,,	15·2	,,	263
,,	5,000	,,	18·5	,,	271
,,	6,000	,,	21·7	,,	277
,,	7,000	,,	24·4	,,	287
,,	8,000	,,	26·8	,,	299
,,	9,000	,,	29·0	,,	311
,,	10,000	,,	31·2	,,	321
,,	11,000	,,	33·4	,,	329
,,	12,000	,,	35·6	,,	337
,,	13,000	,,	37·8	,,	344
,,	14,000	,,	40·1	,,	349
,,	15,000	,,	42·1	,,	356
,,	16,000	,,	44·2	,,	362
,,	17,000	,,	45·4	,,	375
,,	18,000	,,	46·7	,,	386
,,	19,000	,,	48·1	,,	395
,,	20,000	,,	49·0	,,	409
,,	21,000	,,	50·1	,,	419
,,	22,000	,,	50·9	,,	432
,,	23,000	,,	51·7	,,	445

These results, showing the whole decrease of temperature of the air from the earth up to 23,000 feet, differ very considerably from those with a clear sky, to be spoken of presently. The numbers in the last column show the average increment of height for a decline of 1°, as found by using the temperatures of the extremities of the column above. To 1000 feet high the average is 1° in 223 feet, increasing gradually to 1° in 445 feet at 23,000 feet.

Clear Sky.

By adding together the numbers in column 31 in the same way the following results are found:—

	feet	feet	°		feet.
From	0 to	1,000 the decrease was	6·2, or 1° on the average of		162
,,		2,000 ,,	10·9	,,	184
,,		3,000 ,,	14·7	,,	204
,,		4,000 ,,	18·0	,,	223
,,		5,000 ,,	20·9	,,	239
,,		6,000 ,,	23·5	,,	256
,,		7,000 ,,	26·0	,,	271
,,		8,000 ,,	28·7	,,	279
,,		9,000 ,,	31·2	,,	289
,,		10,000 ,,	33·6	,,	298
,,		11,000 ,,	35·6	,,	309
,,		12,000 ,,	37·9	,,	317
,,		13,000 ,,	40·1	,,	324
,,		14,000 ,,	42·1	,,	333
,,		15,000 ,,	43·8	,,	343
,,		16,000 ,,	46·0	,,	348
,,		17,000 ,,	47·9	,,	355
,,		18,000 ,,	49·6	,,	363
,,		19,000 ,,	51·1	,,	372
,,		20,000 ,,	52·4	,,	382
,,		21,000 ,,	53·6	,,	392
,,		22,000 ,,	54·7	,,	405
,,		23,000 ,,	55·7	,,	413
,,		24,000 ,,	57·0	,,	422
,,		25,000 ,,	58·1	,,	431
,,		26,000 ,,	59·1	,,	441
,,		27,000 ,,	60·1	,,	449
,,		28,000 ,,	61·0	,,	459
,,		29,000 ,,	61·8	,,	469
,,		30,000 ,,	62·3	,,	482

These results, showing the whole decrease of temperature from the ground to 30,000 feet, differ greatly, as just mentioned, from those with a cloudy sky.

The numbers in the last column, showing the average increase of height for a decline of 1° of temperature from the ground to that elevation, are all smaller than those with a cloudy sky at the same elevation. Each result is based upon at least seven experiments, taken at different times of the year, and up to this height considerable confidence may be placed in the results; they show that a change takes place in the first 1000 feet of 1° on an average of 162 feet, increasing to about 300 feet at 10,000 feet; in the year 1862 this space of 300 feet was at 14,000 feet high, and in 1863 at 12,000 feet high, therefore the changes of temperature have been less in 1863 than those in 1862, and also less in 1864 than in 1863; but the experiments have all been taken at different times of the year.

Without exception the fall of 1° has always taken place in the smallest space when near the earth. To determine this space, and also the law of decrease near the earth, all the observations of temperature of the air up to 5000 feet were laid down on large diagrams, and a line was made to pass through them, giving equal weight to every observation; the result at every 200 feet was then read out, and in this way the next series of Tables were formed.

Table V.—Showing the Mean Temperature of the Air at every 200 feet up to 5000 feet.—Fourteenth Ascent.

1863. Height, in feet, above the mean level of the sea.	Temperature of the Air. Ascending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.	Descending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.
August 31.			°	°	°			°	°	°
5000	From 6h 7m p.m. to 6h 20m 30s p.m.		42·8	41·5	+1·3	From 6h 44m p.m. to 6h 53m 20s p.m.	In basin of clouds.	38·9	38·8	+0·1
4800			43·2	42·2	+1·0			39·2	39·1	+0·1
4600			43·6	42·9	+0·7			39·6	39·6	0·0
4400		Very cold.	45·1	43·4	+0·7		Getting into clouds.	40·1	40·1	0·0
4200			45·2	44·0	+1·2			40·7	40·6	+0·1
4000			45·2	44·6	+0·6			41·5	41·0	+0·5
3800			45·2	45·2	0·0		Just in cloud.	44·1	41·5	−0·4
3600			46·3	45·8	+0·5		In white mist.	42·1	42·0	+0·1
3400			47·0	46·4	+0·6			42·4	42·5	−0·1
3200			47·4	47·0	+0·4			43·0	43·0	0·0
3000			47·5	47·6	−0·1		Leaden sky above.	43·2	43·5	−0·3
2800		Cumulus on our level.	47·7	48·2	−0·5			44·1	44·1	0·0
2600			50·7	48·8	+1·9			44·8	44·7	+0·1
2400			50·7	49·4	+1·3			45·1	45·2	−0·1
2200			50·9	50·0	+0·9			45·7	45·7	0·0
2000			51·3	50·7	+0·6			46·3	46·3	0·0
1800			51·9	51·4	+0·5		Stratum of clouds above.	46·9	46·9	0·0
1600			52·4	52·0	+0·4			47·5	47·5	0·0
1400		Above clouds.	52·8	52·6	+0·2			48·0	48·1	−0·1
1200			53·3	53·2	+0·1			48·3	48·8	−0·5
1000		Entering into cloud.	54·9	53·9	+1·0			49·0	49·4	−0·4
800			55·7	54·8	+0·9			50·3		
600			55·8	55·9	−0·1			53·7		
400			56·0	57·4	−1·4					
200			56·0	59·4	−3·4					
ground.			64·0	64·0	0·0					
2000	From 6h 53m 20s p.m. to 6h 55m p.m.		50·0	...	...	From 6h 55m p.m. to 7h 5m p.m.		50·2	50·2	0·0
1800			50·6	...	...			50·4	50·4	0·0
1600			50·3	...	...			50·5	50·5	0·0
1400		In clouds.	50·9	..	...		In uniform mist.	50·5	50·7	−0·2
1200			51·0	...	...			50·5	51·1	−0·6
1000			51·0	...	...			51·0	51·5	−0·5
800			50·5	...	...			53·1	52·0	+1·1
600			...	...	...			53·7	52·5	+1·2
400			...	...	...			53·7	53·0	+0·7
200			...	...	...			53·4	52·4	+1·0
ground.			...	...	...			53·5	53·9	−0·4

TABLE V. (*continued.*)

FIFTEENTH ASCENT.

1863. Height, in feet, above the mean level of the sea.	Temperature of the Air.									
	Ascending.					Descending.				
	Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.	Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.
September 29.	From 7^h 42^m a.m. to 7^h 58^m 30^s a.m.		°	°	°	From 10^h 13^m a.m. to 10^h 23^m a.m.		°	°	°
5000			35·6	34·2	+ 1·4		...	35·7	35·7	0·0
4800			36·0	34·7	+ 1·3		...	36·0	36·0	0·0
4600			36·6	35·3	+ 1·3		...	36·8	36·5	+ 0·3
4400			37·1	36·0	+ 1·1		...	37·6	37·0	+ 0·6
4200			37·4	36·6	+ 0·8		...	38·5	37·8	+ 0·7
4000			37·8	37·2	+ 0·6		...	38·7	38·6	+ 0·1
3800			38·6	37·8	+ 0·8		...	38·4	39·2	− 0·8
3600			40·0	38·4	+ 1·6		...	38·5	39·8	− 1·3
3400			41·2	39·0	+ 2·2		...	40·3	40·7	− 0·4
3200			41·7	39·6	+ 2·1		...	41·2	41·6	− 0·4
3000		Sun faint.	41·8	40·2	+ 1·6		...	41·5	42·4	− 0·9
2800			42·1	40·8	+ 1·3		...	42·2	43·1	− 0·9
2600			43·8	41·4	+ 2·4		...	43·1	43·8	− 0·7
2400			44·0	42·1	+ 1·9		...	45·0	44·7	+ 0·3
2200			45·0	42·7	+ 2·3		...	46·4	45·8	+ 0·6
2000			45·0	43·3	+ 1·7		...	47·0	46·8	+ 0·2
1800			45·0	43·9	+ 1·1		...	48·0	47·8	+ 0·2
1600			45·0	44·6	+ 0·4		...	49·0	48·8	+ 0·2
1400			45·0	45·2	− 0·2		...	...	50·0	
1200		Misty all round.	45·0	45·9	− 0·9		...	...	51·0	
1000			45·5	46·5	− 1·0		...	...	51·8	
800			46·0	47·1	− 1·1		...	...	52·6	
600			47·1	47·7	− 0·6		...	...	53·4	
400			47·8	48·5	− 0·7		...	...	54·5	
200			47·9	49·2	− 1·3		...	...	55·7	
ground.			48·0	49·9	− 1·9		...	...	56·9	

SIXTEENTH ASCENT.

1863. Height, in feet, above the mean level of the sea.	Ascending: Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.	Descending: Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.
October 9.	From 4^h 27^m p.m. to 4^h 37^m p.m.					From 4^h 53^m p.m. to 5^h 14^m 30^s p.m.				
5000		Clear sky.	35·0	35·0	0·0		...	33·6	33·6	0·0
4800			35·7	35·8	− 0·1		...	34·0	31·7	+ 2·3
4600			34·2	36·7	− 2·5		...	34·5	33·6	+ 0·9
4400			36·8	37·4	− 0·6		...	35·0	34·0	+ 1·0
4200			37·5	38·0	− 0·5		...	33·8	34·5	− 0·7
4000			39·8	38·6	+ 1·2		...	35·8	35·9	+ 0·1
3800			40·8	39·3	+ 1·5		...	36·5	35·5	+ 1·0
3600			41·2	40·1	+ 1·1		...	37·0	35·9	+ 1·1
3400			41·5	40·8	+ 0·7		...	37·5	36·5	+ 1·0
3200		Mist over land.	41·9	41·5	+ 0·4		...	38·3	36·9	+ 1·4
3000			42·2	42·2	0·0		...	39·0	37·4	+ 1·6
2800			42·8	42·9	− 0·1		...	40·7	37·9	+ 2·8
2600			43·1	43·6	− 0·5		...	41·0		
2400			45·0	44·3	+ 0·7					
2200			45·7	45·0	+ 0·7					
2000			46·8	45·8	+ 1·0					
1800			47·7	46·6	+ 1·1					
1600			48·1	47·4	+ 0·7					
1400			48·8	48·2	+ 0·6					
1200			49·1	49·1	0·0					
1000			49·8	50·0	− 0·2					
800			52·5	50·9	+ 1·6					
600			52·7	51·9	+ 0·8					
400			53·0	52·8	+ 0·2					
200			53·7	53·7	0·0					
ground.			54·5	54·6	− 0·1					

SIXTEENTH ASCENT (*continued.*)

1864. Height, in feet, above the mean level of the sea.	Temperature of the Air. Ascending. Between what times.	Ascending. Circumstances.	Ascending. Observed temp.	Ascending. Adopted temp.	Ascending. Calculated effect of disturbance.	Descending. Between what times.	Descending. Circumstances.	Descending. Observed temp.	Descending. Adopted temp.	Descending. Calculated effect of disturbance.
Oct. 9 (*cont.*).			°	°	°			°	°	°
3200	From 5h 14m p.m. to 5h 25m p.m.		40·6	...	...	From 5s 25m p.m. to 5s 36m p.m.		40·3		
3000			41·0	...	...			40·5		
2800			42·5	...	...			40·9		
2600			42·8	...	...			41·3		
2400			...	...	...			41·9		
2200			...	...	...			42·4		
2000			...	...	...			43·5		
1800			...	...	...		A thin mist.	44·4		
1600			...	...	...			44·5		
1400			...	...	...			44·7		
5000	From 5h 36m 40s p.m. to 5h 48m 30s p.m.		35·5	35·5	0·0			Too dark to read the instruments.		
4800			36·1	36·1	0·0					
4600			36·9	36·9	0·0					
4300			37·2	37·1	+ 0·1					
4200			37·8	37·8	0·0					
4000			38·0	38·4	− 0·4					
3800			38·5	39·0	− 0·5					
3600			39·4	39·6	− 0·2					
3400			40·4	40·1	+ 0·3					
3200		A sudden dryness.	41·3	40·6	+ 0·7					
3000			42·2	41·2	+ 1·0					
2800			43·3	41·8	+ 1·5					
2600			44·4	42·4	+ 2·0					
2400			44·7	42·9	+ 1·8					
2200			44·8	43·3	+ 1·5					
2000			44·8	43·8	+ 1·0					
1800			44·8	44·3	+ 0·5					
1600			44·8	44·8	0·0					
1400			44·7	45·3	− 0·6					

SEVENTEENTH ASCENT.

1864. Height, in feet, above the mean level of the sea.	Ascending. Between what times.	Ascending. Circumstances.	Ascending. Observed temp.	Ascending. Adopted temp.	Ascending. Calculated effect of disturbance.	Descending. Between what times.	Descending. Circumstances.	Descending. Observed temp.	Descending. Adopted temp.	Descending. Calculated effect of disturbance.
Jan. 12, 1864.										
5000	From 2h 8m p.m. to 2h 31m p.m.		36·4	...	...	From 3h 54m 30s p.m. to 4h 4m 30s p.m.	Very misty.	30·0		
4800			36·6	...	...			31·3		
4600			37·0	...	...			31·9		
4400			37·3	...	...			31·5		
4200		Sudden change of temp.	37·8	...	...			32·5		
4000			38·2	...	...			33·0		
3800			41·5	...	...			33·7		
3600			42·5	...	...			34·5		
3400			43·0	...	...			35·2		
3200			44·2	...	...			36·1		
3000		Calm and warm to sense.	44·8	...	...			36·8		
2800			44·5	...	...			37·5		
2600			44·2	...	...			38·4		
2400			44·1	...	...			38·5		
2200			44·0	...	...			38·8		
2000		Quite warm.	43·8	...	...			39·1		
1800			43·0	...	...			39·2		
1600		Sensibly warm.	41·1	...	...			39·4		
1400			40·5							
1200			38·9							
1000			39·1							
800			39·5							
600			39·7							
400			40·7							
200			41·1							
ground.			41·5							

Table V. (*continued.*)

Eighteenth Ascent.

1864. Height, in feet, above the mean level of the sea.	Temperature of the Air. Ascending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.	Descending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.
April 6.			°	°	°			°	°	°
5000	From 4^h 9^m p.m. to 4^h 22^m p.m.		36·0	...	...	From 4^h 52^m p.m. to 5^h 7^m p.m.		43·0		
4800			35·8	...	...			42·8		
4600			35·0	...	...			42·5		
4400			34·2	...	...			42·3		
4200			33·0	...	...			42·2		
4000			33·0	...	...			41·8		
3800			33·0	...	...			41·2		
3600			33·0	...	...			41·0		
3400		Fog wetting.	33·5	...	...			41·0		
3200			33·5	...	...			40·1		
3000			33·6	...	...			39·7		
2800			35·0	...	...			39·2		
2600			36·5	...	...			39·5		
2400			36·2	...	...			39·5		
2200		Very misty; entering cloud.	37·0	...	...			39·6		
2000			37·5	...	...		Below cloud.	39·7		
1800			38·3	...	...			40·1		
1600			39·5	...	...			40·0		
1400			40·8	...	...			40·4		
1200			41·1	...	...			40·8		
1000		Very misty.	41·7	...	...			41·7		
800			42·4	...	...			42·4		
600			44·2	...	...			43·2		
400			45·2	...	...			45·2		
200			45·5	...	...			45·5		
ground.			45·5	...	...			45·8		
Nineteenth Ascent.										
June 13.										
3000	From 7^h to 7^h 8^m p.m.	Cloudless.	51·5	51·5	0·0	From 7^h 8^m to 7^h 11^m 15^s p.m.	...	51·4	51·5	− 0·1
2800			52·4	52·3	+ 0·1		...	51·6	51·7	− 0·1
2600			52·7	52·7	− 0·5		...	52·2	52·4	− 0·2
2400			52·4	53·4	− 1·0		...	53·1	53·3	− 0·2
2200			54·0	53·6	+ 0·4					
2000			54·2	54·5	− 0·3					
1800			55·1	55·2	− 0·1					
1600			56·1	56·1	0·0					
1400			56·9	57·1	− 0·2					
1200			57·6	57·8	− 0·2					
1000			58·8	58·5	+ 0·3					
800			59·1	58·9	+ 0·2					
600			59·2	59·4	− 0·2					
400			59·7	59·8	− 0·1					
200			60·8	60·5	+ 0·3					
ground.			61·8	61·5	+ 0·3					
3400	From 7^h 13^m 45^s to 7^h 19^m 30^s p.m.		48·0	48·0	0·0	From 7^h 20^m to 7^h 35^m 30^s p.m.	...	47·0	46·8	+ 0·2
3200			46·9	47·0	− 0·1		...	48·2	48·5	− 0·3
3000			48·1	48·1	0·0		...	49·6	49·4	+ 0·2
2800			49·6	49·5	+ 0·1		...	50·8	50·8	0·0
2600			50·8	50·5	+ 0·3		...	51·0	51·0	0·0
2400			51·2	51·5	− 0·3					

TABLE V. (*continued.*)

NINETEENTH ASCENT (*continued*).

1864. Height, in feet, above the mean level of the sea.	Temperature of the Air. Ascending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.	Descending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.
June 13 (*con.*).			°	°	°			°	°	°
3000	...	...	51·0	51·0	0·0	From 7h 52m p.m. to 8h 14m p.m.	...	49·0	49·2	− 0·2
2800	...	...	51·5	51·5	0·0		...	49·0	49·5	− 0·5
2600	...	...	51·0	51·0	0·0		...	49·1	50·0	− 0·8
2400	...	...	...	...	...		...	50·3	50·5	− 0·2
2200	...	...	...	...	...		...	51·1	51·0	+ 0·1
2000	...	...	...	...	...		...	51·7	51·9	− 0·2
1800	...	...	...	...	...		...	53·3	52·8	+ 0·5
1600	...	...	...	...	...		...	53·7	53·4	+ 0·3
1400	...	...	...	...	...		...	53·8	53·7	+ 0·1
1200	...	...	...	...	...		...	53·9	53·8	+ 0·1
1000	...	...	...	...	...		...	54·0	53·9	+ 0·1
800	...	...	...	...	...		...	54·0	54·0	0·0
600	...	...	...	...	...		...	54·0	54·0	0·0
400	...	...	...	...	...		...	54·0	54·0	0·0
200	...	...	...	...	...		...	54·0	54·0	0·0
ground.	...	...	...	...	...		...	54·0	54·0	0·0

TWENTIETH ASCENT.

June 20.										
4000	From 6h 17m to 6h 27m 15s p.m.	In clouds.	52·4	51·4	+ 1·0	From 6h 31m to 6h 35m p.m.	...	51·2	51·4	− 0·2
3800			52·1	51·9	+ 0·2		...	51·2	51·3	− 0·1
3600			52·4	52·4	0·0		...	51·6	51·3	+ 0·3
3400			53·1	53·2	− 0·1		...	51·9	51·5	+ 0·4
3200			54·0	53·5	+ 0·5		...	52·0	52·0	0·0
3000			54·0	54·0	0·0		...	52·9	53·9	+ 1·0
2800			54·3	54·7	− 0·4		...	53·2	53·5	− 0·3
2600			55·9	55·5	+ 0·4					
2400			57·1	56·6	+ 0·5					
2200			58·1	57·4	+ 0·7					
2000			58·1	58·1	0·0					
1800			58·1	58·7	− 0·6					
1600			59·1	59·5	− 0·4					
1400			60·8	60·4	+ 0·4					
1200			61·7	61·5	+ 0·2					
1000			62·4	62·4	0·0					
800			63·0	63·2	− 0·2					
600			64·2	64·0	+ 0·2					
400			65·2	64·9	+ 0·3					
200			66·0	65·8	+ 0·2					
ground.			66·5	66·6	− 0·1					

TABLE V. (*continued.*)

TWENTIETH ASCENT (*continued*).

1864. Height, in feet, above the mean level of the sea.	Temperature of the Air. Ascending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.	Descending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.
June 20.			°	°	°			°	°	°
4200	From 6^{h} 37^{m} 45^{s} to 6^{h} 49^{m} 15^{s} p.m.	...	50·0	50·0	0·0	From 6^{h} 54^{m} 15^{s} to 7^{h} 16^{m} p.m.		49·3	49·6	−0·3
4000		...	50·6	51·4	−0·8			49·9	50·2	−0·3
3800		...	50·9	52·0	−1·1			50·2	51·0	−0·8
3600		...	53·2	52·6	+0·6			50·8	51·8	−1·0
3400		...	53·7	53·2	+0·5			51·2	52·6	−1·4
3200		...	54·0	53·6	+0·4			52·0	53·5	−1·5
3000		...	54·0	53·9	+0·1			54·1	54·5	−0·4
2800		...	53·9	54·0	−0·1			56·4	55·5	+0·9
2600		...	...	...	...			58·0	56·6	+1·4
2400		...	...	...	...			58·8	57·7	+1·1
2200		...	...	...	...			60·2	58·7	+1·5
2000		...	...	...	...			61·1	59·8	+1·3
1800		...	...	...	...			60·9	60·6	+0·3
1600		...	...	...	...			60·7	61·2	−0·5
1400		...	...	...	...			60·5	61·7	−1·2
1200		...	...	...	...			61·1	62·2	−1·1
1000		...	...	...	...		Misty.	62·0	62·8	−0·8
800		...	...	...	...			62·6	63·0	−0·4
600		...	...	...	...			63·2	63·5	−0·3
400		...	...	...	...			64·0	64·1	−0·1
200		...	...	...	...			64·3	64·5	−0·2
ground.		...	...	...	...			64·6	64·7	−0·1

TWENTY-FIRST ASCENT.

1864. Height, in feet, above the mean level of the sea.	Ascending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.	Descending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.
June 27.										
5000	From 6^{h} 33^{m} 30^{s} to 7^{h} 41^{m} p.m.	Sun clear.	42·3	41·7	+0·6	From 7^{h} 41^{m} to 8^{h} 54^{m} 30^{s} p.m.	...	42·3	41·7	+0·6
4800			43·3	41·9	+1·4		...	41·5	41·5	0·0
4600			43·3	42·2	+1·1		...	41·2	41·2	0·0
4400			43·1	42·7	+0·4		...	41·2	41·2	0·0
4200			42·9	43·0	−0·1		...	41·3	41·3	0·0
4000			43·7	43·7	0·0		...	41·6	41·6	0·0
3800			44·7	44·7	0·0		...	41·9	42·0	−0·1
3600			46·0	45·7	+0·3		...	42·0	42·5	−0·5
3400			46·8	46·6	+0·2		...	42·2	43·0	−0·8
3200			48·0	47·4	+0·6		...	42·5	43·5	−1·0
3000			49·4	48·2	+1·2		...	42·7	44·0	−1·3
2800			49·5	49·0	+0·5		...	43·5	44·6	−1·1
2600			50·1	49·8	+0·3		...	44·5	45·3	−0·8
2400			50·9	50·6	+0·3		...	45·2	46·0	−0·8
2200			51·7	51·4	+0·3		...	46·2	46·7	−0·5
2000			52·4	52·2	+0·2		...	47·0	47·4	−0·4
1800			52·9	53·0	−0·1		...	47·5	48·0	−0·5
1600			53·4	53·8	−0·4		...	47·6	48·3	−0·7
1400			54·1	54·6	−0·5		...	48·2	48·7	−0·5
1200			54·8	55·7	+0·1		...	48·5	48·8	−0·3
1000			56·7	56·9	−0·2		...	48·9	48·9	0·0
800			59·5	58·2	+1·3		...	49·0	49·0	0·0
600			61·0	59·8	+1·2		...	49·0	49·0	0·0
400			62·5	62·0	+0·5		...	...	49·0	
200			...	64·4	...		...	The bal	loon th	en
ground.			...	67·1	...		...	turned	to asce	nd.

Table V. (*continued.*)

Twenty-first Ascent (*continued*).

1864. Height, in feet, above the mean level of the sea.	Temperature of the Air. Ascending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.	Descending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.
June 27 (*con.*).			°	°	°			°	°	°
4000	From $8^h\ 54^m\ 30^s$ to $9^h\ 4^m$ p.m.	...	45·0	44·8	+0·2					
3800		...	46·3	45·2	+1·1					
3600		...	46·8	45·7	+1·1					
3400		...	46·7	46·2	+0·5					
3200		...	46·7	46·7	0·0					
3000		...	46·8	46·8	0·0					
2800		...	47·0	47·0	0·0					
2600		...	47·2	47·2	0·0					
2400		...	47·0	47·3	−0·3					
2200		...	46·8	47·4	−0·6					
2000		...	46·7	47·6	0·0					
1800		...	46·5	47·8	−0·3					
1600		...	47·3	48·0	−0·7					
1400		...	48·2	48·2	−0·9					
1200		...	48·6	48·4	+0·2					
1000		...	48·5	48·5	0·0					
800		...	48·5	48·5	0·0					
600		...	48·6	48·6	0·0					
400		...	48·4	48·4	0·0					
200										
ground.										

Twenty-second Ascent.

1864. Height, in feet, above the mean level of the sea.	Ascending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.	Descending. Between what times.	Circumstances.	Observed temp.	Adopted temp.	Calculated effect of disturbance.
August 29.										
5000	From $4^h\ 6^m\ 20^s$ p.m. to $4^h\ 17^m\ 30^s$ p.m.	Clear blue sky.	54·4	54·8	−0·4	From $5^h\ 18^m\ 40^s$ to $5^h\ 32^m$ p.m.	Clear blue sky.	49·0	50·1	−1·1
4800			54·4	55·4	−1·0			50·0	50·8	−0·8
4600			53·0	56·0	−3·0			50·8	51·5	−0·7
4400			54·5	56·7	−2·2			52·0	52·2	−0·2
4200			57·0	57·4	−0·4			52·5	52·9	−0·4
4000			57·5	58·1	−0·6			53·0	53·7	−0·7
3800			58·0	58·8	−0·8			54·0	54·4	−0·4
3600			59·5	59·5	0·0			55·1	55·1	0·0
3400			61·4	60·3	+1·1			55·4	55·9	−0·5
3200			62·4	61·1	+1·3			57·6	56·6	+1·0
3000			62·8	61·8	+1·0			58·5	57·4	+1·1
2800			63·1	62·5	+0·6			59·1	58·1	+1·0
2600			63·8	63·2	+0·6			59·8	58·8	+1·0
2400			65·0	64·2	+0·8			60·5	59·6	+0·9
2200			66·6	65·0	+1·6			61·2	60·3	+0·9
2000			67·4	65·8	+1·6			61·8	61·0	+0·8
1800			68·6	66·7	+1·9			62·5	61·7	+0·8
1600			69·9	67·6	+2·3			63·0	62·4	+0·6
1400			70·7	68·4	+2·3			64·9	63·2	+0·8
1200			71·0	69·2	+1·8			64·5	64·0	+0·5
1000			71·0	70·0	+1·0			65·5	65·0	+0·5
800			71·1	70·8	+0·3			66·0	65·8	+0·2
600			71·4	71·6	+0·8			66·6	66·6	0·0
400			72·1	72·5	−0·4			67·6	67·4	+0·2
200			72·4	73·4	−1·0			68·0	68·2	−0·2
ground.			72·5	74·3	−1·8			69·0	69·0	0·0

The numbers in the following Table differ very much from those in Table VI. in the Reports for the year 1862 and 1863; in these the largest numbers were those at the bottom of the column, and the smaller at higher elevations, and a decrease of temperature with elevation was shown without exception.

In the following Table there are instances of departure from both those indications, and other particulars which present all the above numbers to be combined with previous results.

In the first remarks on Table III. at page 266, the decrease of temperature as observed in the first 200 feet was no less than 8°; by the adopted curves passing nearly through the observed temperatures, it gives $2\frac{1}{4}$° decline in each 100 feet near the earth; these results seem doubtful; they differ so much from all others, that it seems likely that the readings were affected by the presence of many persons near the car of the balloon before starting, or that I have read the instruments wrongly by 5° before leaving the earth.

On January 12 (the only winter ascent in the series) the numbers are for the first time affected by the sign —, showing an increase of temperature with increase of elevation, and the numbers near the earth are smaller than those at higher elevations.

On April 6 the numbers are also anomalous as compared with those previously obtained; near the earth there was no change, and then a large change, and higher still some numbers are affected with the — sign.

On June 13, on descending at the time of sunset, it will be seen that there was scarcely any change of temperature for 1500 feet.

On June 20, on descending a little before sunset, the change was very small, and very different from corresponding changes on the ascent an hour before.

On June 27 there seemed scarcely any change in temperature up to 3000 feet, at readings taken after sunset, and till it was too dark to read the instruments.

The results on none of these days can be used in deducing general laws. The endeavour has been in the past year to take observations at times in the day and times in the year at which no observations had previously been made, resulting in these very different results.

The only days this year available for general combination are September 29, from observations made between 8^h a.m. and 10^h a.m., with a chiefly cloudy sky; and the numbers in column 28 show the mean values at the different elevations, and October 9 and August 29 for clear skies, and these results are shown in column 30.

The numbers in column 32 show the general mean from all the observations with cloudy skies, as based upon the number of experiments as shown in column 33 at each elevation, and these vary from 19 to 29.

The numbers in column 35 show the results for clear or nearly clear skies, as based on the number of experiments as shown in the column 36, varying in number from 8 to 12.

In column 34 the space in feet is shown for an increase of 1° with cloudy skies, varying from 167 feet near the earth to 334 at heights exceeding 3000 feet.

In column 37 the same results are shown for clear skies, being 143 feet near the earth, gradually increasing to 334 feet at heights exceeding 1600 feet.

TABLE VI.—Showing the Decrease of Temperature with every

Height above the level of the sea.		Aug. 31, 1863.			Sept. 29, 1863.		Oct. 9, 1863.			Jan. 12, 1864.		Apr. 6, 1864.		June 13, 1864.					
		State of the Sky.																	
		In cloud at 1000 ft.; clear.	Cloudy below 3000 feet.	Uniform mist.	Cloudy.		Clear.			Misty.		Cloudy.		Clear.					
From	To	Ascending.	Descend.	Descend.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Descending.
feet.	feet.	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
4900	5000	0·3	0·1	..	0·2	0·1	0·4	0·2	0·3	0·2	0·6	−0·1	−0·1	..	..	..	..	..	..
4800	4900	0·4	0·2	..	0·3	0·2	0·4	0·2	0·3	0·2	0·7	−0·1	−0·1	..	..	..	..	..	..
4700	4800	0·3	0·2	..	0·3	0·2	0·4	0·2	0·4	0·2	0·3	−0·4	−0·1	..	..	..	..	..	..
4600	4700	0·4	0·3	..	0·3	0·3	0·5	0·3	0·4	0·2	0·3	−0·4	−0·2	..	..	..	..	..	..
4500	4600	0·3	0·2	..	0·4	0·2	0·4	0·2	0·6	0·1	−0·2	−0·4	−0·1	..	..	..	..	..	..
4400	4500	0·2	0·3	..	0·3	0·3	0·3	0·3	0·6	0·2	−0·2	−0·4	−0·1	..	..	..	..	..	..
4300	4400	0·3	0·2	..	0·3	0·4	0·3	0·2	0·4	0·2	0·5	−0·6	0·0	..	..	..	..	..	..
4200	4300	0·3	0·3	..	0·3	0·4	0·3	0·3	0·3	0·3	0·5	−0·6	−0·1	..	..	..	..	..	..
4100	4200	0·3	0·2	..	0·3	0·4	0·3	0·2	0·3	0·2	0·3	0·0	−0·2	..	..	..	..	..	..
4000	4100	0·3	0·2	..	0·3	0·4	0·3	0·2	0·3	0·2	0·2	0·0	−0·2	..	..	..	..	..	..
3900	4000	0·3	0·2	..	0·3	0·3	0·3	0·3	0·3	1·5	0·3	0·0	−0·3	..	..	..	..	..	..
3800	3900	0·3	0·3	..	0·3	0·3	0·4	0·3	0·3	1·6	0·4	0·0	−0·3	..	..	..	..	..	..
3700	3800	0·3	0·2	..	0·3	0·3	0·4	0·2	0·3	0·5	0·4	0·0	−0·1	..	..	..	..	..	..
3600	3700	0·3	0·3	..	0·3	0·3	0·4	0·2	0·3	0·5	0·4	0·0	−0·1	..	..	..	..	..	..
3500	3600	0·3	0·2	..	0·3	0·3	0·3	0·2	0·3	0·3	0·4	0·2	0·0	..	..	..	..	..	..
3400	3500	0·3	0·3	..	0·3	0·4	0·4	0·3	0·2	0·2	0·3	0·3	0·0	..	..	..	..	..	..
3300	3400	0·3	0·2	..	0·3	0·4	0·3	0·2	0·3	0·6	0·4	0·0	−0·4	..	..	0·5	0·8	..	..
3200	3300	0·3	0·3	..	0·3	0·4	0·4	0·3	0·3	0·6	0·5	0·0	−0·5	..	..	0·5	0·9	..	..
3100	3200	0·3	0·2	..	0·3	0·4	0·3	..	0·3	0·3	0·4	0·0	−0·2	..	..	0·5	0·4	..	..
3000	3100	0·3	0·3	..	0·3	0·3	0·4	..	0·3	0·3	0·3	0·1	−0·2	..	..	0·6	0·5	..	..
2900	3000	0·3	0·3	..	0·3	0·3	0·3	..	0·3	−0·1	0·3	0·7	−0·2	0·4	0·1	0·7	0·7	0·2	0·1
2800	2900	0·3	0·3	..	0·3	0·3	0·4	..	0·3	−0·2	0·4	0·7	−0·3	0·4	0·1	0·7	0·7	0·3	0·2
2700	2800	0·3	0·2	..	0·3	0·4	0·3	..	0·3	−0·2	0·4	0·7	−0·2	0·2	0·3	0·5	0·1	0·2	0·2
2600	2700	0·3	0·3	..	0·3	0·3	0·4	..	0·3	−0·2	0·5	0·8	−0·1	0·2	0·4	0·5	0·1	0·3	0·3
2500	2600	0·3	0·2	..	0·3	0·4	0·3	..	0·3	−0·1	0·1	−0·2	0·0	0·3	0·4	0·5	..	..	0·2
2400	2500	0·3	0·3	..	0·4	0·4	0·4	..	0·1	0·0	0·0	−0·1	0·0	0·4	0·5	0·5	..	..	0·3
2300	2400	0·3	0·2	..	0·3	0·5	0·3	..	0·2	0·0	0·1	0·4	0·0	0·1	..	..	..	..	0·2
2200	2300	0·3	0·3	..	0·3	0·5	0·4	..	0·2	−0·1	0·2	0·4	0·1	0·1	..	..	..	..	0·3
2100	2200	0·3	0·3	..	0·3	0·6	0·4	..	0·2	−0·1	0·1	0·3	0·0	0·4	..	..	..	..	0·4
2000	2100	0·4	0·3	..	0·3	0·5	0·4	..	0·3	−0·1	0·2	0·2	0·1	0·5	..	..	..	..	0·5
1900	2000	0·3	0·3	0·1	0·3	0·5	0·4	..	0·2	−0·4	0·1	0·4	0·2	0·3	..	..	..	..	0·4
1800	1900	0·4	0·3	0·1	0·3	0·5	0·4	..	0·3	−0·4	0·0	0·4	0·2	0·4	..	..	..	..	0·5
1700	1800	0·3	0·3	0·0	0·3	0·5	0·4	..	0·2	−0·9	0·1	0·6	0·1	0·4	..	..	..	..	0·3
1600	1700	0·3	0·3	0·1	0·4	0·5	0·4	..	0·3	−0·9	0·1	0·6	0·0	0·5	..	..	..	..	0·3
1500	1600	0·3	0·3	0·1	0·3	0·6	0·4	..	0·2	−0·3	..	0·6	0·2	0·5	..	..	..	..	0·2
1400	1500	0·4	0·3	0·1	0·3	0·6	0·4	..	0·3	−0·3	..	0·7	0·2	0·5	..	..	..	..	0·1
1300	1400	0·3	0·3	0·2	0·3	0·5	0·4	..	..	−0·8	..	0·2	0·2	0·3	..	..	..	..	0·0
1200	1300	0·3	0·4	0·2	0·4	0·5	0·5	..	..	−0·8	..	0·1	0·2	0·4	..	..	..	..	0·1
1100	1200	0·3	0·3	0·2	0·3	0·4	0·4	..	..	0·1	..	0·3	0·4	0·3	..	..	..	..	0·0
1000	1100	0·4	0·3	0·2	0·3	0·4	0·5	..	..	0·1	..	0·3	0·5	0·4	..	..	..	..	0·1
900	1000	0·4	..	0·2	0·3	·4	0·4	..	..	0·2	..	0·3	0·4	0·2	..	..	..	..	0·0
800	900	0·5	..	0·3	0·3	·4	0·5	..	..	0·2	..	0·4	0·3	0·2	..	..	..	..	0·0
700	800	0·5	..	0·2	0·3	·4	0·4	..	..	0·1	..	0·9	0·4	0·2	..	..	..	..	0·0
600	700	0·6	..	0·3	0·3	0·4	0·5	..	..	0·1	..	0·9	0·4	0·3	..	..	..	..	0·0
500	600	0·7	..	0·2	0·4	0·5	0·4	..	..	0·5	..	0·5	1·0	0·2	..	..	..	..	0·0
400	500	0·8	..	0·3	0·4	0·6	0·5	..	..	0·5	..	0·5	1·0	0·2	..	..	..	..	0·0
300	400	1·1	..	0·2	0·3	0·6	0·4	..	..	0·2	..	0·1	0·2	0·3	..	..	..	..	0·0
200	300	1·1	..	0·2	0·4	0·6	0·5	..	..	0·2	..	0·2	0·1	0·4	..	..	..	..	0·0
100	200	2·2	..	0·2	0·3	0·6	0·4	..	..	0·2	..	0·0	0·1	0·5	..	..	..	..	0·0
0	100	2·2	..	0·3	0·4	0·6	0·5	..	..	0·2	..	0·0	0·2	0·5	..	..	..	..	0·0
No. of col.		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.

Increase of Height of 100 feet up to 5000 feet.

June 20, 1864.				June 27, 1864.			Aug. 29, 1864.		Mean.				General mean (omitting July 17, 1862, August 31, 1863, January 12, April 6, June 13, 20, and 27, 1864.)					
State of the Sky.																		
Cloudy.				Partially clear.			Clear.						Cloudy.			Clear.		
Ascending.	Descending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Ascending.	Descending.	Cloudy.	No. of experiments.	Clear.	No. of experiments.	Mean.	Number of experiments.	Space passed through for a decline of 1°.	Mean.	Number of experiments.	Space passed through for a decline of 1°.
°	°	°	°	°	°	°	°	°	°		°		°		feet.	°		feet.
..	..	..	..	0·1	0·1	..	0·2	0·3	0·1	2	0·3	5	0·3	20	334	0·3	10	334
..	..	..	..	0·1	0·1	..	0·3	0·4	0·2	2	0·3	5	0·3	20	334	0·3	10	334
..	..	..	..	0·1	0·1	..	0·3	0·3	0·2	2	0·3	5	0·3	19	334	0·3	10	334
..	..	..	..	0·2	0·2	..	0·3	0·4	0·3	2	0·4	5	0·3	19	334	0·3	10	334
..	..	..	..	0·2	0·0	..	0·3	0·3	0·3	2	0·4	5	0·3	20	334	0·3	10	334
..	..	..	..	0·3	0·0	..	0·4	0·4	0·3	2	0·4	5	0·3	20	334	0·3	10	334
..	..	..	..	0·1	0·0	..	0·3	0·3	0·3	2	0·3	5	0·3	23	334	0·3	10	334
..	..	..	..	0·2	0·1	..	0·4	0·4	0·3	2	0·3	5	0·3	23	334	0·3	10	334
..	..	0·5	0·3	0·3	0·1	..	0·3	0·4	0·3	2	0·3	5	0·3	23	334	0·3	12	334
..	..	0·6	0·3	0·4	0·2	..	0·4	0·4	0·3	2	0·3	5	0·3	24	334	0·3	12	334
0·2	0·0	0·4	0·4	0·5	0·2	0·2	0·3	0·3	0·3	2	0·3	5	0·3	24	334	0·3	12	334
0·3	−0·1	0·5	0·4	0·5	0·2	0·2	0·4	0·4	0·3	2	0·3	5	0·3	24	334	0·3	12	334
0·2	0·0	0·3	0·4	0·5	0·2	0·2	0·3	0·3	0·3	2	0·3	5	0·3	25	334	0·3	11	334
0·3	0·0	0·3	0·4	0·5	0·3	0·3	0·4	0·4	0·3	2	0·3	5	0·3	25	334	0·3	11	334
0·4	0·1	0·3	0·4	0·4	0·2	0·2	0·4	0·4	0·3	2	0·3	5	0·3	25	334	0·3	11	334
0·4	0·1	0·3	0·4	0·5	0·3	0·3	0·4	0·4	0·3	2	0·3	5	0·3	25	334	0·3	11	334
0·2	0·2	0·2	0·4	0·4	0·2	0·2	0·4	0·3	0·3	2	0·3	5	0·3	25	334	0·3	11	334
0·1	0·3	0·2	0·5	0·4	0·3	0·3	0·4	0·4	0·3	2	0·3	5	0·3	25	334	0·3	11	334
0·2	0·4	0·1	0·5	0·4	0·2	0·0	0·3	0·4	0·3	2	0·3	4	0·3	26	334	0·3	10	334
0·3	0·4	0·2	0·5	0·4	0·3	0·1	0·4	0·4	0·3	2	0·3	4	0·4	25	251	0·3	10	334
0·3	0·3	0·0	0·5	0·4	0·3	0·1	0·3	0·3	0·3	2	0·3	4	0·4	26	251	0·3	10	334
0·4	0·4	0·1	0·5	0·4	0·3	0·1	0·4	0·4	0·3	2	0·3	4	0·4	26	251	0·3	10	334
0·4	..	..	0·5	0·4	0·3	0·1	0·4	0·3	0·3	2	0·3	4	0·4	27	251	0·3	10	334
0·4	..	..	0·6	0·4	0·4	0·1	0·4	0·4	0·3	2	0·4	4	0·4	27	251	0·3	10	334
0·5	..	..	0·5	0·4	0·3	0·0	0·4	0·4	0·3	2	0·4	4	0·4	28	251	0·3	10	334
0·6	..	..	0·6	0·4	0·4	0·1	0·5	0·4	0·4	2	0·4	4	0·4	28	251	0·3	10	334
0·4	..	..	0·5	0·4	0·3	0·0	0·4	0·3	0·4	2	0·3	4	0·4	27	251	0·3	10	334
0·4	..	..	0·5	0·4	0·4	0·1	0·4	0·4	0·4	2	0·4	4	0·4	27	251	0·3	10	334
0·3	..	..	0·5	0·4	0·3	0·1	0·4	0·3	0·4	2	0·3	4	0·4	27	251	0·3	10	334
0·4	..	..	0·6	0·4	0·4	0·1	0·4	0·4	0·4	2	0·4	4	0·4	27	251	0·3	10	334
0·3	..	..	0·4	0·4	0·3	0·1	0·4	0·3	0·4	2	0·3	4	0·4	27	251	0·3	10	334
0·3	..	..	0·4	0·4	0·3	0·1	0·5	0·4	0·4	2	0·4	4	0·4	27	251	0·3	10	334
0·4	..	..	0·3	0·4	0·1	0·1	0·4	0·3	0·4	2	0·3	4	0·4	29	251	0·3	10	334
0·4	..	..	0·3	0·4	0·2	0·1	0·5	0·4	0·4	2	0·4	4	0·4	29	251	0·3	10	334
0·4	..	..	0·2	0·4	0·2	0·1	0·4	0·4	0·4	2	0·4	4	0·4	31	251	0·4	11	251
0·5	..	..	0·3	0·4	0·2	0·1	0·4	0·4	0·4	2	0·4	4	0·4	31	251	0·4	11	251
0·5	..	..	0·2	0·5	0·0	0·1	0·4	0·4	0·4	2	0·4	3	0·4	28	251	0·4	8	251
0·6	..	..	0·3	0·6	0·1	0·1	0·4	0·5	0·4	2	0·4	3	0·4	28	251	0·5	8	201
0·4	..	..	0·3	0·6	0·0	0·0	0·4	0·4	0·4	2	0·4	3	0·4	28	251	0·5	8	201
0·5	..	..	0·3	0·6	0·1	0·1	0·4	0·5	0·4	2	0·4	3	0·4	28	251	0·5	8	201
0·4	..	..	0·1	0·6	0·0	0·0	0·4	0·4	0·4	2	0·4	3	0·4	24	251	0·5	8	201
0·4	..	..	0·1	0·7	0·1	0·0	0·4	0·4	0·4	2	0·4	3	0·4	22	251	0·5	8	201
0·4	..	..	0·2	0·8	0·0	0·0	0·4	0·4	0·4	2	0·4	3	0·4	22	251	0·5	8	201
0·4	..	..	0·3	0·8	0·0	0·1	0·4	0·4	0·4	2	0·4	3	0·4	22	251	0·5	8	201
0·4	..	..	0·3	1·1	0·0	0·1	0·4	0·4	0·4	2	0·4	3	0·5	20	201	0·5	8	201
0·5	..	..	0·3	1·1	0·0	0·1	0·5	0·4	0·5	2	0·4	3	0·5	20	201	0·5	8	201
0·4	..	..	0·2	1·2	..	..	0·4	0·4	0·5	2	0·4	3	0·5	20	201	0·5	8	201
0·5	..	..	0·2	1·2	..	..	0·5	0·4	0·5	2	0·4	3	0·5	20	201	0·6	8	167
0·4	..	..	0·1	1·3	..	..	0·5	0·4	0·5	2	0·4	3	0·5	20	201	0·6	8	167
0·4	..	..	0·1	1·4	..	..	0·5	0·4	0·5	2	0·5	3	0·6	20	167	0·7	8	143
19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37

§ 6. Variation of the Hygrometric Condition of the Air with Elevation.

All the adopted readings of the temperature of the dew-point in Section 4 were laid down on diagrams, and joined by lines drawn from one to the other. In the case of the temperature of the air, when thus joined, a curved line can be drawn through them, giving equal weight to every observation, but this cannot be done with respect to the temperature of the dew-point, it being far more variable than the temperature of the air, and the numbers in the following Table are those as read at every 1000 feet from the diagram formed simply by joining the point of observation.

Table VII.—Showing the Variation of the Hygrometric condition of the Air at every 1000 feet of Height.

Fourteenth Ascent.

1863. Height, in feet, above the mean level of the sea.	Humidity of the Air. Ascending. Between what times.	Circumstances.	Temperature of the dew-point.	Elastic force of vapour.	Degree of humidity.	Descending. Between what times.	Circumstances.	Temperature of the dew-point.	Elastic force of vapour.	Degree of humidity.
August 31.			°	in.				°	in.	
8000	From $6^h\ 7^m$ p.m. to $6^h\ 29^m\ 30^s$ p.m.	Sun shining.	18·8	·102	52	From $6^h\ 29^m\ 30^s$ p.m. to $6^h\ 52^m$ p.m.		24·5	·132	53
7000		Very dark cloud near us.	19·1	·103	51			27·3	·149	65
6000			28·6	·157	66			30·3	·169	73
5000			32·2	·182	66		In basin of clouds.	31·5	·177	75
4000		Very cold.	36·7	·218	72			33·9	·195	74
3000			41·5	·262	79			42·1	·268	97
2000		Above cloud.	47·5	·329	88		Just in clouds.	45·0	·299	95
1000			52·7	·399	93			47·4	·328	94
ground		Getting into cloud.	56·7	·461	77		Stratum of clouds above.			
2000	From $6^h\ 52^m$ p.m. to $6^h\ 55^m$ p.m.	In clouds.	47·2	·325	90	From $6^h\ 55^m$ p.m. to $6^h\ 58^m$ p.m.	In uniform mist.	46·0	·311	85
1000			48·5	·342	91			49·1	·349	93
ground										

August 31.—The temperature of the dew-point on the ground before starting was 56°·7, or 7°·3 below that of the air; at 1100 feet these two temperatures were both 54°, the air being saturated with moisture; at 1150 feet the air suddenly became drier, the difference between the temperatures of the air and dew-point was 5°; at 7100 feet the temperatures of the air and dew-point were 34° and 18° respectively, and remained at these values nearly, while the balloon ascended to more than 8000 feet and descended to 7900 feet. The difference between the temperatures of the air and dew-point after this was generally less and less to 3000 feet, at which clouds were entered, and the air was nearly saturated with moisture; at 1000 feet high the temperature of the air was 49°, and that of the dew-point 47°·4.

The balloon then reascended, and on again entering cloud at 1580 feet, the air was again saturated with moisture, and on descending, it was nearly saturated at 1200 feet and at 820 feet; at the latter height the respective temperatures were 53° and 52°.

TABLE VII. (*continued.*)

FIFTEENTH ASCENT.

1863. Height, in feet, above the mean level of the sea.	Humidity of the Air. Ascending. Between what times.	Circumstances.	Temperature of the dew-point.	Elastic force of vapour.	Degree of humidity.	Humidity of the Air. Descending. Between what times.	Circumstances.	Temperature of the dew-point.	Elastic force of vapour.	Degree of humidity.
September 29.	From 7^h 42^m a.m. to 9^h 31^m 30^s a.m.		°	in.		From 9^h 33^m 30^s a.m. to 10^h 19^m a.m.		°	in.	
16000										
15000		Sun shining.	−10·0	·026	54					
14000			+ 0·5	·045	68					
13000			10·1	·068	81		...	1·3	·046	54
12000		No sun.	2·7	·049	58		...	2·2	·048	51
11000			− 8·6	·029	31		...	− 3·8	·036	33
10000		Dense clouds above us.	− 2·0	·040	36		...	−10·2	·026	21
9000			+15·5	·088	71		...	− 5·5	·033	25
8000			13·7	·081	53		...	2·8	·049	32
7000			19·5	·105	66		Sun warm.	14·8	·085	48
6000		Clouds above and below.	24·4	·131	72			20·8	·112	59
5000			28·5	·156	75		...	23·8	·128	56
4000			32·4	·184	81		...	24·5	·132	56
3000		Sun faint.	38·5	·233	87		...	23·6	·127	49
2000			40·7	·254	86		...	26·8	·146	45
1000		Misty all round.	42·6	·273	89					
ground			44·1	·289	86					

September 29.—The temperature of the dew-point decreased from 44° on the ground, or 490 feet above the sea, to $42\frac{1}{2}$° at 1000 feet above the sea, where mist was prevalent, and the degree of humidity increased from 86 to 89.

On passing out of the mist at 3000 feet the humidity declined from 87 to 58 at 8000 feet; here there were dense clouds both above and below; at 9000 feet the degree of humidity was 71.

There were faint gleams of the sun at 10,000 feet, and the difference between the temperature of the air and dew-point was $22\frac{1}{2}$°, the degree of humidity being 36, showing a decrease of no less than 35 in a difference of 1000 feet of elevation; at 11,000 feet it was drier still, the temperatures of the air and dew-point being 16°·9 and —8°·6 respectively, or a difference of 25°·5, and the degree of humidity 31; at 13,000 feet the difference had decreased to 4°·4 and the humidity increased to 81; at 15,000 feet it was 12°·0, and the humidity had decreased to 54; the balloon continued to ascend, but the humidity is unknown above the last-mentioned height, till on descending to 13,000 feet it was 54, and the difference between the temperatures of the air and dew-point was 13°·9; at 10,000 feet the air again became very dry, the two temperatures being 22°·9 and —10°·2 respectively, showing a difference of 33°·1 and a humidity of 21; the air then gradually became less dry till 5000 feet, when the difference was 11°·9 and the humidity 56; after this the difference increased in a small amount, and then decreased to 20°·2 at 2000 feet, where the humidity was 45.

TABLE VII. (*continued.*)

SIXTEENTH ASCENT.

1863. Height, in feet, above the mean level of the sea.	Humidity of the Air. Ascending. Between what times.	Circumstances.	Temperature of the dew-point.	Elastic force of vapour.	Degree of humidity.	Descending. Between what times.	Circumstances.	Temperature of the dew-point.	Elastic force of vapour.	Degree of humidity.
October 9.			°	in.				°	in.	
7000	From 4^h 27^m p.m. to 4^h 43^m 30^s p.m.	Mist over land.	19·8	·107	61	From 4^h 48^m p.m. to 5^h 1^m 30^s p.m.	...	18·3	·099	58
6000			22·1	·118	66		...	20·5	·110	61
5000			26·0	·141	69		...	23·4	·125	65
4000			31·0	·174	71		...	26·2	·142	68
3000			34·3	·198	74		...	31·1	·174	71
2000			37·6	·225	70					
1000			40·5	·252	70					
ground			44·1	·289	68					
3000	...	...	32·2	·182	71	From 5^h 2^m p.m. to 5^h 8^m p.m.	...	33·0	·188	74
2000	...	...	...	...	...		A thin mist.	39·0	·238	84
8000	From 5^h 9^m p.m. to 5^h 55^m 45^s p.m.	A sudden dryness.	9·7	·067	43	...	...	Too dark to observe.		
7000			12·8	·077	46	...	...			
6000			19·0	·103	56	...	...			
5000			27·6	·151	72	...	...			
4000			31·1	·174	76	...	...			
3000			35·0	·204	76	...	...			
2000			41·1	·258	87	...	...			

October 9.—The difference between the temperatures of the air and dew-point on the ground was $10\frac{1}{2}°$, their respective readings being $54\frac{1}{2}°$ and 44°; and this difference varied but little till 7310 feet was reached, at which height the temperatures were 30° and 18° respectively. On descending to 2330 feet the temperature of the air was 42°, and that of the dew-point $35\frac{1}{2}°$, the difference being $6\frac{1}{2}°$. On reascending the difference was found to be rather larger, but on descending again it decreased to $6\frac{1}{2}°$ at 2270 feet, where mist was prevalent, and it decreased to 2°·7 at 1500 feet, the two temperatures being 44°·8 and 42°·1 respectively. On ascending to 3300 feet, the air became suddenly drier, continued of the same degree of humidity to 4000 feet, above which there was less and less humidity with increase of elevation till the height of 8000 feet was reached, when it became too dark to read the instruments.

Table VII. (*continued.*)

Seventeenth Ascent.

1864. Height, in feet, above the mean level of the sea.	Humidity of the Air. Ascending. Between what times.	Circumstances.	Temperature of the dew-point.	Elastic force of vapour.	Degree of humidity.	Humidity of the Air. Descending. Between what times.	Circumstances.	Temperature of the dew-point.	Elastic force of vapour.	Degree of humidity.
January 12.			°	in.				°	in.	
11000	From 2^h 8^m p.m. to 3^h 25^m p.m.	Fine snow.	− 0·9	·042	51	From 3^h 36^m p.m. to 4^h 3^m 15^s p.m.	Snow fine and thin.	2·4	·049	61
10000			4·8	·053	52			14·5	·084	91
9000		Misty.	2·5	·049	38		Clouds above and below.	17·4	·095	88
8000			9·5	·066	43			20·0	·108	88
7000		Colder current.	15·2	·086	50		Near clouds.	23·0	·123	92
6000			28·3	·155	83		Very misty.	25·9	·140	87
5000			28·5	·156	70			28·5	·156	93
4000			27·6	·151	65			30·1	·168	89
3000			36·5	·216	73			34·4	·199	91
2000		Calm and warm to sense.	39·5	·242	85			38·0	·229	96
1000		Sensibly warm.	35·7	·209	84					
ground.			35·9	·211	80					

January 12.—The temperature of the dew-point on leaving the earth was 36°, that of the air 41½°, the degree of humidity was 80. The air gradually became more moist on ascending till 1300 feet was reached, when the difference between the two temperatures was 3°·1; a warm current was then met with, but the difference between the two temperatures did not vary much till 2200 feet was passed, then it increased to 10½° at 4000 feet; the air again became moist, and at 6000 feet the difference of temperature amounted to only 4½°, with 83 as the degree of humidity. The depression of the wet thermometer below the dry greatly increased, till at 9300 feet it was 20°·7, the degree of humidity being 38; and at 9800 feet cloud was entered; the difference decreased to 12°·2, and the degree of humidity increased to 56; the air then became drier, and at 11,900 feet (the highest point) the difference was 23°·7, and the degree of humidity 42. On descending the air gradually became moist, till at 8600 feet it was nearly saturated, then became somewhat drier, but was again nearly saturated at 5000 feet, the degree of humidity being 93; again it became drier, but at 2000 feet the air was within 1° of saturation, after which it became slightly drier till the ground was reached.

TABLE VII. (*continued.*)

EIGHTEENTH ASCENT.

1864. Height, in feet, above the mean level of the sea.	Humidity of the Air. Ascending. Between what times.	Circumstances.	Temperature of the dew-point.	Elastic force of vapour.	Degree of humidity.	Descending. Between what times.	Circumstances.	Temperature of the dew-point.	Elastic force of vapour.	Degree of humidity.
April 6.			°	in.				°	in.	
11000	From 4^h 9^m 10^s p.m. to 4^h 37^m p.m.		15·2	·086	39	From 4^h 37^m p.m. to 5^h 7^m p.m.		16·5	·092	39
10000			15·0	·086	42			22·5	·120	41
9000		Sun warm.	20·9	·112	56		Very warm.	24·4	·131	42
8000			25·5	·138	58			26·8	·146	47
7000			34·4	·199	85			29·8	·166	53
6000		Blue sky	31·4	·176	84		Entered cloud.	31·0	·174	64
5000			28·8	·158	74			32·1	·182	66
4000			31·0	·174	87			32·5	·184	69
3000		Fog wetting.	31·5	·177	91			32·0	·181	74
2000		Entering cloud, misty.	33·7	·193	85			33·3	·190	78
1000			34·2	·197	75			35·2	·205	78
ground.		Very misty.	38·5	·233	76			36·8	·218	61

NINETEENTH ASCENT.

1864. Height, in feet, above the mean level of the sea.	Ascending. Between what times.	Circumstances.	Temperature of the dew-point.	Elastic force of vapour.	Degree of humidity.	Descending. Between what times.	Circumstances.	Temperature of the dew-point.	Elastic force of vapour.	Degree of humidity.
June 13.										
3000	From 7^h p.m. to 7^h 8^m p.m.		38·6	·234	64			38·6	·234	64
2000			39·0	·238	56					
1000			42·4	·271	55					
ground.			44·7	·296	54					
3000			38·3	·023	69			37·5	·225	63
3000			41·1	·258	70	From 7^h 52^m p.m. to 8^h 14^m p.m.		36·5	·216	62
2000								43·4	·281	73
1000								46·5	·317	75
ground.								46·1	·312	74

April 6.—The temperature of the dew-point on leaving the earth was 38°·5, and the degree of humidity 76, the difference between the temperature of the air and that of the dew-point being 7°.

This difference remained nearly stationary till about 1400 feet, where mist was prevalent; the balloon entered cloud at 2100 feet, and by the time 2470 feet was reached the difference had declined to 2°. The air then became rather drier, but by the time 3500 feet was attained, the difference only equalled 1°, after which the air became several times moist and dry; at 6900 feet the difference was 3°, then it suddenly became drier, and continued to get so till 9400 feet, when it amounted to 19½°, and continued about the same till 11,000 feet (the highest point), where it equalled 21°. On descending the air gradually became moist, and continued so till within 1400 feet of the earth, the difference being at that height 5°, after which it began to increase, and continued to do so, till on the ground it amounted to 9°, these respective values being 45°·8 and 36°·8.

June 13.—The temperature of the dew-point was 44½° on the ground before starting, the difference between that and the temperature of the air being 17°, which nearly gradually declined to 13° by the time 3000 feet was gained. On descending the temperature was found to be nearly the same at 2300 feet as it was at 3000 feet; the difference at the lower of these elevations was 14°; on reascending the difference decreased till 3450 feet was gained, then increased to 13° by 3540 feet; on descending it remained nearly the same; on again ascending it differed very little also till 3050 feet was reached, where it was also 13°; the balloon then turned to make our downward journey, when the difference decreased to 9° and to 8° by the time the ground was reached.

TABLE VII. (*continued.*)

TWENTIETH ASCENT.

1864. Height, in feet, above the mean level of the sea.	Humidity of the Air.									
	Ascending.					Descending.				
	Between what times.	Circumstances.	Temperature of the dew-point.	Elastic force of vapour.	Degree of humidity.	Between what times.	Circumstances.	Temperature of the dew-point.	Elastic force of vapour.	Degree of humidity.
June 20.	From 6h 17m p.m. to 6h 27m 15s p.m.		°	in.		From 6h 31m p.m. to 6h 35m p.m.		°	in.	
4000			48·0	·335	85			47·7	·331	88
3000			48·0	·335	80			47·0	·323	80
2000			50·0	·366	76					
1000			51·1	·375	66					
ground			55·8	·446	68					
4000	From 6h 41m p.m. to 6h 48m p.m.		48·6	·343	93	From 6h 48m p.m. to 7h 16m p.m.		46·9	·332	89
3000			49·2	·351	84			50·4	·366	87
2000								51·1	·375	69
1000								54·0	·418	75
ground								54·0	·418	68

June 20.—The temperature of the dew-point was 55°·8 on the ground, the difference between that and the temperature of the air being 10°·7, declining very gradually till 4100 feet was gained, where the difference was $3\frac{1}{2}$°; on descending it gradually increased to 2740 feet, it then being 4°; on reascending the air again began to get moist, although at several points it seemed inclined to get drier, but then went back to its moist state again; at 4270 feet, however, complete saturation was met with; on descending it became drier in the first 100 feet, remained about the same for 800 feet, then became moist at 3200 feet; became drier at 2700 feet, after which, with one slight exception, it remained the same till the ground was reached, the difference then being $10\frac{1}{2}$°.

June 27.—The temperature of the dew-point was $46\frac{1}{2}$° on the ground, differed but little from 43° from 500 feet to 1500 feet high, was about $40\frac{1}{2}$° at 3000 feet, and 38° at 4000 feet; at about 4100 feet the air was more moist, the difference between the temperatures of the air and dew-point being $2\frac{1}{2}$°; this difference increased till at 5000feet it was rather less than 4°, the humidity being 86°. On descending the air became gradually drier, till at nearly 4500 feet the difference was 6°·2; the air then again became moist, for at 3600 feet it was $2\frac{1}{2}$°, the air then began to get drier; continuing to do so till at 660 feet it was $10\frac{1}{2}$°; on reascending this difference very gradually increased till about 3650 feet, when it was 13°; on reaching 3240 feet it had

Table VII. (*continued.*)

Twenty-first Ascent.

1864. Height, in feet, above the mean level of the sea.	Humidity of the Air. Ascending. Between what times.	Circumstances.	Temperature of the dew-point.	Elastic force of vapour.	Degree of humidity.	Descending. Between what times.	Circumstances.	Temperature of the dew-point.	Elastic force of vapour.	Degree of humidity.
June 27.			°	in.				°	in.	
5000	From $6^h 33^m 30^s$ p.m. to $7^h 41^m$ p. m.		38·5	·233	86	From $7^h 41^m$ p.m. to $8^h 52^m$ p.m.		38·5	·233	87
4000			38·2	·231	81			35·3	·206	78
3000			40·5	·252	71			38·3	·231	84
2000			40·2	·249	63			40·5	·232	78
1000			44·5	·294	64			38·3	·231	67
0										
4000	From $8^h 54^m 30^s$ p.m. to $9^h 4^m$ p.m.		35·6	·208	70					
3000			36·7	·218	68					
2000			35·4	·207	65					
1000			37·0	·220	64					
0										
Twenty-second Ascent.										
August 29.										
14000	From $4^h 6^m 20^s$ p.m. to $4^h 49^m 30^s$ p.m.	Clear blue sky.	22·5	·120	59	From $4^h 49^m 30^s$ p.m. to $5^h 32^m$ p.m.	Clear blue sky.	− 2·2	·040	25
13000			10·8	·070	37			− 2·3	·040	24
12000			13·9	·081	40			6·2	·057	32
11000			25·0	·135	56			12·8	·077	41
10000			29·6	·164	64			19·5	·105	54
9000			28·8	·158	58			31·7	·179	79
8000			28·2	·154	46			20·1	·108	42
7000			37·5	·225	60			21·0	·113	38
6000			41·0	·257	60			37·2	·222	79
5000			43·5	·283	67			42·3	·270	78
4000			37·0	·220	47			44·8	·297	74
3000			41·9	·266	47			51·9	·386	79
2000			45·4	·304	45			45·4	·304	55
1000			46·4	·316	42			47·6	·330	53
ground.			45·4	·304	38			47·9	·334	47

decreased to 8°, but on attaining 3520 feet it was 11½°, and at 4000 feet the temperatures of the air and dew-point were 45° and 35½° respectively, showing a difference of 9½°, and a humidity of 70°.

August 29.—The differences between the temperatures of the air and those of the dew-point in this ascent were rather remarkable; on starting it was very large, viz. 27°, their respective readings being 72½° and 45½°, and the degree of humidity 38. The difference decreased very gradually till 4500 feet was gained, when the air became suddenly moist, the difference only amounting to 6½° at 5600 feet, then became dry, and continued so till 11,000 feet was reached, the humidity being 56; after which it increased in dryness till the difference equalled 23° at 13,000 feet, the humidity having decreased to 37; it was moderately moist at the highest point, the difference there being 9°.

On descending, at 14,000 feet the air became very suddenly dry, the difference between the two temperatures increasing from 9° to 32° in a minute and a half, and the humidity being 25; it then declined to 6° at 9100 feet, increased again to 23° at 7350 feet; decreased to 6½° by 4550 feet, after which it increased to 21° on the ground, where the degree of humidity was 47.

TABLE VIII.—Showing the Degree of Humidity at every 1000 feet.

Height above the level of the sea.	August 31, 1863.				Sept. 29, 1863.		October 9, 1864.					Jan. 12, 1864.		April 6, 1864.		June 13, 1864.						June 20, 1864.				June 27, 1864.			Aug. 29, 1864.		Mean.			
	State of the Sky.																																	
	In cloud at 1000 ft., clear above.	Cloudy below 3000 ft.	Uniform mist.		Cloudy.		Clear.					Misty.		Cloudy.		Clear.						Cloudy.				Partially clear.			Clear.					
	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Descending.	Ascending.	Ascending.	Descending.	Cloudy.	Number of experiments.	Clear.	Number of experiments.
feet.																																		
15000	...	...	...	...	54	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	54	1		
14000	...	...	...	...	68	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	59	25	68	1	42	2
13000	...	...	...	...	81	54	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	37	24	68	2	32	2
12000	...	...	...	...	38	51	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	40	32	45	2	36	2
11000	...	...	...	...	31	33	...	...	...	...	...	51	61	39	39	...	...	...	...	...	...	...	...	...	...	...	...	...	56	41	43	6	48	2
10000	...	...	...	...	36	21	...	...	...	...	...	52	91	42	41	...	...	...	...	...	...	...	...	...	...	...	...	...	64	54	47	6	59	2
9000	...	...	...	...	71	25	...	...	...	...	...	38	88	56	42	...	...	...	...	...	...	...	...	...	...	...	...	...	58	79	54	6	68	2
8000	52	53	...	...	53	32	...	...	...	...	43	43	88	58	47	...	...	...	...	...	...	...	...	...	...	...	...	...	46	42	54	6	47	5
7000	51	65	...	...	66	48	61	58	...	...	46	50	92	85	53	...	...	...	...	...	...	...	...	...	...	...	...	...	60	38	66	6	56	7
6000	66	73	...	...	72	59	66	61	...	...	56	83	87	84	64	...	...	...	...	...	...	...	...	...	...	...	...	...	60	79	75	6	66	7
5000	66	·75	...	...	75	56	69	65	...	...	72	70	93	74	66	...	...	...	...	...	...	...	...	...	...	86	87	...	67	78	73	6	74	9
4000	72	74	...	...	81	56	71	68	...	...	76	65	89	53	69	...	...	...	...	...	...	85	88	93	89	81	78	70	47	74	77	10	71	10
3000	79	97	...	...	87	49	74	71	71	74	76	73	91	91	74	64	64	69	63	70	62	80	80	84	87	71	84	68	47	79	81	11	70	17
2000	88	95	90	85	86	45	70	...	...	84	87	85	96	85	78	56	...	...	...	...	73	76	...	...	69	63	78	65	45	55	83	11	70	11
1000	93	94	91	93	89	...	70	...	...	...	...	84	...	75	78	55	...	...	...	...	75	66	...	...	75	64	67	64	42	53	84	10	61	8
0	77	...	...	...	86	...	68	...	...	...	...	80	...	76	61	54	...	...	...	...	73	68	...	...	68	...	...	...	38	47	73	7	56	5
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.

The numbers in this Table show, as in all the previous experiments, that the moisture of the air at the same elevation is very different at different times; and that on the same day the moisture is very differently distributed, there having been on some of the days of experiments several successive wet and dry strata placed one above the other.

The numbers in the last columns show the average results at the different elevations, in the two states of cloudy and clear skies, and the number of experiments upon which each result is based.

By combining those with a cloudy sky with those previously obtained, according to the number of observations upon which each value was based, the following results were obtained:—

With an overcast sky, the degree of humidity on the earth was........	74	from	19	experiments.
At 1000 feet	76	,,	33	,,
2000 ,, ...	76	,,	34	,,
3000 ,, ...	78	,,	35	,,
4000 ,, ...	75	,,	27	,,
5000 ,, ...	74	,,	16	,,
6000 ,, ...	73	,,	14	,,
7000 ,, ...	62	,,	11	,,
8000 ,, ...	54	,,	11	,,
9000 ,, ...	50	,,	11	,,
10,000 ,, ...	48	,,	10	,,
11,000 ,, ...	47	,,	10	,,
12,000 ,, ...	52	,,	6	,,
13,000 ,, ...	58	,,	6	,,
14,000 ,, ...	52	,,	5	,,
15,000 ,, ...	59	,,	3	,,
16,000 ,, ...	59	,,	2	,,
17,000 ,, ...	47	,,	2	,,
18,000 ,, ...	33	,,	2	,,
19,000 ,, ...	24	,,	2	,,
20,000 ,, ...	29	,,	2	,,
21,000 ,, ...	22	,,	2	,,
22,000 ,, ...	34	,,	1	,,
23,000 ,, ...	40	,,	1	,,

The law of moisture here shown is a slight increase from the earth to the height of 3000 feet, and then a slight decrease to 6000 feet, the degree of humidity being at this elevation nearly of the same value as on the ground. From 6000 to 7000 feet there is a large decrease, and then an almost uniform decrease to 11,000 feet; it increases from 12,000 to 16,000 feet, and then decreases. The number of experiments up to 11,000 feet vary from 10 to 35, and I think great confidence may be placed in the results to this elevation; but at heights from 12,000 feet the number of experiments are evidently too small to speak with any confidence in respect to the results.

By treating the results with a clear or a nearly clear sky in the same way, the following results were obtained.

With a clear sky, the degree of humidity was—

On the ground	59	from	9	experiments.
At 1000 feet	61	,,	14	,,
2000 ,,	70	,,	17	,,
3000 ,,	71	,,	23	,,
4000 ,,	71	,,	19	,,
5000 ,,	69	,,	17	,,
6000 ,,	62	,,	15	,,
7000 ,,	56	,,	16	,,
8000 ,,	50	,,	14	,,
9000 ,,	50	,,	9	,,
10,000 ,,	46	,,	18	,,
11,000 ,,	43	,,	10	,,
12,000 ,,	35	,,	8	,,
13,000 ,,	37	,,	7	,,
14,000 ,,	37	,,	7	,,
15,000 ,,	44	,,	5	,,
16,000 ,,	40	,,	5	,,
17,000 ,,	39	,,	4	,,
18,000 ,,	21	,,	2	,,
19,000 ,,	36	,,	2	,,
20,000 ,,	33	,,	1	,,
21,000 ,,	32	,,	1	,,
22,000 ,,	21	,,	1	,,
23,000 ,,	16	,,	1	,,

The law of moisture here shown is a slight increase to 1000 feet, a considerable increase between 1000 and 2000 feet, a nearly constant degree of humidity from 2000 to 5000 feet, and a gradual decrease afterwards to 12,000 feet; at greater heights the numbers are less regular. The results up to 11,000 feet are based upon experiments varying from 10 to 23, and are most likely very nearly true normal values; at heights exceeding 12,000 feet the number of experiments have varied from 1 to 8, and no great confidence can be placed in them.

By comparing the results from the two states of the sky, the degree of humidity of the air up to 1000 feet high is 15 less with a clear sky than with a cloudy; from 2000 to 5000 feet it is from 4 to 6 less; at 6000 feet the air with a clear sky is much drier than at 5000, but with a cloudy sky it is nearly of the same degree of humidity, so that the difference between the two states is large, amounting to no less than 11; this difference decreases to 0 at 9000 feet, but increases to 4 at 11,000 feet; at heights exceeding 11,000 feet the air with clear skies generally becomes very dry, but with cloudy skies frequently becomes more humid, as was to be expected from the fact of the presence of clouds at heights exceeding 3 and 4 miles.

In both states of the sky at extreme elevations the air becomes very dry, but, so far as my experiments go, is never free from water.

§ 7. Comparison of the Temperature of the Dew-point, as determined by different Instruments and Methods, and Comparison of the Results together.

Table IX.—Showing the Temperature of the Dew-point, as determined at about the same height by different instruments and methods, and comparison of the results together.

Under 1000 feet.

Date.	Height.	Dew-point temperatures.				Temperature of the dew-point as determined by					
		Calculated from		Observed by		Dry and Wet (free) above that b			Dry and Wet (aspirated) above that by		Daniell's Hygrometer above that by Regnault's.
		Dry and Wet (free).	Dry and Wet (aspirated).	Daniell's Hygrometer.	Regnault's Hygrometer.	Dry and Wet (aspirated).	Daniell's Hygrometer.	Regnault's Hygrometer.	Daniell's Hygrometer.	Regnault's Hygrometer.	
d h m	feet.	°	°	°	°	°	°	°	°	°	°
Aug. 31 6 0	ground	56·7	..	57·0	..	..	−0·3				
6 53⅙	812	46·8	..	48·0	..	..	−1·2				
6 59½	704	51·6	..	51·0	..	..	+0·6				
Sept. 29 7 12	ground	43·4	42·4	43·5	..	+1·0	−0·1	..	−1·1		
Jan. 12 2 5	ground	36·0	..	35·0	..	..	+1·0				
Apr. 6 4 8	ground	38·5	..	40·0	..	..	−1·5				
5 25	ground	36·7	..	37·0	37·5	..	−0·2	−0·7	..	..	−0·5
June 13	ground	44·1	..	..	44·0	..	..	+0 7			
27 6 31	ground	49°	..	..	45·6	..	..	+3·5			

Between 1000 to 2000 feet.

Aug. 31 6 50⅙	1803	45·4	..	45·0	..	..	+0·4				
6 54	1287	50·0	..	50·0	..	..	0·0				
6 54⅓	1775	48·2	..	49·0	..	..	−0·8				
6 55½	1995	45·9	..	46·5	..	..	−0·6				
6 57½	1200	49·5	..	50·0	..	..	−0·5				
6 58	1171	49·5	..	50·0	..	..	−0·5				
Oct. 9 5 31	1976	38·8	..	40·0	..	..	−1·2				
5 32½	1930	40·7	..	40·0	..	..	+0·7				
5 34½	1827	40·7	..	40·0	..	..	+0·7				
5 36	1586	41·4	..	41·0	..	..	+0·4				
5 34	1782	42·1	..	43·0	..	..	−0·9				
June 3 7 3¼	1982	39·0	..	..	40·5	..	..	−1·5			

TABLE IX. (*continued.*)

Between 2000 to 3000 feet.

Date.				Height.	Dew-point temperatures. Calculated from Dry and Wet (free).	Dew-point temperatures. Calculated from Dry and Wet (aspirated).	Dew-point temperatures. Observed by Daniell's Hygrometer.	Dew-point temperatures. Observed by Regnault's Hygrometer.	Temperatures of the dew-point as determined by Dry and Wet (free) above that by Dry and Wet (aspirated).	Dry and Wet (free) above that by Daniell's Hygrometer.	Dry and Wet (free) above that by Regnault's Hygrometer.	Dry and Wet (aspirated) above that by Daniell's Hygrometer.	Dry and Wet (aspirated) above that by Regnault's Hygrometer.	Daniell's Hygrometer above that by Regnault's.
	d	h	m	feet.	°	°	°	°	°	°	°	°	°	°
Aug.	31	6	16	2270	46·4	..	48·0	..	..	−1·6				
		6	49½	2466	42·8	..	43·0	..	..	−0·2				
Sept.	29	7	47⅝	2129	40·8	..	41·0	..	..	−0·2				
		7	50	2197	40·9	40·7	..	..	+0·2					
Oct.	9	5	15	2369	34·9	..	28·5	..	..	+6·4				
		5	25¾	2905	31·4	..	31·5	..	..	−0·1				
		5	26	2554	32·2	..	33·5	..	..	−1·3				
		5	27	2386	33·2	..	34·0	..	..	−0·8				
		5	29	2072	37·5	..	36·0	..	..	+1·5				
		5	30	2042	38·6	..	38·5	..	..	+0·1				
		5	39	2120	40·7	..	..	41·0	..	..	−0·3			
		5	40	2124	40·9	..	41·0	..	..	−0·1				
Jan.	12	2	18	2010	42·0	42·0	..	..	0·0					
		2	19	2204	38·5	37·5	..	37·0	+1·0	..	+1·5	..	+0·5	
		2	20	2639	37·9	37·9	..	..	0·0					
		2	21	2686	37·7	37·5	..	..	+0·2					
		2	23	2775	37·5	37·5	..	..	0·0					
Apr.	6	4	14½	2170	34·0	..	..	35·0	..	..	−1·0			
		4	56½	2691	31·8	..	..	34·0	..	..	−2·2			
June	20	6	23	2786	47·6	..	..	48·3	..	..	−0·7			
		6	38	2820	48·5	..	..	48·0	..	..	+0·5			

From 3000 to 4000 feet.

Date.				Height.	Calculated from Dry and Wet (free).	Calculated from Dry and Wet (aspirated).	Observed by Daniell's Hygrometer.	Observed by Regnault's Hygrometer.	Free above Dry and Wet (aspirated).	Free above Daniell's Hygrometer.	Free above Regnault's Hygrometer.	Aspirated above Daniell's Hygrometer.	Aspirated above Regnault's Hygrometer.	Daniell's Hygrometer above that by Regnault's.
Aug.	31	6	18½	3263	40·4	..	45·0	..	..	−4·6				
Sept.	29	7	52½	3278	35·9	..	35·5	..	..	+0·4				
		10	15½	3529	24·6	..	25·0	..	..	−0·4				
Oct.	9	4	58	3679	27·3	..	28·0	..	..	−0·7				
		4	59	3548	27·7	..	27·5	..	..	+0·2				
		5	0	3268	29·0	..	..	29·0	..	..	0·0			
		5	4½	3125	29·6	..	25·5	..	..	+4·1				
		5	7	3272	29·6	..	26·0	..	..	+3·6				
		5	20½	3275	30·2	..	28·0	..	..	+2·2				
		5	43	3326	32·4	..	33·0	..	..	−0·6				
April	6	4	18	3507	31·5	..	32·0	..	..	−0·5				
June	13	7	8	3031	39·8	..	..	38·5	..	..	+1·3			
		7	20	3461	37·0	..	..	37·5	..	..	−0·5			
		7	23½	3327	41·0	..	..	40·0	..	..	+1·0			
June	20	6	38	2820	48·5	..	..	48·0	..	..	+0·5			
		6	56	3390	47·7	..	..	47·0	..	..	+0·7			
June	27	7	12	3871	37·4	..	..	39·2	..	..	−1·8			

Table IX. (*continued.*)

From 4000 to 5000 feet.

Date.	Height.	Dew-point temperatures.				Temperatures of the dew-point as determined by					
		Calculated from		Observed by		Dry and Wet (free) above that by			Dry and Wet (aspirated) above that by		Daniell's Hygrometer above that by Regnault's.
		Dry and Wet (free).	Dry and Wet (aspirated).	Daniell's Hygrometer.	Regnault's Hygrometer.	Dry and Wet (aspirated).	Daniell's Hygrometer.	Regnault's Hygrometer.	Daniell's Hygrometer.	Regnault's Hygrometer.	
d h m	feet.	°	°	°	°	°	°	°	°	°	°
Aug. 31 6 $20\frac{1}{3}$	4632	33·7	..	34·0	..	..	−0·3				
6 $46\frac{1}{4}$	4009	33·7	..	35·0	..	..	−1·3				
Sept. 29 7 57	4398	31·6	32·1	..	..	−0·5	..				
Oct. 9 4 55	4409	24·2	..	..	24·0	..	..	+0·2			
4 $55\frac{1}{6}$	4302	25·3	..	26·0	..	..	−0·7				
4 57	4024	26·0	..	..	26·0	..	..	0·0			
Jan. 12 2 30	4044	27·4	..	..	27·5	..	..	−0·1			
June 20 6 31	4006	47·1	..	..	48·0	..	..	−0·9			
6 50	4271	49·2	..	..	49·0	..	..	+0·2			
27 7 17	4131	36·4	..	..	34·5	..	..	+1·9			
Aug. 29 4 15	4730	44·3	..	..	43·5	..	..	+0·8			

From 5000 to 6000 feet.

Aug. 31 6 $21\frac{1}{6}$	5844	29·6	..	30·0	..	..	−0·4				
6 42	5891	31·0	..	31·5	..	..	−0·5				
Sept. 29 8 1	5789	25·2	..	26·0	..	..	−0·8				
10 11	5613	24·9	..	25·0	..	..	−0·1				
Oct. 9 4 38	5499	25·5	..	..	26·0	..	..	−0·5			
4 $52\frac{1}{2}$	5600	22·7	..	..	21·0	..	..	+1·7			
4 53	5054	23·4	..	22·0	..	..	+1·4				
Jan. 12 2 $31\frac{1}{4}$	5200	26·5	..	..	26·1	..	..	+0·4			
2 33	5610	28·8	..	..	29·5	..	..	−0·7			
April 6 4 25	5827	32·2	..	..	33·2	..	..	−1·0			

From 6000 to 7000 feet.

Aug. 31 6 22	6627	22·5	..	25·0	..	..	−2·5				
Sept. 29 8 5	6429	25·9	..	26·5	..	..	−0·6				
8 7	6385	23·4	..	21·0	..	..	+2·4				
8 9	6647	24·7	..	21·0	..	..	+3·7				
8 11	6966	20·2	..	20·5	..	..	−0·3				
Oct. 9 4 40	6506	22·3	..	..	22·0	..	..	+0·3			
4 41	6732	22·2	..	22·2	..	..	0·0				
4 $41\frac{1}{2}$	6796	21·8	..	..	21·0	..	..	+0·8			
4 49	6731	17·7	..	20·0	..	..	−2·3				
April 6 4 $27\frac{1}{2}$	6882	35·4	..	33·0	..	..	+2·4				

Table IX. (*continued.*)

From 7000 to 8000 feet.

Date.				Height.	Dew-point temperatures. Calculated from Dry and Wet (free).	Dew-point temperatures. Calculated from Dry and Wet (aspirated).	Dew-point temperatures. Observed by Daniell's Hygrometer.	Dew-point temperatures. Observed by Regnault's Hygrometer.	Dry and Wet (free) above that by Dry and Wet (aspirated).	Dry and Wet (free) above that by Daniell's Hygrometer.	Dry and Wet (free) above that by Regnault's Hygrometer.	Dry and Wet (aspirated) above that by Daniell's Hygrometer.	Dry and Wet (aspirated) above that by Regnault's Hygrometer.	Daniell's Hygrometer above that by Regnault's.
	d	h	m	feet.	°	°	°	°	°	°	°	°	°	°
Aug.	31	6	24⅙	7549	19·0	..	22·0	..	..	−3·0				
		6	28	7912	18·8	..	19·5	..	..	−0·7				
		6	28½	7912	18·8	..	20·0	..	..	−1·2				
		6	32	7912	18·8	..	19·5	..	..	−0·7				
		6	37	7022	27·4	..	28·0	..	..	−0·6				
Oct.	9	4	43	7184	16·9	..	..	20·0	..	..	−3·1			
		4	45	7252	19·8	..	20·0	..	..	−0·2				
		4	46½	7310	18·0	..	..	19·0	..	..	−1·0			
Jan.	12	2	52	7602	9·8	..	..	6·0	..	..	+3·8			
		3	0	7775	10·6	..	..	11·2	..	..	−0·6			
		3	2	7931	4·2	−0·8	..	..	+5·0					
April	6	4	48	7036	29·5	..	..	24·5	..	..	+5·0			
Aug.	29	4	25	7158	37·1	..	..	38·0	..	..	−0·9			
		4	26½	7578	30·2	..	..	29·5	..	..	+0·7			
		5	16	7352	19·2	..	..	19·0	..	..	+0·2			

From 8000 to 9000 feet.

Sept.	29	8	16	8041	13·8	..	15·0	..	..	−1·2				
		8	18	8259	16·4	14·7	..	..	+1·7					
		8	20	8446	17·9	15·5	..	..	+2·4					
		10	7	8439	−6·9	..	−5·0	..	..	−1·9				
Jan.	12	3	9	8894	7·2	8·5	..	..	−1·3					
April	6	4	30	8083	25·3	..	..	25·0	..	..	+0·3			

From 9000 to 10,000 feet.

Sept.	29	10	5½	9425	−5·8	..	−5·0	..	..	−0·8				
Jan.	12	3	11	9105	−0·5	−0·2	..	..	−0·3					
		3	15½	9500	8·6	13·5	..	..	−4·9					
		3	16	9500	−3·5	−7·5	−2·0	−2·0	+4·0	−1·5	−1·5	−5·5	−5·5	0·0
		3	16½	9500	3·8	4·5	..	..	−0·7					
		3	18	9586	1·3	1·5	..	..	−0·2					
		3	19	9822	7·8	1·5	..	..	+6·3					
April	6	4	34½	9090	20·0	..	..	18·2	..	..	+1·8			
Aug.	29	5	9	9740	21·2	..	..	20·0	..	..	+1·2			

From 10,000 to 11,000 feet.

Jan.	12	3	21½	10093	−1·7	..	−2·0	..	..	+0·3				
April	6	4	38	10987	16·3	..	..	16·0	..	..	+0·3			

TABLE IX. (*continued.*)

From 11,000 to 12,000 feet.

Date.	Height.	Dew-point temperatures. Calculated from Dry and Wet (free).	Dew-point temperatures. Calculated from Dry and Wet (aspirated).	Dew-point temperatures. Observed by Daniell's Hygrometer.	Dew-point temperatures. Observed by Regnault's Hygrometer.	Temperatures of the dew-point as determined by Dry and Wet (free) above that by Dry and Wet (aspirated).	Dry and Wet (free) above that by Daniell's Hygrometer.	Dry and Wet (free) above that by Regnault's Hygrometer.	Dry and Wet (aspirated) above that by Daniell's Hygrometer.	Dry and Wet (aspirated) above that by Regnault's Hygrometer.	Daniell's Hygrometer above that by Regnault's's.
d h m	feet.	°	°	°	°	°	°	°			
Sept. 29 8 40	11592	−2·7	..	2·5	..	..	−5·2				
8 41	11654	−1·4	..	3·0	..	..	−4·4				
Jan. 12 3 28	11664	−7·2	..	0·0	..	..	−7·2				

From 12,000 to 13,000 feet.

Sept. 29 8 44½	12305	6·1	..	5·0	..	..	+1·1	..			
8 58	12593	12·5	..	13·0	..	..	−0·5	..			
8 59	12926	11·5	..	13·5	..	..	−2·0	..			
9 0	12926	9·5	..	11·0	..	..	−1·5	..			
10 0	12504	−1·7	..	−6·0	..	..	+4·3	..			
Aug. 29 4 39	12973	16·0	..	..	12·0	..	..	+4·0			
5 3	12866	0·4	..	..	0·0	..	..	+0·4			

From 13,000 to 14,000 feet.

Sept. 29 9 4	13025	13·3	..	14·0	..	..	−0·7				
9 10	13279	9·8	..	12·0	..	..	−2·2				
9 12	13882	10·1	..	11·5	..	..	−1·4				
9 15	13791	3·5	..	11·1	..	..	+2·4				
9 52	13175	6·4	..	7·0	..	..	−0·6				
9 56	13947	−0·5	..	0·0	..	..	−0·5				
9 57	13947	−6·0	..	−3·0	..	..	−3·0				

From 14,000 to 15,000 feet.

Sept. 29 9 48	14308	7·2	..	8·0	..	..	−0·8	..			
9 49	14031	6·9	..	8·0	..	..	−1·1				
Aug. 29 4 56	14086	−2·4	..	..	−3·0	..	..	+0·6			

TABLE X.

Heights between			Excess of Temperature of the Dew-point as found by Dry and Wet Thermometers (free) above that found by			
			Daniell's Hygrometer.	No. of obs.	Regnault's Hygrometer.	No. of obs.
feet.		feet.	°		°	
0	to	1000	−0·2	7	+1·2	3
1000	„	2000	−0·2	11	−1·5	1
2000	„	3000	+0·4	10	−0·4	6
3000	„	4000	+0·4	10	+0·2	6
4000	„	5000	−0·8	3	+0·3	7
5000	„	6000	−0·1	5	0·0	5
6000	„	7000	+0·3	8	+0·5	2
7000	„	8000	−1·1	6	+0·5	8
8000	„	9000	−1·5	2	+0·3	1
9000	„	10000	−1·5	1	+0·5	3
10000	„	11000	+0·3	1	+1·5	2
11000	„	12000	−5·6	3	……	…
12000	„	13000	+0·3	5	+2·2	2
13000	„	14000	−0·8	7	……	…
14000	„	15000	−1·0	2	+0·6	1

In the experiments of every year there seems to be no certain difference in the determinations of the temperature of the dew-point by Daniell's and Regnault's hygrometers, and this temperature, determined by the use of the dry- and wet-bulb thermometers, seems to be very closely approximate indeed to the results obtained by either of these instruments, as can be seen by the following comparison of results as found from all the simultaneous determinations of the temperature of the dew-point by Daniell's hygrometer and the dry- and wet-bulb thermometers (free).

The temperature of the dew-point by the dry- and wet-bulb (free) Exps.
up to 1000 feet was 0·1 lower than by Daniell's hygrometer, from 21.
From 1000 to 2000 feet was 0·1 lower than by „ from 40.
2000 to 3000 feet was 0·1 lower than by „ from 54.
3000 to 4000 feet was the same as by „ from 60.
4000 to 5000 feet was 0·4 lower than by „ from 33.
5000 to 6000 feet was 0·6 lower than by „ from 33.
6000 to 7000 feet was 0·2 lower than by „ from 34.
7000 to 8000 feet was the same as by „ from 8.
8000 to 9000 feet was 1·5 higher than by „ from 2.
9000 to 10,000 feet was 1·2 higher than by „ from 2.
10,000 to 11,000 feet was 0·3 higher than by „ from 1.
11,000 to 12,000 feet was 5·6 lower than by „ from 3.
12,000 to 13,000 feet was 0·3 higher than by „ from 5.
13,000 to 14,000 feet was 0·8 lower than by „ from 7.
14,000 to 15,000 feet was 1·0 lower than by „ from 2.

The number of experiments made up to the height of 7000 feet varying from 21 to 60 in each 1000 feet, as taken in the last 3 years, is sufficient to enable us to speak with confidence; the results are that the temperatures of the dew-point, as found by the use of the dry- and wet-bulb thermometers and my Hygrometrical Tables, are worthy of full confidence up to this point. At heights exceeding 7000 feet, the three years' experiences do not yield a sufficient number of experiments to give satisfactory results. Before we can speak with certainty at these elevations more experiments must be made.

Table XI.—Simultaneous readings of a delicate blackened bulb thermometer fully exposed to the sun's rays, and of a delicate thermometer carefully shaded from the influence of the sun, the bulbs of the two instruments being within 3 inches of each other, together with observations by Herschel's actinometer, at different elevations.

Time of observation.	Height above mean sea-level.	Temperature of Shaded Thermometer.	Temperature of Blackened Bulb Thermometer.	Excess of reading of Blackened Bulb Thermometer.	Remarks.
					August 31, 1863.
h m s	feet.	°	°	°	
6 15 40 p.m.	1963	51·5	52·0	+0·5	Sun shining.
19 0 „	4167	45·2	46·0	+0·8	
20 40 „	5403	42·0	42·5	+0·5	
24 0 „	7315	34·0	37·0	+3·0	Blue sky.
32 0 „	7912	34·0	37·0	+3·0	
34 0 „	7621	36·0	39·0	+3·0	Blue sky.
37 0 „	7022	38·0	39·0	+1·0	
37 30 „	6898	38·5	38·2	−0·3	Losing sight of the sun.
42 30 „	5289	38·5	39·0	+0·5	
46 15 „	4009	41·5	42·0	+0·5	In basin of cloud; misty.
47 30 „	3480	42·1	42·5	+0·4	
51 30 „	1193	48·2	48·5	+0·3	
55 30 „	1995	50·0	51·0	+1·0	In clouds.
					September 29, 1863.
7 52 0 a.m.	2870	42·0	43·0	+1·0	Faint sun.
7 59 0 „	5314	35·2	36·0	+0·8	
8 0 0 „	5473	33·8	34·2	+0·4	The liquid in the chamber of the actinometer fully exposed did not move at all.
3 0 „	6117	31·5	32·0	+0·5	
4 0 „	6325	31·3	31·8	+0·5	
5 0 „	6429	30·5	31·5	+1·0	
6 0 „	6385	30·0	31·0	+1·0	
11 30 „	7201	28·5	29·2	+0·7	Faint gleams of light.
13 0 „	7671	27·2	28·1	+0·9	The reading of the actinometer did not change.
20 0 „	8446	26·2	27·2	+1·0	
28 0 „	9563	21·5	23·0	+1·5	A faint sun.
32 0 „	10646	18·1	18·4	+0·3	Gleams of sun.

TABLE XI.—September 29 (*continued*).

Time of observation.	Height above mean sea-level.	Temperature of Shaded Thermometer.	Temperature of Blackened Bulb Thermometer.	Excess of reading of Blackened Bulb Thermometer.	Remarks.
h m s	feet.	°	°	°	
8 44 30 a.m.	12416	12·2	12·5	+0·3	No sun.
47 0 „	12414	14·2	16·5	+2·3	
49 0 „	12857	16·2	16·2	0·0	Clouds above.
53 0 „	12666	17·8	20·0	+2·2	
54 0 „	12533	17·8	19·5	+1·7	The reading of the actinometer decreased on exposing it to the sun.
57 0 „	12704	17·5	20·9	+3·4	
9 0 0 „	12926	11·5	13·0	+1·5	
3 0 „	13025	15·0	15·0	0·0	Sun shining.
7 0 „	13030	15·0	16·5	+1·5	A bright sun. The increase of scale reading by the actinometer was 5 divisions in 1^m.
8 0 „	13160	16·0	19·0	+3·0	
13 0 „	14218	13·1	13·1	0·0	
15 0 „	13791	12·2	12·2	0·0	
23 0 „	13695	7·2	10·0	+2·8	Sun shining. The scale reading of the actinometer increased 3 divisions; then 4 divs.; then 5 divs. in 1^m, and decreased 3 divisions in the shade in 1^m.
28 0 „	13807	3·0	6·0	+3·0	
31 0 „	15517	2·0	4·6	+2·6	
33 0 „	16590	0·0	0·0	0·0	
36 0 „	14219	7·5	10·0	+2·5	
38 0 „	14175	6·0	8·5	+2·5	Sun shining brightly. The increase of actinometer scale divisions in 1^m was 7 divisions.
43 0 „	13897	6·0	8·5	+2·5	
47 0 „	14155	9·5	12·0	+2·5	
49 0 „	14031	13·0	17·1	+4·1	Sun shining. The actinometer increased 8 divisions in one minute; then 7 divisions in one minute; and then 8 divisions in one minute.
49 30 „	13175	13·9	19·0	+5·1	
50 0 „	13175	14·1	18·9	+4·8	
52 0 „	13175	15·1	18·9	+3·8	
54 0 „	14459	13·1	15·2	+2·1	
55 0 „	14347	13·2	15·0	+1·8	
56 0 „	13947	13·5	17·2	+3·7	
57 0 „	13947	13·2	17·5	+4·3	
58 0 „	13332	14·1	19·0	+4·9	
59 0 „	12642	17·0	21·0	+4·0	
10 3 30 „	10534	21·0	25·2	+4·2	
4 0 „	10284	22·0	27·0	+5·0	
5 0 „	9671	23·0	28·5	+5·5	
6 0 „	9179	25·2	29·5	+4·3	
6 30 „	8933	26·0	30·0	+4·0	
7 30 „	8209	27·0	31·9	+4·9	The increase of scale division in 1^m by the actinometer was 20 divs.; then 25 divs., and at 2500 ft. 25 divs. The actinometer increase in 1^m was 48 divs.
11 0 „	5618	34·5	39·0	+4·5	
16 0 „	3224	41·2	49·2	+8·0	
17 0 „	2828	42·0	49·0	+7·0	
19 0 „	2039	47·0	53·0	+6·0	
40 0 „	ground.	......	......	......	

January 12, 1864.

Time of observation.	Height above mean sea-level.	Temperature of Shaded Thermometer.	Temperature of Blackened Bulb Thermometer.	Excess of reading of Blackened Bulb Thermometer.	Remarks.
h m s	feet.	°	°	°	
2 5 0 p.m.	ground	42·0	41·8	−0·2	Atmosphere thick and misty.
9 0 „	655	40·0	39·5	−0·5	Over the river Thames.
13 0 „	1336	41·0	41·0	0·0	
16 0 „	1816	43·0	43·5	+0·5	
20 0 „	2639	44·0	44·0	0·0	Cloudy.
21 0 „	2687	44·0	44·0	0·0	
21 30 „	2735	44·0	44·1	+0·1	
23 0 „	2775	44·0	44·0	0·0	
24 0 „	2689	44·2	44·0	−0·2	
25 0 „	2689	44·5	45·0	+0·5	
26 0 „	3005	44·5	44·7	+0·2	
27 0 „	3282	43·5	43·0	−0·5	
28 30 „	3821	41·5	41·5	0·0	
34 0 „	5924	32·2	32·0	−0·2	
34 30 „	6144	31·5	32·7	+1·2	
41 0 „	6678	30·0	30·0	0·0	
41 30 „	6650	29·5	29·3	−0·2	Cloudy.
47 0 „	6984	30·8	30·7	−0·1	
50 0 „	7277	31·0	31·0	0·0	
56 0 „	7614	29·2	29·2	0·0	
57 0 „	7044	30·5	30·5	0·0	
58 0 „	8118	30·5	30·5	0·0	
3 2 0 „	7931	27·2	28·0	+0·8	
3 0 „	8086	27·2	27·5	+0·3	
4 0 „	8189	27·2	27·2	0·0	
6 0 „	8346	26·5	26·5	0·0	
8 0 „	8766	26·0	26·0	0·0	
10 0 „	9104	24·5	24·5	0·0	
15 0 „	9437	20·5	20·5	0·0	
15 30 „	9500	20·5	20·5	0·0	
16 0 „	9500	20·5	20·5	0·0	
16 30 „	9500	20·5	20·5	0·0	
17 30 „	9560	21·0	21·0	0·0	
18 0 „	9586	21·0	21·0	0·0	
19 0 „	9822	20·0	20·0	0·0	Cloudy.
21 0 „	10090	17·2	17·2	0·0	
21 20 „	10090	17·2	17·1	−0·1	
21 40 „	10319	16·2	16·2	0·0	
22 30 „	10469	15·5	15·2	−0·3	
23 0 „	10469	15·0	15·0	0·0	
24 0 „	10619	14·0	14·0	0·0	
38 15 „	10289	16·2	16·5	+0·3	
38 30 „	10221	16·2	16·2	0·0	
39 0 „	10085	16·2	16·2	0·0	
39 10 „	10017	16·2	16·2	0·0	
39 10 „	9921	16·5	16·5	0·0	In snow.
39 30 „	9516	16·8	16·8	0·0	
39 45 „	9408	17·2	17·2	0·0	
40 0 „	9273	18·0	18·2	+0·2	
40 30 „	9316	18·0	18·2	+0·2	
41 0 „	9199	18·5	18·5	0·0	
41 45 „	8939	21·0	21·0	0·0	
42 30 „	8765	21·0	21·0	0·0	No use could be made of the actinometer at all in this ascent.
44 30 „	7993	22·5	22·5	0·0	
47 0 „	7447	23·2	23·2	0·0	
53 0 „	5465	28·5	28·5	0·0	
54 30 „	5142	30·3	30·5	+0·2	
1 0 „	3091	37·2	37·5	+0·3	

April 6, 1864.

Time of observation.	Height above mean sea-level.	Temperature of Shaded Thermometer.	Temperature of Blackened Bulb Thermometer.	Excess of reading of Blackened Bulb Thermometer.	Remarks.
h m s	feet.	°	°	°	
4 10 10 p.m.	867	42·0	43·0	+1·0	Very misty.
16 0 "	2775	34·5	35·9	+1·4	
19 0 "	3884	32·0	34·1	+2·1	
20 30 "	4404	34·2	35·5	+1·3	Cloudy.
23 0 "	5251	36·2	38·1	+1·9	
25 0 "	5827	36·0	36·2	+0·2	
26 0 "	6500	34·2	34·8	+0·6	
29 0 "	7493	40·2	42·1	+1·9	
34 0 "	8854	34·2	35·1	+0·9	
36 0 "	10155	35·2	41·0	+5·8	
39 0 "	10470	43·0	48·5	+5·5	Sun shining; could not get the sun to shine full on the actinometer, and did not succeed in obtaining one good result.
42 0 "	8642	46·8	51·0	+4·2	
43 0 "	7783	47·0	52·0	+5·0	
44 30 "	7524	46·2	53·0	+6·8	
46 0 "	7869	46·0	53·0	+7·0	
46 30 "	7947	46·0	53·0	+7·0	
47 30 "	7410	46·2	54·0	+7·8	
48 0 "	7036	46·2	53·7	+6·5	
50 30 "	6153	44·0	47·0	+3·0	Entered cloud.
54 0 "	3821	41·0	41·0	0·0	

June 13, 1864.

7 7 15 p.m.	2880	52·2	53·0	+0·8	
10 0 "	2837	51·7	53·0	+1·3	
11 30 "	2380	52·8	55·5	+2·7	Sun bright.
12 0 "	2300	53·3	56·0	+2·7	
17 30 "	3106	47·2	47·5	+0·3	
19 0 "	3350	46·7	46·3	−0·4	
32 45 "	3349	48·2	48·5	+0·3	
46 30 "	2550	51·5	52·0	+0·5	

June 20, 1864.

6 19 30 p.m.	1550	59·0	59·0	0·0	
20 30 "	2006	58·2	58·2	0·0	Misty all round.
21 30 "	2236	58·2	58·3	+0·1	

June 27, 1864.

6 35 0 p.m.	610	60·1	59·2	−0·9	
35 0 "	719	59·5	59·0	−0·5	
37 0 "	865	58·5	58·0	−0·5	
38 30 "	1054	57·8	57·0	−0·8	
42 30 "	1497	56·5	55·0	−1·5	
49 18 "	717	58·0	56·8	−1·2	
52 0 "	1019	57·0	55·9	−1·1	
7 3 30 "	1514	54·5	54·0	−0·5	
4 0 "	1578	54·0	53·5	−0·5	Sun at the edge of cloud.
12 0 "	3871	46·2	45·0	−1·2	
19 0 "	3845	43·1	42·0	−1·1	
25 0 "	3322	47·2	45·0	−2·2	Sun shining on the blackened bulb thermometer.
39 30 "	4796	44·1	41·5	−2·6	
53 0 "	3958	42·0	41·5	−0·5	
8 3 30 "	2994	43·0	44·0	+1·0	

August 29, 1864.

Time of observation.	Height above mean sea-level.	Temperature of		Excess of reading of Blackened Bulb Thermometer.	Remarks.
		Shaded Thermometer.	Blackened Bulb Thermometer.		
h m s	feet.	°	°	°	
4 17 0 p.m.	4730	54·2	54·0	−0·2	
17 30 ,,	5066	54·2	54·8	−0·6	
20 0 ,,	5767	54·2	52·0	−2·2	
26 30 ,,	7578	50·2	52·0	+1·8	
38 20 ,,	12700	33·5	35·0	+1·5	
39 0 ,,	12773	32·8	35·2	+2·4	
44 0 ,,	14000	34·6	42·0	+7·4	Sun hot.
47 30 ,,	14317	35·5	42·0	+6·5	
49 30 ,,	14581	34·2	35·5	+1·5	
55 0 ,,	14086	31·0	37·0	+6·0	
5 11 0 ,,	9268	36·2	42·0	+5·8	
11 30 ,,	9143	37·2	43·0	+5·8	
16 0 ,,	9352	42·5	51·0	+8·5	

On August 31, at the height of 7000 and 8000 feet high, the blackened bulb thermometer exposed to the full influence of the sun, read 3° only higher than the shaded thermometer.

On September 29, at the height of 14,000 feet, the excess of reading of the blackened bulb thermometer was $2\frac{1}{2}$° only under a bright sun, and the increase of readings of the actinometer was 3 divisions to 5 divisions only; at 13,000 feet the excess of blackened bulb readings increased to 4° and 5°, and the increase in one minute of the actinometer readings were 7 to 8 divisions. At the height of 3000 and 4000 feet the influence of the sun increased, raising the blackened bulb to 7° and 8° in excess of the readings of the shaded thermometer; the scale readings of the actinometer increased to 20 and 25 divisions in one minute, and on reaching the ground the increase in the same time was from 48 to 50 divisions.

On January 12 the readings of the exposed and shaded thermometers were nearly always alike.

On April 6 I was unable to use the actinometer, and never succeeded in placing it properly. The excess of reading of the blackened bulb thermometer was but small during the cloudy state of the sky, and increased to 5° and 6° at 10,000 feet, this excess becoming larger on descending into the lower atmosphere, until cloud was entered.

On June 13 the excess was at all times small.

On June 20, at many inspections the readings of the two thermometers were identical.

On June 27 the exposed thermometer nearly always read lower than the shaded thermometer; on examination of these instruments afterwards, they were both found to read correctly.

On August 29 the blackened bulb thermometer read lower than the shaded thermometer, when 6000 feet were passed; it then read higher, increasing to 7° at 14,000 feet high.

From all these experiments it seems that the heat-rays from the sun for the small bulb of a thermometer, communicate very little or no heat to it, and the heat is less in proportion to the less density of the atmosphere; similar results being shown by the use of Herschel's actinometer.

On the Oxygenic condition of the Atmosphere.

August 31, 1863.

At 6^h 20^m 30^s p.m., at 4907 feet. There was no ozone.
At 6^h 37^m 30^s p.m., at 6898 feet. There was no ozone.

September 29, 1863.

At 8^h 1^m a.m., at 5789 feet. There was no ozone by paper test.
At 8^h 2^m a.m., at 6000 feet. No ozone by powder test.
At 8^h 41^m a.m., at 11,654 feet. Ozone by powder tinged to 4.
At 9^h 16^m a.m., at 13,805 feet. No ozone by paper.
At 9^h 57^m a.m., at 13,947 feet. No ozone.
At 9^h 57^m 30^s a.m., at 13,747 feet. Ozone powder coloured to 8.

January 12, 1864.

At 2^h 57^m p.m., at 7044 feet. Ozone=1.
At 3^h 6^m p.m., at 8346 feet. Ozone=1.
At 3^h 10^m p.m., at 9104 feet. Ozone=1.
At 3^h 16^m p.m., at 9500 feet. Ozone=1. Iodide paper coloured to 1.
At 3^h 17^m p.m., at 9536 feet. Ozone=1. Iodide paper coloured to 1.

June 27, 1864.

At 7^h 2^m p.m., at 1134 feet. Ozone paper tinged to 1, powder to 2.
At 7^h 36^m p.m., at 4270 feet. Ozone paper tinged to 2, powder to 3.
At 7^h 51^m p.m., at 4115 feet. Ozone paper tinged to 3, powder to 4.

August 29, 1864.

At 4^h 33^m p.m., at 10,875 feet. Ozone coloured to 1.
At 4^h 47^m 30^s p.m., at 14,317 feet. Ozone paper coloured to 2.

Heights and Appearance of the Clouds.

August 31, 1863.

At 6^h 14^m 30^s p.m., at 1145 feet. Entering the clouds.

At 6^h 14^m 40^s p.m., at (1262) feet. Above the clouds.

At 6^h 15^m p.m., at (1496) feet. Cumulus clouds below, in detached masses.

At 6^h 15^m 40^s p.m., at 1963 feet. Cumulus and scud far below.

At 6^h 17^m 40^s p.m., at (2737) feet. Cumulus in white heaps on our level. Sun shining on some clouds, but not others.

At 6^h 20^m 30^s p.m., at (4907) feet. Cumulus in beautiful hills, cirrocumulus above us at angles of 45° and 75°. Cumulus far above, the same as on July 21, 1862.

At 6^h 21^m 30^s p.m., at 6404 feet. Cirrus above; clouds piled up in heaps around, above and below us, peak upon peak. A very dark cloud with a little blue in it.

At 6^h 25^m 40^s p.m., at (7629) feet. Cirrus, cirrocumulus and blackish-brown strata above. Clouds all shapes and sizes. Masses of cumulus in distorted forms. Rocky clouds below us.

At 6^h 29^m 50^s p.m., at (8033) feet. Rainbow between lower cumulus and upper clouds.

At 6^h 31^m p.m., at 8033 feet. Very small patches of cirrus.

At 6^h 32^m 30^s p.m., at 7912 feet. Another rainbow over clouds in rocky heaps. Colours of the clouds opposite to the sun:—Top layer (1) brown; (2) bluish black; (3) darker bluish black; (4) thin layer of white; (5) greenish brown; (6) uniform rocky clouds forming the base of everything.

At 6^h 35^m p.m., at (7480) feet. Colour of the clouds under the sun:—Top layer (1) brown; (2) dark blue; (3) whitish grey-black; (4) uniform rocky cumulus clouds.

At 6^h 37^m p.m., at 7022 feet. Patches of cumulus apparently resting on the earth.

At 6^h 37^m 10^s p.m., at 6980 feet. The colour of the clouds opposite to the sun:—Top layer (1) brown; (2) bluish brown; (3) rocky brown clouds; (4) bluish black; (5) uniform base of rocky cumulus.

At 6^h 38^m 30^s p.m., at 6626 feet. Edge of cumulus and brownish cloud tinged by the sun. The tops of the peaks of the rocky clouds on nearly the same level as ourselves. Saw straggling bits of cloud between the upper and lower strata.

At 6^h 43^m p.m., at 5389 feet. Peaks after peaks rising up to our level and clearly defined against the sky; a cloud with a little red in it, not opposite to the sun. View confined on all sides by peaks of cloud, higher on three sides than on the fourth.

At 6^h 44^m 30^s p.m., at 4865 feet. In a basin of clouds, higher on three sides than on the fourth.

At 6^h 45^m 30^s p.m., at 4452 feet. Entering into the clouds.

At 6^h 46^m 15^s p.m., at 4009 feet. In basin of clouds; misty.

At 6^h 46^m 40^s p.m., at (3886) feet. Just entering into cloud.

At 6^h 47^m p.m., at 3787 feet. Just in clouds.

At 6^h 47^m 10^s p.m., at (3685) feet. In white mist.

At 6^h 48^m 30^s p.m., at (2908) feet. Steady leaden sky above; layers of detached clouds below.

At 6^h 50^m p.m., at (2061) feet. A uniform stratum of cloud above.

At 6^h 54^m p.m., at 1287 feet. In clouds.

At 6^h 54^m 10^s p.m., at 1580 feet. Above the clouds. Colours of the clouds:—Top layer (1) deep greenish blue; (2) bluish black; (3) green rocky clouds; (4) slightly rocky clouds.

At 6^h 55^m p.m., at 2024 feet. In clouds again.

At 6^h 56^m 30^s p.m., at (1597) feet. In uniform white mist.

September 29, 1863.

Before starting the sky was cloudy.

At 7^h 46^m a.m., at 1092 feet. Misty all round, east the clearest.

At 8^h 4^m 30^s a.m., at 6375 feet. Clouds above and below.

At 8^h 5^m a.m., at 6429 feet. There are clouds very high above us.

At 8^h 18^m a.m., at 8259 feet. Dense clouds above us, very high indeed; there are two layers below us.

At 8^h 20^m a.m., at 8446 feet. Misty.

At 8^h 24^m a.m., at 9193 feet. Many clouds apparently on the ground, twelve cumuli in a patch.

At 8^h 25^m a.m., at 9252 feet. Detached cumuli apparently resting on the ground like huge swans in some places, in others as though there had been a simultaneous discharge of heavy ordnance. Three distinct layers of cloud.

At $8^h\ 34^m\ 40^s$, a.m. at 11,082 feet. Beautiful blue tinge over bed of clouds.
At $8^h\ 35^m$ a.m., at 11,062 feet. Clouds a mile above us at least.
At $8^h\ 49^m$ a.m., at 12,857 feet. Clouds above us.
At $8^h\ 52^m\ 30^s$ a.m., at 12,800 feet. Stratus clouds, some on our level and some at a higher elevation.
At $8^h\ 54^m\ 30^s$ a.m., at 12,818 feet. A very great variety of cloud.
At $8^h\ 55^m$ a.m., at 12,818 feet. Stratus on our level, sixteen distinct cumuli apparently resting on the ground, like smoke on discharging ordnance.
At $8^h\ 57^m$ a.m., at 12,704 feet. A beautiful tinge of blue over the clouds.
At $8^h\ 58^m$ a.m., at 12,593 feet. Seas of white rocky cloud; mist.
At $9^h\ 1^m$ a.m., at 12,926 feet. Counted forty separate cumuli, apparently resting on the earth.
At $9^h\ 3^m$ a.m., at 13,025 feet. Sun bringing mist up vertically.
At $9^h\ 8^m$ a.m., at 13,160 feet. Clouds are above us still.
At $9^h\ 12^m$ a.m., at 13,882 feet. Clouds are above us still.

October 9, 1863.

Before starting the sky was clear.
At $4^h\ 31^m$ p.m., at 1573 feet. The sky was cloudless except near the horieon.
At $4^h\ 44^m$ p.m., at 7193 feet. Rose coloured cumuli clouds in the S.; white in the W.; no clouds except near the horizon.
At $5^h\ 10^h$ p.m., at 2863 feet. Misty.
At $5^h\ 25^m$ p.m., at 3383 feet. The western sky is magnificent, the eastern is dotted with fine cumuli.
At $5^h\ 32^m\ 30^s$ p.m., at 1930 feet. A thin mist.

January 12, 1864.

Before starting the sky was cloudy, overcast, the air misty and thick.
At $2^h\ 20^m$ p.m., at 2639 feet. Cloudy.
At $2^h\ 21^m\ 30^s$ p.m., at 2735 feet. In fog.
At $2^h\ 41^m\ 30^s$ p.m., at 6650 feet. Cloudy.
At $3^h\ 32^m$ p.m., at 11,774 feet. Snow-granules.
At $3^h\ 36^m$ p.m., at 11,007 feet. Snow fine and thin.
At $3^h\ 41^m\ 30^s$ p.m., at 9026 feet. Clouds below us, a great dense cloud above us.
At $3^h\ 45^m$ p.m., at 7732 feet. Above cloud; line of cloud due N. and S.
At $3^h\ 47^m$ p.m., at 7447 feet. Line of cloud remarkable, very well defined.
At $3^h\ 47^m\ 30^s$ p.m., at 7226. About entering cloud.
At $3^h\ 48^m$ p.m., at 6967 feet. In cloud.
At $3^h\ 49^m$ p.m., at 6640 feet. Out of cloud.
At $3^h\ 50^m\ 30^s$ p.m., at 6040 feet. Very misty.
At $4^h\ 8^m\ 30^s$ p.m., at 1324 feet. Very misty.

April 6, 1864.

Before starting the sky was uniformly cloudy; there was no sun, and objects were misty in the distance.
At $4^h\ 10^m\ 10^s$ p.m., at 867 feet. Very misty.
At $4^h\ 14^m\ 30^s$ p.m., at 2170 feet. Misty; entering cloud.
At $4^h\ 20^m$ p.m., at 4260 feet. Two layers of cloud.
At $4^h\ 23^m$ p.m., at 5251 feet. No break in the clouds.
At $4^h\ 50^m\ 30^s$ p.m., at 6153 feet. Entered cloud.
At $4^h\ 51^m$ p.m., at 5536 feet. Stratus clouds on our level.

June 13, 1864.

Before starting the sky was cloudless, the horizon misty.

At 7^h 28^m 30^s p.m., at 3543 feet. The horizon was misty all round.

June 20, 1864.

Before starting the sky was cloudy.

At 6^h 19^m p.m., at 1462 feet. Misty all round.

At 6^h 24^m p.m., at 3086 feet. Clouds under us.

At 6^h 24^m 30^s p.m., at 3214 feet. Clouds around us.

At 6^h 25^m p.m., at 3375 feet. Entering cloud.

At 6^h 26^m p.m., at 3696 feet. In a white cloud; fog; can see nothing; the clouds are blacker above than below.

At 6^h 44^m p.m., at 3549 feet. Misty below.

At 6^h 45^m p.m., at 3669 feet. Black mist below. Clouds apparently blacker below than above, entering cloud.

At 6^h 51^m p.m., at 4271 feet. Still in cloud.

At 6^h 54^m 30^s p.m., at 4130 feet. Clouds darker.

June 27, 1864.

Before starting the sky was covered with cirrocumulus.

At 6^h 34^m 30^s p.m., at 484 feet. Misty.

At 7^h 49^m 20^s p.m., at 4471 feet. Very misty.

At 8^h 15^m 30^s p.m., at 3579 feet. Clear sky above.

August 29, 1864.

At 4^h 19^m p.m., at 5664 feet. Cirri above.

Appearance of the Sky.

August 31, 1863.

At 6^h 33^m 30^s p.m., at (7696) feet. Blue sky above.

At 6^h 54^m p.m., at 1287 feet. Sky of a greenish colour.

September 29, 1863.

At 9^h 20^m a.m., at 13,695 feet. Blue sky above.

October 9, 1863.

At 5^h 10^m p.m., at 2863 feet. Blue sky above.

June 27, 1864.

At 7^h 44^m 30^s p.m., at 4597 feet. Light blue sky.

August 29, 1864.

At 4^h 19^m p.m., at 5664 feet. Deep blue sky.

Velocity of the Wind by the Balloon, and by Robinson's Anemometer at the Royal Observatory, Greenwich.

On September 29 the balloon left Wolverhampton at $7^h\ 43^m$ a.m., and fell near Sleaford, a point 95 miles from the place of ascent, at $10^h\ 30^m$ a.m. During this time the horizontal movement of the air was 33 miles as registered at Wrottesley Observatory.

On October 9 the balloon left the Crystal Palace at $4^h\ 29^m$ p.m., and descended at Pirton Grange, a point 35 miles from the place of ascent, at $6^h\ 30^m$ p.m. Robinson's anemometer during this time registered 8 miles at the Royal Observatory, Greenwich, as the horizontal movement of the air.

On January 12 the balloon left the Royal Arsenal, Woolwich, at $2^h\ 8^m$ p.m., and descended at Lakenheath, a point 70 miles from the place of ascent, at $4^h\ 19^m$ p.m. At the Royal Observatory, by Robinson's anemometer, during this time the motion of the air was 6 miles only.

On April 6 the balloon left the Royal Arsenal, Woolwich, at $4^h\ 8^m$ p.m. Its correct path is not known, as it entered several different currents of air, the earth being invisible owing to the mist; it descended at Sevenoaks, in Kent, at $5^h\ 17^m$ p.m., a point 15 miles from the place of ascent. 5 miles was registered during this time by Robinson's anemometer at the Royal Observatory, Greenwich.

On June 13 the balloon left the Crystal Palace at $7^h\ 0^m$ p.m., and descended at East Hornden, a point 20 miles from the place of ascent, at $8^h\ 15^m$ p.m. Robinson's anemometer during this time registered 17 miles at the Royal Observatory, Greenwich.

On August 29 the balloon left the Crystal Palace at $4^h\ 6^m$ p.m., and descended at Wybridge, at $5^h\ 30^m$ p.m., a point 13 miles from the place of ascent. During this time 15 miles was registered by Robinson's anemometer at the Royal Observatory, Greenwich.

Direction of the Wind.

September 29, 1863.

Before starting, the wind was from the S.W., and remained so during the ascent and descent of the balloon.

October 9, 1863.

Before starting the wind was from the S.E.

At $4^h\ 34^m$ p.m., at 3700 feet. Changed direction from N.W. to N.

At $5^h\ 13^m$ p.m., at 2715 feet. Moving N.W. again.

January 12, 1864.

At $2^h\ 9^m$ p.m., at 655 feet. Changing direction towards the S.W.; wind N.E.

At $2^h\ 10^m$ p.m., at 1328 feet. Moving W.; wind E.

At $2^h\ 11^m$ p.m., at 1518 feet. Wind S.W.

At $2^h\ 19^m$ p.m., at 2204 feet. Wind still S.W.

At $2^h\ 32^m\ 30^s$ p.m., at 5401 feet. We are now going northwards; wind S.

At $3^h\ 3^m$ p.m., at 8086 feet. Changed direction; moving N.N.E.; wind S.S.W.

At $3^h\ 20^m$ p.m., at 10,017 feet. Entered a S.S.E. current.

April 6, 1864.

Before starting the wind was from the S.E.
At 4^h 14^m p.m., at 2161 feet. Entered a W.S.W. current.

ON THE PROPAGATION OF SOUND.

August 31, 1863.

At 6^h 13^m 30^s p.m., at 648 feet. People heard shouting.
At 6^h 15^m 40^s p.m., at 1963 feet. Could hear a loud buzzing noise; railway whistle heard.
At 6^h 37^m p.m., at 7022 feet. No sound of any sort.
At 6^h 57^m 30^s p.m., at 1200 feet. Heard children's voices.

September 29, 1863.

At 8^h 13^m a.m., at 7671 feet. The report of a gun was heard.
At 8^h 46^m 30^s a.m., at (12,415) feet. The report of a gun was heard.
At 9^h 11^m 15^s a.m., at (13,602) feet. A shrill whistle in the balloon was heard as a ringing sound for 10 seconds, afterwards passing down the balloon.
At 9^h 45^m a.m., at 14,224 feet. The report of a gun again heard.

October 9, 1863.

At 4^h 39^m 30^s p.m., at 6277 feet. The deep roar of London heard.
At 4^h 40^m p.m., at 6506 feet. The roar of London deep and continuous.
At 4^h 48^m p.m., at 7087 feet. The roar of London very deep.
At 5^h 3^m p.m., at 3067 feet. Noise of London heard.

January 12, 1864.

At 2^h 46^m p.m., at 6885 feet. Can hear the ticking of a steam-threshing machine.
At 2^h 48^m p.m., at 7118 feet. Can hear people's voices.

June 13, 1864.

At 7^h 21^m p.m., at 3291 feet. Heard the report of a gun 10 seconds after seeing the flash.

June 20, 1864.

At 6^h 29^m p.m., at 4102 feet. Can hear the ticking of a watch plainly.
At 6^h 30^m p.m., at 4122 feet. Heard a railway train.
At 6^h 51^m p.m., at 4271 feet. Heard the report of a gun.
At 6^h 54^m 30^s p.m., at 4130 feet. A church clock striking.

June 27, 1864.

At 7^h 45^m p.m., at 4699 feet. Heard a dog barking.
At 7^h 53^m p.m., at 3958 feet. Can hear voices.
At 8^h p.m., at 3604 feet. The report of a gun heard.
At 8^h 6^m p.m., at 2594 feet. The report of a gun again heard.
At 8^h 8^m 30^s p.m., at 2529 feet. Heard the whistle of a railway train.
At 8^h 29^m 30^s p.m., at 2003 feet. Sounds very distinctly heard.
At 8^h 33^m p.m., at 1936 feet. A bell heard with a clear sound.
At 8^h 39^m p.m., at 2337 feet. Heard the report of a gun again.

Physiological Observations.

January 12, 1864.

At 3^h 39^m 30^s p.m., at 9516 feet. Mr. Norris reddish blue, Mr. Coxwell darker, and Mr. Glaisher redder than usual.

June 20, 1864.

At 6^h 31^m 30^s p.m., at 3938 feet. The number of pulsations in a minute were as follows:—Mr. Goodchild, 90; Mr. Allport, the same; Master Glaisher, 86; Mr. Jackson and Mr. Coxwell, 94; Mr. Glaisher, 96; Mr. Knight, 110; and Mr. Bourne, 112.

At 6^h 51^m 30^s p.m., at (4276) feet. The number of pulsations in a minute were as follows:—Mr. Allport, 84; Mr. Goodchild, 86; Mr. Knight, 90; Mr. Coxwell, 94; Mr. Jackson, 96; Mr. Bourne, 98.

June 27, 1864.

At 6^h 43^m p.m., at 1497 feet. The number of pulsations in a minute were as follows:—Mr. E. Atkinson, 78; Mr. Coxwell, 84; Mr. Glaisher, 104; Mr. Ingelow, 108; Mr. Collins, 108; Mr. Woodroffe, 120.

At 6^h 56^m p.m., at 1660 feet. The number of respirations per minute were as follows:—Mr. Collins, 11; Mr. Coxwell, 15; Mr. J. Atkinson, 17; Mr. E. Atkinson, 17; Mr. Ingelow, 18; Mr. Glaisher, 18½; Mr. Woodroffe, 19; Mr. Ellis, 20. Mr. Collins repeated the experiment and found it still the same.

At the Alliance Inn, Brookland, at midnight. Mr. Coxwell's pulsations were 90 in a minute; Mr. Glaisher's pulsations were 88 in a minute; Mr. Collins's pulsations were 94 in a minute; Mr. J. Atkinson's pulsations were 74 in a minute.

The number of respirations per minute were as follows:—Mr. Coxwell, 18; Mr. Glaisher, 17; and Mr. Collins, 15.

August 29, 1864.

At 4^h 50^m p.m., at 14,580 feet. Mr. Glaisher's pulsations were 110, and respiration 20 in a minute.

At 4^h 52^m 30^s p.m., at 14,281 feet. Mr. Glaisher's pulsations were 97 in a minute.

At 5^h 3^m p.m., at 12,866 feet. Mr. Glaisher's pulsations were 99, Mr. Coxwell's 102, and Messrs. Norris and Cranston's each 118 in a minute. The number of respirations in one minute were as follows:—Mr. Norris, 10; Mr. Glaisher, 18; and Messrs. Coxwell and Cranston, each 22.

On the different Appearance of Gas in the Balloon.

August 31, 1863.

At 6^h 17^m 40^s p.m., at 2737 feet. Gas cloudy.

At 6^h 21^m 30^s p.m., at 6409 feet. Balloon quite full; gas very opaque, and issuing from the neck.

At 6^h 43^m 30^s p.m., at 5235 feet. Gas cloudy.

At 6^h 44^m 20^s p.m., at (4927) feet. Gas clearing; valve faintly seen.

At 6^h 45^m p.m., at 4784 feet. Gas clearer; netting visible.

At 6^h 47^m p.m., at 3787 feet. Gas clearer still, but not quite clear.

At 6^h 53^m p.m., at 859 feet. Gas clear.

At 6^h 56^m 30^s p.m., at 1597 feet. Gas beautifully clear.

September 29, 1863.

At 8^h 4^m a.m., at 6321 feet. Gas cloudy.
At 8^h 22^m a.m., at 8726 feet. Gas getting clearer.
At 9^h 1^m 15^s a.m., at 12,926 feet. Gas clear.

January 12, 1864.

At 2^h 41^m 30^s p.m., at 6650 feet. Gas opaque.

April 6, 1864.

At 4^h 25^m 30^s p.m., at 6163 feet. Gas clearer.

June 20, 1864.

At 6^h 24^m p.m., at 3086 feet. Gas thick and cloudy, and issuing from the neck of the balloon.
At 6^h 35^m p.m., at 3002 feet. Gas clear.
At 6^h 35^m 15^s p.m., at 2840 feet. Gas bright.
At 6^h 40^m p.m., at 2990 feet. Gas clear.
At 6^h 47^m 30^s p.m., at (3886) feet. Gas much cloudier, and issuing from the neck of the balloon.
At 6^h 48^m p.m., at 4013 feet. Gas thick.

June 27, 1864.

At 8^h 43^m p.m., at 1836 feet. Gas clear.

The Lines in the Spectrum.

September 29, 1863.

At 7^h 59^m a.m., at 5314 feet. The lines B to G in the sky spectrum visible.
At 8^h a.m., at 5473 feet. The line F is beautifully defined; cannot see A, and can just see G; sky spectrum.
At 8^h 6^m a.m., at 6385 feet. Can see B to G, sky spectrum.
At 9^h 14^m a.m., 14,096 feet. Spectrum everywhere, B to G, F very distinct; sky spectrum.
At 9^h 22^m a.m., at 13,695 feet. Sun spectrum, H clear, dark beyond.
At 9^h 23^m a.m., at 13,695 feet. Sun spectrum, A clear.
At 9^h 25^m a.m., at 13,982 feet. Lines clear and numerous in the sun spectrum, extending from A to beyond H.
At 9^h 41^m a.m., at 14,203 feet. The sun spectrum extended from A to far beyond H, and was very beautiful.
At 9^h 43^m a.m., at 13,897 feet. Line H in the spectrum clear and vivid.
At 9^h 44^m a.m., at 13,897 feet. The sun spectrum very vivid and very long; H made up of fine lines.

October 9, 1863.

At 5^h 7^m p.m., at 3272 feet. Faint spectrum on all sides.

Time of Vibration of a Horizontal Magnet.

June 27, 1864.

h	m	s		feet							seconds.
At 6	50	30	at	903	there were	30	vibrations	of a	horizontal	magnet in	48·0
„ 7	22	15	„	3487	„	30	„	„	„	„	49·1
„ 7	29	0	„	3197	„	30	„	„	„	„	49·0
„ 7	32	0	„	3415	„	30	„	„	„	„	48·9
„ 7	37	0	„	4467	„	30	„	„	„	„	49·2
„ 7	44	0	„	4597	„	30	„	„	„	„	49·2
„ 7	46	0	„	4692	„	30	„	„	„	„	49·0
„ 7	57	30	„	3686	„	30	„	„	„	„	49·0
„ 8	4	0	„	2744	„	30	„	„	„	„	48·7
„ 8	9	30	„	2929	„	16	„	„	„	„	26·5
„ 8	25	0	„	2710	„	30	„	„	„	„	48·5

At the Alliance Inn, Brookland, at 1^h a.m., on June 28, 30 vibrations of the same horizontal magnet were observed as follows:—in $47^s·2$, $47^s·2$, $47^s·2$, $46^s·5$, and in $47^s·2$.

August 29, 1864.

At the Royal Observatory, Greenwich, at noon,

					seconds.
30	vibrations	of a	horizontal	magnet was	49·0
30	„	„	„	„	48·5
30	„	„	„	„	48·8
30	„	„	„	„	49·0

h	m	s		feet.							seconds.
At 4	41	30	at	13,375	there were	26	vibrations	of a	horizontal	magnet in	46·8
„ 4	45	0	„	14,293	„	30	„	„	„	„	52
„ 4	47	30	„	14,317	„	28	„	„	„	„	49·5

On June 27, at the average height of 3350 feet, the magnet vibrated in 1·635
On the ground at Brookland, one vibration was .... 1·698
On Aug. 29, at the average height of 14000 feet, the magnet vibrated in 1·767
At the Royal Observatory, Greenwich, one vibration was .... 1·627

Therefore the time of vibration seems to be somewhat longer in the higher atmosphere than on the ground; the difference being somewhat greater than as shown above in consequence of the higher temperature of the earth.

General Observations.

August 31, 1863.

At 6^h 21^m 30^s p.m., at 6404 feet. The Tyne was visible almost to its source.

At 6^h 27^m p.m., at 7790 feet. Newcastle seen.

At 6^h 33^m 30^s p.m., at 7690 feet. Wind was felt in our faces.

At 6^h 37^m 30^s p.m., at 6898 feet. Losing sight of the sun. Travelling along a line of railway in the direction of Durham. Wind gentle. Fields seen with sheaves of corn through a break in the clouds.

At 6^h 57^m 30^s p.m., at 1200 feet. Earth seen faintly; can see furnaces and tramways; Durham Minster in sight on a hill; Leanside Junction visible.

At 6^h 59^m p.m., at 840 feet. Going towards hills beyond Leanside.

September 29, 1863.

At 8^h 21^m a.m., at 8504 feet. Temperature of gas 29°·0 in the neck of balloon.

At 8^h 22^m 30^s a.m., at 8726 feet. No sun here; about 30 miles distant the sun is shining on the landscape, over a large space, which appears very bright in contrast with all around.

At 8^h 31^m a.m., at 1030 feet. The earth looks like a beautiful garden at places from 20 to 30 miles distant, upon which the sun is shining brightly.

At 8^h 40^m a.m., at 11,592 feet. Passing a large town; query, Nottingham or Ashby-de-la-Zouch.

At 8^h 42^m a.m., at 11,857 feet. Ice on water.

At 8^h 44^m a.m., at 12,305 feet. Moving straight for the Wash.

At 8^h 57^m a.m., at 12,704 feet. A beautiful tinge of blue.

At 9^h a.m., at 12,926 feet. Smoke streaming up to a height of about $1\frac{1}{2}$ mile.

At 9^h 1^m 30^s a.m., at 12,926 feet. Examined the balloon internally for holes or rents; the dome of the balloon appeared greatly increased in size; does looking through gas enlarge objects?

At 9^h 12^m a.m., at 13,882 feet. The air is nearly saturated.

At 9^h 29^m a.m., at 13,982 feet. Filled bag with air.

At 9^h 32^m a.m., at 16,284 feet. Filled another bag with air.

At 9^h 43^m a.m., at 13,897 feet. A beautiful ring on the blackened bulb of hygrometer. Packed up dry and wet thermometers.

At 9^h 47^m a.m., at 14,155 feet. Can see 50 miles of coast well.

At 10^h 9^m a.m., at 7396 feet. Sun warm.

October 9, 1863.

At 4^h 30^m 30^s p.m., at 899 feet. Very rapid decline of temperature.

At 4^h 32^m 30^s p.m., at 2279 feet. A golden sunset, colours very intense.

At 4^h 35^m 30^s p.m., at 4111 feet. Temperature again falling quickly.

At 4^h 36^m p.m., at 4219 feet. The Thames visible to its mouth.

At 4^h 37^m 30^s p.m., at 5672 feet. The sea beyond the mouth of the Thames visible.

At 4^h 39^m 30^s p.m., at 6277 feet. Over London.

At 4^h 41^m p.m., at 6732 feet. The river Thames like a canal.

At 4^h 41^m 30^s p.m., at 6796 feet. London looks very fine indeed.

At 4^h 44^m p.m., at 7193 feet. The sunset is gorgeous.

At 4^h 45^m p.m., at 7252 feet. The ships in the Thames appear long and narrow, and steamboats like moving toys.

At 4^h 46^m p.m., at 7303 feet. The docks distinct and very clear.

At 4^h 46^m 30^s p.m., at 7310 feet. Can see the inner court of the Bank; St. Paul's Cathedral looks small; all streets in the city are distinctly visible; Milbank Prison and Oxford Street seen very clearly.

At 4^h 49^m p.m., at 6731 feet. Blue smoke of London curving upward; mist towards south of London bounded by a straight line.

At 4^h 52^m 45^s p.m., at 5433 feet. Leaving London.

At 5^h 55^m 10^s p.m., at 4302 feet. The wet thermometer reading is increasing more than the dry-bulb.

At 5^h 2^m p.m., at 3040 feet. Nearly over Tottenham.

At 5^h 4^m p.m., at 3087 feet. Beautiful golden sunset.

At 5^h 42^m 15^s p.m., at 2909 feet. A sudden dryness.

At 5^h 43^m p.m., at 3326 feet. Too dark to observe either Daniell's or Regnault's hygrometer.

At 5^h 57^m p.m., at 8416 feet. Not sure of decimals in thermometer readings.

At 6^h p.m., at 8714 feet. Could not read at all after this.

January 12, 1864.

At 2^h 6^m p.m., on ground. Great deposit on Regnault.

At 2^h 8^m 30^s p.m., at 368 feet. Over the river Thames.

At 2^h 14^m p.m., at 1773 feet. Crossing Tilbury; off the river.

At 2^h 15^m p.m., at 1787 feet. Crossing the line again.

At 2^h 21^m 30^s p.m., at 2735 feet. Crossing Hainault Forest; earth looks dull.

At 2^h 44^m p.m., at 6692 feet. Can see Chelmsford.

At 2^h 55^m p.m., at 7666 feet. Can see Blackwater; estimated distance from the coast 10 miles.

At 3^h 11^m p.m., at 9105 feet. Applied water to wet-bulb thermometer.

At 3^h 14^m p.m., at 9437 feet. On a level with Harwich or Colchester.

At 3^h 21^m 40^s p.m., at 10,319 feet. Query over Newmarket.

At 3^h 35^m p.m., at 11,353 feet. Rabbits heavy and dull.

At 3^h 36^m 30^s p.m., at 10,879 feet. Dog whining.

At 4^h p.m., at 3384 feet. Applied water to wet-bulb thermometer; forest of pines visible.

April 6, 1864.

At 4^h 16^m p.m., at 2775 feet. Over the edge of the river on the Essex side.

At 4^h 18^m p.m., at 3507 feet. The goat uneasy.

At 4^h 20^m 30^s p.m., at 4404 feet. Goat less uneasy.

At 4^h 23^m p.m., at 5251 feet. Can see a very large oval in the cloud, with balloon in the centre; no prismatic colours.

At 4^h 26^m 30^s p.m., at 6627 feet. Immense halo upon the clouds.

At 6^h 37^m p.m., at 11,075 feet. A rent in the balloon very high up.

June 13, 1864.

At 7^h 1^m 30^s p.m., at 1155 feet. Apparently going over the Isle of Dogs.

At 7^h 5^m p.m., at 2282 feet. Sun on the water dazzling in the direction of London.

At 7^h 15^m p.m., at 2694 feet. In a line with Charlton.

At 7^h 18^m p.m., at 3234 feet. In a line with Woolwich.

At 7^h 31^m p.m., at 3517 feet. Erith Church nearly under us.

At 7^h 36^m 51^s p.m., at 2602 feet. Over the edge of the river bank.

At 7^h 38^m 36^s p.m., at 2813 feet. Over the edge of the river bank on the Essex side: therefore 1^m 45^s was the time occupied in crossing the river.

June 20, 1864.

At 6^h 18^m p.m., at 772 feet. Passing over Derby.

At 6^h 19^m p.m., at 1462 feet. Over the Derwent.

At 6^h 36^m 40^s p.m., at 2740 feet. Can see Nottingham.

At 6^h 41^m p.m., at 3050 feet. Nottingham race-course and Burford seen; moving towards Sherwood Forest.

At 6^h 57^m p.m., at 3360 feet. Over Nottingham and Lincoln Railway.

June 27, 1864.

At 6^h 37^m p.m., at 865 feet. Over Penge.

At 6^h 38^m p.m., at 970 feet. Going nearly towards Bromley.

At 6^h 38^m 30^s p.m., at 1054 feet. Over Chatham and Dover line of railway.

At 6^h 48^m p.m., at 840 feet. Over Shortlands.

At 6^h 48^m 30^s p.m., at 750 feet. Can see the fountains playing at the Crystal Palace.

At 6^h 49^m 30^s p.m., at 713 feet. Can see the new church at Bromley.

At 6^h 50^m p.m., at 846 feet. Passing south of Bromley.

At 6^h 53^m p.m., at 1309 feet. Going over Hayes Common.

At 7^h 3^m p.m., at 1460 feet. Passing down the Sevenoaks road.

At 7^h 18^m p.m., at 4840 feet. Golden tinge over the water.

At 7^h 26^m p.m., at 3322 feet. Sun shining on black-bulb thermometer.

At 7^h 26^m 30^s p.m., at 3302 feet. Can see Farningham; passing Madams-court Hill.

At 7^h 34^m 30^s p.m., at 3734 feet. Crossing Sevenoaks line.

At 7^h 35^m p.m., at 3907 feet. Can see Knoll House.

At 7^h 45^m p.m., at 4699 feet. Passing to the left of Tunbridge.

At 7^h 54^m p.m., at 3958 feet. Near village of Hadlow.

At 7^h 56^m 30^s p.m., at 3936 feet. Nearly over the Medway.

At 8^h 0^m 30^s p.m., at 3450 feet. Can see main line of South-eastern Railway.

At 8^h 3^m p.m., at 3044 feet. Belt across the sun visible, apparently on our level.

At 8^h 3^m 30^s p.m., at 2994 feet. Can see two horses, and a man leading them.

At 8^h 17^m p.m., at 3444 feet. Going over Goudhurst.

At 8^h 22^m 30^s p.m., at 2828 feet. Passing between Hawkhurst and Cranbrook.

At 8^h 28^m 20^s p.m., at 2221 feet. Cranbrook very distinct.

At 8^h 32^m p.m., at 1831 feet. The country is very beautiful.

At 8^h 36^m p.m., at 2208 feet. Over Tenterden.

At 9^h 8^m p.m., at 6168 feet. Could not see to read the instruments after this time.

August 29, 1864.

At 4^h 14^m p.m., at 4612 feet. Balloon revolving once in three minutes.

At 4^h 28^m 30^s p.m., at 8224 feet. Ships appear very small.

At 4^h 36^m p.m., at 10,875 feet. The fountains at the Crystal Palace look very small.

At 4^h 57^m p.m., at 13,991 feet. Nearly over Erith.

At 5^h 17^m 30^s p.m., at 6558 feet. Over the edge of the river bank.

Meteorological Observations made at different Stations in connexion with the Balloon Ascent on

August 31, 1863.

Newcastle-on-Tyne.

Time of observation.	Reading of Barom. reduced to 32° F.	Reading of Thermom. Dry.	Reading of Thermom. Wet.	Temp. of the dew-point.	Tension of vapour.	Degree of humidity.	Direction of wind.	Amount of cloud 0–10.	Amount of ozone.	Remarks.
h m	in.	°	°	°	in.					
9 0 a.m.	29·708	49·5	47·5	45·3	·303	86	N.E. by N.	...	...	Dull. Thunder with heavy rain at 8 p.m. and afternoon.
3 0 p.m.	29·698	60·0	58·5	57·2	·469	91	N.E. by N.	...	...	
6 0 „	29·720	57·5	55·2	53·2	·406	89	......	...	...	
9 0 „	29·742	55·0	52·0	49·1	·349	81	N.W. by N.	...	...	Dull.

September 29, 1863.

Wrottesley Observatory.

Time of observation.	Barom.	Dry.	Wet.	Dew-point.	Tension of vapour.	Humidity.	Wind.	Cloud.	Ozone.	Remarks.
7 30 a.m.	29·456	43·0	42·6	42·1	·268	97	S.	9·0	...	Fine.
7 40 „	29·453	43·0	42·7	42·3	·270	98	S.			
7 50 „	29·457	43·8	43·0	43·0	·277	100	S.			
8 0 „	29·458	44·0	43·5	42·9	·276	96	S.	8·0	...	
8 10 „	29·458	44·5	43·9	43·4	·281	96	S.			
8 20 „	29·458	45·0	44·4	43·7	·285	89	S.			
8 30 „	29·455	46·0	45·0	43·9	·287	93	S.	5·0	...	
8 40 „	29·454	46·8	45·7	44·4	·293	92	S.			
8 50 „	29·454	47·1	46·0	44·8	·297	92	S.			
9 0 „	29·455	48·0	46·9	45·6	·306	92	S.	9·0	...	
9 10 „	29·455	48·1	46·7	45·1	·301	90	S.			
9 20 „	29·456	47·9	46·5	44·9	·298	93	S.			
9 30 „	29·454	48·4	46·9	45·2	·302	89	S.	7·5	...	
9 40 „	29·453	49·4	47·9	46·2	·313	90	S.			
9 50 „	29·450	50·0	48·0	45·9	·309	86	S.			
10 0 „	29·456	50·1	47·9	45·6	·306	85	S.S.W.	6·0	...	
10 10 „	29·450	51·4	49·0	46·5	·317	84	S.S.W.			
10 20 „	29·451	51·2	49·0	46·7	·319	85	S.S.W.			
10 30 „	29·457	52·0	49·2	46·3	31·5	81	S.S.W.	6·0	...	
10 40 „	29·454	52·8	49·7	46·6	31·8	80	S.S.W.			
10 50 „	29·459	52·8	49·0	45·2	30·2	76	S.S.W.			Between 7^h 45^m a.m. and 10^h 30^m a.m. 33 miles of air passed over the observatory according to the anemometer.

September 29, 1863.

Beeston Observatory.

Time of observation.	Barom.	Dry.	Wet.	Dew-point.	Tension of vapour.	Humidity.	Wind.	Cloud.	Ozone.	Remarks.
9 45 a.m.	29·989	55·6	52·2	48·9	·346	79	S.W. by S.	2·2	...	The weather very fine.
10 0 „	29·988	55·5	52·1	48·9	·346	82	S.W. by S.	2·0	...	
10 15 „	29·988	55·0	51·7	48·6	·343	79	S.W. by S.	2·7	...	In the W. and N. much wild cumulus and cirri coming up and moving rapidly in W.S.W. currents, and very high cirri in N. current, some low cirri rapidly in N.E. currents. The sky in S. to E., from zenith

Meteorological Observations made at different Stations in connexion with the Balloon Ascent on September 29, 1863 (*continued.*)

BEESTON OBSERVATORY (*continued*).

Time of observation.	Reading of Barom. reduced to 32° F.	Thermom. Dry.	Thermom. Wet.	Temp. of the dew-point.	Tension of vapour.	Degree of humidity.	Direction of wind.	Amount of cloud 0–10.	Amount of ozone.	Remarks.
h m	in.	°	°	°	in.					to horizon, cloudless, except two or three small hemispherical cumuli; sky clear and brilliant; distant hills hazy. The wind became S.W. by S. at 5h, and in which quarter it remained (moving in oscillations from S.W. to S.S.W. till 3h 3m p.m., when it was S.S.E. for 5 minutes, after which it became stationary in the W.S.W. all day).
10 30 a.m.	29·988	54·7	51·6	48·7	·344	80	s.w. by s.	5·0	...	The weather fine, but clouds moving in W.S.W., N.E., and N. currents.
10 45 „	29·984	54·5	51·6	48·8	·345	80	s.w. by s.	5·5	...	The weather fine.
11 0 „	29·984	54·5	51·5	48·6	·343	80	s.w. by s.	3·0	...	
11 30 „	29·980	55·0	51·8	48·8	·345	80	s.w. by s.	3·0	...	
12 30 p.m.	29·977	55·7	51·7	48·0	·335	75	s.w. by s.	9·0	...	Nearly overcast; brisk wind; cumulostrati.
3 0 „	29.931	56·3	52·2	48·4	·346	74	s.w. by s.	2·0	...	The weather very fine.

October 9, 1863.

ROYAL OBSERVATORY, GREENWICH.

Time of observation.	Barom.	Dry.	Wet.	Dew-point.	Tension of vapour.	Humidity.	Wind.	Cloud.	Ozone.	Remarks.
3 0 p.m.	29·409	57·6	51·7	46·4	·316	67	S.S.E.	2	...	Some patches of cumulus and cirrus scattered over the sky.
3 15 „	29·408	57·6	52·0	46·9	·322	68	S.S.E.	4	...	Cumulus, cirrus, and a few cirrostratus clouds.
3 30 „	29·408	57·2	51·0	45·3	·303	64	S.S.E.	3	...	Cirrus, cumulus, and cirrostratus.
3 45 „	29·407	57·0	50·7	45·0	·299	64	S.S.E.	4	...	
4 0 „	29·405	55·7	50·5	45·6	·306	69	S.S.E.	3	...	Cirrus, cirrocumulus, cumulostratus.
4 15 „	29·405	54·8	49·7	44·8	·297	69	S.S.E.	2	...	
4 30 „	29·406	53·4	49·3	45·2	·302	74	S.S.E.	0	...	Sky is nearly cloudless; a little light cloud in the S.W. and W.
4 45 „	29·407	52·6	48·7	44·8	·297	75	S.S.E.	1	...	Light clouds in the N.E. and S.W.
5 0 „	29·408	51·3	48·2	45·0	·299	79	S.S.E.	1	...	Balloon first seen at 4h 55m N. of the River Thames.
5 15 „	29·408	50·4	47·7	44·8	·297	82	S.E.	1	...	Clear southward; hazy in the N. Balloon seen bearing N.N.W.; moving northwards.
5 30 „	29·410	49·8	46·8	43·6	·284	78	S.E.	0	...	A few light clouds in N.E.; hazy in N.; cirrostratus generally round the horizon.
5 45 „	29·414	48·9	46·5	43·9	·287	86	E.S.E.	0	...	Cirrostratus near the horizon, but of no numerical value; hazy in the N. Balloon disappeared at 5h 27m.
6 0 „	29·414	48·4	46·4	44·2	·290	86	E.S.E.	0	...	Cloudless.
6 30 „	29·414	48·4	46·8	45·0	·299	89	E.	0	...	

Meteorological Observations made at different Stations in connexion with the Balloon Ascent on

January 12, 1864.—Royal Observatory, Greenwich.

Time of observation.	Reading of Barom. reduced to 32° F.	Reading of Thermom. Dry.	Reading of Thermom. Wet.	Temp. of the dew-point.	Tension of vapour.	Degree of humidity.	Direction of wind.	Amount of cloud 0–10.	Amount of ozone.	Remarks.
h m	in.	°	°	°	in.					
2 0 p.m.	29·962	40·7	38·4	35·8	·210	84	S.S.E.	10	...	
2 15 „	29·961	40·1	38·4	36·2	·214	86	S.S.E.	10	...	
2 30 „	29·961	39·9	38·2	36·0	·212	87	S.S.E.	10	...	
2 45 „	29·964	39·8	38·2	36·1	·213	87	S.S.E.	10	...	
3 0 „	29·973	39·7	38·1	36·0	·212	87	S.S.E.	10	...	
3 15 „	29·978	39·1	37·7	35·9	·211	89	S.S.E.	10	...	
3 30 „	29·980	38·6	37·2	35·4	·207	89	S.S.E.	10	...	Overcast; cirrostratus.
3 45 „	29·983	38·6	37·3	35·6	·208	90	S.S.E.	10	...	
4 0 „	29·985	38·6	37·3	35·6	·208	89	S.S.E.	10	...	
4 15 „	29·986	38·6	37·3	35·6	·208	89	S.S.E.	10	...	
4 30 „	29·986	38·3	37·2	35·2	·205	89	S.S.E.	10	...	
4 45 „	29·989	38·2	37·0	35·3	·206	90	S.S.E.	10	...	
5 0 „	29·998	38·7	37·2	35·7	·209	90	S.S.E.	10	...	

April 6, 1864.

Royal Observatory, Greenwich.

Time of observation.	Barom. reduced to 32° F.	Dry.	Wet.	Temp. of the dew-point.	Tension of vapour.	Degree of humidity.	Direction of wind.	Amount of cloud 0–10.	Amount of ozone.	Remarks.
2 0 p.m.	30·070	44·8	41·8	38·2	·231	78	N.N.E.	10	0	
2 15 „	30·070	45·0	42·3	39·1	·238	64	N.N.E.	10	0	
2 30 „	30·069	44·9	42·1	38·8	·236	80	N.N.E.	10	0	
2 45 „	30·065	44·9	42·1	38·8	·236	80	N.N.E.	10	0	
3 0 „	30·056	45·0	42·2	38·9	·237	79	N.N.E.	10	0	
3 15 „	30·056	44·7	41·8	38·3	·231	79	N.N.E.	10	0	
3 30 „	30·057	45·0	42·2	38·9	·237	79	N.N.E.	10	0	
3 45 „	30·056	44·9	42·0	38·6	·234	80	N.N.E.	10	0	Overcast; a few drops of fine rain at 4^h 20^m.
4 0 „	30·055	45·0	42·3	39·1	·238	76	N.N.E.	10	0	
4 15 „	30·057	44·8	42·1	38·9	·237	80	N.N.E.	10	0	
4 30 „	30·055	45·1	42·1	38·6	·234	79	N.N.E.	10	0	
4 45 „	30·055	45·6	42·6	39·0	·238	79	N.N.E.	10	0	
5 0 „	30·053	44·8	41·5	37·8	·227	76	N.N.E.	10	0	
5 15 „	30·053	44·7	41·4	37·5	·225	76	N.N.E.	10	2	
5 30 „	30·054	44·3	41·2	37·6	·227	77	N.N.E.	10	2	
5 45 „	30·054	44·2	41·6	38·5	·233	80	N.N.E.	10	2	
6 0 „	30·054	44·1	41·5	38·4	·232	80	N.N.E.	10	2	

June 13, 1864.

Royal Observatory, Greenwich.

Time of observation.	Barom. reduced to 32° F.	Dry.	Wet.	Temp. of the dew-point.	Tension of vapour.	Degree of humidity.	Direction of wind.	Amount of cloud 0–10.	Amount of ozone.	Remarks.
6 0 p.m.	29·476	61·9	52·3	44·0	·288	52	......	0	...	Sky cloudless, excepting a small patch of cirrocumulus in the N.E.
7 0 „	29·480	59·0	52·2	46·2	·313	62	......	0	...	Balloon seen at 7^h 7^m moving due E.
7 15 „	29·481	58·2	52·0	46·2	·313	65	......	0	...	Cloudless. Balloon still rapidly moving to the E., veering in a slight degree to the S.
7 30 „	29·484	57·2	51·2	45·7	·307	65	......	0	...	Cloudless. Balloon last seen at 7^h 23^m.
7 45 „	29·486	56·5	50·7	45·4	·304	67	......	0	...	
8 0 „	29·487	55·9	49·5	45·5	·305	64	......	0	...	
8 15 „	29·488	54·9	48·6	42·6	·273	64	......	0	...	Cloudless.
8 30 „	29·498	53·1	48·4	42·9	·276	70	......	0	...	
8 45 „	29·498	52·8	48·2	43·6	·284	71	......	0	...	
9 0 „	29·499	52·8	48·2	43·6	·284	71	......	0	...	

Meteorological Observations made at different Stations in connexion with the Balloon Ascent on

June 20, 1864.

Beeston Observatory.

Time of observation.	Reading of Barom. reduced to 32° F.	Reading of Thermom. Dry.	Reading of Thermom. Wet.	Temp. of the dew-point.	Tension of vapour.	Degree of humidity.	Direction of wind.	Amount of cloud 0–10.	Amount of ozone.	Remarks.
h m	in.	°	°	°	in.					
4 35 p.m.	29·949	68·0	60·1	53·9	·416	60	...	10		
4 40 "	29·949	68·0	60·1	53·9	·416	60	...	10		
4 45 "	29·947	68·0	60·1	53·9	·416	60	...	10		
4 50 "	29·947	67·7	60·0	53·9	·416	61	...	10		
4 55 "	29·946	67·6	60·1	54·2	·421	62	...	9		
5 0 "	29·945	67·4	59·9	54·1	·419	62	...	8		
5 5 "	29·943	67·2	59·8	54·1	·419	62	...	6	...	Considerable breaks in the clouds.
5 10 "	29·943	67·0	60·0	54·4	·424	64	...	7		
5 15 "	29·944	66·7	59·8	54·2	·421	64	...	7		
5 20 "	29·939	66·3	59·7	54·3	·422	66	...	7		
5 25 "	29·941	66·0	59·6	54·3	·422	66	...	7		
5 30 "	29·941	65·6	59·5	54·5	·425	69	...	7		
5 35 "	29·941	65·3	59·2	54·2	·421	68	...	7		
5 40 "	29·941	65·7	59·6	54·5	·425	68	...	8		
5 45 "	29·941	66·0	59·7	54·2	·421	67	...	8		
5 50 "	29·939	66·3	59·8	54·5	·425	66	...	9		
5 55 "	29·939	66·3	59·8	54·5	·425	66	...	9		
6 0 "	29·941	66·1	59·7	54·1	·419	67	...	9		
6 5 "	29·940	66·0	59·5	54·2	·421	66	...	9		
6 10 "	29·940	65·7	59·3	54·0	·418	67	...	9		
6 15 "	29·938	65·7	59·3	54·0	·418	67	...	10		
6 20 "	29·938	65·5	59·2	54·0	·418	67	...	10		
6 25 "	29·937	65·3	59·1	54·1	·419	68	...	10		
6 30 "	29·938	65·0	59·0	54·1	·419	68	...	10	...	At 6h 29m the balloon was exactly opposite this observatory (Beeston), a.m.
6 35 "	29·933	64·7	58·9	54·0	·418	69	...	10	...	At 6h 33m sand thrown out and the balloon rose 2°.
6 40 "	29·930	64·7	58·6	53·4	·409	67	...	10	...	At 6h 38m balloon exactly over Wollaston Hall, altitude 25°.
6 45 "	29·929	64·7	58·4	52·7	·399	66	...	10	...	At 0h 41m balloon disappeared in clouds in the N.N.E.
6 50 "	29·929	64·7	58·4	52·7	·399	66	...	10		
6 55 "	29·927	64·8	58·4	53·1	·404	66	...	10		
7 0 "	29·925	64·8	58·4	53·1	·404	66	...	10		
7 5 "	29·921	64·6	58·3	53·0	·403	67	...	10		
7 10 "	29·921	64·6	58·2	52·8	·400	66	...	10		
7 15 "	29·919	64·3	58·2	52·9	·401	66	...	10		
7 20 "	29·919	64·1	58·1	53·1	·404	72	...	10		
7 25 "	29·917	64·0	58·1	53·2	·406	68	...	10		
7 30 "	29·918	63·8	58·0	53·2	·406	70	...	9		
8 30 "	29·918	63·0	57·4	52·6	·397	69	...	9		
9 0 "	29·913	62·4	57·5	53·2	·406	73	...	9		
9 30 "	29·899	62·0	57·5	53·7	·413	74	...	9		
10 10 "	29·882	61·7	57·1	53·0	·403	74	...	9		

Meteorological Observations made at different Stations in connexion with the Balloon Ascent on

June 27, 1864.—Blackheath.

Time of observation.	Reading of Barom. reduced to 32° F.	Thermom. Dry.	Thermom. Wet.	Temp. of the dew-point.	Tension of vapour.	Degree of humidity.	Direction of wind.	Amount of cloud 0–10.	Amount of ozone.	Remarks.
h m	in.	°	°	°	in.					
6 15 p.m.	30·045	60·4	53·7	47·9	·334	63	W.S.W.	9	...	Nearly overcast.
6 30 „	30·045	60·0	52·8	46·4	·316	61	......	7	...	Blue increasing above, cumuli surrounding.
6 40 „	30·045	60·0	52·6	46·0	·311	60	......	9	...	} Cumuli and cumulostratus in the east.
6 50 „	30·045	60·0	52·5	45·9	·309	60	......	9	...	
7 0 „	30·045	60·1	53·1	46·8	·321	62	......	7		
7 10 „	30·045	60·0	52·5	45·9	·309	60	......	7		
7 20 „	30·046	59·1	52·2	46·1	·312	62	......	5	...	Zenith clear; cumuli all round.
7 30 „	30·046	58·5	52·5	47·2	·325	66	......	3		
7 40 „	30·040	58·3	52·0	46·4	·316	65	......	5		
7 50 „	30·037	58·2	52·1	46·7	·319	66	......	6	...	} Cumulus and cirrocumulus.
8 0 „	30·035	58·2	52·3	47·0	·323	67	......	6	...	
8 10 „	30·028	57·9	52·0	46·7	·319	67	......	7	...	
8 20 „	30·028	57·4	51·8	46·8	·321	67	......	8	...	Zenith particularly clear.
8 30 „	30·028	56·5	51·7	47·4	·328	72	......	3	...	Zenith perfectly clear; clouds in N.
8 40 „	30·028	56·1	51·0	46·2	·313	70	......	5	...	{ Cumulus and cirrocumulus in the zenith; cumulus in the N.; cumulostratus in the E., and clear in the S. and S.E.
8 50 „	30·027	...	...	...	...	...	......	...	...	

August 29, 1864.

Royal Observatory, Greenwich.

Time of observation.	Reading of Barom. reduced to 32° F.	Thermom. Dry.	Thermom. Wet.	Temp. of the dew-point.	Tension of vapour.	Degree of humidity.	Direction of wind.	Amount of cloud 0–10.	Amount of ozone.	Remarks.
3 0 p.m.	29·877	77·5	62·1	51·4	·379	40	S.W.	5	0	} Light high cirrus.
3 15 „	29·877	77·0	61·7	51·0	·374	40	S.W.	5	...	
3 30 „	29·877	75·5	61·6	51·6	·382	44	S.W.	5	...	
3 45 „	29·879	74·7	61·4	51·8	·385	45	S.S.W.	5	...	
4 0 „	29·879	73·8	60·3	50·4	·366	44	S.W.	5	0	
4 6 10s	......	...	...	...	...	...	......	...	...	Balloon seen to rise from the Crystal Palace grounds.
4 15 „	29·881	73·4	59·7	49·7	·357	43	S.S.W.	5		
4 30 „	29·873	72·4	58·5	48·1	·366	43	S.S.W.	5		
4 40 „	......	...	...	...	...	...	......	...	...	Estimated place of balloon S. of Woolwich.
4 45 „	29·873	72·0	57·6	46·8	·321	41	S.S.W.	4		
5 0 „	29·870	71·0	57·5	47·2	·325	42	S.S.W.	3	0	
5 1 „	......	...	...	...	...	...	......	...	...	Through a 30-in. achromatic telescope, the several parts of the grapnel, connecting-rope, netting, &c. could be distinctly seen; and Mr. Glaisher could also be seen at one end of the car (probable distance from Greenwich 8 miles). From $5^h\ 1^m$ to $5^h\ 6^m+$. The balloon rotated in the direction S.W., N.E., in $5\frac{1}{2}^m$.
5 7 „	......	...	...	...	...	...	......	...	...	Sand was thrown out several times from $5^h\ 7^m$ to $5^h\ 12^m$. Another revolution of balloon S.W., N.E., in 5^m.

Meteorological Observations made at different Stations in connexion with the Balloon Ascent in

August 29, 1864 (*continued*).—ROYAL OBSERVATORY, GREENWICH.

Time of observation.	Reading of Barom. reduced to 32° F.	Thermom. Dry.	Thermom. Wet.	Temp. of the dew-point.	Tension of vapour.	Degree of humidity.	Direction of wind.	Amount of cloud 0–10.	Amount of ozone	Remarks.
h m	in.	°	°	°	in.					
1 12 p.m.	......	...	...	...	...	...	......	...	...	Grapnel still visible, but connecting-rope not distinguished.
5 15 „	29·869	69·9	58·3	49·4	·353	48	s.s.w.	3	...	Sand thrown out.
5 17 „	......	...	...	...	...	...	......	...	...	Mr. Coxwell visible in ring.
5 22 „	......	...	...	...	...	...	......	...	...	Balloon descending; gas being let off rapidly; balloon quite flaccid.
5 27 „	......	...	...	...	...	...	......	...	...	Moving northwards; still seen through mist, apparently over Essex Marshes, far beyond North Woolwich.
5 30 „	29·871	69·6	58·1	49·3	·352	49	s.s.w.	2	...	The zenith is almost entirely free from clouds.
5 31 „	......	...	...	...	...	...	......	...	...	Balloon down; grapnel caught; balloon jerked over. The place of descent was observed to be not far from the Essex bank of the river, and was estimated near Purfleet, or perhaps further on near bank opposite to Northfleet.
5 45 „	29·875	68·6	57·5	48·8	·345	49	s.s.w.	1	...	Light clouds near horizon.
6 0 „	29·875	67·5	57·0	48·7	·344	50	s.s.w.	0	0	Cloudless, with the exception of a few light clouds in the S. and S.E.

August 29, 1864.—BLACKHEATH.

Time of observation.	Barom.	Dry.	Wet.	Dew-point.	Tension of vapour.	Humidity.	Wind.	Cloud.	Ozone.	Remarks.
1 0 p.m.	29·944	71·1	58·4	48·7	·344	45	w. by s.	7	...	Cirrus, cumulus, cirrostratus, and cumulostratus.
2 0 „	29·950	74·6	62·9	54·5	·425	50	w. by s.	3	0	Cumulus and cirrostratus in horizon; clear in zenith.
2 30 „	29·950	74·1	62·6	54·1	·419	50	w.	3	...	Detached cirrocumulus and cirrostratus; clear in zenith.
3 0 „	29·950	73·6	62·1	53·7	·413	50	w.	3	0	Clear in zenith; cirrocumulus in horizon.
3 10 „	29·950	73·0	61·1	52·3	·393	48	w. by s.	4	...	Clear in zenith, with the exception of a cirrocumulus cloud.
3 20 „	29·950	73·6	61·3	52·4	·394	48	w. by s.	4	...	
3 30 „	29·950	73·1	61·0	52·0	·388	48	s.w.	4	...	Cirrostratus and cumulus.
3 40 „	29·950	72·6	60·7	51·8	·385	48	s.w.	4	...	
3 50 „	29·950	72·2	60·5	51·8	·385	49	s.w.	5	...	
4 0 „	29·950	71·8	60·3	51·6	·382	49	s.w.	7	0	Cirrostratus and cirrocumulus.
4 10 „	29·950	71·0	60·0	51·6	·382	50	s.w.	4	...	
4 20 „	29·950	70·9	60·0	51·6	·382	50	s.s.w.	4	...	
4 30 „	29·950	70·8	59·0	49·8	·358	48	s.s.w.	3	...	
4 40 „	29·950	70·7	59·2	50·2	·364	48	s.s.w.	2	...	Cirrus in horizon.
4 50 „	29·950	70·4	59·4	51·0	·374	50	s.s.w.	2	...	
5 0 „	29·940	70·2	59·5	51·2	·377	51	s.s.w.	2	0	
5 10 „	29·940	69·9	59·4	51·3	·378	52	s.s.w.	2	...	Clear above; cirrostratus in the horizon.
5 20 „	29·940	68·8	59·0	51·3	·378	53	s.s.w.	2	...	
5 30 „	29·940	68·6	59·0	51·5	·381	54	s.s.w.	0	...	A few light cirrus clouds in horizon.
5 40 „	29·940	68·5	59·0	51·5	·381	54	s.s.w. by s.	0	...	
5 50 „	29·940	68·0	58·3	50·7	·370	53	s.s.w. by s.	0	...	
6 0 „	29·940	67·5	58·0	50·4	·366	54	s.s.w. by s.	0	...	Sky looks misty.

Further Report on Shetland Dredgings. *By* J. Gwyn Jeffreys, *F.R.S.*

The dredging-expedition this year occupied nearly three months. A relation lent me his yacht, and I had every reason to be satisfied with the master and crew, who did all in their power to promote the object of the expedition. The master had been my dredger on the last occasion; and I this time engaged in that capacity Archibald McNab, of Inverary, who had formerly been employed by the late Mr. Barlee and myself in dredging on the west coast of Scotland and that part of Shetland which we now visited. McNab evidently took a great interest in the work, and I cannot speak too highly of his conduct. I had also extra hands to assist in dredging. Mr. Waller and Mr. Peach were my companions; and both most ably and zealously cooperated with me in this last investigation of the marine invertebrate fauna of the Shetland Isles. The cost of the expedition (exclusive of travelling and personal expenses) was about £220, towards which £75 was granted by the Association.

But the weather was, as usual, unpropitious. We found, to our disappointment, that in this year the beginning of May was fine, and that time we just missed. The rest of May and all June were more or less stormy. The second week in July was more favourable than any other part of the season. The variability of the weather in this district is very great, and no year is alike in that respect. The fishermen say that they never could depend on any particular month in previous years as the finest or best suited for their work; and they told me that this season was the worst they had experienced for the last twenty years. However, we continued to get some dredging (on an average one or two days in each week); and altogether we were not unsuccessful, owing in a great measure to having so much time at our disposal. The stations which we revisited this year, and made our head-quarters, were the Whalsey Skerries and Balta, both exceedingly well adapted for the exploration of the eastern side of the Shetland sea-bed. It would of course be desirable to explore also the western side, although that has partially been done by Mr. McAndrew. Perhaps he, or some other zoologist, will at a future time complete this part of the investigation.

The most interesting species of Mollusca obtained on this occasion were *Kellia cycladia*, *Trochus amabilis*, *Margarita elegantula*, *Rissoa Sarsi*, *R. Jeffreysi*, *Eulima stenostoma*, *Cerithiopsis costulata*, *Nassa haliäeti*, *Mangelia nivalis*, *Cylichna alba*, a new species of *Amphisphyra* (which I propose to call *expansa* and will presently describe), *Clio retusa*, and *C. infundibulum*. The *Nassa haliäeti* is described and figured in Hörnes's valuable monograph on the miocene shells of the Vienna Basin, under the name of *Columbella corrugata*, Bonelli, who seems to have considered it the same as the *Buccinum corrugatum* of Brocchi. I do not know Bonelli's work; but the *Buccinum corrugatum* of Brocchi ('Conchiologia fossile Subapennina,' tom. ii. p. 652, tab. 15. fig. 16) is certainly not our shell. Brocchi refers his species to the *Buccinum stolatum* of Renier, an Adriatic shell, which the latter mistook for the species of that name described by Gmelin, and which is a native of Tranquebar. Our species does not belong to the genus *Cithara* of Schumacher, as I had at first supposed; but it is remarkably interesting as being identical with a miocene species, which has not reappeared or been detected in the pliocene formation, and therefore might naturally be supposed to have become extinct. I lately took an opportunity of showing both the recent and fossil shells to Mr. Henry Adams; and his skilful and practised eye could not detect any difference between them.

Isocardia cor, Natica monilifera, N. sordida, and *Defrancia gracilis* occurred in a living state. These have been usually regarded as southern forms; and the last two are not in Lovén's Catalogue. All are conspicuous and well-known species; and I have selected them from many others in the same category to show the wide range of their distribution. The first (*Isocardia cor*) is not uncommon in the newer glacial deposits near Christiania, and is associated, with species some of which exist at present only within the arctic circle.

In one of my former Reports I noticed that the marine fauna of Shetland is in the main Scandinavian. This, indeed, would be the natural inference from the geographical position of these isles. But it has undoubtedly also a southern character, and includes many species which inhabit the Mediterranean. Some naturalists, who appear not to have studied the question in all its bearings, ascribe this southern element to the influence of the Gulf-stream. I cannot help repeating what I have already urged elsewhere*, that the *eastern* coasts of Shetland are, so far as can be ascertained, quite exempt from the operation and effect of this mighty "river in the ocean." No seeds of tropical plants, no *Ianthinæ, Spirula,* exotic kinds of *Teredo, Velella,* or other pelagic animals which usually accompany the course of the Gulf-stream have ever been found on any part of these coasts. The only driftwood which has been observed floating in the sea, or cast ashore by the waves—and in this treeless district every kind of wood is much sought after—consists of Norwegian fir-trees, often with their roots, and drilled by the same species of *Teredo* (*T. megotara* or *nana*) that attacks piles and fixed wood-work, as well as boats, equally in the harbours of East Shetland and Norway. Besides, another consideration must not be lost sight of, viz. that the Mediterranean fauna is quite independent of the Gulf-stream; and a glance at Maury's chart will show that the direction of its course, or of the "drift" which may have been mistaken for it, off the western coasts of Europe and Africa (including the entrance to the Straits of Gibraltar) is entirely *southward,* and forms in fact the return-current. The present distribution of marine life in the European seas must be traced in some other way, and with reference to geological conditions. Palæontologists are well aware that many kinds of Mollusca which still inhabit the Mediterranean, but not our seas, left their remains on the area that now constitutes the eastern coasts of England, perhaps at a period long antecedent to the origin of the Gulf-stream. Several species of Mollusca, which may be termed southern forms, likewise occur on the Dogger Bank and the coasts of Yorkshire and Northumberland; and among them may be enumerated *Trochus millegranus, Scalaria Turtoni, Natica sordida, Murex erinaceus, Defrancia brachystoma,* and *Pleurotoma teres.* To these may be added a fine Echinoderm lately captured off Scarborough, which had not before been observed so far north, viz. *Echinus melo,* var. *Sardica.* It is not uncommon in the south of Europe; but I believe it is only known as British through Mr. Peach having discovered it, some years ago, on the Cornish coast.

Other branches of marine zoology, in connexion with the Shetland dredgings, have been worked out by skilful and experienced naturalists; and when I mention their names and the departments which they have undertaken, the members of the Association will doubtless be satisfied that full justice has been done to these explorations. Reports or lists will be presented by Mr. Alder as to the Nudibranchs, Tunicata, and Polyzoa, by Mr. Spence Bate and the Rev. A. M. Norman on the Crustacea, by Dr. Baird on the Annelids,

* 'British Conchology,' Introduction, p. xcviii.

by Mr. Norman on the Echinodermata, by Mr. Peach also on the last-named class as well as the Polyzoa, by Professor Allman on the Hydrozoa, by Mr. Brady on the Foraminifera, and by Dr. Bowerbank on the Sponges*. Such a division of labour has, I think, had the effect of increasing the result, and making the whole more complete and valuable.

I have been enabled by means of this expedition to confirm my former observations, embodied in the last Report, with respect to the nature of the sea-bed which has been thus explored, and to certain physiological and geological conditions. To these may be now added some further remarks.

More quasi-fossil shells were dredged, and for the first time in this district *Lepeta cœca*, dead, but apparently as fresh as any Scandinavian specimen. A perfect specimen of *Rhynchonella psittacea* was also obtained at a depth of 86 fathoms; but it had two tell-tale associates. One was *Pecten Islandicus*, and the other *Spirorbis granulatus*, var. *heterostropha*, of much larger size than specimens of the same Annelid from the southern coasts of England; the *Spirorbis* was also dead, and covered both the *Rhynchonella* and *Pecten*. *S. granulatus* has not been found in a living state north of the Hebrides, so far as I have been able to discover. This appears to have been one of the numerous relics of the glacial or post-glacial epoch; it is an inhabitant of shallow water, and affords another confirmatory proof of my hypothesis that the Shetland sea-bed has sunk considerably during a comparatively recent period.

It seems to me as if shells belonging to the same species, that are common to the littoral and deep-water zones, attain a greater size and thickness in the former than in the latter habitat. Such are *Venus gallina*, *Tellina fabula*, *Mactra solida* (compared with its variety *elliptica*), *Tectura virginea*, *Rissoa Alderi* (*R. soluta* of Forbes and Hanley, but not of Philippi), *Trochus zizyphinus*, *T. cinerarius*, *T. tumidus*, and *Buccinum undatum* compared with its variety *Zetlandica*. Mr. Jordan informs me that he has observed the same difference with regard to specimens of *Pandora inæquivalvis* and its variety *obtusa*, *Tectura virginea*, and *Chiton discrepans*, which he has lately taken on the shore and dredged off the Channel Isles. More extensive observations are unquestionably desirable, if not necessary, before this proposition can be substantiated; but it has been abundantly proved by the researches of Dr. Davy, Forchhammer, and Bischof that the quantity of carbonate of lime held in solution by sea-water, and from which shells are secreted, occurs chiefly along coast-lines, being derived from terrestrial sources, and brought down to the sea by rivers, streams, and the washings of rain and waves. This would give a reason for littoral shells being more solid than those from deep water; and possibly the greater abundance of food in the former than in the latter case might account for the increase of bulk.

I noticed in the last Report that living Mollusca taken by the dredge from considerable depths, and placed in a shallow vessel of water drawn from the shore, did not appear to be in the slightest degree affected by the sudden change of bathymetrical conditions. I wish to qualify this statement, and at the same time to record a further observation. It is quite true that the Mollusca in question were lively and active in their new habitat; but those which were of the univalve kind exhibited a peculiarity and habits with which I was much struck. All of them, on being placed in the vessel, tried to escape from the bottom, and quickly found their way up the sides to the open air; some floated with the sole of the foot uppermost, and the shell downwards. Now it is very certain that in their native habitat, at a depth

* These lists will be given in the next volume of Reports.

of nearly 500 feet, these mollusks, which are ground-dwellers and have no means of rising to the surface of the sea, could not have floated in this way, or even had time or an opportunity, since they were taken up from the depths of the ocean, to acquire such a habit. Was it instinct? If so, when was it implanted? Another fact worthy of notice is the eagerness which they displayed to escape out of the water and to breathe the open air. One would have supposed that the water at the bottom of the ocean was much less aërated or oxygenated than that on the shore, and that the mollusks would have supplied their gills more copiously in surface-water with the requisite element. But exactly the contrary has been ascertained by some experiments conducted on board the French surveying-ship 'Bonite'; and it is now clearly established that the quantities of atmospheric air increase with the depth. According to Dr. Wallich, in an admirable chapter of his 'North Atlantic Sea-bed,' entitled "The Bathymetrical Limits of Life in the Ocean," the proportion of gaseous matter taken up by water is very greatly increased under an increase of pressure, all gases (especially oxygen and hydrogen) being easily compressible and becoming fluid under a comparatively slight pressure. We but imperfectly understand the mode in which the solution of atmospheric air in sea-water is brought about; but the tendency of fluids to absorb gaseous bodies is constant under all circumstances, and the quantity which they are capable of appropriating increases with pressure. It therefore follows that the deeper the stratum of water, the greater must be the amount of gaseous matter held in solution by it. For a more detailed explanation of this problem I must refer to the work above cited. I can now understand why deep-water mollusks do not find in the surface-water the same supply of atmospheric air as they had been accustomed to, and why they creep out of it into the open air to avoid a sensation which we should call stifling or suffocation.

I will conclude with extracts from the works of two great and pleasant writers, which relate to the subject-matter of this Report. We will first hear Professor Edward Forbes:—

"I can speak personally as to the pleasure of such explorations, the more to be esteemed since in these days there are few countries so entirely new as to warrant the traveller's boast that he is the first educated man to visit them and to discover their wonders. But beneath the waves there are many dominions yet to be visited, and kingdoms to be discovered; and he who venturously brings up from the abyss enough of their inhabitants to display the physiognomy of the country will taste that cup of delight, the sweetness of whose draught those only who have made a discovery know." ('The Natural History of the European Seas,' p. 11.)

Professor Kingsley comes next and last. He says, with equal truth, that there is a mysterious delight in the discovery of a new species; but he thinks "the pleasure is too great; that it is morally dangerous, for it brings with it the temptation to look on the thing found as your own possession, all but your own creation; to pride yourself on it, as if God had not known it for ages since,—as if all the angels in heaven had not been admiring it, long before you were born or thought of." ('Glaucus,' p. 28.)

Description of a New Species of Amphisphyra*.

AMPHISPHYRA EXPANSA†, Jeffreys.

BODY gelatinous, clear white, sprinkled all over with minute black specks.

* Shaped at both ends like a mallet. † Spread out.

Snout broad, bilobed in front.
Eyes none.
Foot oval, cloven in front, with a large triangular expansion or ear-shaped process at each side of this part, widely, deeply, and evenly forked behind.
Ovary yellowish brown.
Shell barrel-shaped, but much narrower at the top than the bottom (where it is considerably expanded), thin, nearly transparent, and slightly prismatic.
Sculpture apparently smooth, but exhibiting under the microscope a few slight and indistinct spiral striæ.
Colour white, except the apex or nucleus, which is horn-colour.
Spire truncated.
Suture deep or channelled, and somewhat angulated.
Whorls three and a half, rapidly increasing; the first is nipple-shaped, and projects beyond the rest.
Mouth pear-shaped, upper corner not quite reaching to the spire; base spread out and rounded.
Outer lip thin and flexuous.
Pillar-lip folded outwards, at first straightish, and afterwards curved.
Umbilicus narrow and groove-like, formed by the reflexion of the pillar-lip.
Length, 0·215; breadth, 0·185.

Habitat. Shetland, in muddy sand, 82 fathoms, fifty miles S.S.E. of the Whalsey Skerries; and on a sandy bottom called the "Haddock ground," 43 fathoms, at a distance of about five miles from the shore between the Skerries and Fetlar Island. One living specimen was dredged in each of these places, and a dead shell also in the former; it appears, therefore, to be a rare species, The animal is bold and active, and crawls rapidly. It differs from that of *A. hyalina* in colour; in the front lobes forming part of the foot in the present species, but of the snout or head-veil in the other (which in that species resemble tentacles, and are folded back or carried erect when the animal crawls, as in *Cylichna*); in the total want of eyes; and in the tail of the foot being evenly forked in *A. expansa*, and unequally divided or heterocercal in *A. hyalina*. The absence of eyes is a remarkable character; and there can be no question of the fact, so far as the best optical instruments, long and patient examination under the most favourable circumstances, and the concurrent testimony of three practised observers can establish it. A living individual of each species was placed side by side, and fully displayed itself. One had distinct eyes, which were widely separated, placed outside the shell, but far back on the head-veil. The other, which was three times as large and equally exposed to view, exhibited no trace of eyes anywhere, although it was examined in every position in order to detect their existence. They could not have been subcutaneous, because the tissues of the animal were nearly transparent, and a high microscopical power was employed, by which the internal structure was clearly seen. Analogous cases occur in *Eulima distorta* and *E. stenostoma*, as well as in *Mangelia nebula* and *M. nivalis* among our native mollusks. The shell of *A. expansa* differs from that of *A. hyalina* chiefly in being broader and more dilated at the sides; it is likewise of a much larger size. From *A. globosa* it may be distinguished by its greater solidity, being proportionally larger, and especially in the form of the spire, which is broader and entirely visible, instead of being (as in the last-named species) acuminated or ending in an obliquely angular point, so as almost to conceal the whorls. The kindness of Professor Lovén in supplying me with, among other types of his species, a specimen of *A. globosa* has enabled me to institute this comparison; and I have also been favoured by Professor Lilljeborg with a Norwegian example of the same species.

With respect to the genus *Amphisphyra* of Lovén, I would take this opportunity of remarking that Messrs. H. and A. Adams, in their well-known 'Genera of Recent Mollusca,' have substituted the name *Diaphana*, as having been given by the late Captain Brown before the publication of Lovén's 'Index Molluscorum Scandinaviæ'; but on referring to the second and latest edition of Brown's 'Illustrations of the Recent Conchology of Great Britain and Ireland,' which bears the date of 1844, it will be seen that he cancelled or discarded that name, and placed his *Diaphana candida* (our *Amphisphyra hyalina*) in his new genus *Utriculus*, along with *Cylichna obtusa* and a fossil species of *Philine*.

There are four British species of *Amphisphyra*, viz. *A. hyalina*, *A. expansa*, and two others. One of these last I noticed and figured in the 'Annals and Magazine of Natural History' for January 1858, under the name of *A. globosa*, erroneously supposing it to be Lovén's species. The name of the British shell may be changed to *ventricosa*. The other is undescribed, and was found by Mr. Robert Dawson in shell-sand from Haroldswick Bay, in the north of Shetland; it may be the *Bulla denticulata* of Adams.

In the course of the above mentioned dredging-operations on the coast of Shetland, which were undertaken last year at the instance of the British Association, I obtained two full-grown and living specimens of *Stilifer Turtoni*, adhering to an *Echinus Dröbachiensis* of O. F. Müller, or *E. neglectus* of Lamarck. The *Echinus* was also covered with numerous clusters of egg-shaped spawn, which apparently had been deposited by one of the *Stilifers*.

I will not say, as is too frequently said on such occasions, that nothing or but little is known on the subject. This is not the case; but I will endeavour to add something to our knowledge of a curious mollusk, which is especially interesting in respect to its peculiar structure and habits, as well as of the difficulty felt by naturalists in assigning to it a correct place in the system of conchology.

For the discovery of this mollusk science is indebted to the indefatigable labours of the late Dr. Turton. In the 'Zoological Journal,' for October 1825, an article by him, entitled "Description of some new British Shells," comprised one which he named *Phasianella stylifera*, and of which he says, "We found a dozen of these beautiful little shells alive, and attached to the spines of the *Echinus esculentus*, dredged up in Torbay." The reason which he gives for placing it in *Phasianella* is singular. It is that, in order to prevent the excessive multiplication of genera, he combined with that genus many of the small turbinated shells, such as otherwise answer to Lamarck's character, whether they have an operculum or not; and such as have the margin of the aperture united all round he cast into the new genus *Cingulus*, after Dr. Fleming.

This last-named author, in his 'History of British Animals,' included in his genus *Velutina* Turton's little shell; but, after showing in what respects it differed from *Phasianella*, not less than from *Velutina*, he suggested that it should probably constitute a new genus, *Stylina*. That name, however, had been pre-engaged twelve years before by Lamarck for a tropical genus of stony Polypes, which he had originally called *Fascicularia*. Its adoption for the Mollusk also would therefore be contrary to usage, especially as the somewhat similar name of *Stilifer* has now been recognized for upwards of thirty years. I am aware that this is one of the questions of scientific nomenclature upon which naturalists are by no means agreed. I do not pretend to set myself up as a judge, and my opinion may be taken for what it is worth.

Mr. Broderip was the first to ascertain the zoological nature of the mollusk now under consideration; and in the 'Proceedings of the Zoological Society' for 1832 will be found an admirable communication from him on the subject. He there proposed the generic name which it still bears—*Stilifer*. A more detailed description of the animal from his pen will be presently given in full. The following remarks were appended to Broderip's memoir in the 'Proceedings of the Zoological Society:'—"Mr. Owen, to whom Mr. Broderip acknowledges himself indebted for the anatomical particulars which he had recorded of *Stilifer Astericola*, subsequently exhibited a series of drawings of the animal and of its various parts, so far as he had been able to observe them in the specimens brought home by Mr. Cuming. He also read a more detailed description of the peculiarities remarked by him during the dissection of the individuals which had been entrusted to him for that purpose." Some such drawings are engraved in Sowerby's 'Genera of Recent and Fossil Shells,' and the different parts are designated by letters; but, unfortunately, no reference was published, except to one of the figures.

Soon afterwards appeared one of the Numbers of Sowerby's 'Genera' containing an account of the present genus, with the signature of Mr. Broderip. The first syllable of the name *Stilifer* is here spelt (probably owing to a printer's error) with a *y*; in the 'Proceedings of the Zoological Society' it is correctly spelt with an *i*. The generic characters of the animal are as follows:—

Pallium crassum, carnosum, cyathiforme, testæ anfractus ultimos obtegens. Proboscis longissima, retractilis. Tentacula rotunda, crassa, subacuminata, ad basin proboscidis posita. Oculi ad basin tentaculorum sessiles, minimi. Branchiæ stirps solitaria. Animal marinum. Asteriæ cutem penetrans.

After the English version of these characters, a few more particulars are given,—viz. that the mantle is of a green hue, and has a small aperture at its base, and that on its ventral aspect is the rudiment of a foot. It is likewise mentioned that "Mr. Cuming found this elegant parasite burrowed in different parts of the rays of the oral disk of *Asterias solaris*. It is almost hidden from sight, so deeply does the animal penetrate into the substance of the Starfish, in which its make a comfortable cyst for itself, wherein it most probably turns by the aid of its rudimentary foot. All the specimens infested with *Styliferi* appeared to be in the best health. Though there is reason to believe that they feed upon the juices of the Starfish, with that instinct of self-preservation imparted to all parasites, whose existence depends upon that of their nidus, the *Stylifer*, like the Ichneumon among insects, appears to avoid the vital parts; for in no instance did Mr. Cuming find it imbedded anywhere save in the rays, though some had penetrated at their base, and very near the pelvis." I must confess that I am not prepared to adopt this teleological mode of reasoning, so far as regards the *Stilifer*; because it does not appear that the Starfish has, in the calcareous and solid parts inhabited by its so-called parasite, any internal juices or soft tissue on which the latter can feed. The investing membrane is wholly external. Although the above description of the animal was undoubtedly correct and circumstantial, it must not be forgotten that it was drawn up from specimens which had been preserved for a considerable time in spirits. The examination of such specimens could not yield the same result, in a scientific point of view, as that of living individuals in their native habitat.

Our best British malacologist, Mr. Alder, is the only one who has noticed the animal of *S. Turtoni.* The specimen which he examined was rather injured, and in a very sickly state. He says, "It was white, had a rather large foot, without operculum, and a rounded head with two cylindrical tentacles, and minute eyes at the (external or posterior) base. No portion of the shell was covered by the fleshy parts; but we are not prepared to say that, in a state of vigour, the animal has not the power of extending some part of the mantle or foot over it. The remains of the animal, examined under a microscope, did not show any denticulated tongue." (I may add, by way of parenthesis, that Mr. Alder has, within the last few days, examined the soft parts of two more individuals which I sent him for that purpose, but failed to detect any traces of a spinous tongue.) He has also observed that "the otolites are circular, with a central dot, that the gill consists of a single series of triangular lobes, and that the mouth breaks up into squarish angular fragments, not crystalline, perhaps horny."

In 1850, Mr. Arthur Adams, one of the authors of a work so indispensable to all students of general conchology ('The Genera of Recent Mollusca'), published in the 'Voyage of the Samarang' some interesting details with respect to the animal of another species of *Stilifer.* This species he named *S. astericola,* erroneously supposing it to be identical with the one described by Broderip; but afterwards, finding out his mistake, he substituted *ovoideus* as the specific name of his *Stilifer.* His diagnosis is as follows:—

> "Tentacles slender, subulate, simple. Eyes sessile at the outer bases of the tentacles. Mantle enclosed. Foot linguiform, forming an elongated anterior lobe, rudimentary behind."

As will be presently seen, the animal of the European species differs in several respects from the above description. Its tentacles are thick, cylindrical, and more or less strangulated, instead of "slender, subulate, simple;" the eyes are not placed "at the outer bases of the tentacles," but behind them on the neck; the mantle is always expanded over part of the shell during the lifetime of the animal, and never "enclosed," nor is it even withdrawn at its death; and so far from the foot being "rudimentary behind," it is well developed, and peculiarly constructed, The animal of *S. Turtoni* is, besides, ciliated all over—a character which distinguishes it at once from any species of *Eulima,* with which it has been usually associated in works treating on the classification of the Mollusca. Perhaps this character may have been hitherto overlooked.

Messrs. Adams, in their 'Genera,' added some further information as to the habits of *Stilifer*:—

"These singular animals are parasitic in the skins of Starfishes, burrowing beneath the surface, and producing tumours often of a considerable size. When removed and placed in water, they do not appear to possess much locomotive power, but extend the tongue-shaped foot, and use it as an exploring organ."

The 'Journal de Conchyliologie' for 1851 contains a notice by M. Petit de la Saussaye of the present genus, and a description of a new species, *S. Mittrei.* He added nothing to our knowledge of the animal, but attributed a greater antiquity than had been supposed to the discovery of *Stilifer,* in a purely conchological point of view, by identifying *Helix corallina* of Chemnitz as the original species. Chemnitz says that he found a dozen specimens of the shell, which he had thus provisionally named, in the crevices of Madrepores and other stony corals that had been collected on the shore of one of the West-India Islands for the purpose of being burnt into lime and that had formed part of the ballast of a vessel bound to Europe. As the corals had lain on the beach for a long time, Chemnitz thought the shells might have been terrestrial, and not marine. Mistakes of a similar kind have been made by modern conchologists—e. g. *Halia Priamus*.

M. Hupé, the able and courteous curator of the natural-history collections in the Jardin des Plantes (whose knowledge of the recent Echinodermata is very extensive), published in the 'Revue et Magasin de Zoologie' for March 1860 a description of another species, under the name of *Stilifer Orbignyanus*. While examining a specimens of *Cidaris imperialis*, Lam., from New Holland, he noticed that two of the spines were unusually enlarged, tumid and irregularly spherical; at their base he observed two small vertical slits, like button-holes, placed opposite to each other. A section of these spines showed that in the cavity of one was enclosed an adult Stilifer, and in the other, two specimens, which were also adult, besides several embryonic shells. With respect to the mode by which the Stilifer had thus become enclosed, M. Hupé was of opinion that the cavities were not made by them, but that the interposition of some part of the mollusk had prevented its being completely imprisoned in the spine during the progress of the growth of the *Cidaris*, which would otherwise have enveloped and smothered the *Stilifer*. He was kind enough to show me the specimens; and theyseemed to present an analogous case to that of *Stilifer astericola*, which I had examined in Mr. Cuming's collection.

Lastly, I would cite an excellent monograph by Dr. Fischer, which appeared in the 'Journal de Conchyliologie' for April last, on the genera *Stylifer* and *Entoconcha* (p. 91 &c.). In this monograph all the known species of *Stilifer* are redescribed, and a new one (*S. Paulucciæ*) well described and figured. According to Fischer, the *Entoconcha mirabilis* of J. Müller, found in *Synaptæ* at Trieste, is probably the fry of some other mollusk. At all events, we want more information about it. It is almost microscopic.

But to return to *Stilifer*. Fischer suspected that it is not a true parasite. He says that the discovery by M. Hupé proves that, although living like a parasite on the tegumentary system of the Echinoderms or their appendages, the *Stilifer* does not feed on their substance, as has been supposed. Its nourishment comes with the sea-water through the openings of the cavity which it occupies: perhaps its proboscis may be protruded for the purpose of seeking this nourishment. I need not say that the reputation of Dr. Fischer as a physiologist, especially with regard to the Mollusca, makes any opinion of his on such subjects very valuable. I share his incredulity as to *Stilifer* being a parasite in the ordinary meaning of the word; but my impression is that it feeds on the excretions of Echinoderms, and not on animalcules or other organized and living matter with which sea-water abounds. It has never been found except on Echinoderms, or imbedded in their rays or spines. All the specimens of *Stilifer Turtoni* which I have seen *in situ* (and they have been rather numerous) occupied the *upper* sides of *Echini*, in the area of the vent or anal opening. The *Echini* so infested appeared to be invariably in perfect health and vigour. The Shetland specimen of *E. Dröbachiensis* was carefully watched by me for more than twelve hours. Its tubular suckers and pedicellariæ continued in active although intermittent motion during all that period. The *Stilifers* were nestling or slowly crawling about among the spines; but they did not touch any of the suckers of the *Echinus*, which, being retractile, could easily have been withdrawn into the test; nor could I detect either of the mollusks in the act of feeding on the outer membrane or any other part of the *Echinus*. At the same time it is clear that there is some connexion between the peculiar habitat selected by the *Stilifer* and its food; for if it subsisted on any living organisms, it would hardly confine itself to Echinoderms, but have a more varied range of habitat. Such shelter as an *Echinus* or *Asterias* could afford might be as easily obtained in crevices of rocks or in the cavities of deserted shells. Consequently, although I do not consider this a case of true parasitism, like that of the mistletoe among plants, neither would I refer it to epiphytism, like that of a tropical orchid. It rather reminds one of the scavenger-habits of dung-beetles.

I have in another place* endeavoured to show that the pretty little bivalve shell called *Montacuta substriata*, which also infests various Echinoids, is not really a parasite. This always occupies a different part of the *Echinus* from that where the *Stilifer* take up its abode; it adheres by its byssus to the ventral spines near the opening of the mouth on the *under* side. Here it probably avails itself of the current or indraught excited by the ciliary action of the *Spatangus* or other Echinoid for its own purposes; and both partake of the same food in amicable but unconscious relation to each other. As far as I have been able to observe, the *Stilifer* does not cause more inconvenience than the *Montacuta* to its not unwilling host.

The suctorial proboscis, as well as the want of a denticulated tongue in *Stilifer Turtoni*, strengthens the supposition that its food consists of extremely soft or semifluid matter, and not of organisms which have any degree of solidity. *Dentalium*, which preys on Foraminifera and other minute animals, has (according to Lacaze-Duthiers) a very complicated lingual apparatus; and even the little *Rissoa*, which feeds on seaweeds, often of the most delicate and filmy texture, possesses a pair of horny jaws and a tongue armed with a strong central tooth, which is flanked on each side by a formidable row of serrated lateral teeth. *Stilifer* has no jaw or tooth of any kind.

The late Mr. Stewart, of the College of Surgeons (whose untimely death is still deplored by all who study the British Echinodermata), was of opinion that *Stilifer Turtoni* infested *Echini* for the sole purpose of depositing its spawn. We know, from the observations of Mr. Peach, that *Lamellaria perspicua* frequents the shore at Wick, between tide-marks, every summer, and makes a nidus for its spawn in a species of *Botryllus*. But *Lamellaria* is not, like *Stilifer*, restricted to a particular habitat. The former attaches itself to the underside of loose stones, and is also found generally distributed over the sea-bed, except perhaps in the spawning-season. The *Echini* on which *Stilifer Turtoni* have been taken are very rarely covered with spawn: and *Stilifers* of all ages, from one to half-a-dozen, occur on *Echini*, but nowhere else,

The fecundity of *Stilifer* is very great; and it therefore ought not to be a rare shell. I counted at least one hundred fry in one of the clusters of spawn on the back of the Shetland sea-egg; and as there were 41 of these clusters, this would yield a prospective harvest of more than 4000 specimens—enough to supply almost all the conchologists in the world. Moreover one of the adult *Stilifers* appeared to be full of spawn. As the *Echinus* probably could not accommodate more than half-a-dozen *Stilifers* when they came to maturity, what would have become of the rest, supposing any of them escaped being the prey of other animals? Would they migrate, and form colonies on other *Echini*? They have feet and eyes; and suitable habitations are not

* British Conchology, vol. ii. p. 208.

wanting in the same part of the sea-bed where I procured the specimens which have given rise to the above remarks.

Various have been the positions which conchologists have, from time to time, assigned to this remarkable mollusk in their systems of classification. Turton placed it in *Phasianella*; Fleming in *Velutina*, but with doubt; Reeve at first between *Turritella* and *Cerithium*, but recently between *Canalifera* and his *Turbinacea*; Macgillivray among his *Turbinina*, and next to *Lacuna*; Forbes and Hanley, as well as Woodward, in *Pyramidellidæ*; H. & A. Adams as a distinct family between *Eulimidæ* and *Cerithiopsidæ*; Clark in *Pyramidellidæ*, between *Aclis* and *Scalaria*; and Gray also in the same family, between his genus *Hyala* (*Rissoa vitrea*) and *Entoconcha*. I am inclined to agree with the Messrs. Adams in making *Stilifer* the type of a separate family; but it is much more difficult to say to what other families it has the nearest affinity. *Pyramidellidæ*, as represented in our seas by *Odostomia*, ought not to be far separated from it; and *Ianthinidæ* have similar relations to it in respect of the nucleus or apex of the shell. *Homalogyra* has sessile eyes placed on the neck, as in *Stilifer*, but has no tentacles; and it is also finely ciliated all over.

The presence or absence of an operculum is evidently not a character of sufficient value to distinguish one family, or even one genus, from another, seeing that some species of the same genus (e. g. *Mangelia*) possess an operculum, while their congeners (although closely allied in all other respects) have none.

The stiliform character of the spire in this genus, although remarkable, is not peculiar to it, or to *Odostomia*, *Turbonilla* (or *Chemnitzia*), *Eulimella*, or *Ianthina*. *Melampus bullæoïdes* has the apical whorls formed in the same mamillated fashion; and in several genera of *Bullidæ* the shell exhibits the same feature. These, however, may be regarded as cases of analogy rather than of affinity. The nucleus of the spire, or first-formed whorls, in many univalves ceases to be occupied by the animal after it has attained a certain growth, being too small for its requirements—like a householder, who usually moves, once at least during his life, into a tenement larger than the one he at first inhabited. In the case of the Mollusca above referred to, the original and now useless tenement remains fixed to the new one; but in *Bulimus decollatus*, some species of *Clausilia*, and in *Truncatella truncatula* the topmost story is knocked off and replaced by a partition wall. *Cæcum glabrum* and *C. trachea* even undergo partial metamorphoses, the shell of each having at first a regular spire, and, when this is lost, becoming a slightly curved cylinder. The genera *Leptoconchus* of Rüppell and *Campulotus* of Guettard (*Magilus*, Montfort) also appear to be related to *Stilifer* in their quasiparasitic habits. The first-named genus is destitute of an operculum, except in its younger state; the other has an operculum at all ages (Deshayes, 'Mollusques de l'île de Réunion').

The conjecture of the late Professor d'Orbigny that *Stilifer* ought to merge in *Eulima*, and that the latter may be also parasitic, has no foundation. It is true that species of *Eulima* have been found in the stomachs of *Holothuriæ*; and the "trepang," or dried "bêche de mer," of which the Japanese are so fond, frequently contains these shells. But this is not a case of parasitism: the *Eulima* feeds the *Holothuria*, instead of feeding upon it.

Let me say a few words as to the name of this genus and the European species. Although the Greek orthography is followed in our word *style*, it is clear that the Latin word *stilus* was not spelt with a *y*: it is from this latter word that *Stilifer* is derived. Whether it is correct to form a generic name with an adjective may be very questionable; but use has sanctioned it in the present instance, as well as in *Spirifer, Stiliger, Lobiger, Ianthina, Vitrina*, and many other such names of general acceptation.

According to some purists, the specific name given by the discoverer, if subsequently adopted as generic, ought to be retained; so that the European species would be *Stilifer stilifer*. Precedents are not wanting for such a reduplication of the name under similar circumstances, e. g. *Volva volva, Turricula turricula*, &c. But it would be very inconvenient to alter the specific name *Turtoni*, which is so familiar to all conchologists, to say nothing of the inelegance of this system of nomenclature, or of its being contrary to one of the rules recommended by a committee of the British Association.

This specific name has been spelt, too, in different ways. We have *Galeomma Turtoni, Scalaria Turtonis*, and not only *Stilifer Turtoni* of Broderip, but *S. Turtonii* of Lovén. The termination of the proper name from which all these originated is a Greek, and not a Latin, form; and if it is to be so declined, the genitive would be *-is*, with the penultimate syllable short, as *Actæon, Actæŏnis*; *Alcmæon, Alcmæŏnis*, &c.: so *Turton, Turtŏnis*. But if we Latinize the name by adding *us* to it, the genitive would be *i*: *Turtonus, Turtoni*; just as *Galen* was *Galenus-i* in the works of ancient authors. I must offer an apology for this pedantic explanation, although it may be well to have the name in question uniformly spelt.

The following are all the known species of *Stilifer*, with such particulars of their geographical distribution and habits as I have been able to collect.

A. Spire short.

1. *Stilifer Turtoni*, Broderip.

Synonyms: *Phasianella stylifera*, Turton.
Stylifer globosus, Johnston (1841).
S. astericola, Brown (1844).
S. stylifera, Hanley (1844).
S. Turtonii, Lovén (1846).

Habitat. On *Echinus esculentus, E. saxatilis, E. pictus* (Norman, MS.), and *E. Dröbachiensis*, in from 20 to 80 fathoms, British and Scandinavian Seas.

This being local, and more especially the subject of the present paper, some further details of its distribution may be desirable.

British Isles.—Torbay, on *Echinus esculentus*, L. (*E. sphæra*, Müll.): Turton. Berwick, on *E. esculentus*: Johnston. Northumberland and Durham, on *E. pictus*: Alder, Howse, and Brady. Cork: Humphreys. Plymouth, on *E. saxatilis*: Stewart, Bate, and J. G. J. Shetland, on *E. Dröbachiensis*, Müll. (*E. neglectus*, Lam.): J. G. J.

(N.B. Although most Scandinavian naturalists consider the *Echinus neglectus* of Lamarck to be the same species as the *E. Dröbachiensis* of Müller's Prodromus to the 'Zoologia Danica,' it may be doubted whether the latter species is not the *E. Flemingii* of Ball. Müller's description is "hemisphæricus, pallidus, *spinis longis, albis*," which seems to agree better with *E. Flemingii* than with *E. neglectus*.)

The shell described by Professor Macgillivray, in his 'Molluscous Animals of Aberdeen, Kincardine, and Banff,' as *Stylina stylifera*, and stated to have been found by one of his pupils "adhering to an *Actinia* brought up by the lines," was the young of a common West Indian land shell belonging to the *Cyclophoridæ*. The habitat alone might have induced a suspicion that this shell was not our *Stilifer*; and I had an opportunity of ascertaining what it really was.

Scandinavia.—From Bohuslän in Sweden to the coast of Norway: Lovén. Christiania-fiord, Norway, on *Echinus esculentus* at Dröbak, and on fishing-grounds at two other places: Asbjörnsen. Bohuslän, in 20 fathoms, on *E. neglectus*: Malm.

Fischer also states that *Stilifer Turtoni* is not uncommon on *Echinus lividus,* near the mouth-opening; but he cites no authority for this unusual habitat. *E. lividus,* as is well known, excavates holes in slate and gneissic rocks, within tide-marks, and its lower surface is pressed closely to the stone.

Another instance of the same kind of mollusk infesting different Echinoids is that of *Montacuta substriata,* which has been found not only on *Spatangus purpureus,* but on *S. meridionalis, Amphidetus ovatus, Brissus lyrifer, Echinus esculentus,* and *Cidaris hystrix.*

2. *S. astericola,* Broderip.

Hab. Lord Hood's Island, on *Asterias solaris* (*A. helianthus,* Lam.): Cuming.

3. *S. Mittrei,* Petit.

Hab. Indian Ocean: Mittré.

4. *S. fulvescens,* A. Adams.

Hab. Isle of Labuan, in an *Asterias*: A. Adams.

5. *S. ovoideus,* H. & A. Adams.

Syn. *S. astericola,* A. Adams.

Hab. Borneo, in the body of an *Asterias*: A. Adams.

6. *S. Orbignyanus,* Hupé.

Hab. New Holland, enclosed in the spines of *Cidaris imperialis*: Hupé.

7. *S. robustus,* Pease.

Hab. Sandwich Isles, on *Echini*: Pease.

8. *S. apiculatus,* Souverbie.

Hab. New Caledonia?: Montrougier.

9. *S. eburneus,* Deshayes.

Hab. Isle of Bourbon, on *Echini* and *Asteriæ*: Maillard.

B. Spire long.

10. *S. corallinus,* Chemnitz.

Hab. West Indies, in madrepores and other corals: Chemnitz.

11. *S. subulatus,* Broderip.

Hab. West Indies?

12. *S. Barronii,* A. Adams.

Hab. Tropical seas, encysted in the integuments of an *Asterias*: Barron.

13. *S. exaratus,* A. Adams.

Hab. Philippine Isles, in the integuments of an *Asterias*: A. Adams.

14. *S. subangulatus,* A. Adams.

Hab. West Indies.

15. *S. Acicula,* Gould.

Syn. *Eulima vitrea,* A. Adams.

Hab. Fiji Isles, in *Holothuriæ*: United States Exploring Expedition.

16. *S. Paulucciæ*, Fischer.

Hab. Red Sea, among the spines of *Echinus trigonarius*, Lam.: Marquise Paulucci.

Besides the above, may be noticed an undescribed or unnamed species dredged by Mr. M'Andrew off the Canary Isles (if it is not *S. Turtoni*), another collected at Guadeloupe by M. Beau, and five more, bearing the following names, but without description,—viz. *Stilifer Broderipii*, *S. Cumingii*, *S. fastigiatus*, and *S. solidus* of Adams's 'Genera,' and *S. pyramidalis* of Mr. Reeve. In the British Museum is an unnamed *Stilifer* from Port Natal, said to have been found attached to the mouth of a Starfish.

It is not improbable that some of the species enumerated in the 2nd section, having an elongated spire, may belong to *Eulima* or *Niso*, instead of to *Stilifer*.

I am not aware of any fossil species having been discovered.

I will now give the result of my examination of the animal of *S. Turtoni*, from notes made at the time.

Body white, and delicately stippled; the whole of the upper surface is covered with microscopical and extremely short cilia, which are in constant motion; these cilia are arranged in scale-like bunches, and by their action produce a circulating current.

Mantle thickened at its edges, and spread over the lower part of the shell, so as to form a disk.

Pallial fold, or branchial opening, on the right-hand side, forming a canal which terminates in an oval or roundish hole.

Head-lobes, rounded and flattened, nearly transparent, one on each side a little below the snout or mouth.

Snout rather long when extended, but usually folded inwards and trunk-like, slightly bilobed, and placed between the tentacles and the foot.

Tentacles club-shaped, somewhat compressed, thick, and rather long, sometimes expanded at the tips, which are blunt and widely diverging, but united at their bases; they are more or less strangulated or constricted, usually at about one-fourth of the distance from their bases.

Eyes exceedingly small, seated on the neck or back of the head, at some distance behind the tentacles.

Foot tongue-shaped and elongated, bulbous and forming a creeping-disk in front, somewhat tubular in the middle, and tapering to a fine point behind; the sole, or under part, is slit in the middle for more than three-fourths of its length, the opening or commencement of the slit being near the bulbous part and oval.

Male organ spike-shaped, and resembling an auxiliary tentacle.

Habitat. Whalsey Skerries, East Shetland, about 40 miles from land, in 80 fathoms, sandy bottom, on an *Echinus Dröbachiensis*. A pair of the *Stilifer* were attached to the sea-egg on its upper surface, between the spines near the vent or anal orifice; and the same part was also covered with about forty clusters of spawn, which appeared to be in various stages of development. The adult *Stilifers* were not firmly attached to the *Echinus* (like the *Caligus* to a codfish), but frequently shifted their places by creeping between the spines. I gently removed one of them with a stiff camel's-hair brush, and placed it in a glass tube with sea-water. It was at first very sluggish or timid, and evidently unaccustomed to its new habitat, lying at the bottom of the tube; but afterwards it recovered itself, and crawled up the side by means of the front part of its foot, very slowly and by an imperceptible movement; the other part of the foot was not pressed to the glass, but rested on the mantle. The foot was occasionally twisted about and contracted, as if through uneasiness. The animal was never wholly withdrawn into the shell, although I irritated it with that object. The slit in the foot probably serves for the admission of water into some tubular cavity or vessels which permeate this organ; this would have the effect of enlarging and swelling the foot, so as to protect the *Stilifer* from being crushed by the spines of the *Echinus*. A slight leverage or action of this kind at the base of the spines would, of course, answer the purpose far better than a much stronger leverage or power exerted at the top of the spines. The fry are enveloped in a gelatinous case. When detached and examined under a microscope, each had three lobes, of which the two larger were in front; these were finely ciliated, the cilia being rather long, and their points sometimes touching the surface of the glass cell which contained the fry. The fry rapidly whirled themselves about by means of the cilia, but occasionally rested. They occupied nautiloid shells of a single turn.

One of the *Stilifers* appeared to be full of spawn-masses, which were perceptible with the microscope by reason of the shell being transparent. The other *Stilifer* was a male. I afterwards replaced the latter in its old quarters, where it was evidently more comfortable than in the glass tube; and it soon adhered to the sea-egg by the prehensile lobe of its foot, and settled down among the spines.

The ciliation of the body of *Stilifer* is also a characteristic feature of *Homalogyra* (perhaps the living representative of *Euomphalus*), which is a minute (but not microscopical) mollusk, without tentacles, and forms a discoidal shell. It is an inhabitant of the European seas, and comprises two species. Forbes and Hanley called one of these species *Skenea nitidissima*, and the other *Skenea rota*. Dr. Fischer imagined that the first-named species was the fry of some larger mollusk, because it was ciliated; but he must have either overlooked the fact, or else not have been aware, that in all the species of *Trochus, Rissoa,* and other genera the tentacles are ciliated, and also, in some species, other parts of the body. Mr. Clark was not more happy in his conjecture that *Homalogyra rota* was the fry of *Cæcum trachea*, the natural history of which this accomplished malacologist had so successfully investigated. I am not aware, indeed, that these shells or their animals have any character in common; besides which, it may be observed that the operculum of *Homalogyra* is flat and paucispiral, with an excentric nucleus, while that of *Cæcum* is more or less conical and multispiral, with a central nucleus, as in *Vermetus*. (Since this paper was read, I have received from the Marquis James Doria specimens of the young of *C. trachea*, which he had dredged at Spezzia. The terminal part or spire is very different from that of *H. rota*.)

The sexes in *Stilifer* appear to be separate, as may be seen from my description of the animal of *S. Turtoni*.

The shell of this species has been often described; but I will briefly notice some of its characters, which have not been satisfactorily stated. The spire, for the first three whorls, is cylindrical and narrow; it then enlarges suddenly and disproportionately, and consists of three or four more whorls, which are rounded and extremely ventricose or swollen. The apex or nucleus of the spire is not reversed, although often set obliquely; it projects like the stump of a flagstaff which had been stuck in a slanting position on a steep mound. The columellar lip, in adult and perfect specimens, is slightly reflected. The lower part of the mouth is semicircular; it is not effuse or spread outwards, as in *Eulima* or *Aclis*.

I cannot conclude without acknowledging my obligations to Mr. Peach for the diagram which has illustrated this paper, and to my old and worthy friend Mr. Alder for the loan of an exquisite drawing of the animal of *Stilifer Turtoni*, made by him a few years ago, and which fully confirms my account of its organization.

Report of the Committee on the Distribution of the Organic Remains of the North Staffordshire Coal-field.—Preliminary Notice. *By a Committee, consisting of* Sir Philip de M. Grey Egerton, *Bart., M.P., F.R.S.,* Professor J. H. Huxley, *F.R.S., and* William Molyneux, *F.G.S.* (Reporter).

The great or Pottery coal-field of North Staffordshire is triangular in form, the apex resting to the North between ridges of the Millstone-grits of Biddulph Moor and Mow Cop, the base stretching out from Madeley on the west to Weston Coyney on the east, bordered by Permian and New Red Sandstones, a distance of nearly ten miles. With this may be included the detached measures of Cheadle, Cheddleton, Wetley Moor, and the Roaches, the whole comprising an area of upwards of eighty square miles. It is difficult to determine the actual number of workable beds of either coal or ironstone contained in these fields, in consequence of the lithological difference in the measures of collieries distant from each other; but notwithstanding this, it appears tolerably certain that there are from forty-five to fifty workable seams of coal 2 feet and upwards in thickness, and about half that number which may be taken as of little or no commercial value, the whole constituting a mass of about 180 feet of solid coal. With these are associated about twenty workable bands of ironstone, and numerous others of inferior quality and local range, but interesting from the character of the organic remains they are generally found to contain.

The base of the series is a somewhat remarkable band of hæmatite resting immediately upon (or separated by an irregular deposit of yellowish clays from) the Upper Millstone-grits of Ipstones and the Churnet valley. There is a tradition that this ore was worked by the Danes 800 years ago; and this opinion is strengthened by the fact of the stone having been extensively worked along the sides of the Churnet valley at a time (of which no other record exists) previous to its rediscovery by a Cornish miner, named Bishop, within the last few years. Many thousands of pounds have been lost in the fruitless search for this stone outside the basin in which it appears to be confined, and efforts are still being made to reach it in the neighbourhood of Cellarhead and Wetley Moor. From this to the uppermost of the unproductive beds of the coal-field, the measures represent a thickness of nearly 5700 feet, and to the work of collecting and tabulating the organic remains of this enormous thickness of strata, grouped over an area of eighty square miles, the last two years have been principally devoted; but it will require another year at least to prepare satisfactory tables of the distribution of the fish and shells of which the field contains such varied and interesting examples.

Previous to last year but one instance was known of the occurrence of marine shells in other than deposits belonging to the lower, or lowest measures of this field. The exception consists of the discovery, about five years ago, of Discinæ in a nodule of the Priors-field ironstone, which lies near the base of the thick ironstones of the middle measures; but the circumstance was overlooked, and such organisms were supposed to be confined to a certain horizon, defined by a bed of what is generally known as Stinking Coal, worked principally for furnace purposes in the Churnet valley, and finding its representative in the little coal of Wetley Moor, and the thin seam of the Roaches. A careful examination, however, of beds exposed by sinkings at Longton, led to the discovery of fossils in the shales of a thin unworked coal called the Bay Coal, lying nearly 4000 feet above the Stinking Coal, which corresponded in every essential degree with the fossils of that well known bed in the Churnet valley. It is, however, a remarkable fact that, although some of the organisms of these widely-separated beds belong to the same type, there is a marked difference in their mode of occurrence, and in the number and variety of both the genera and species they represent. The Stinking-Coal Mollusca consist of immense numbers of compressed *Aviculo-pecten*, *Goniatites*, and *Posidonia*, with *Lingula* and *Orthoceras*. In the Bay Coal shales *Posidonia* appears, so far as is known, to be absent, but *Aviculo-pecten* is represented by two species, accompanied by interesting examples of *Goniatites*, *Lingula*, and *Orthoceras*. Here, however, come for the first time in this field, *Spirifer*, *Ctenodonta*, *Macrocheilus*, *Naticopsis*, *Nautilus*, and *Loxonema*, and with these are associated at least two species of *Discina*. Again, below the Bay Coal, in the Prior's-field ironstone, *Discina* is now found to be accompanied by *Lingula*, but hitherto none of the other forms alluded to have been found associated with them. Up to the present moment no instance has come under notice of the direct commingling of *Anthracosia* or its congeners with either of the shells referred to. In the case of the Bay Coal, there is immediately above, and in contact with the Lingula shales, a thin band of ironstone, containing *Anthracomya Phillipsii*; but the separation of the organic contents of the two beds is as complete as if hundreds of feet of strata divided the period of deposition of the one from that of the other. Equally marked and distinct are the Aviculo-pecten and Goniatite beds of the lowest measures; wherever they occur they are found in immense numbers, generally compressed and confined to a well-marked line of deposit, never exceeding 16 inches in thickness, and in no case becoming incorporated with the shales immediately above or below it. This peculiarity is further illustrated by a thin band of lean ironstone, lying about 50 feet above the Stinking Coal in the Churnet valley, in which were discovered last year remarkably fine examples of *Aviculo-pecten papyraceus*. The Froghall hæmatite, in some instances of thinning out, forms the matrix of *Anthracosia acuta*, but beyond this its organic contents are remarkably scanty and obscure. Below this bed, at the base of what, however, appears to be the shales of the first grit, occurs another band of hæmatite, which, in its line of outcrop on the banks of the river Churnet near Consall, is overlaid by a nodular bed of earthy ironstone, containing *Goniatites* and *Posidonia*; and in the shales by which it is covered, these fossils are accompanied by *Aviculo-pecten* and *Orthoceras*. It is therefore a matter of some interest that the lowest or first fossiliferous deposit of the true coal-measures of this field is characterized by a mollusk regarded as of freshwater origin, which, existing during the deposition of the thick intervening chocolate-coloured shales, ultimately gave place to the marine forms of the Stinking Coal shales, and with its congeners alternated with *Aviculo-pecten*, *Goniatites*, and *Posidonia* to the base of the more productive measures of the great Pottery coal-field. Beyond this, up to the Prior's-field ironstone, 2500 feet above it, no known break occurs in the distribution of the inferred freshwater mollusks, but they spread outwards and upwards, varying in species and thickness of deposit, occasionally forming compact masses several feet in depth, and affording, independent of their geological interest, in many well-known cases a reliable key to the miner in his critical and laborious pursuits.

The distribution of fish-remains is as a rule more general and uniform than that of the mollusks; and although in the presumed marine deposits there is a specific difference in the case of *Palæoniscus*, in no other genus met with is it perceptible. In the hæmatite bed a fish-scale, and one only, has been found, and this, the earliest representative of the order appears to be an example of *Diplopterus*. The Stinking-Coal shales contain, intermixed with the marine fossils enumerated, two or three species of *Palæoniscus*, large spines, and a curious palate as yet undescribed; and it is an interesting fact in connexion with this bed that in no other deposit but the shales of the Bay Coal have similar species of *Palæoniscus* been met with. As far therefore as the subject has been investigated, two instances occur throughout this enormous deposit of coal-measures, of the introduction on a definite horizon of animal life restricted to particular limits, and holding no communion with that by which it was preceded and followed.

Palæoniscus is the most widely distributed fish in this field, remains of it being found in nearly sixty different beds; it often occurs in a beautiful state of preservation, especially in the shales of the Deep Mine ironstone at Longton; and it may be here remarked as a somewhat significant circumstance that, in coal and ironstone shales thickly charged with shells, fish-remains seldom occur otherwise than as detached scales and teeth; and even these as a rule are confined to a bed, lying in the form of a bone-bed, immediately upon the coal or ironstone with which they are associated. The ironstones of the Knowles and Cockshead coal often contain well-preserved fish; and in the shales of the former, as well as in those of the Brown Mine, are occasionally found concretionary masses of shells in the form of nodules, but in no instance has either fish or shell been detected within the body of coal itself, although almost every coal-seam contains upon its upper surface a thin coating as it were of broken and detached organisms, either fish or shell, or both. It would therefore appear that after the submergence of the coal-bed, and before the waters had become charged with mud or other extraneous matter, subsequently deposited, the fish or mollusk sinking to the bottom was subjected to the action of currents, by which the disintegrated parts were carried here and there, and redeposited on the surface of the future coal-seam, or band of ironstone.

Succeeding *Palæoniscus* in point of numbers and general distribution is a fish with small cycloid scales, provisionally assigned to the genus *Rhizodus*, but to which in point of fact no satisfactory position has at present been attributed. There are at least three specieies of it, and, like *Megalichthys*, it occurs in from forty to fifty separate deposits. Occasionally in the Brown Mine, New and Knowles ironstones, are found portions of jaws of various sizes, some of which belong undoubtedly to *Megalichthys*, but others are as yet undetermined. It is a circumstance of note, that of the great number of such fragments of *Megalichthys* as show scales *in situ*, not one has been met with which could possibly have formed part of a fish less than 18 inches in length, whereas in the case of the cycloidal-scaled fishes the majority of specimens range in length from 6 to 8 inches. With the other fish contained in this field the Report will deal hereafter: as far as can at present be ascertained, they comprise a list of nearly forty genera, represented by probably ninety species, many of which are new to science.

Report of the Committee on Standards of Electrical Resistance.

The Committee consists of—Professor Williamson, Professor Wheatstone, Professor W. Thomson, Professor Miller, Dr. A. Matthiessen, Mr. Fleeming Jenkin, Sir Charles Bright, Professor Maxwell, Mr. C. W. Siemens, Mr. Balfour Stewart, Dr. Joule, and Mr. C. F. Varley.

In the present Report it is thought unnecessary again to refer to the objects with which the Committee was appointed, or to recapitulate the arguments for and against the various systems of standards which have been from time to time proposed. The Committee have seen no reason to alter the conclusions previously adopted, and now propose briefly to state the progress made in the practical development of those conclusions, which may be found expressed at length in the Report for 1863.

That Report announced the adoption by the Committee of the absolute electromagnetic system of measurement, based on the metre, gramme, and second, with certain modifications to facilitate the practical construction or use of the standards; and it further stated that in 1863 the absolute resistance of a certain German-silver coil had been measured with considerable accuracy.

No standards based on the 1863 determination were officially issued, inasmuch as it was felt that a second determination was absolutely required before complete dependence could be placed either on the method employed or on the results obtained. Some coils representing 10 of the British Association units, *i. e.* 10^7 absolute units according to the 1863 determination, were made by Messrs. Elliott Brothers, and a set from 1 to 10000 was made from the 1863 determination by Messrs. Siemens and Halske of Berlin. This last set is intended for Col. Douglas, the Superintendent of the Government telegraph lines in India; and a few of Messrs. Elliotts' coils have been bought by persons who were unwilling to wait for the final experiments by the Committee. None of these coils have been in any way certified as correct by the Committee.

In order thoroughly to test the value of the experiments made in 1863, it was determined that not only every measurement should be made afresh, but that every element in the experiment should be varied. The experiment consisted essentially in causing a coil, or rather two coils, of copper wire to revolve or spin at a certain definite rate, and in observing the deflection of a magnet, suspended within the coil, by the reflexion of a scale in a mirror attached to the magnet.

The measurements required in the calculation are the following:—

a. The mean radius of the coils.

n. The number of turns made by the copper conductor forming the coils.

l. The effective length of the wire.

b. The breadth of the section of the coil.

c. The depth of the section of the coil.

b'. The distance of the mean plane of the coil from the axis of rotation.

T. The time of 100 revolutions of the coil.

D. The distance of the scale from the mirror.

δ. The scale-reading during each experiment.

The above measurements are required for what may be called the simple theory, that is to say, the theory omitting all the necessary corrections arising from self-induction, torsion of fibre, &c. For these corrections it is further necessary to measure—

1st. The coefficient of torsion of the fibre.

2nd. The magnetic moment of the suspended magnet.

3rd. The horizontal component of the earth's magnetism.

4th. The variation of the electrical resistance of the coil during each experiment and between each experiment.

5th. The variation in the direction of the earth's magnetic force.

6th. The irregularities resulting from the unavoidable departures from that relative position of the telescope, mirror, scale, and magnet which would be theoretically most desirable.

In the experiments made at King's College in 1864, every part of the apparatus, except the distance of the mean planes of the two coils from the axis of rotation, was altered; so that every measurement was not only made afresh, but, where susceptible of change, was considerably different in magnitude.

Few of the measurements could be made by the means employed with greater accuracy than one part in 10000, and some of them were not determined even with this degree of accuracy. No very perfect agreement between two entirely distinct series of experiments was therefore to be expected; but the Sub-Committee, consisting of Professor Maxwell and Mr. Jenkin, who this year have undertaken the experiments, are fortunately able to report a concordance between the determinations of 1863 and 1864 which is most satisfactory.

The difference between a standard constructed from the mean result of the 1863 experiments and a standard constructed from the mean result of the 1864 experiments would be only 0·16 per cent. The probable error of the 1863 experiments is 0·24 per cent. if the mean of each day's experiments be counted as one only; the probable error of the 1864 experiments is 0·1 per cent. if the mean of each pair of experiments with the coil revolving in two opposite directions be taken as one experiment.

Taking into account the agreement between the means of the two years, we may say that the determination of the Sub-Committee does not probably differ from true absolute measurement by 0·08 per cent.

The Committee are of opinion that, in the present state of electrical science, the result now obtained is satisfactory, and will justify the immediate construction of final standards of electrical resistance.

It can hardly be doubted that, with the lapse of time and the inevitable progress of knowledge, still better determinations will some day be made; and that even now, with still greater care and by still further multiplying the number of experiments, a somewhat more perfect agreement between the standards and the theoretical absolute measurement could be ensured.

The Committee had then to consider whether this possibly still more perfect agreement would be worth the very great time, the labour, and the money which would have to be bestowed upon it. It has never been proposed that the British Association standard should be considered as representing exactly an absolute measurement; whatever may be the state of science, any such pretension could not be well founded, for all that can be done at any time, by the very greatest care, is to reduce the possible error to less than a certain amount. The amount of probable error in the present determination is so small as to be insignificant for any of the present purposes of science, and will always remain insignificant for any practical applications. For these applications it is chiefly important that every copy of the standard, whatever that may be, should be accurately made—a condition which is quite unaffected by the greater or less discrepancy between the standard and true absolute measurement.

The reproduction of the standard can perhaps be more easily effected, if ever it be necessary, by a given weight of metal or alloy than by a fresh absolute determination.

Meanwhile practical standards of resistance are urgently required, and the Committee are pressed to come to a decision. Defective systems are daily taking firmer root, and the measurement of currents, quantity, capacity, and electromotive force call urgently for the attention of your Committee.

Under these circumstances they have decided to rest content with the results of the experiments now completed, and to commence at once the construction of standard coils.

The details of the experiments on absolute resistance are given in Appendix A.

It may be useful here to mention that the new unit will be roughly equal to 0·0736 times Dr. Matthiessen's mile of copper wire, and more exactly 1·0456 times Siemens's unit, according to standards which have kindly been sent by Dr. Siemens to several members of the Committee and others*.

The questions of chief importance, after the magnitude of the standard has been chosen and determined, concern the choice of a suitable form and material for the actual construction of the standard, and in this choice the permanence of the standard is above all essential.

Dr. Matthiessen has for two years been endeavouring, at the request of the Committee, to discover whether the electrical resistance of various metals, under various conditions, can be considered as constant, or can be proved to alter. His Report for the present year is given in Appendix B, and will be found to confirm, in a great measure, the conclusions arrived at in his Report for 1863.

No variation has been observed by him in the electrical resistance of annealed wires of silver, copper, gold, platinum, nor in the hard-drawn wires of gold, platinum, or of the gold-silver alloy. But a change *has* been observed in the hard-drawn wires of silver and copper—a change most rapid in the first year, but very sensible in the second year; a somewhat capricious change has also been observed in certain annealed German-silver wires, while others have been proved constant. This result has been independently observed by other members of the Committee. In the hard-drawn wires of silver and copper the direction of the change has been such as to bring the resistance of hard-drawn wires more nearly to resemble that of annealed wires, diminishing the resistance; in other words, it is such a change as would be produced by partial annealing.

From these experiments it is clearly undesirable that silver or copper should be used for standards even in their annealed state; and the change in these metals further indicates that for standards of other metals the partially annealed is preferable to the hard-drawn condition.

The experiments on these points must be continued for many years before much reliance can be placed on the results; and meanwhile equal standards

* Twenty-five units are within one per cent. equal to the mile of No. 16 copper wire in use by the Electric and International Company. Mr. Varley has promised that for the future exact equality shall be aimed at.

must be constructed of various materials, and protected in various ways, for reference and comparison.

The precautions taken to prevent chemical action and mechanical injury are given in Appendix B. of the Report for 1863. Coils of wire covered with silk, baked, and imbedded in solid paraffin, appear, at present, to be the most promising form for the unit standards. Authentic copies of the standard coils made of platinum-silver alloy, which appears likely to be permanent, might be issued at about £2 10*s*. each, and coils prepared from these by electrical instrument-makers could be verified at a moderate rate at Kew, where the original standards will be deposited. No officially authentic coil can be issued until the standards themselves have been made.

The reproduction of the standard forms the next point for consideration. Notwithstanding the good results obtained by Professor Thomson's method of making an absolute measurement, the Sub-Committee do not recommend the adoption of this process for the reproduction of the standard, which may some day become necessary, owing to the accidental destruction of, or change in the Kew standards. Dr. Matthiessen, on the other hand, states, with confidence, that a standard may be reproduced by means of metal wires of given weight and length, or by means of mercury, within about 0·01 per cent.; the report of his investigation on this subject, made conjointly with Mr. C. Hockin, is contained in Appendix C, and may be summed up as follows. He first draws a distinction between ordinary care, great care, and absolute care. He considers that with ordinary care the gold-silver alloy is the most suitable material (see Report, 1862) for the reproduction; but when great care is used lead is recommended as the most suitable material, but any reproduction by one material should be checked by others, such as mercury. With absolute care it appears that almost any material might be used. It must be remembered that Dr. Matthiessen considers that he himself has not taken absolute but only great care.

The following Table shows the number of wires of each material tested, their maximum discrepancy, and the probable error in a standard reproduced by similar experiments:—

Metal.	No. of wires.	Maximum discrepancy expressed as a fraction of the whole conducting-power.	Probable error.
Silver	3	0·0014	0·00052
Copper	3	0·0011	0·00021
Gold	3	0·0005	0·00011
Lead	4	0·00054	0·00006
Gold-silver alloy	5	0·00073	0·00001
Mercury	3	0·00151	0·00009

Commercially pure lead differed from the chemically pure lead by only about 0·04 per cent.

For an account of the care taken by Dr. Matthiessen in the chemical preparation of the metals he used, and in their subsequent treatment and electrical comparison, we must refer to Dr. Matthiessen's own Report, Appendix C.

With reference to mercury, great difficulty exists in making the experiments, and it is much to be regretted that Dr. Matthiessen's experiments, very accordant in themselves, do not give results agreeing with Dr. Siemens's

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Approximate Relative Values of various Units of Electrical Resistance.

Description.	Name.	Absolute $\frac{\text{foot}}{\text{second}} \times 10^7$.	Thomson's old unit.	Jacobi.	Weber's absolute $\frac{\text{metre}}{\text{second}} \times 10^7$.	Siemens 1864 issue.	Siemens (Berlin).	Siemens (London).	B. A. unit, or Ohmad.	Digney.	Bréquet.	Swiss.	Matthiessen.	Varley.	German Miles.	Observations
Absolute $\frac{\text{foot}}{\text{second}} \times 10^7$ electro-magnetic units (new determination)	Absolute $\frac{\text{foot}}{\text{second}} \times 10^7$.	1·000	0·9520	0·4788	0·3316	0·3187	0·3168	0·3131	0·3048	0·03289	0·03123	0·02924	0·02243	0·01190	0·005307	Calculated from the B. A. unit
Absolute $\frac{\text{foot}}{\text{second}} \times 10^7$ electro-magnetic units (old determination)	Thomson's unit	1·0505	1·000	0·5029	0·3483	0·3348	0·3328	0·3289	0·3202	0·03455	0·03279	0·03071	0·02357	0·01251	0·005574	From an old determination by Weber
Twenty-five feet of a certain copper wire, weighing 345 grains	Jacobi	2·088	1·988	1·000	0·6925	0·6655	0·6618	0·6540	0·6367	0·06869	0·06520	0·06106	0·04686	0·02486	0·01108	No measurement made, ratio between Siemens (Berlin) and Jacobi taken from "Weber's Galvanometrie"
Absolute $\frac{\text{metre}}{\text{second}} \times 10^7$ electro-magnetic units determined by Weber (1862)	Weber's absolute $\frac{\text{metre}}{\text{second}} \times 10^7$	3·015	2·871	1·444	1·000	0·9607	0·9556	0·9443	0·9191	0·09919	0·09416	0·08817	0·06767	0·03591	0·01655	Measurement taken from a determination in 1862 of a standard sent by Prof. Thomson, does not agree with Weber's own measurement of Siemens's units, by Weber 1 Siemens's unit = $1·025 \times 10^7$ metres-second.
One metre of pure mercury, one square millimetre section at 0° C.	Siemens 1864 issue......	3·138	2·988	1·503	1·041	1·000	0·9950	0·9829	0·9563	0·1033	0·09799	0·09177	0·07047	0·03737	0·01666	Measurement taken from three coils issued by Messrs. Siemens.
One metre of pure mercury, one square millimetre section at 0° C.	Siemens (Berlin)	3·156	3·004	1·511	1·046	1·005	1·000	0·9881	0·9625	0·1038	0·09852	0·09227	0·07081	0·03757	0·01675	Measurement taken from coils exhibited in 1862 by Messrs Siemens, Halske & Co. (well adjusted).
One metre of pure mercury, one square millimetre section at 0° C.	Siemens (London)	3·194	3·040	1·529	1·059	1·017	1·012	1·000	0·9742	0·1050	0·0997	0·09337	0·07166	0·03802	0·01695	Measurement taken from coils exhibited in 1862 by Messrs Siemens, Halske & Co. (well adjusted).
British Association unit	B. A. unit, or Ohmad...	**3·821**	**3·123**	**1·570**	**1·088**	**1·0456**	**1·039**	**1·026**	**1·000**	**0·1079**	**0·1024**	**0·0959**	**0·0736**	**0·03905**	**0·01741**	Equal to 10,000,000 $\frac{\text{metres}}{\text{second}}$ according to experiments of Standard Committee.
One kilometre of iron wire, four millimetres in diameter (temperature not known)	Digney............	30·40	28·94	14·56	10·08	0·0968	9·634	9·520	9·266	1·000	0·0491	0·8889	0·6822	0·3620	0·1613	From coils exhibited in 1862 (pretty well adjusted).
One kilometre of iron wire, four millimetres in diameter (temperature not known).................	Bréquet	32·03	30·50	15·34	10·62	10·20	10·15	10·13	9·760	1·054	1·000	0·9365	0·7187	0·3814	0·1700	From coils exhibited in 1862 (indifferently adjusted).
One kilometre of iron wire, four millimetres in diameter (temperature not known).	Swiss	34·21	32·56	16·38	11·34	10·90	10·84	10·71	10·42	1·125	1·068	1·000	0·7675	0·4072	0·1815	From coils exhibited in 1862 (badly adjusted).
One English standard mile of pure annealed copper wire $\frac{1}{16}$ in. diameter at 15°·5 C.	Matthiessen.............	44·57	42·43	21·34	14·78	14·19	14·12	13·95	13·59	1·66	1·391	1·303	1·000	0·5306	0·2365	From a coil lent by Dr Matthiessen (of German-silver wire).
One English standard mile of one special copper wire $\frac{1}{16}$ inch in diameter......	Varley	84·01	79·96	40·21	27·85	26·75	26·61	26·30	25·61	2·763	2·622	2·456	1·885	1·000	0·4457	From coils lent by Mr. Varley (well adjusted).
One German mile = 8238 yards of iron wire $\frac{1}{6}$ inch in diameter (temperature not known*)	German mile	188·4	179·4	90·22	62·48	60·03	59·71	59·00	57·44	6·198	5·882	5·509	4·228	2·243	1·000	From coils exhibited in 1862 by Messrs. Siemens, Halske & Co.*

* Messrs. Siemens do not now manufacture coils with this unit, which has been abandoned by them in favour of the mercury unit given above.

experiments. The discrepancy will be best explained by the following Table, giving the value of a column of mercury at 0° C. one metre long, and having a cross section equal to one square millimetre, according to various experiments, and with the specific gravity used respectively by Dr. Siemens and Dr. Matthiessen.

Definition.	Value in B. A. units.
1. Mercury unit according to Siemens's standard issued in 1864. Sp. gr. mercury assumed at 13·557	0·9564
2. Mercury unit according to Siemens's experiments made for 1864 standard, but assuming sp. gr. mercury at 13·595*.	0·9534
3. Mercury unit according to Dr. Matthiessen's experiments. Sp. gr. mercury assumed at 13·557	0·9646
4. Mercury unit according to Dr. Mathiessen's experiments. Sp. gr. mercury assumed at 13·595	0·9619
5. Mercury unit according to one set of coils exhibited in 1862 by Dr. Siemens (Berlin)	0·9625
6. Mercury unit according to a second set of coils exhibited in 1862 by Dr. Siemens (London)	0·9742

Dr. Matthiessen considers No. 4 the true value, while Dr. Siemens supports No. 1. The Committee do not desire to express any opinion on this subject, but only to draw attention to the great discrepancies which follow the apparently simple definition of the mercury unit (first proposed by Marié Davy). Even now it cannot be said that a trustworthy standard, answering to the definition, exists.

The Committee have little to report concerning the standard instruments for the measurement of currents, quantity, capacity, or electromotive force. The drawings for a standard galvanometer and electro-dynamometer have been begun. An electro-dynamometer, suitable for general use, has been constructed by Professor W. Thomson, and experiments are being made with it.

Professor Thomson has also had some fine apparatus made for the measurement of electrostatic phenomena and their comparison with electromagnetic measurements; but it will be best to describe the instruments when the experiments have been completed.

Dr. Joule has made some preliminary experiments with the view to redetermine the mechanical equivalent of the unit of heat by electrical means.

Thus, although the Committee have not accomplished all that they hoped, they feel that such progress is being made as will justify their reappointment.

They have received assurances that the British Association system of units will be readily adopted in this kingdom, in India, Australia, and Germany. They believe that it will be accepted in America and in many other parts of the world.

From France no response has yet been obtained.

The Committee wish to express their sincere regret at the death of one of their members, Dr. Esselbach. He had made valuable experiments on the electromotive force of various chemical combinations, and had promised to communicate them to the Committee; but their record is now probably lost.

Before concluding, the Committee have to thank Mr. Charles Hockin for the efficient assistance he has afforded, both in the determination of the resistance unit and in Dr. Matthiessen's researches.

* This is the mean of the values given by Kopp, Regnault, and Balfour Stewart. The discrepancy between the two values is far greater than could be due to any confusion as to the reference of the specific gravity to water at 0° and at maximum density.

Appendix A.—*Description of a further Experimental measurement of Electrical Resistance made at King's College.* By Prof. T. C. Maxwell and Mr. Fleeming Jenkin, *with the assistance of* Mr. Charles Hockin.

The method employed in these experiments has been fully described in Appendix D. to the Report of 1863. In the new experiments, the elements of the calculation were varied as much as possible; fresh wire was wound on the experimental coils; observations were made with velocities differing widely from one another. Fresh measurements were made of all the corrections required, and greater precautions were taken to avoid local disturbances.

n, the number of windings, was ..... 319.
l, the effective length of the wire .... 311·2356 metres.
the mean circumference .... 0·993987 „
a, the mean radius .... 0·158194
b, the breadth of each coil .... 0·1841
$2b$, the distance from centre to centre of each coil .... 0·03851
c, the depth of the layers.......... 0·01608
The weight of the wire and silk .... 110 oz. 8 dwt.
$\sin^3 a = 1$.
D the distance from the mirror to the scale; 2212 millims. in some experiments, 2116 millims. in others.

The following Table gives the result of the experiments, and the comparison with those of 1863.

Time of 100 revolutions, in seconds.	Values found for coil in terms of 10^7 for each experiment.	Value of B.A. unit in terms of $10^7 \frac{\text{metre}}{\text{seconds}}$, as calculated from each experiment.	Value from mean of each pair of experiments.	Percentage error from mean value.
17·54	4·7201	1·0121	0·9978	−0·22
17·58	4·5914	0·9836		
77·62	4·8848	1·0468	1·0040	+0·40
76·17	4·4871	0·9613		
53·97	4·6607	0·9985	0·9992	−0·08
54·53	4·6666	0·9998		
41·76	4·6279	0·9915	0·9925	−0·75
41·79	4·6275	0·9936		
54·07	4·6496	0·9961	0·9924	−0·76
53·78	4·6146	0·9886		
17·697	4·6108	0·9878	1·0007	+0·07
17·783	4·7313	1·0136		
17·81	4·6452	0·9952	1·0063	+0·63
17·78	4·7489	1·0174		
17·01	4·7567	1·0191	1·0043	+0·43
16·89	4·6187	1·9895		
21·35	4·6834	1·0034	1·0022	+0·22
21·38	4·6727	1·0011		
21·362	4·6526	0·9968	1·0040	+0·40
21·643	4·7134	1·0096		
11·247	4·8658	1·0424	0·9981	−0·19
16·737	4·5305	0·9707		

Probable error of R (1864)=0·1 per cent.
Probable error of R (1863)=0·24 per cent.
Difference in two values 1864 and 1863=0·16 per cent.
Probable error of two experiments=0·08 per cent.

In constructing the standard coil, in consideration of the much greater range of velocities used in 1864, the 1864 mean value was allowed to have five times the weight of the mean value obtained in 1863.

Appendix B.—*On the Electrical Permanency of Metals and Alloys.* *By* A. Matthiessen, *F.R.S.*

In Appendix A. of the Report of your Committee of last year, I gave the results of some experiments made to test the electrical permanency of some metals and alloys. On August 5 of this year I re-tested them, and give the results in the following Table, taking the conducting-power of No. 15 = 100·00, as was done in last year's Report.

	May 9, 1862.	T.	June 14, 1863.	T.	Aug. 5, 1864.	T.
1. Silver: hard-drawn	100·00	20·2	103·915	20·0	104·397	20·2
2. Silver: annealed........	100·00	20·2	99·947	20·1	100·013	20·1
3. Silver: hard-drawn	100·00	20·2	102·807	20·2	103·655	20·1
4. Silver: annealed........	100·00	20·2	100·031	20·0	100·048	20·0
5. Copper: hard-drawn.....	100·00	20·1	100·248	20·2	100·276	20·0
6. Copper: annealed	100·00	20·1	100·015	20·0	100·010	20·1
7. Copper: hard-drawn	100·00	20·0	100·149	19·8	100·200	20·2
8. Copper: annealed	100·00	20·0				
9. Gold: hard-drawn	100·00	20·0	100·045	20·2	100·000	20·2
10. Gold: annealed	100·00	20·0	100·062	20·0	99·960	20·2
11. Gold: hard-drawn......	100·00	20·0	99·869	20·2	99·937	20.0
12. Gold: annealed	100·00	20·0	99·877	20·3	99·960	20·0
13. Platinum: hard-drawn ..	100·00	20·0	99·951	20·2	99·989	20·2
14. Platinum: hard-drawn ..	100·00	20·0	99·999	20·2	100·008	20·1
15. Gold-silver alloy: hard-drawn	100·00	20·0	100·000	20·2	100·000	20·2
16. Gold-silver alloy: hard-drawn	100·00	19·9	99·963	20·3	99·996	20·0
17. German silver: annealed.	100·00	20·3	100·162	20·0	100·135	20·0
18. German silver: annealed.	100·00	20·3	100·145	20·0	100·152	20·0
19. German silver: annealed.	100·00	..	100·217	20·2	100·193	20·2

From the above it will be seen that the following wires have not sensibly altered in their conducting-power during the space of two years.

No.	May 9, 1862.	June 14, 1863.	August 5, 1864.	Maximum difference corresponds to.
2.	100·00	99·911	99·977	0·25°
4.	100·00	99·959	99·976	0·10
6.	100·00	99·979	100·010	0·05
9.	100·00	100·117	100·072	0·30
10.	100·00	100·062	100·032	0·20
*11.	100·00	99·941	99·937	0·15
*12.	100·00	99·985	99·960	0·10
13.	100·00	100·023	100·061	0·15
14.	100·00	100·071	100·044	0·20
15.	100·00	100·000	100·000	
16.	100·00	99·963	99·996	

* Without taking into consideration the corrections due to temperature, I placed in last year's Report these two wires with those whose conducting-powers had changed.

All the values have been reduced to the first observed temperature, assuming that all pure metals vary in conducting-power alike with temperature. The correction made was the addition or subtraction of 0·036 for each 0°·1, which number corresponds to the correction of conducting-power for temperature at 20°. No correction has been made in the cases of No. 15 and 16, for it is so small that it may be neglected, being about 0·006 for each 0°·1.

As stated in last year's Report, the differences may be considered due to temperature; for, as there explained, a difference in the temperature of the wire and the bath might well exist, and we find in most cases a difference in the conducting-power corresponding to 0°·1 to 0°·2.

It is interesting to find that hard-drawn silver and copper wires become partially annealed by age, at least the increment in the conducting-power would indicate such to be the case. In the case of silver, a decided increment will be observed.

No. 8, copper, annealed, has altered so much, that there can be no doubt that it was badly soldered.

With regard to the alteration observed with the German-silver wires, it may here again be stated that it is not to be assumed that all wires of this alloy will alter in like manner. An example of this has lately come to my notice. About two years ago I made a coil of the gold-silver alloy, which was compared with one of Prof. Thomson's German-silver coils, and having them still in my possession, they have now been re-compared with the following results:—

July 8th, 1862. Resistance of Thomson's coil being 1 at 18°·4, that of the gold-silver coil was ·88445 at 18°·4.

August 6, 1864. Resistance of Thomson's coil being 1 at 18°·4, that of the gold-silver coil was ·88447 at 18°·4.

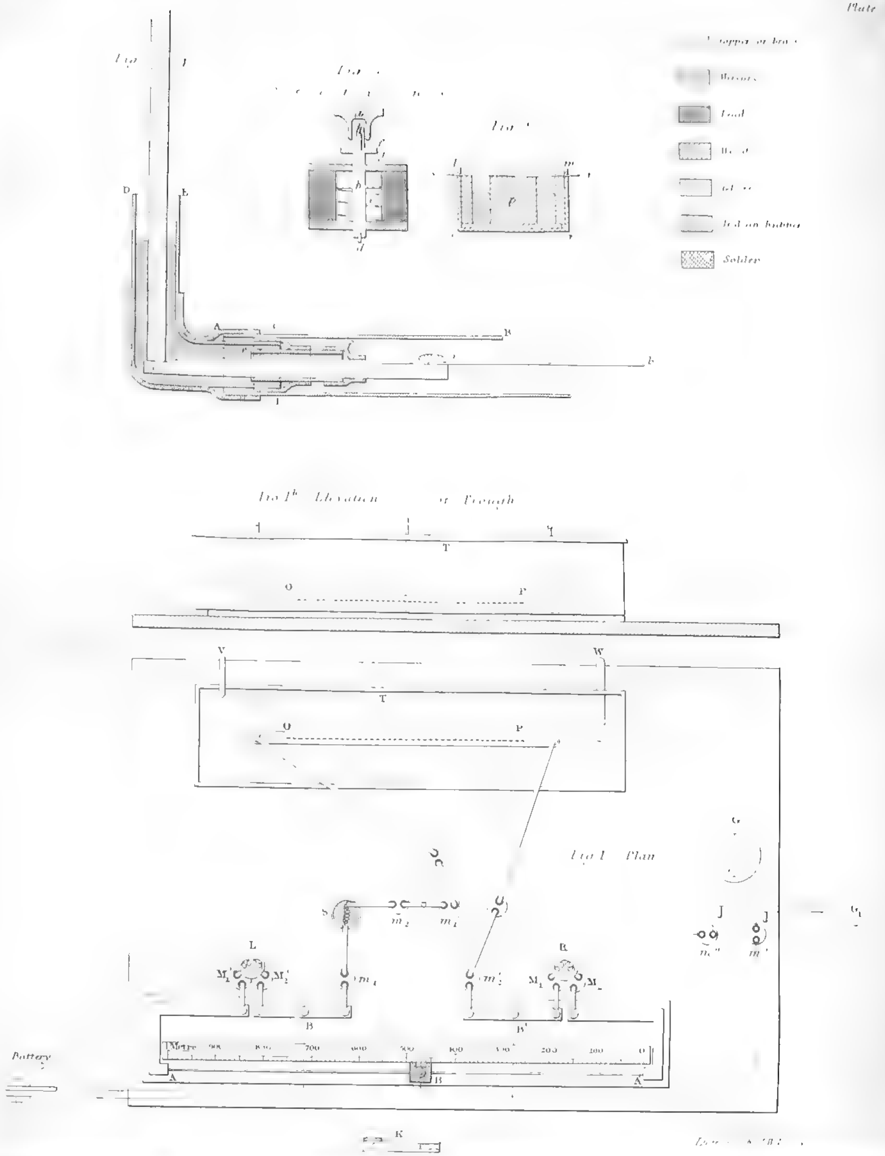
It is worthy of remark that the first comparison was made by Dr. C. Vogt, the last by Mr. C. Hockin, and with entirely different apparatus, showing that different observers with different apparatus obtain absolutely the same results, when they take great care in making the observations.

The above proves that the conducting power of all specimens of German-silver wire does not alter by age. Further experiments are being made on this subject, and in the course of a year or so we shall be able to say how far German silver may be trusted for making resistance coils.

Appendix C.—*On the Reproduction of Electrical Standards by Chemical Means. By* A. Matthiessen, *F.R.S., and* C. Hockin, *Fellow of St. John's College, Cambridge.*

Having been requested by your Committee to make some experiments with the view of discovering the best method of reproducing an unit of electrical resistance by chemical means, we have carried out the research of which we now propose to give the results.

The experiments have been made with unusual care. It is important to point out the degree of precaution that has been taken to insure trustworthy results. The care taken in these experiments may be called great care as opposed to ordinary care on the one hand, and thorough care on the other. By ordinary care is meant the care usually taken in scientific research, where no extraordinary precautions are had recourse to. The sort of accuracy obtained when a unit is reproduced with ordinary care may be seen by reference to former results. For instance, in the determination of the conducting-power of mercury, described in 'Phil. Trans.', results were obtained


Solder
Lead
Fig. 1 Elevation
Trough
Fig. 1 Plan
Battery
Metre
L
R
B
B'
A
A'
T
O
P
V
W
G
J
S
K

differing in some cases by 1·6 per cent. The same degree of accuracy was obtained in the determination of the mercury unit by Dr. W. Siemens, described in 'Phil. Mag.'

On the other hand, in the experiments to be described, and in those made by Mr. Sabine, the results differ by only a few hundredths per cent.

The results of the determinations of the conducting-power of the gold-silver alloy, described in the 'Phil. Mag.' Feb. 1861, differ from each other by 1·5 per cent., the values now found for the same quantity differ by only seven-hundredths per cent. No doubt if greater care had been taken and more perfect instruments used, still better results would have been obtained.

Perhaps the great difference between what is above called great care and ordinary care lies in the time employed. The experimenter using great care has to neglect almost all consideration of time, and repeat his experiments at reasonable intervals, in all cases in which it is possible, that by lapse of time such error, as at first there is no means of detecting, may increase, and so become apparent. The meaning of absolute care is clear. When absolute care is taken no precautions are omitted, the best instruments obtained, and every care taken in the manipulation.

The apparatus used in the following research will first be described, the results obtained will be then given, and finally some remarks made on them.

Description of Apparatus.

Battery.—The battery employed was a single Bunsen's cell. The wires connecting it with the bridge ran parallel to each other the whole of their length, so that no attraction was exercised on the magnet of the galvanometer by the current traversing them*.

Balance.—For measuring the resistance of the wires a Wheatstone's balance, as modified by Kirchhoff, was employed. A plan of it is given at Plate IV. (fig. 1).

L and R are two resistance coils acting as the arms of the balance. They are joined by the wire $A A_1$, along which the eblock B connected with one end of the galvanometer coil can be moved.

The wire A A′ of the instrument was made of an alloy containing 85 per cent. of platinum and 15 per cent. of iridium. The advantages of employing this alloy are that it does not readily oxidize, that it does not change much in conducting-power with an alteration of temperature, and that it does not alloy with mercury.

S is a standard coil immersed in an oil-bath.

O P is the wire to be measured or compared with the standard S, and is immersed in a large trough of water.

G is an ordinary galvanometer by which approximate results are first observed.

G_1 is a very sensitive Thomson's reflecting galvanometer, by which the final observations are made.

M_1, M_2 &c., m_1, m_2 &c. are mercury cups used to connect the several parts of the circuit by thick copper rods and bars, plainly shown on the drawing. The arrangement shown was found convenient, as it admitted of adjustment to various positions and dimensions of conductors to be compared. The position of B on the wire A A′ could be observed by a boxwood scale divided into millimetres and a pointer on the block.

K is a key used to complete the battery circuit, and worked by a treadle

* The battery circuit was generally broken, and was closed by pressing down a treadle, placed under the table, with the foot. The terminals were of platinum.

from below. An enlarged section of the block B is given in fig. 3. *a*, is a wooden handle, by which the rod *b*, with the platinum point *d*, can be depressed so as to come in contact with the wire of the bridge. When the pressure of the hand is removed the spring *e* lifts the handle and breaks the contact. The galvanometer wire is screwed in between the metal plates *f* and *g*. A pad of gutta percha between the knob *h* and the handle prevented any sensible thermal current. To the top of the block was fixed a piece of brass with a slit in it to serve as a pointer. A lens also was fastened to the handle to read fractions of a millimetre on the scale. The body of the block was of lead, with a slab of ebonite at the top and bottom. The block ran on a tramway parallel to the scale and wire of the balance.

A section of one of the mercury cups is given at fig. 2. At the bottom of the cylindrical cup *l m n o* is placed an amalgamated copper plate, and mercury is poured into the cup; the plate is held down by the wooden cylinder *p*, and this is kept in its place by the pin *r s*. This plug fits the cup closely, and is pierced with two or more holes for the terminals to pass through. The cups were propped up with wedges, when placed under the fixed terminals of the balance, that these might press firmly against the metal bottoms of the cups.

Each of the coils R and L had a resistance of about 20 metres of the wire of the instrument. Careful measures were made of the resistance of the wire of the bridge at different points in order to find if there were any very faulty points in it; this was done by putting the coils R and L in their places, and increasing the resistance of one of them by means of a short piece of wire. The effect of this wire was to shift the zero-point. Two coils, differing about one-tenth per cent., were then placed in the centre of the instrument and the reading taken; these coils were then reversed and the reading again taken.

Suppose $2l$ the resistance of the circuit from the point B to B′ when the short wire is removed, z the change in the zero-point caused by the insertion of the short wire above mentioned, and x the difference of a pair of readings; resistances being expressed in millimetres of the wire A A′, and lengths expressed in millimetres of the scale. Then the resistance of a millimetre of the wire of the instrument about the zero-point is

$$=(l+z)\cdot\frac{a-b}{a+b}\cdot\frac{2}{x},$$

$\frac{a}{b}$ is the ratio of the two centre coils.

The value of this expression was found for different points from one end to the other of the wire, and did not vary more than two- or three-tenths of a millimetre, an error not considerable enough to affect the results obtained with the instrument.

The value of the coil R was thus found. It was placed in the mercury cups m'_1, m'_2, and the cups m_1, m_2 were joined by a stout copper bar. Two coils, the ratio of the resistance of which was known, were placed in the two centre cups and the reading taken.

Let $\frac{a}{b}$ be the ratio of two centre coils, x the reading of scale, which was divided from A′ to A, $R+r$ the resistance of the circuit from B′ to the point of wire opposite that end of the scale nearest to R, viz. A′, l the corresponding quantity for the other side of the instrument.

Then clearly

$$\frac{R+r+x}{l+1000-x}=\frac{a}{b},$$

or

$$R+r=\frac{a}{b}(l+1000-x)-x.$$

The readings are given in the following Table.

Ratio of $\frac{a}{b}$.	Reading.	Value of R+r.	Value of R+r.
24 : 1	120·5	20987+24l	21215
26 : 1	186·5	20964+26l	21210
29 : 1	269	20930+29l	21205
34 : 1	375	20875+34l	21197
36 : 1	409	20867+36l	21208
37 : 1	425·25	20841+37l	21192
39 : 1	454·25	20830+39l	21201
42 : 1	493·25	20790+42l	21188
47 : 1	547·25	20732+47l	21177
55 : 1	613	20672+55l	21193
60 : 1	645·25	20625+60l	21194
68 : 1	688	20528+68l	21173
76 : 1	720·75	20483+76l	21203

Zero-point was at 516.

Resistance of half length of circuit is 21712 millimetres of wire.

All these values are within necessary errors of observation. The first few values are most to be relied on, as the values of r+R depend nearly directly on 1000$-r$.

So many measurements were made in order to find whether the wire tapered towards either end. The similarity of the values found for R+r shows this better, perhaps, than the direct method before described.

A set of similar measurements were made with the coil L in the left-hand mercury cups, and equally good results obtained.

The galvanometer employed was one of Thomson's reflecting galvanometers, made by Messrs. Elliott Brothers. A short coil was employed. The instrument was placed in a deal box, blackened inside, with large apertures to observe through. The spot of light could thus be clearly seen, and the divisions of the scale were sufficiently illuminated to enable the observer to see immediately in which direction the spot of light moved. The instrument was sufficiently delicate to show 0·001 per cent. difference in the ratio of any two nearly equal conductors compared, corresponding to $\frac{1}{10}$ millims. on scale of bridge.

An ordinary galvanometer was also at hand to find about the place of reading on the scale.

The balance employed for weighing was by Liebrich of Giessen, and would weigh to $\frac{1}{10}$th of a milligramme with accuracy. The weights were adjusted by Oertling, and again tested by weighing them against the largest weight (50 grms.). Mr. Balfour Stewart was kind enough to test this weight, and found its value to be exactly 50·0000 grms. All weighings made in this research were double weighings.

The measurements of lengths of wires tested were made with a beam compass. It was furnished with a vernier carrying a telescope. The instrument was fixed horizontally before a window, the ends being clamped to shelves in the wall on either side of the window.

The telescope pointed downwards, and the wires to be measured were laid on a board fixed below the instrument.

With this apparatus measurements could be made with the greatest certainty to $\frac{1}{40}$th of a millimetre, the telescope being sufficiently powerful to show much smaller lengths than this.

We are indebted to Mr. B. Stewart for measuring the values of the divisions of the instrument.

Thermometers.—Two thermometers were employed. They were made by Messrs. Negretti and Zambra. One was divided to $\frac{1}{5}$th of a degree Centigrade, the other to single degrees. The large thermometer was found to be correct by the Kew standard. The zero-points of the thermometers were carefully taken.

Trough.—The wires, the resistance of which were to be determined, were placed in a glass tube immersed in a trough of water.

The trough was 1·5 m. long by 0·15 m. square section. A stream of water flowed through it, coming in by the tube V (fig. 1) and escaping by the waste-pipe W. This arrangement was adopted because it was found that naphtha or oil soon acted on the wires and altered their resistance, so that they could not be immediately exposed to the action of a liquid. The details of the arrangement will be understood by reference to fig. 4.

The wire to be tested, $a\,b$, was soldered at its ends to copper bars as $a\,c$. On to each of these bars was slipt a piece of glass tubing, as $e\,f$. These tubes were fastened to the copper bars by india-rubber tubing. The wire, with its connexions, was then placed in the large glass tube A B. The piece of tubing $e\,f$ was then fastened to the bent tube C E D F by india-rubber tubing.

The ends of the terminals $a\,c$ were beaten out flat and amalgamated. The bent tubes were nearly filled with mercury, and the terminal c was connected with the mercury cups m'_1, m'_2 of the instrument by copper rods amalgamated at each end.

The resistances of the wires were compared with those of coils of German silver, well varnished, immersed in a cup of oil. The temperature of the oil was determined by the small thermometer before described.

Method of observing.—The wires were placed in the trough and the connexions made. The water was then turned on and allowed to flow for about fifteen minutes. The large thermometer was placed in the trough, and the temperature was read off by means of a lens placed so as to avoid all error of parallax. The small galvanometer was then connected with the electric balance, and the approximate reading found.

The large galvanometer was next connected, and the block handle pressed down until any thermal current that existed had ceased to cause the needle of the galvanometer to oscillate. The battery contact was then made for an instant with the foot. The slight kick given by the spot of light at once showed which way the block had to be moved, without its being necessary to keep the battery on long enough to heat the conductors sensibly.

The observing-room was kept at a very equable temperature by a screen before the window, also the wire of the balance was protected by a piece of boarding from the heat radiating from the observer's body.

After every observation the temperature of the coil and the water in the trough was read off, and if any difference was observed between these readings and those first taken, the observation was rejected and another one taken.

Four observations were made on each wire at intervals of from twenty to forty minutes.

Before noting down the scale-reading all the connectors were moved, and if no change in resistance was observed the connexions were presumed to be good.

All results are given in terms of weight and length, as it is impossible to measure the diameter of a small wire with the accuracy with which the weight can be found; moreover, the cross section of a wire is not generally a circle, and the mean diameter varies slightly from point to point however carefully it may be drawn.

A great oversight was made in not observing the specific gravity of each wire, so that the results of the experiments now made could be compared with former ones. This omission was first made because it was thought that the results of former experiments could be used; but after several measurements had been made it was found that the values of the specific gravity of wires of the same metal, given by different observers, varied so much that it was impossible to find the resistance of a wire of a metal of which the length and sectional area are known, from the resistance of a wire of which the length and weight are known without taking the specific gravity of the wire actually experimented on.

Silver.

Three silver wires were compared.

I. From commercially pure nitrate of silver.
II. From French coin.
III. From English coin.

The silver was first dissolved in nitric acid and then diluted with water and precipitated by hydrochloric acid. The chloride was then well washed, and afterwards fused with pure carbonate of sodium. The resulting button of silver was fused a second time with borax and a little nitrate of potassium; lastly, before casting, it was fused with a piece of charcoal floating on the top. The mould was about 35 millimetres long by 4½ millimetres diameter. The drawing of the wire was conducted with the utmost care. The wire was annealed only twice during the process.

In drawing all wires the end first entering the hole was reversed at each successive drawing, after it had been drawn down to about one-half its required diameter. The wires were twice drawn through each of the smallest holes, the ends being reversed as before.

To measure the harder wires they were straightened by rolling them between two smooth boards, and then passed through a thermometer tube of such a length that the ends just projected from the tube, the long ones being cut into two or three lengths for the purpose. It was found that the wire could be pulled out of the tube and reinserted many times without altering the length by half one-tenth of a millimetre. Some care was necessary in soldering the wires to their connexions. A small lump of hot solder was placed in the terminal, and the end of the wire steadily and slowly pushed into it until it set. Thus the boundary between the wire and solder was well defined, and the wire could be cut off at exactly the required point. The wires were weighed and measured after the resistance had been taken.

The care taken in drawing the silver wires accounts for the close agreement of the results. Another wire was drawn as rapidly as possible through the latter holes to harden it, and a difference of $3\frac{1}{2}$ per cent. was found in its conducting power.

The results are given in the following Table:—

Wire No. I.

Temperature of coil.	Reading of bridge-scale.	Temperature of wire.
21·1	888	21·3
21·2	888	21·3
21·4	890	21·4
21·3	891	21·4
Length 1·5906 m.	Zero-point at 514·25.	Weight 2·9208 grammes.

No. II.

18·8	194	19·3
19·0	199	19·4
19·3	204	19·5
19·4	206	19·6
Length 1·6749 m.	Zero-point at 514·25.	Weight 3·4419 grammes.

No. III.

18·6	840	18·2
18·8	855	18·8
19·3	870	19·2
19·8	880	19·5
Length 1·3692 m.	Zero-point at 513·7.	Weight 2·1572 grammes.

Resistance of metre-gramme wire No. I. 1·0000.
" " No. II. 0·9991.
" " No. III. 0·9986.

Copper.

Three copper wires were tried. The copper employed was electrotype copper, and it was drawn without previous fusion. The copper of wires Nos. I. and II. was prepared by Messrs. De la Rue & Co., that of No. III. wire as follows. Sulphate of copper was made by dissolving electrotype copper in pure sulphuric acid, and twice recrystallizing. The copper was obtained from the sulphate thus prepared by electrolysis. It was precipitated on a greased platinum pole, the other pole being of electrotype copper.

Wire No. I.

Temperature of coil.	Reading of bridge-scale.	Temperature of wire.
23·4	244	21·2
23·6	246	21·3
23·7	248	21·3
23·8	250	21·4
Length 1·9324 m.	Zero-point at 514.	Weight 3·9867 grammes.

No. II.

20·1	198	19·9
20·5	217	20·2
20·8	221	20·4
20·8	223	20·45
Length1181·05m.	Zero-point at 514.	Weight 1·4908 grammes.

No. III.

21·6	565	20·8
21·8	570	21
21·8	573	21
22·0	572·5	21
Length 1·6187 m.	Zero-point at 514.	Weight 2·7151 grammes.

Resistance of metregramme of wire No. I. 1·0000.
" " No. II. 1·0005.
" " No. III. 1·0011.

GOLD.

Three gold wires were tried.

No. I. from Australian gold.
No. II. from English coin.
No. III. from English coin.

The metal was first dissolved in nitro-hydrochloric acid, the excess of acid was then evaporated off, and the salt largely diluted with water to precipitate the chloride of silver. After filtering the gold was precipitated by sulphurous acid, the precipitate collected in a small beaker, and washed four times with hydrochloric and nitric acid alternately. After drying it was fused with borax and nitrate of potassium and cast. It was again fused, and finally cast in the mould.

Wire No. I.

Temperature of coil.	Reading of bridge-scale.	Temperature of wire.
20·2	849	18·8
20·4	849·8	18·8
20·4	851·5	18·9
20·8	852·5	18·9
Length 0·8854 m.	Zero-point at 515·2.	Weight 2·2200 grammes.

No. II.

21·6	634·5	20·2
21·6	638	20·3
21·6	638	20·3
21·8	638	20·3
Length 0·9998 m.	Zero-point at 515·2.	Weight 2·9021 grammes.

No. III.

19·8	782	19·2
20·1	788	19·4
20·5	784·6	19·6
20·8	797	19·8
Length 1·0211 m.	Zero point-at 515.	Weight 2·9753 grammes.

Resistance of metregramme of wire No. I. 1·0000
" " No. II. 0·9998
" " No. III. 0·9995

LEAD.

With lead very good results were obtained. Five wires were determined.

The wires were pressed at a gentle heat, the press being carefully bored and cleaned beforehand. As the wire came from the press it was received on a smooth board. It was then at once soldered on to the connexions and placed in the trough. The solder employed was Wood's cadmium alloy. After being cut from the connectors the wire was straightened by rolling between two boards with great care; it was then placed on the board beneath the beam-compass, adjusted to the groove below the line of motion of the cross wires of the telescope, and carefully measured and then weighed.

Wire No. I. was cut from a bar of commercially pure lead, prepared by Mr. Baker of Sheffield.

Wire No. II. made from lead obtained by heating the acetate thrice recrystallized. This specimen was kindly prepared by Mr. Mathews.

Wire No. III. from the acetate of lead of commerce twice crystallized.

Wire No. IV. from the acetate of lead of commerce three times crystallized.

Wire No. V. from the seventh recrystallization of acetate of lead. Kindly prepared by Professor Atkinson.

Wire No. I.

Temperature of coil.	Reading of bridge-scale.	Temperature of wire.
18·1	355	17·5
18·2	362	17·8
18·3	362	17·6
18·4	362	17·6
Length 0·4907 m.	Zero-point at 514.	Weight 2·0689 grammes.

No. II.

16·4	855	17·1
16·4	867	17·5
18·0	869	17·6
18·1	869	17·6
Length 0·5100 m.	Zero-point at 514·5.	Weight 2·1320 grammes.

No. III.

17·0	746	16·1
17·0	748	16·2
17·2	748	16·2
17·4	748	16·3
Length 0·4910 m.	Zero-point at 516.	Weight 1·9883 grammes.

No. IV.

17·2	525	15·3
17·6	529	15·3
17·7	530	15·3
17·8	535	15·4
Length 488·2 m.	Zero-point at 515·2.	Weight 1·9991 grammes.

No. V.

18·8	628	17·8
18·8	628	17·8
19·1	634	18·0
19·6	640	18·2
Length 0·4915 m.	Zero-point at 515·5.	Weight 2·0253 grammes.

Resistance of metregramme of wire No.	I.	1·00000
" "	II.	1·00045
" "	III.	1·00029
" "	IV.	1·00054
" "	V.	1·00026

Gold-silver alloy.

No. I. Part of the alloy formerly prepared for the experiments described in 'Phil. Mag.' Feb. 1861, and there described as wire No. I.

No. II. Part of No. VII. there described.

No. III. Part of No. VIII. there described.

No. IV. From the first three alloys mixed and refused and drawn.

No. V. Alloy reprepared from the pure metals.

Wire No. I.

Temperature of coil.	Reading of bridge-scale.	Temperature of wire.
17·8	816	17·8
18·4	821·6	18·2
19·8	831·5	20·2
20·0	845	21·2
Length 0·5374 m.	Zero-point at 517·6.	Weight 1·8607 grammes.

No. II.

18·4	481·0	18·6
18·8	482·4	18·8
19·6	486·0	19·4
20·0	497·6	21·3
Length 0·4263 m.	Zero-point at 517·3.	Weight 1·2082 grammes.

No. III.

19·2	594	17·8
20·0	600·2	19·2
18·6	595·4	18·2
19·0	596·0	18·5
Length 0·3709 m.	Zero-point at 517·4.	Weight 0·9052 grammes.

No. IV.

18·8	870	17·8
19·0	870	17·9
19·1	869	18·0
19·3	869	18·0
Length 0·5472 m.	Zero-point at 514·5.	Weight 1·9199 grammes.

No. V.

18·8	542	17·6
19·0	541·6	17·7
19·2	541·4	17·6
19·2	541·8	17·7
Length 0·6333 m.	Zero-point at 515.	Weight 2·6497 grammes,

Results for Gold-silver alloy.

Resistance of metre-gramme of wire	No. I.	1·00000.
" "	No. II.	0·99963.
" "	No. III.	1·00017.
" "	No. IV.	1·00036.
" "	No. V.	0·99996.

Mercury.

Three tubes were filled with mercury and their resistance taken.

Tubes Nos. I. and II. with distilled mercury treated with nitric and sulphuric acid.

Tube No. III. with mercury distilled from a specimen which contained a small quantity of gold.

The lengths of the column are given below in their order.

Tube I.	Tube II.	Tube III.
mm.	mm.	mm.
383	291	245
384	288	242
390	289	240
386	287	240
389	288	242
384½	288	243
381	291	243
377	290	244
384½	292	246
392	288	246
399	288	248
405	289	248
407	288	252
407	288	253
406	288	254
413	290½	254
418	292	257
424	293	228
416·5	295	260
416	297	262
414		265
405		267
405		
$\log \frac{C'}{C}$ $=\bar{1}\cdot9995018$.	$\log \frac{C'}{C}$ $=\bar{1}\cdot9998710$.	$\log \frac{C'}{C}$ $=\bar{1}\cdot9995614$.

Several other kinds of mercury were tried in one and the same tube, and the resistances found to be the same within two or three-hundredths per cent.

Sixteen tubes were obtained, picked from a great number, and of these the three best ones were taken. No. I. was not so good a tube as the others, as the outside was uneven, rendering it impossible to calibrate it with very great accuracy.

To calibrate a tube it was taken and carefully cleaned with pure nitric acid, and then with a solution of caustic potash. It was then well rinsed with distilled water, and dried by passing a current of hot air through a chloride-of-calcium bulb, and then through the tube. A small column of mercury was put in the tube, and the length of column measured by the beam-compass. The column was shifted along the tube by sucking up or blowing through an india-rubber tube with a chloride-of-calcium tube inserted between it and the tube to be calibrated. By this arrangement the column could be adjusted with the greatest nicety to the place in the tube required. The lengths of the column were taken at equal intervals from one end of tube to the other. The formula for correction used is given below.

Let C be conducting-power of a tube of uniform bore and of length, capacity equal to that of tube considered; C′ observed conducting-power. Then

$$C' = C\frac{n^2}{\Sigma\lambda\,\Sigma\frac{1}{\lambda}},$$

where n is the number of measurements made, λ the length of the column of mercury in any position. The summation extending to all the readings taken

The ends of the tubes were ground by putting some emery powder and naphtha on a slate table, holding the tube vertically upright with the left hand and with the right hand rubbing the end of the tube in contact with the table round the circumference of a small circle. Thus the end of the tube was made slightly convex, the opening being at the apex of the convexity. To measure the tubes they were placed under the beam-compass, and a stout pin inserted partially into each end.

From the shape of the ends of the tube, the point where the pin emerged from the tube could be exactly seen and the measurement made with certainty. Many measurements were made turning the tube round its axis through a small angle before each measurement, and the mean of the lengths found taken for the true length. To find the weight of the tube full of mercury it was carefully cleaned, filled with mercury, and placed in a long narrow trough full of pure mercury. The tube was held down by iron weights, a thermometer inserted in the trough, and the apparatus allowed to stand until the temperature was constant. After the true temperature had been obtained the tube was taken out of the trough and the contents weighed.

This was managed in the following manner. One operator took hold of the tube by pressing a finger against each end and lifting from the trough; the little globules adhering to the outside of the tube were then rapidly removed by two assistants with brushes.

The mercury was then allowed to flow slowly out into a small porcelain crucible and weighed. In this way pretty consistent results were obtained if the tubes were cleaned before each filling.

To determine the resistances of the tubes they were placed in the water trough, with bent pieces of tubing fastened on to the ends with india-rubber tubing and reaching above the surface of the water.

The terminals were of copper, well amalgamated. They dipped into the bent tubes and came flat against the ends of the tubes, the resistance of which was to be determined. In the calculation of the weight of mercury at 0° in the tube from the observed weight, Regnault's value for the expansion was used.

Connexions of amalgamated platinum were first used, but did not give good results. It was found that the amalgamation was imperfect. The mercury adhering to the platinum was rubbed off against the ends of the tube, and the resistance varied with the height of the mercury in the bent tubes. The platinum was amalgamated by dipping it into a mixture of mercury and sodium amalgam. The sodium was then oxidized and dissolved off by dipping the platinum in a little dish of water and hydrochloric acid. The terminal was then drawn through a dish of clean mercury, so that the water floated off. The platinum was then for the time beautifully amalgamated; but the mercury soon drained off when the plate was exposed to the air, and could be easily rubbed off even when the platinum was immersed in mercury.

Mercury.

Tube No. I.

Temperature of coil.	Reading of bridge-scale.	Temperature of wire.
18°·1	346	18°·2
18·4	349·2	18·6
18·4	349.2	18·8
18·8	348	18·0
grms.	Zero-point 515	Length 0·9365 m.
Wt., temp. 19°·6 .... 24·7021		
" 21·0 .... 24·6930		
" 20·8 .... 24·6950		
Wts. reduced to 21°:—		
24·6958		
24·6930		
24·6940		

Tube No. II.

19°·6	188	19°·0
19·9	186·8	19·05
20·0	186·5	19·1
20·0	186·5	19·1
grms.		Length 0·6563 m.
Wt. at 21°·2 .... 12·3140		
" 21·6 .... 12·3132		

Tube No. III.

19°·0	633·5	18°·9
19·0	633·1	18·8
19·1	631·7	18·8
19·15 grms.	631·3	18·8
Wt. at 22°·2 .... 8.2894		Length 0·5497 m.
" 22·2 .... 8·2836		

Results.

Resistance of tube	No. I.	1·00000
,, ,,	No. II.	0·99849
,, ,,	No. III.	1·00000

An approximate table is subjoined of the resistances of a metre-gramme of the different metals in terms of the B. A. unit, 1864.

Copper	0·1469
Silver	0·1682
Gold	0·4150
Gold-silver alloy	1·668
Lead	2·257
Mercury	13·06

From the foregoing results we may draw these conclusions.

That with great care an unit may be reproduced with great accuracy by any of the metals or alloys above mentioned.

Of those tested it appears that lead is the most preferable on account of its easy purification, and because the presence of impurities, amounting to several per cent., produce no very disproportionate effect on its conducting-power. For instance—

Conducting-power of lead is			7·77
Of lead with	12·7	per cent. volume of tin is	8·13
,,	10.6	,, ,, cadmium	8·38
,,	2·3	,, ,, bismuth	7·0
,,	3·8	,, ,, antimony	7·1
,,	2·3	,, ,, silver	7·9

With the other metals and alloys tested a much greater difference is found in the conducting-power when such impurity exists.

A few examples will show this.

The conducting-power of pure copper is			100
Of copper with	1·6	per cent. in volume of silver	65
Of silver with	1·2	,, ,, gold	59
Pure silver being taken as 100.			
Of gold with	1·2	per cent. of silver	73·8
The conducting-power of pure gold being 78.			
If the conducting-power of mercury is			10·9
That of mercury with	1·18	per cent. volume of lead is	11·5
,,	1·8	,, ,, tin	11·8
,,	1·8	,, ,, zinc	12·4
,,	0·7	,, ,, gold	11·6
,,	1·2	,, ,, silver	11·6

The manipulation with lead is rendered easier by its high resistance.

Mercury is easily purified, and good results are always obtained with it. It would, however, in reproducing an unit, be necessary to distill the mercury, because traces of such impurities as silver and gold, which may easily get into it when in use in a laboratory, cannot be removed by treatment with nitric acid. The chief labour is in selecting and calibrating the tubes, and this is very great.

The results obtained with the gold-silver alloy, even when prepared by different persons, supposing great care used, give very accordant results, and for the easiness with which it can be made may be recommended for reproducing an unit.

Electrotype copper would appear a good substance. The agreement of results obtained with commercial electrotype copper with those obtained with copper prepared from pure salts shows this.

The maximum difference of the conducting-powers of electrotype copper, as observed with ordinary care, is 1·6 per cent. Copper is not, however, to be preferred, as great care and some practice is necessary to draw a good wire.

The purification and drawing of pure gold and silver would, in the hands of anyone but a chemist, lead to no good results, in all probability. These facts being considered, we should prefer lead for the reproduction of an unit. No doubt it would be well to use two or three substances to check the results. For these auxiliary substances mercury and the gold-silver alloy may be recommended. The choice between these two will depend on the appliances of the individual observer. When thorough care is taken all the above means are equally good.

On forming an opinion on the difficulty of reproducing an unit by chemical means it must be remembered that if anything like accuracy is wished for, not only expensive and delicate apparatus is required, but also very much time must be spent, and a great deal of experience in the manipulation is required. The experiments here described extended over about six months. Any person wishing to reproduce an unit should bear these considerations in mind, especially as it is the intention of your Committee to cause coils to be issued representing a known resistance. That copies of a given resistance can be made to a much greater accuracy than that to be obtained by chemical or other known means of reproduction, and that coils can be compared by different observers with different apparatus to almost any degree of accuracy, although this fact has been brought into question by a former experimenter, is proved by the following facts.

The two units which have come into our hands, made by Messrs. Siemens and Halske from copies of the coil used last year by your Committee for the determination of the absolute unit, were compared against the standard coil and found to agree with it within two-hundredths per cent. Again, copies of Weber's unit, one made of the gold-silver alloy, the other of German silver, were compared at the interval of two years by different observers with different apparatus, and the results found to agree to one-half a hundreth per cent.

It is from the fact that copies can be produced with almost absolute accuracy, with a minimum of cost and labour as compared with chemical or mechanical means of reproduction, that we seem quite justified in recommending all who wish to obtain a standard to procure a copy of the British Association unit, or any other in general use. As copies of the British Association unit are being sold at a reasonable price by several of the leading instrument-makers, which we are given to understand will agree together very closely, we confidently recommend the adoption of this unit.

And in conclusion, we still adhere to the opinion, given in Appendix C of the Report of 1862, that the best means of reproducing an unit, for those who have not the opportunity of procuring a copy, and who cannot afford the time and expense necessary to reproduce the unit with great care, is to procure a given length and weight of the gold-silver alloy, such as shall have been found equal to the unit adopted. The quantity required being very nearly 0·5995 of a metre of a wire, one metre in length of which would weigh a gramme for the British Association unit.

On the Fall of Rain in the British Isles during the Years 1862 *and* 1863. *By* G. J. Symons, *M.B.M.S.*

The resolution of the General Committee of this Association having involved two branches of progress in the collection of rainfall statistics, it appears best to notice separately what has been done in each.

To take first the grant for additional rain-gauges and its appropriation. The whole of the existing stations contributing to the tables of rainfall published in the British Association Report for 1862, together with all additional stations subsequently obtained, were laid down on blank maps, a list was then made of the localities where new stations were most urgently required, and this list was forwarded (with the following letter) to "The Times."

To the Editor of The Times.

Sir,—I have on several occasions been indebted to your courtesy for the rapid circulation of particulars of rainfall; may I anticipate your assistance in obtaining a few recruits in rather out-of-the-way districts, some of which can hardly be reached save by "The Times?"

Those of your readers who take an interest in the subject are mostly aware that the collection of statistics of rainfall which I commenced a few years since, has extended so much, that there are now nearly 700 stations contributing their observations to a common centre, and receiving in return copies of those made at all the others. They will, therefore, probably be at first surprised to find that the object of this letter is to obtain *more* stations, and will require some information before they see the necessity that exists for their establishment. The fact is, that although there are now probably as many stations at work as are necessary for most purposes, they are not uniformly distributed throughout the United Kingdom; and as it is impossible to expect a gentleman to change his residence because his observations would be more valuable elsewhere, it is obvious that the only plan is to start fresh gauges in the districts where observations are required.

This proposal has been endorsed by the British Association, and funds have been placed at my disposal "for the purpose of constructing and transmitting rain-gauges to districts where observations are not at present made."

My first request is, that any persons who regularly observe the fall of rain, and have not yet communicated with me, will do so at once, as otherwise I might be starting gauges unnecessarily close to them. My second request is that persons residing in or near any of the undermentioned towns or districts, having an available open space, and willing to take charge of a very simple gauge, will notify their consent to me. It will save much correspondence if they also state whether they will purchase a gauge (both Negretti and Zambra, and Casella now make them accurately, as low as 10*s.* 6*d.* each), or prefer my sending one of the British Association gauges.

The list looks rather extensive, and is so, but the blank places exist, and it is surely better to acknowledge than to ignore them. It is a good time for commencing, as a little practice may now be had before the new year begins. There is no subscription, nor anything of the kind; for the observers either receive the publications gratis, or at the cost of printing, paper, and postage; neither is there any difficulty in observing, for my correspondents are of both sexes, all ages, and all classes.

I am, Sir, your obedient Servant,
G. J. SYMONS.

129 Camden Road Villas, N.W., Nov. 24th, 1863.

Towns and Districts from the Vicinity of which Returns of the Fall of Rain are desired.

ENGLAND.—Appleby, *Westmoreland.* Bellingham, Morpeth, *Northumberland.* Whitby, Northallerton, Goole, *Yorkshire.* Spilsby, *Lincoln.* Uppingham, *Rutland.* Downham Market, Swaffham, *Cambridge.* Tamworth, *Stafford.* Hereford. Whitchurch, *Salop.* Shaftesbury, *Dorset.* Moreton-Hampstead, Hartland, *Devon.*

WALES.—Between Brecknock and Rhayader, Merthyr-Tydvil, Carmarthen, Aberystwith, Montgomery, Dolgelley, Bala, near Snowdon.

SCOTLAND.—Along the border line. Woodhead, *Ayrshire.* In the Carse of Gowrie. Huntly, *Aberdeen.* In the inland parts of Caithness, Ross, and Inverness.

IRELAND.—In the Counties of Mayo, Roscommon, Longford, Leitrim, Cavan, Louth, Antrim, Donegal, Wexford, Tipperary, Limerick (South), and Kerry (East), especially near the Lakes.

About three hundred replies were received to this letter, and the task of selecting the most eligible localities and persons was very onerous, not to mention the correspondence necessarily involved. Eventually, however, Mr Symons was enabled to send the following letter to "The Times," as some acknowledgment of the service rendered by the insertion of the previous letter.

To the Editor of The Times.

SIR,—Many of your readers may feel interested in the result of your inserting my plea for additional observers of the fall of rain in districts whence previously returns had not been received.

As letters are still pouring in daily, and the arrangements far from complete, the following list comprises but a portion of the service rendered. I thought I knew pretty well what assistance I should receive, but am happy to say that both in quality and quantity my estimate has been surpassed. The applications for "Association" gauges from districts to which I should like to have sent them, have been so much more numerous than was expected, that a most reluctant refusal has been frequently necessitated, and individual replies to all the offers of assistance rendered all but impossible. The former (financial) difficulty has been much lessened, by the large proportion of my correspondents, who, on learning how matters stood, have defrayed the cost of their own instrument, as well as undertaken the necessary duties.

The extent to which this extra kindness has prevailed, will not be the least pleasant feature in the account of my stewardship, which I shall have to render at the Bath Meeting of the British Association.

It may be well to correct an erroneous impression which seems rather prevalent, viz., that I do not care for observations save from the districts I named; that is not the case. I do not for a moment undertake to use anybody's observations—good, bad, or indifferent; but in an amateur system, removal and death are constantly thinning the ranks, and hence it becomes necessary to have a reserve corps ready to fill the vacancies; besides which, they act as checks on one another.

I cannot conclude without a special word of thanks for the sister isle, whence a most unexpectedly warm response has been received—unexpected, because Ireland had been far behind both England and Scotland, having in 1862 only 24 contributors, against 404 and 160 respectively. Now however, though still least in number, they are so well distributed over the country, as to afford safe *data* for the discussion of its rainfall, save that Killarney has not yet sent in a representative.

With many thanks for your assistance, to which science owes so much,

I am, Sir, your obedient Servant,

G. J. SYMONS.

129 Camden Road Villas, N.W., Dec. 16th, 1863.

Additional Localities whence Returns of the Fall of Rain will in future be received.

IRELAND.—*Londonderry*—Moneydig, Garvagh. *Antrim*—Antrim. *Down*—Waringstown. *Louth*—Dundalk. *Cavan*—Owendoon, Bawnboy; Red Hills, Belturbet; Cavan. *Sligo*—Doo Castle, Bunninadden; Hazlewood; Sligo. *Mayo*—Castlebar. *Roscommon*—Holywell. *Longford*—Edgworthstown. *Westmeath*—Athlone. *Dublin*—Clonsilla; Dublin. *Galway*—Innishambo, Lough Corrib; Galway. *Clare*—Ennis. *Tipperary*—Ballytristreen; Ballywalter-house, Cashel; Roscrea. *Limerick*—Blackwater.

SCOTLAND.—*Roxburgh*—Falnash; Borthwickbrae; Goldielands, Hawick; Lynnwood; Kirkton; Langraw; Menslaws; Sunlawshill; Sunnyside, Jedburgh *Renfrew*—Lochwinnoch. *Ayr*—Mauchline. *Dumbarton*—Stuckgown, Arrochar.

MONMOUTH AND WALES.—*Monmouth*—Abercarn; Abergavenny; Rockfield. *Glamorgan*—Merthyr-Tydvil. *Carmarthen*—Carmarthen. *Cardigan*—Goginan, Aberystwith; Frongoch, Aberystwith. *Merioneth*—Talgarth Hall, Machynlleth. *Montgomery* — Berriew. *Carnarvon* — Llanfairfechan; Pwllheli.

ENGLAND.—*Middlesex*—Highgate. *Surrey*—Croydon; Bagshot. *Kent*—Sandgate; West Wickham. *Hants*—Ryde. *Berks*—Wallingford. *Bedford*—Potton. *Oxford*—Henley-on-Thames. *Cambridge*—Abington Pigotts; Bexwell, Downham. *Essex*—Rochford. *Dorset*—Fontmell Magna, Shaftesbury; Gillingham; Sherborne. *Devon*—Great Torrington; Hartland; Hele, Cullompton; Torquay; Sidmouth; Otterhead, Honiton. *Gloucester*—Charlton Kings. *Hereford*—Hereford; Broomy Hill, Hereford. *Salop*—Evelith, Shiffnal; Whitchurch. *Worcester*—Malvern. *Leicester*—Woodhouse, Loughborough. *Lincoln*—Welton House, Spilsby; Horncastle. *Lancashire*—Ulverstone. *York*—Tranby Park, Hessle; Doncaster; Saddleworth; Whitby; Helmesley-in Ryedale; Northallerton; Upleatham, Redcar. *Northumberland*—Deadwater; Millfield, Wooler; Morpeth; Whitley, North Shields. *Cumberland*—Scaleby, Carlisle. *Westmoreland*—Appleby.

Gauges at Owendoon, Pwllheli, Torquay, Whitchurch, Fontmell Magna, Hartland, Holywell, Whitby, Antrim, Bunninadden, Innishambo, Northallerton, Berriew, Letterkenny, Ennis, Kiltennel, Acol, Caermarthen, and Brithdin, Dolgelley, were erected out of the grant made last year, and a further grant will be applied for this year in order to render the system still more complete.

It may be added that the above list of new stations must be looked upon simply as the record of stations at work prior to January 1st, 1864, since which time there has been a steady increase in the numbers.

One most important step has been taken during the present year, namely, the organization of a series of stations in the north of Wales, especial attention being paid to the district immediately around Snowdon, the principal object being to compare the fall in that part of the country with that in the Lake District of Cumberland and Westmoreland. Owing to the previous expenditure of the whole of last year's small grant, the cost of this series of stations has fallen on Captain Mathew, of Wern, Carnarvon; while, owing to Mr. Symons's illness, the trouble of organizing them and superintending the erection of the gauges has also fallen on Captain Mathew; it is, however, doubtful if it could have been in better hands. The gauges were specially constructed with regard to their adaptability for the measurement of snow as well as rain; how far they will answer remains to be proved; they were made by Casella, and tested by Mr. Symons before being despatched to Captain Mathew. It is proposed that there shall be not less than twenty-two stations, so as to render the series as complete as possible.

The following Table gives their heights above Mean Sea-Level, and other particulars.

Stations.	Height of Rain-gauge.		
	Above Ground.		Above Sea-level.
	ft.	in.	ft.
Portmadoc	15	0	20
Maentwrog—Cae'n-y-coed	1	0	15
Festiniog—Blaen-y-ddol	1	0	600
Trawsfynydd	0	7	700
Beddgelert—Sygun	5	6	330
Llangybi—Cefn	1	1	200
Carnarvon—Plas Brereton	1	0	35
Llanberis—Glyn Padarn	1	0	377
Royal Victoria Hotel	1	0	370
Dinorwic Quarry	1	10	850
Bethesda—Penrhyn Quarry	5	0	1000
Brynderwen	1	0	550
Llanllyfni—Gilgwyn Quarry	1	0	500
Bettws-y-coed	1	2	70
Rhiwbryfdir—Rhiwbryfdir Quarry	10	0	1200
Llanystumdwy—Talarvor	3	0	50
Pwllheli—Bodfaen	...		..
Clynnog	...		..

TABLE (*continued*).

Stations.	Height of Rain-gauge. Above Ground.		Height of Rain-gauge. Above Sea-level.
	ft.	in.	ft.
Conway	1	0	15
Bala	. . .		. .
Dolgelley	. . .		43
Aberdaron—Sarn	1	3	340
Anglesea—Menaifron	4	9	17
Llanfair-yn-nghornwy	5	0	120

It cannot but be very gratifying to all those who are interested in the important practical question of the fall of rain in this country to find Captain Mathew ready to take, single-handed, both the trouble and expense of organizing this extensive cordon of stations, almost, if not quite as extensive as those supported for some years in the Lake District by the Royal Society; but he, like Colonel Ward and the Rev. J. Chadwick Bates, spare neither trouble nor expense in working out their several branches of rainfall investigations, so that there is good ground to expect that many questions hitherto unsolved will be completely settled in the course of a very few more years.

Further examination has been made of the gauges actually at work, upwards of 100 having been visited and tested *in situ*, a most important matter; far more so than the examination of gauges before they are sent off into the country, inasmuch as the former ensures the knowledge of the accuracy or otherwise of the instrument, and *also* the suitability of its position, while the latter object is of course only to be attained by actually visiting each station. Although this requires both labour, time, and expense, its paramount importance demands its speedy accomplishment. In the interim every endeavour is made to check the erection of any but accurate instruments, upwards of 150 having been tested last year previous to their despatch to various parts of the United Kingdom, as well as some for foreign countries.

Details respecting the fall of rain in 1862–63 can only be given advantageously in tables, whereof are appended to this Report such as will render evident the variations and particulars most worthy of interest; but the broad outlines characterizing the distribution of rain during 1862 and 1863 may be thus briefly sketched. Taking, first, the whole of the stations in England, Scotland, and Ireland, we find the average fall in each of the years 1860, 1861, and 1862 about 10 per cent. above the average of the last half-century*; but on closely examining Table I., it will be found that the excess thus shown is apparent rather than real, being due mainly to the enormous excesses in the Lake District—averaging about 30 inches per year. We find moreover that the fall in the three years 1860, 1861, and 1862 was nearly equal, the difference in fact being less than half an inch, while 1863, which was rather drier than the others, differed only by 5 per cent. These uniform results are very surprising, considering that in some districts the fluctuation has been nearly 100 per cent.; for instance, Holkham, 1860, was 35 inches, 1863, was only 18 inches. Torosay Castle, 1860, was 70 inches,

* See Brit. Assoc. Report, 1862, p. 296, Table II., whence it appears that the rainfall during the ten years 1850–59 was 5 per cent. below the mean of the 50 years ending 1861. Therefore the mean value 34·98 has been raised to 36·73 before making these deductions.

and 1863 was 111 inches—a difference in the one case the reverse of the other; in the one case of 17 inches excess in 1860, the other 41 inches excess in 1863; yet the general average throughout the country remains nearly constant; it is in fact a similar compensation in yearly totals to that which has prevailed during the drought now so much felt in the south of England at the very time that the north-west of Scotland has been suffering from want of dry weather.

It is further evident, from even a cursory examination of the Table of average fall, that there has been a series of three dry years in the Midland Counties of England, just as there has been a series of three wet ones in Ireland and along the west coast of Scotland.

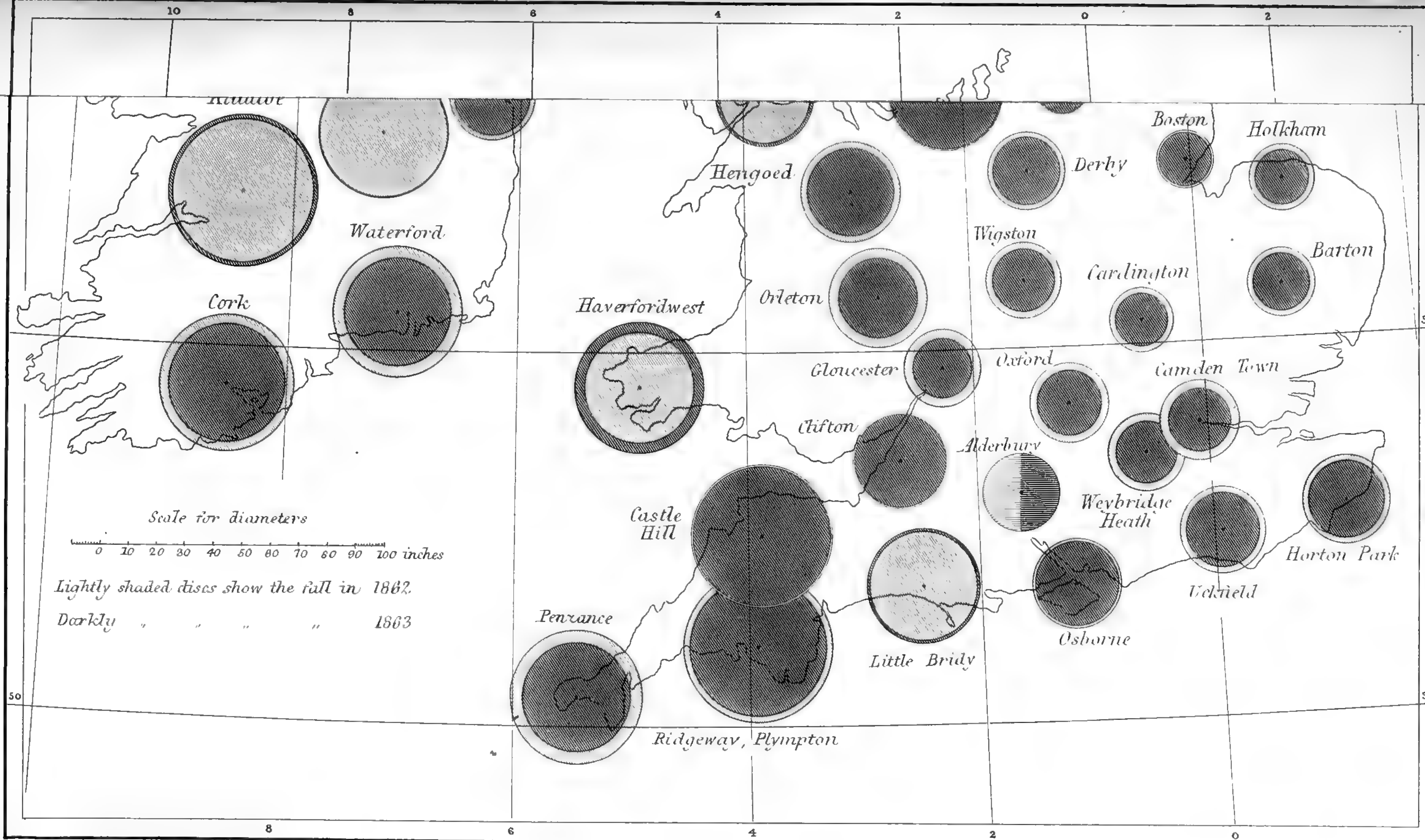
The drought at stations in the North Midland Counties has been even more felt than is warranted by the small fall in 1863, because the ground has had no chance of resuming its normal condition since the partial drought in 1861. The minimum recorded fall is 14·46 in 1863 at Southwell, Nottinghamshire, in which district seven stations return less than 17 inches; on the other hand the maximum of 1863, 173·84 at Seathwaite, is supported by 173 inches at Drishaig, by Dalmally, and by six other stations with an annual fall between 100 and 150 inches.

The fall in different districts, and the difference between the fall in the years 1862 and 1863, are shown by the accompanying map, similar in scale and design to the one published with the last Report, and in many respects evidencing the same equipoise, if it may so be termed, as in the years 1860 and 1861. In this map, as in the previous one, we find the lighter disks larger than the dark in the greater part of England, Eastern Scotland, and most parts of Ireland; that is to say, the earlier year wetter than the later, 1862 wetter than 1863, just as 1860 was wetter than 1861; the differences between the two years (shown by the breadth of the annulus) was less than in the previous case, and in one instance (Alderbury), vanished entirely. The English Lakes, North Wales, and West Scotland had their heaviest fall in the other year, 1863, just as they had previously in 1861; thus, as before stated, *seeming* to suggest a species of compensation.

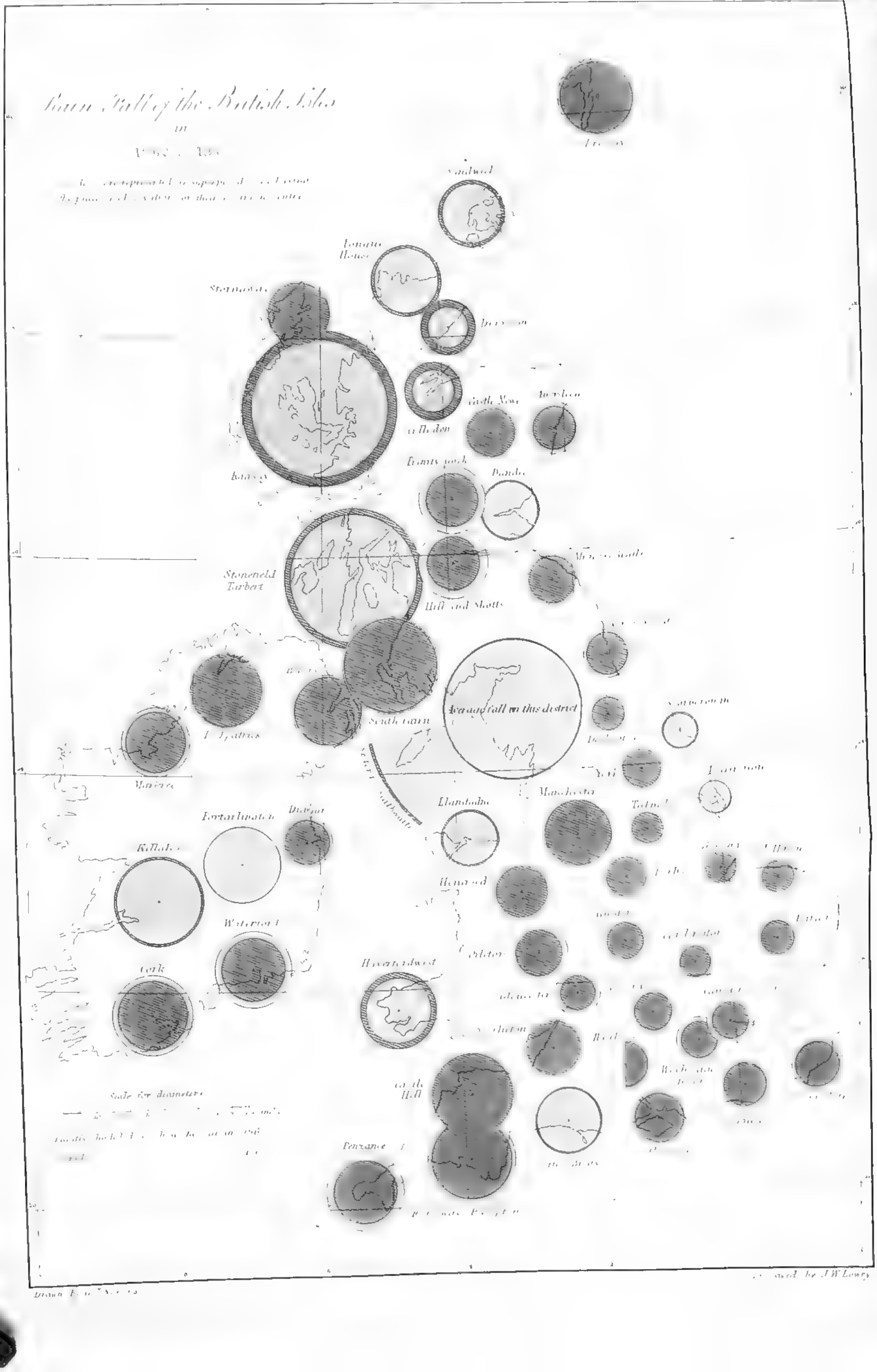
In these Tables the arrangement is primarily into counties, the stations in each county being in the order of latitude from S. to N. The counties are grouped similarly with the classification of the Registrars-General of England and Scotland, as explained on p. 294 of the previous Report. It should be mentioned that the following Tables do not contain all the observations received by Mr. Symons; persons requiring further information should apply to him at 136 Camden Road, N.W., London.

TABLE I.—Comparison of the Rainfall in the four years 1860, 1861, 1862, and 1863, with the average of the ten years 1850–59.

England.							
Division.	Station.	County.	Average Fall.	1860.	1861.	1862.	1863.
			in.	in.	in.	in.	in.
I.	Enfield	Middlesex . . .	22·67	34·57	20·02	26·41	24·83
II.	Chichester . . .	Sussex	26·67	37·44	25·15	27·47	25·08
	Ventnor	Hants	28·46	36·18	27·29	29·93	27·56
III.	Hitchin	Herts	24·72	30·28	19·92	22·52	19·35
	Banbury	Oxon	24·73	31·92	22·34	27·51	21·15



Drawn by G.J. Symons. Engraved by J.W. Lowry.



Rain Fall of the British Isles
in
Sandwick
Stornoway
Castle Newe
Aberdeen
Culloden
Braemar
Bannock
Stonefield
Tarbert
Hill and Shotts
Southampton
Average fall in this district
Llandudno
Manchester
Portarlington
Killaloe
Waterford
Cork
Haverfordwest
Penzance
Scale for diameters
Drawn by
Engraved by J.W. Lowry

TABLE I. (*continued*).

Division.	Station.	County.	Average Fall.	1860.	1861.	1862.	1863.
		ENGLAND (*continued*).					
			in.	in.	in.	in.	in.
IV.	Epping	Essex	23·18	37·03	20·42	25·86	19·25
	Dorward's Hall	Essex	20·55	26·08	18·83	21·78	17·33
	Burnham	Norfolk	26·86	34·69	24·78	26·71	22·96
	Holkham	Norfolk	26·13	34·69	21·80	22·72	18·23
V.	Baverstock	Wilts	28·69	37·45	26·75	30·30	30·45
	Goodamoor	Devon	54·12	72·02	53·66	63·14	58·80
	Exeter Institution	Devon	26·91	36·08	25·80	29·58	31·44
	Clysthydon	Devon	30·74	41·52	25·21	30·93	32·32
	Broadhembury	Devon	32·75	42·62	28·52	36·77	35·28
	Helstone	Cornwall	36·22	42·96	37·62	38·43	35·96
	Bodmin	Cornwall	43·48	56·33	44·56	47·36	42·35
	Brislington	Somerset	27·74	41·23	28·91	35·94	30·92
VI.	Cirencester	Gloucester	29·60	36·94	27·39	32·46	27·95
	Shiffnal	Shropshire	24·02	31·23	23·80	25·70	21·21
	Orleton	Worcester	28·82	36·89	29·81	34·31	27·67
VII.	Wigston	Leicester	26·39	31·47	23·20	26·13	21·77
	Derby	Derby	23·98	32·77	22·01	26·28	23·60
VIII.	Liverpool	Lancashire	24·34	24·53	23·15	27·66	30·21
	Bolton	Lancashire	44·01	57·66	44·91	53·43	53·75
	Rufford	Lancashire	33·24	39·66	34·79	37·70	39·74
	Preston (Howick)	Lancashire	34·28	39·76	36·59	44·33	41·87
	Stonyhurst	Lancashire	45·37	50·60	49·00	54·40	58·06
	Coniston	Lancashire	71·40	89·50	102·20	96·40	83·90
IX.	Redmires	York, W. Riding	37·86	44·28	37·94	40·06	40·70
	Standedge	York, W. Riding	49·58	56·75	49·75	53·25	60·50
	Well Head, Halifax	York, W. Riding	30·71	34·33	30·79	32·22	37·58
	Leeds, M. & Co.	York, W. Riding	20·91	28·60	23·30	21·25	21·45
	Settle	York, W. Riding	35·55	41·78	41·79	42·77	44·28
	Patrington	York, E. Riding	20·65	28·58	18·62	18·72	18·84
	York	York, E. Riding	22·02	30·37	20·27	23·11	22·23
X.	Bishopwearmouth	Durham	16·91	24·71	19·30	20·97	21·71
	Seathwaite	Cumberland	126·98	142·20	182·58	170·03	173·84
	Keswick	Cumberland	55·01	54·17	74·42	61·63	71·54
		SCOTLAND.					
XIII.	Thurston	Haddington	26·96	34·10	25·80	30·40	25·80
	Glencorse	Edinburgh	36·96	29·70	38·10	43·10	39·30
	Inveresk	Edinburgh	24·72	31·97	28·51	32·89	29·10
XIV.	Bothwell Castle	Lanark	27·76	26·02	25·44	38·96	30·32
	Mansfield, Largs	Ayr	43·06	44·60	55·80	54·70	54·10
	Brisbane	Ayr	46·86	48·45	62·00	59·70	55·60
XV.	Castle Toward	Argyll	47·88	47·18	65·34	62·27	57·26
	Torosay Castle	Argyll	74·64	69·70	96·00	94·00	111·00
XVI.	Pittenween	Fife	24·38	27·36	28·45	25·97	22·40
	Deanston Ho.	Perth	39·21	37·30	45·05	51·55	44·55
	Stanley	Perth	29·05	31·11	34·58	34·07	27·75
	Craigton	Forfar	31·87	37·57	34·93	38·24	28·85
	Hill Head	Forfar	31·06	37·43	35·55	37·33	28·40
	Seichen	Forfar	32·07	38·80	36·88	38·46	30·21
XVII.	Castle Newe	Aberdeen	32·99	40·49	39·06	29·41	28·79
XIX.	Sandwick	Orkney	36·14	37·96	41·18	34·38	39·72
	Bressay	Shetland	36·22	36·80	41·15	45·95	43·40
		IRELAND.					
XX.	Portlaw	Waterford	39·49	46·71	49·31	50·10	41·74
XX.	Killaloe	Clare	38·35	48·76	51·84	47·37	50·53
XXI	Black Rock, Dublin	Dublin	21·78	26·70	24·67	24·98	23·07
XXII.	Markree	Sligo	36·35	43·74	47·16	39·91	34·71

Table I. (*continued*).

Abstract.	Average Fall.	1860.	1861.	1862.	1863.
	in.	in.	in.	in.	in.
England	34·37	42·89	36·50	39·11	37·78
Scotland	36·58	38·62	43·17	44·20	40·97
Ireland	33·99	41·48	43·24	40·59	37·51
United Kingdom	34·98	41·00	40·97	41·30	38·75

Table II.—Rainfall in 1862 and 1863, at selected stations.

Div. I.—Middlesex.

	1862.	1863.
	in.	in.
Hammersmith	26·64	21·23
Camden Town	27·57	21·49
Tottenham	26·48	20·68

Div. II.—South-Eastern Counties.

Dunsfold	25·10	21·51
Redhill	29·84	20·97
Brockham, Betchworth	29·48	22·19
Bagshot	28·49	25·47
Horton Park, Hythe	30·74	26·77
Tunbridge	27·62	23·28
Linton Park	26·93	22·75
Welling	26·08	19·52
Aldwick, Bognor	25·48	21·70
Brighton	28·80	28·10
West Thorney	24·72	24·24
Chichester Museum	27·47	25·08
Chilgrove	32·35	30·45
Hurstpierpoint	28·74	27·09
Petworth	29·31	26·51
Balcomb Place	34·12	28·40
Fairlight	27·18	22·09
Battle	32·47	29·55
Maresfield, Forest Lodge	31·05	25·71
Ventnor	29·93	27·56
Osborne	30·65	28·84
Bournemouth	27·99	30·10
Lyndhurst	30·28	33·82
Southampton Ord. Survey Office	34·01	31·50
Petersfield	38·13	35·79
Arle Bury	32·46	26·90
Aldershot	25·88	23·45
Long Wittenham	29·79	25·20

Div. III.—South Midland Counties.

	1861.	1863.
	in.	in.
Hunton Bridge	26·79	23·38
Field's Weir	25·72	22·07
Berkhampstead	29·50	26·75
Hitchin	22·52	19·35
Royston	23·93	17·87
Hartwell Rectory	21·58	19·08
Oxford (Radcliffe Obs.)	27·42	22·37
Banbury	27·51	21·15
Althorp House	24·21	16·97
Wellingborough	27·00	17·63
Tetworth Hall	21·89	18·94
Aspley	26·52	21·82
Bedford	20·95	16·75
Cambridge	23·86	18·12
Wisbeach Observatory	21·30	19·36
Mid Level Sluice	23·26	22·13

Div. IV.—Eastern Counties.

Epping	25·86	19·25
Witham	21·78	17·33
Dunmow	22·81	18·05
Bocking	24·14	19·72
Ashdon	22·53	19·84
Grundisburgh	24·61	18·36
Culford, Bury St. Edmunds	23·78	20·39
Diss	23·25	17·20
Cossey	22·26	18·01
Egmere	23·92	18·24
Holkham	22·72	18·23

Div. V.—South-Western Counties.

Alderbury	26·80	26·80
Baverstock	30·30	30·45
Longbridge, Deverill	38·69	37·97
Marlborough	31·22	28·84
Calne	33·27	25·88
Badminton	33·14	30·68
Portland	26·22	28·12
Encombe	34·79	41·20
Little Bridy	37·22	38·62
Bridport	32·12	33·90
Ford Abbey	37·71	38·22
Saltram	46·92	43·68
Torhill	50·49	44·26
Goodamoor	63·14	58·80
Highwick	40·45	37·29
Dartmoor	98·51	82·14
Westbrook	34·61	35·37
Edgecumbe	52·02	41·96
Exeter (Albert Terrace)	31·40	32·15
Broadhembury	36·77	35·28
Tiverton	42·72	38·94
Meshaw	45·02	41·41
Castle Hill	48·86	48·32
Barnstaple	43·78	40·17

Table II. (*continued*).

	1862. in.	1863. in.
Helstone	38·43	35·96
Penzance	44·64	38·00
Tehidy Park	45·70	36·88
Truro	44·65	40·28
Newquay	38·62	37·40
Tideford	43·89	37·99
Bodmin	47·36	42·35
Treharrock	41·04	40·42
Rosecarrock	42·27	40·14
Camelford	54·63	50·58
Taunton	27·32	28·54
Long Sutton	28·22	30·42
Street	32·22	32·18
Sidcot	35·18	34·39
Sherborne	39·55	36·97
Batheaston	29·61	25·46
Brislington	35·94	30·92
Div. VI.—West Midland Counties.		
Clifton	32·87	32·26
Cirencester	32·46	27·95
Quedgeley	29·96	23·74
Gloucester (The Spa)	26·86	20·06
Leominster	29·09	22·15
Cleobury Mortimer	28·83	23·50
Haughton Hall, Shiffnal	25·70	21·21
Shrewsbury	26·51	25·44
Hengoed	34·68	30·32
Wrottesley	26·61	23·86
Northwick Park	30·20	23·80
West Malvern	31·89	28·23
Lark Hill, Worcester	30·44	23·80
Orleton	34·31	27·67
Leamington	27·09	21·82
Rugby	25·19	18·51
Birmingham	31·28	24·56
Div. VII.—North Midland Counties.		
Wigston	26·13	21·77
Leicester	27·24	22·34
Thornton Reservoir	28·14	21·99
Waltham Rectory	23·95	19·39
Greatford	20·53	16·36
Grantham	21·55	16·80
Boston	19·93	18·29
South Kyme	20·45	16·47
Stubton	22·97	19·75
Lincoln	20·31	16·64
Market Rasen	21·31	16·73
Gainsborough	21·36	18·52
Brigg	23·02	24·06
Grimsby	17·34	21·48
New Holland	21·62	22·52
Highfield House	23·88	18·20
Southwell	19·56	14·46
Welbeck Abbey	22·77	19·55
East Retford	22·69	19·63
Derby	26·28	23·60
Chatsworth	30·61	30·52
Chesterfield	26·34	25·06
Chapel-en-le-Frith	41·91	46·65

Div. VIII.—North-Western Counties.

	1862. in.	1863. in.
Macclesfield	36·97	37·11
Kingsley, Frodsham	37·20	37·09
Willaston	27·04	30·40
Thelwall	35·84	38·46
Marple Aqueduct	40·41	39·25
Liverpool Observatory	27·66	30·21
Old Trafford	38·60	38·33
Eccles	37·66	36·22
Bolton-le-Moors	53·43	53·75
Standish	49·01	44·70
Heywood Reservoir, Rochdale	49·86	46·25
Rufford	37·70	39·74
Howick	44·33	41·87
South Shore	37·55	35·30
Stonyhurst	54·40	58·06
Lancaster	46·31	45·78
Holker	47·58	43·20
Coniston	96·40	83·90
Div. IX.—Yorkshire.		
Broomhall Park	30·87	31·62
Redmires	40·06	40·70
Tickhill	18·76	18·15
West Melton	21·99	21·95
Dunford Bridge	52·55	59·46
Penistone	29·09	32·26
Saddleworth	43·02	47·94
Ackworth Villa	24·79	22·55
Wakefield	26·84	25·52
Well Head	32·22	37·58
Otley	31·15	31·70
Boston Spa	25·63	25·09
York	23·11	22·23
Harrogate	32·58	34·76
Settle	42·77	44·28
Arncliffe	64·05	66·43
Patrington	18·72	18·84
Hull (Beverley Road)	23·70	24·63
Holme on Spalding Moor	24·17	24·55
Malton	26·29	27·84
Beadlam Grange	27·95	25·76
Scarborough	19·83	20·90
Redcar	19·14	23·34
Div. X.—Northern Counties.		
Shotley	24·04	30·46
North Shields	28·02	24·71
Stamfordham	26·00	28·60
Alnwick	31·02	27·05
Park End, Hexham	34·74	41·71
Roddam Hall	36·00	26·38
Seathwaite	170·03	173·84
Whinfell Hall	60·81	64·45
Mirehouse	55·29	63·70
Silloth	44·19	43·85
Kendal	54·41	54·92
The How, Windermere	94·27	84·97
Brougham Hall	33·79	36·05

Table II. (*continued*).

Div. XI.—Monmouth, Wales, and the Islands.

	1862. in.	1863. in.
Chepstow	39·55	37·59
Ystalyfera	67·07	61·92
Rhydwen	53·06	49·13
Haverfordwest	38·30	45·13
Buckland	31·29	31·12
Lampeter	43·22	45·38
Gogignan	46·50	48·85
Cefnfaes	47·81	42·72
Llandyfrydog	40·14	40·83
Bangor	45·52	44·94
Llandudno	31·95	34·12
Maes-y-dre	24·09	28·98
Guernsey	32·50	34·80
Jersey	26·84	27·54
Calf-of-Man	42·49	27·87
Point of Ayr	31·73	30·91

SCOTLAND.

Div. XII.—Southern Counties.

	1862. in.	1863. in.
South Cairn	56·00	54·50
Corsewall	42·39	37·00
Little Ross	26·87	27·30
Dumfries	41·43	36·77
Wanlock head	74·10	60·44
Borthwickbrae	51·10	49·00

Div. XIII.—South-Eastern Counties.

	1862. in.	1863. in.
Thirlstane	34·50	26·45
Mungo's Walls	28·80	27·58
Yester	37·84	29·59
East Linton	29·28	24·10
Glencorse	43·10	39·30
Inveresk	32·89	29·10
Edinburgh (Charlotte Sq.)	33·92	25·64
Inchkeith	21·87	17·02

Div. XIV.—South-Western Counties.

	1862. in.	1863. in.
Newmains	70·92	65·00
Auchinraith	40·40	35·05
Baillieston	60·67	49·32
Hillend House	41·09	31·42
Auchendrane	50·17	49·95
Brisbane	59·70	55·60
Nither Place	43·00	63·45
Kilbarchan	75·20	70·30
Ferguslie House	62·03	55·64
Greenock	74·25	75·56

Div. XV.—West Midland Counties.

	1862. in.	1863. in.
Ballock Castle	67·68	57·91
Arddarrock	85·13	78·63
Mugdock	60·60	54·80
Polmaise	49·30	32·85
Ben Lomond	114·70	117·00
Pladda	53·69	43·34
Isle of Cumbræ	48·40	42·40
Mull of Cantyre	43·22	43·55
Devaar, Campbeltown	52·54	51·13
Rhinns of Islay	34·47	35·11
McArthur's Head	68·60	58·10
Stonefield	73·70	80·40
Castle Toward	62·27	57·26
Hafton, Dunoon	91·32	89·64
Otterhouse	64·46	63·86
Fladda	80·90	70·20
Inverary	63·90	87·20
Oban	72·40	82·63
Lismore	48·39	54·12
Corran, Loch Eil	54·54	104·05
Torosay	94·00	111·00
Ardnamurchan	53·04	53·93

Div. XVI.—East Midland Counties.

	1862. in.	1863. in.
Dollar	47·74	28·98
Loch Leven Sluice	42·20	34·30
Isle of May	25·08	18·61
Nookton	34·28	25·79
Pittenweem	25·97	22·40
Deanston	51·55	44·55
Loch Dhu	101·10	94·70
Bridge of Turk	71·90	68·50
Leny	75·00	66·90
Glengyle	105·10	105·50
Auchterarder	38·97	33·29
Stronvar, Loch Earn Head	97·84	89·80
Trinity Gask	39·34	31·05
Perth Academy	25·97	21·99
Stanley	34·07	27·75
Dundee Water Works	33·26	25·31
Craigton	38·24	28·85
Kettins	34·49	26·32
Arbroath	31·33	24·73
Montrose	30·27	23·47

Div. XVII.—North-Eastern Counties.

	1862. in.	1863. in.
The Burn, Brechin	36·20	26·60
Bogmuir	32·40	24·80
Strachan	33·39	26·93
Braemar	33·84	34·11
Aberdeen (Rose St.)	30·77	25·94
Castle Newe	29·41	28·79
Tillydesk	28·26	30·03
Buchanness	22·44	18·93
Kinnaird Head	25·02	26·93
Ashgrove, Elgin	29·63	27·09

Div. XVIII.—North-Western Counties.

	1862. in.	1863. in.
Kyleakin	68·04	95·10
Stornoway	37·23	36·17
Berneray	104·95	102·40
Tarbetness	47·59	47·55
Ardross Castle	34·30	44·36
Cromarty	20·36	26·63
Oronsay	67·50	123·81
Raasay	79·20	90·35
Portree	111·19	148·89
Barrahead	34·65	26·73
Ushenish	51·93	55·73
Island Glass	25·14	23·90
Beaufort Castle	30·07	42·76
Culloden House	24·63	33·88

Table II. (*continued*).

Div. XIX.—Northern Counties.

	1862. in.	1863. in.
Dunrobin	23·65	32·03
House of Tongue	37·50	41·60
Cape Wrath	40·26	50·95
Noss Head	21·04	23·99
Dunnet Head	25·11	24·42
Pentland Skerries	29·23	27·40
Kirkwall	34·73	34·92
Sandwick	34·38	39·72
North Ronaldsay	34·27	36·32
Sumburghead	27·62	25·61
Bressay	45·95	43·40
East Yell	52·21	58·70

IRELAND.

Div. XX.—Munster.

	1862. in.	1863. in.
Cork (Queen's College)	47·27	40·18
Valentia	62·19	64·64
Waterford	45·23	37·10
Portlaw	50·10	41·74
Killaloe	49·85	52·12

Div. XXI.—Leinster.

	1862. in.	1863. in.
Birr Castle	36·28	28·81
Portarlington	45·16	45·31
Fassaroe Bray	45·80	35·87
Dublin (Ordnance Survey Office)	30·18	26·41

Div. XXII.—Connaught.

	1862. in.	1863. in.
Galway (Queen's College)	51·61	62·52
Markree	39·91	34·71

Div. XXIII.—Ulster.

	1862. in.	1863. in.
Armagh	42·05	39·00
Waringstown	34·45	28·39
Belfast, Linen Hall	41·18	38·55
Leckpatrick	42·45	41·70

Table III.—Average fall of Rain in 1862 and 1863, and difference between the two years: deduced from Table II.

Division.		1862.	1863.	1862–1863.
		in.	in.	in.
England:—	I. Middlesex	26·877	21·133	− 5·744
,,	II. South-eastern Counties	29·468	26·234	− 3·234
,,	III. South Midland Counties	24·622	20·234	− 4·388
,,	IV. Eastern Counties	23·424	18·604	− 4·820
,,	V. South-western Counties	40·620	38·032	− 2·588
,,	VI. West Midland Counties	29·645	24·640	− 5·005
,,	VII. North Midland Counties	23·908	21·338	− 2·570
,,	VIII. North-western Counties	44·331	43·312	− 1·019
,,	IX. Yorkshire	30·403	31·656	+ 1·253
,,	X. Northern Counties	53·278	53·899	+ ·621
,,	XI. Monmouth, Wales, and the islands	40·129	39·489	− ·640
Scotland:—	XII. Southern Counties	48·648	44·168	− 4·480
,,	XIII. South-eastern Counties	32·775	27·347	− 4·428
,,	XIV. South-western Counties	57·743	55·129	− 2·614
,,	XV. West Midland Counties	65·330	66·778	+ 1·448
,,	XVI. East Midland Counties	49·185	42·139	− 7·046
,,	XVII. North-eastern Counties	30·136	27·015	− 3·121
,,	XVIII. North-western Counties	52·627	64·161	+11·534
,,	XIX. Northern Counties	33·829	36·588	+ 2·759
Ireland:—	XX. Munster	50·928	47·156	− 3·772
,,	XXI. Leinster	39·355	34·100	− 5·255
,,	XXII. Connaught	45·760	48·615	+ 2·855
,,	XXIII. Ulster	40·032	36·910	− 3·122
	General average	39·698	37·769	− 1·929
	England	33·337	30·779	− 2·558
	Scotland	46·279	45·416	− 0·863
	Ireland	44·019	41·695	− 2·324

TABLES OF MONTHLY RAIN-

ENGLAND AND WALES.

Division I.—Middlesex.

Middlesex.

Height of Rain-gauge above	Hammer-smith.		Bryanston Square.		Camden Town.		Hackney.		Hampstead.		Tottenham.	
Ground ……	1 ft. 0 in.		4 ft. 6 in.		0 ft. 4 in.		0 ft. 6 in.		0 ft. 10 in.		0 ft. 3 in.	
Sea-level……	12 ft.		93 ft.		100 ft.		40 ft.		360 ft.		60 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	iu.	in.	in.
January ……	1·65	2·61	1·71	2·41	1·92	2·69	1·92	2·64	2·00	2·99	1·97	2·81
February …	·34	·49	·40	·67	·31	·79	·74	·72	·37	·76	·35	·5
March ……	3·58	·65	3·68	·75	3·69	·85	3·62	·82	3·59	·87	3·31	·8
April ………	2·62	·58	2·22	·73	2·30	·38	2·44	·40	2·38	·33	2·04	·6
May ………	3·39	1·34	3·23	1·34	3·06	1·41	3·06	1·38	3·45	1·38	2·96	1·2
June ………	2·38	4·74	2·63	4·12	2·43	4·86	2·38	5·04	2·71	5·79	2·37	3·8
July ………	1·94	·84	2·43	·86	2·61	·92	2·48	·86	2·22	1·05	2·31	·7
August ……	1·93	1·69	2·34	2·00	2·73	1·41	3·66	1·96	2·53	1·90	2·45	1·8
September …	2·75	3·76	2·54	3·22	2·19	3·23	2·10	3·28	2·59	2·56	2·13	3·7
October ……	3·33	1·38	3·52	2·05	3·50	1·91	4·12	1·94	3·71	1·92	3·64	1·6
November …	1·10	1·92	1·04	1·82	1·13	1·83	1·02	1·72	1·21	2·26	1·18	1·7
December …	1·63	1·23	1·60	1·10	1·70	1·21	2·28	1·18	1·99	1·16	1·77	1·1
Totals ……	26·64	21·23	27·34	21·07	27·57	21·49	29·82	21·94	28·75	22·97	26·48	20·6

Division II.—South-Eastern Counties (*continued*).

Height of Rain-gauge above	Surrey (*continued*). Bagshot.		Kew Observatory.		Kent. Horton Park, Hythe.		Tunbridge.		Linton Park, Staplehurst.		Maidstone.	
Ground ……	3 ft. 0 in.		0 ft. 0 in.		0 ft. 0 in.		1 ft. 0 in.		0 ft. 6 in.		1 ft. 3 in.	
Sea-level……	200 ft.?		18 ft.		280 ft.?		125 ft.		200 ft.?		60 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January ……	2·26	3·04	1·64	2·49	Monthly fall not yet received.	4·23	1·88	2·61	1·75	2·12	1·74	2·2
February …	·71	·79	·41	·51		1·38	·69	1·12	1·05	·92	·67	1·0
March ……	4·11	1·07	4·47	·68		1·07	3·79	·74	3·90	·77	4·53	·7
April ………	1·90	·56	2·58	·30		1·34	1·93	·54	1·80	·72	2·00	·6
May ………	4·24	1·71	3·77	1·39		1·94	2·21	1·78	2·28	1·62	2·37	1·2
June ………	2·19	3·51	2·37	4·17		2·51	2·52	4·51	2·29	4·51	2·02	4·
July ………	1·70	1·10	2·05	·76		·79	1·32	·83	1·72	·73	1·23	·
August ……	2·42	3·47	2·69	1·75		2·75	2·43	1·80	2·50	2·42	2·40	1·2
September …	1·43	3·79	2·60	2·82		3·25	3·03	3·12	1·93	3·28	2·05	3·6
October ……	4·48	3·04	3·22	2·04		3·38	4·78	2·64	4·30	2·10	4·14	1·7
November …	1·19	1·83	·91	1·92		2·14	·87	1·87	1·30	1·85	1·16	1·
December …	1·86	1·56	1·58	1·12		1·99	2·17	1·72	2·11	1·71	1·85	1·
Totals ……	28·49	25·47	28·29	19·95	30·74	26·77	27·62	23·28	26·93	22·75	26·16	20·

[F]ALL IN THE BRITISH ISLES.

ENGLAND AND WALES.

Div. I. (*cont.*).		Division II.—South-Eastern Counties.													
Middlesex (*continued*).		Surrey.													
Enfield.		Dunsfold, Godalming.		Red Hill.		Deepdene, Dorking.		Brockham, Betchworth.		Cobham.		Weybridge Heath.	
[3]0 ft. 0 in. 140 ft.		0 ft. 6 in. …………		3 ft. 0 in. …………		2 ft. 9 in. …………		0 ft. 6 in. 130 ft.		0 ft. 6 in. 100 ft.		0 ft. 6 in. 120 ft.	
[1]862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
[i]n.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
2·24	3·35	1·79	2·79	3·46	2·63	2·13	3·60	2·16	2·88	1·82	2·65	1·97	2·74
·38	·58	·55	·70	·70	·64	·67	·85	·69	·70	·67	·60	·60	·52
3·60	·96	3·05	·70	4·14	·34	4·13	·70	3·58	·79	3·27	·55	3·81	·65
1·98	·92	1·70	·45	2·59	·54	2·50	·50	2·45	·57	1·83	·41	2·13	·42
3·18	1·38	3·90	1·35	3·15	1·48	3·67	2·05	3·65	1·54	3·66	1·66	3·48	1·28
3·99 {	4·61	1·70	3·90	2·60	3·23	2·93	3·03	2·76	2·85	1·90	3·10	2·41	3·54
	1·00	1·40	1·15	1·30	·88	1·50	1·27	1·68	1·01	1·43	·94	1·67	·83
4·22 {	·74	2·58	1·50	2·13	1·75	3·22	1·63	2·93	1·74	3·01	2·12	2·86	1·62
	4·38	1·87	3·45	1·52	3·77	1·00	3·50	1·44	3·75	1·93	2·87	2·03	4·02
3·89	1·69	3·80	2·20	5·19	2·55	4·80	3·62	4·66	2·81	3·78	2·25	3·55	2·53
1·23	3·23	1·03	1·92	1·18	1·76	1·13	2·37	1·13	1·91	1·36	1·94	1·13	1·91
1·70	1·99	1·73	1·40	1·88	1·40	2·27	2·08	2·35	1·64	1·60	1·42	1·64	1·48
[2]6·41	24·83	25·10	21·51	29·84	20·97	29·95	25·20	29·48	22·19	26·26	20·51	27·28	21·54

Division II.—South-Eastern Counties (*continued*).															
Kent (*continued*).				West Sussex.									
[S]evenoaks.		Welling, Bexley Heath.		Aldwick, Bognor.		Brighton.		West Thorney.		Chichester Museum.		Dale Park, Arundel.	
[.] ft. 0 in. [.]520 ft.		6 ft. 0 in. 150 ft.		0 ft. 6 in. 8 ft.		4 ft. 0 in. 50 ft.?		0 ft. 6 in. 10 ft.		0 ft. 6 in. 20 ft.		4 ft. 0 in. 316 ft.	
[18]62.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
[in].	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
[.]·09	2·80	1·15	2·18	1·80	2·50	1·90	3·40	1·31	3·10	2·14	3·19	2·09	3·70
[.]·59	1·05	·53	·58	·62	·42	·70	·80	·36	·90	·52	·49	·56	·28
[.]·88	·51	3·77	·79	3·81	·90	5·10	1·00	4·10	1·18	4·20	·99	4·56	1·51
[.]·98	·41	3·10	·42	1·46	·63	1·30	·70	1·53	·67	1·57	·58	1·64	·90
[.]·87	1·99	2·62	1·20	3·32	1·45	2·80	1·60	2·90	1·42	3·52	1·20	3·90	2·94
[.]·62	4·66	2·52	3·37	1·40	3·50	2·00	3·40	1·50	3·01	1·31	3·46	2·02	4·17
[.]·82	·81	1·86	·80	1·87	·05	1·90	·60	1·79	·72	1·82	·75	2·24	1·45
[.]·80	2·10	2·24	1·85	1·70	1·95	1·00	2·80	1·34	1·91	1·45	1·87	2·12	2·01
[.]·12	4·10	1·40	3·25	1·55	3·56	2·10	4·50	1·90	4·20	1·62	4·87	1·68	5·25
[.]·64	2·26	4·22	2·09	4·67	2·85	7·10	4·00	4·89	3·32	5·60	3·19	8·94	4·05
[.]·99	2·40	1·10	1·82	1·15	2·27	·90	1·50	·76	2·05	1·32	1·83	1·28	1·88
[.]·91	1·86	1·57	1·17	2·13	1·62	2·00	3·80	2·34	1·76	2·40	2·66	2·99	2·81
[.]·31	24·95	26·08	19·52	25·48	21·70	28·80	28·10	24·72	24·24	27·47	25·08	34·02	30·95

ENGLAND AND WALES.

Division II.—South-Eastern Counties (*continued*).

	West Sussex (*continued*).								East Sussex.			
Height of Rain-gauge above	Chilgrove, Chichester.		Hurstpier-point.		Petworth Rectory.		Balcombe Pl., Cuckfield.		Fairlight.		Battle.	
Ground	0 ft. 6 in.		0 ft. 0 in.		0 ft. 4 in.		0 ft. 6 in.		0 ft. 6 in.		1 ft. 3 in.	
Sea-level......	284 ft.		120 ft. ?		....		340 ft.		500 ft.		....	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	3·21	3·95	2·19	3·44	2·75	3·30	3·45	4·08	1·65	2·91	2·32	4·25
February ...	·75	·94	·61	·95	·25	1·90	·63	1·34	·80	·93	·89	1·16
March	3·99	1·21	3·46	·81	4·45	1·35	5·48	·93	3·45	·74	4·97	1·20
April	1·13	·57	1·48	·60	1·90	·40	1·97	·60	·86	·62	1·30	·74
May	3·55	2·35	3·23	2·18	3·70	1·40	3·36	1·96	2·15	2·52	2·65	2·75
June	2·60	4·52	1·73	4·80	2·13	4·16	2·72	3·68	1·60	2·60	1·91	3·73
July	2·74	·89	1·07	·78	1·51	·70	1·49	·94	1·67	·58	1·95	·78
August	2·39	1·99	1·99	2·52	2·23	1·35	1·62	2·48	1·82	2·31	2·14	2·30
September...	2·24	4·20	2·00	3·41	1·99	4·30	2·22	4·08	2·18	3·28	2·56	4·16
October	5·17	4·33	6·71	3·43	} 7·30	{ 4·35	6·78	3·30	7·68	2·64	8·14	3·52
November ...	1·45	2·24	1·26	1·77	}	{ 2·10	1·45	2·67	·75	1·50	·59	1·95
December ...	3·13	3·26	3·01	2·40	1·10	1·20	2·95	2·34	2·57	1·46	3·05	2·51
Totals	32·35	30·45	28·74	27·09	29·31	26·51	34·12	28·40	27·18	22·09	32·47	29·05

Division II.—South-Eastern Counties (*continued*).

	Hampshire (*continued*).										Berkshire.	
Height of Rain-gauge above	Lyndhurst, New Forest.		Petersfield.		Arle Bury, NewAlresford.		The Wakes, Selborne.		Aldershot.		Long Wittenham.	
Ground	....		....		1 ft. 3 in.		4 ft. 0 in.		3 ft. 0 in.		1 ft. 0 in.	
Sea-level......	....		....		80 ft. ?		500 ft. ?		325 ft.		170 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	3·18	3·86	3·54	4·65	1·75	4·00	2·87	5·42	1·92	3·62	2·11	4·12
February ...	·69	·65	·83	1·33	1·62	1·00	·68	1·43	·56	·80	·49	·75
March	3·72	1·26	4·56	1·20	4·88	·40	5·23	·84	4·67	·80	4·94	·60
April	1·76	1·05	2·86	·85	2·15	1·60	2·55	·67	2·17	·36	2·51	1·37
May	3·64	2·17	3·96	2·59	3·77	1·70	3·62	1·96	3·42	1·77	4·71	1·12
June	1·89	5·67	3·65	3·58	2·99	3·40	2·43	4·07	2·20	3·22	2·77	3·93
July	2·09	1·08	3·25	1·16	2·20	·60	1·62	·96	1·36	·83	2·30	·49
August	1·94	3·54	1·76	2·79	2·60	3·00	2·93	2·52	2·65	2·61	2·01	3·55
September...	1·65	4·24	2·37	6·07	1·80	3·80	1·76	3·77	1·13	3·20	1·72	2·54
October	6·37	4·28	6·78	5·17	5·20	4·00	5·53	4·89	3·03	3·58	3·62	3·89
November ...	·78	2·24	1·42	2·24	1·10	·90	1·28	1·87	1·14	1·30	1·07	1·71
December ...	2·57	3·78	3·15	4·16	2·40	2·50	2·62	2·80	1·63	1·36	1·54	1·13
Totals	30·28	33·82	38·13	35·79	32·46	26·90	33·12	31·20	25·88	23·45	29·79	25·20

ENGLAND AND WALES

Division II.—South-Eastern Counties (*continued*).

East Sussex (*continued*).		Hampshire.													
Forest Lodge, Maresfield.		Ventnor, Isle of Wight.		Ryde, Isle of Wight.		Osborne, Isle of Wight.		Bournemouth.		Southampton, Ordnance Survey Office.		Southampton, Ordnance Survey Office.	
1 ft. 2 in. 301 ft.		3 ft. 0 in. 150 ft.		7 ft. 0 in. 15 ft.		0 ft. 8 in. 172 ft.		1 ft. 0 in. 30 ft.		0 ft. 0 in. 74 ft.		18 ft. 6 in. 92 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
2·55	3·31	2·26	4·19	2·79	4·13	2·60	4·13	2·59	3·16	4·08	5·10	2·88	3·67
·72	1·06	·62	·88	·83	1·10	·90	·98	·32	·96	·79	1·28	·54	·87
3·93	·82	4·41	1·05	5·20	1·22	4·40	·76	4·76	1·24	4·90	1·52	3·52	1·13
1·60	·59	1·65	·62	1·81	·57	1·50	·48	1·29	·85	2·27	·80	1·56	·70
2·72	1·43	3·01	1·79	4·03	2·52	3·90	1·92	3·87	1·46	4·66	2·17	4·07	1·74
2·67	3·78	1·53	3·15	1·56	3·27	1·50	3·02	1·22	4·96	2·11	3·72	1·74	3·72
1·57	·89	1·81	·70	1·79	·71	1·70	·63	1·63	·72	2·08	1·04	1·91	1·06
2·06	2·39	1·35	2·12	1·91	2·23	1·80	2·18	2·24	2·75	1·43	2·51	·89	2·67
2·09	3·69	1·74	3·62	1·84	4·04	1·90	5·40	1·47	3·86	1·17	3·89	1·28	3·17
7·05	3·32	6·87	3·30	9·79	4·09	7·00	3·62	5·18	4·70	6·77	4·54	5·38	3·42
1·15	2·10	1·36	3·07	1·35	2·88	·97	2·41	·92	2·98	·89	2·39	·78	1·81
2·94	2·33	3·32	3·07	2·95	4·06	2·48	3·31	2·50	2·46	2·86	2·54	2·13	1·86
31·05	25·71	29·93	27·56	35·85	30·82	30·65	28·84	27·99	30·10	34·01	31·50	26·68	25·82

Division III.—South Midland Counties.

Herts.										Bucks.		Oxfordshire.	
untonBridge, Watford.		Field's Weir, Hoddesdon.		Berkhamp-stead.		Hitchin.		Royston.		Hartwell Rectory.		Radcliffe Observatory, Oxford.	
5 ft. 6 in. 200 ft.?		2 ft. 0 in. 82 ft.		1 ft. 6 in. 370 ft.		1 ft. 6 in. 240 ft.		0 ft. 7 in. 267 ft.		4 ft. 0 in. 290 ft.		0 ft. 10 in. 210 ft.	
862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1·96	2·99	2·15	3·50	2·81	4·40	1·64	3·04	1·71	2·79	1·82	2·76	2·45	3·18
·48	·52	·38	·70	·56	·80	·49	·55	·41	·52	·24	·58	·28	·68
3·20	·80	3·42	·85	4·44	·95	3·07	·72	3·07	·67	3·03	·65	5·46	·67
2·48	·64	2·60	·80	2·86	1·16	1·77	·60	1·88	·59	2·40	·81	2·28	1·41
3·79	1·43	2·80	1·00	3·33	1·07	2·57	1·09	2·99	·95	2·69	·77	3·75	·94
1·91	4·76	2·30	3·94	2·55	4·87	2·50	2·94	2·00	2·48	1·57	2·79	2·24	3·41
1·54	·90	1·32	·78	1·86	·95	1·37	·81	1·19	·53	1·68	·57	1·75	·66
2·60	3·12	2·65	1·85	2·54	2·60	2·57	2·10	3·00	2·19	1·84	2·04	1·75	2·65
2·71	3·39	1·50	3·05	1·93	3·16	1·66	2·33	2·01	1·98	2·10	2·78	2·15	2·72
3·37	1·88	3·45	2·10	3·41	3·17	2·42	1·99	2·70	1·70	2·34	2·12	2·89	2·96
1·18	1·78	1·40	2·05	1·26	2·20	1·10	2·07	1·41	2·40	·59	2·23	·99	2·01
1·57	1·17	1·75	1·45	1·95	1·42	1·36	1·11	1·52	1·07	1·28	·98	1·43	1·08
6·79	23·38	25·72	22·07	29·50	26·75	22·52	19·35	23·93	17·87	21·58	19·08	27·42	22·37

ENGLAND AND WALES.

Division III.—South Midland Counties (*continued*).

Height of Rain-gauge above	Oxfordshire (*continued*).				Northampton.				Hunts.		Bedford.	
	Radcliffe Observatory, Oxford.		Banbury.		Althorp House.		Welling-borough.		Tetworth Hall.		Aspley, Woburn.	
Ground ...... Sea-level......	24 ft. 0 in. 234 ft.		7 ft. 0 in. 345 ft.		3 ft. 4 in. 310 ft.		0 ft. 2 in.		0 ft. 6 in.		0 ft. 8 in. 460 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	2·14	2·68	2·32	2·73	2·62	2·21	2·21	2·40	1·34	2·35	1·59	2·85
February ...	·24	·53	·28	·52	·33	·22	·57	·30	·31	·33	·35	·54
March	4·31	·56	4·22	·69	3·40	·44	3·72	·63	2·55	·75	4·49	·75
April	1·88	1·13	1·88	1·04	1·40	1·03	1·96	1·13	2·05	·83	2·06	1·34
May	3·09	·86	3·31	·84	2·96	·20	3·36	·47	2·20	·69	3·20	·75
June	2·20	2·84	3·32	4·64	2·31	3·48	2·06	2·66	2·01	2·69	2·57	2·68
July	1·58	·54	2·29	·52	2·45	·51	2·71	·61	1·69	·98	1·98	·73
August	1·33	2·20	1·52	2·21	1·61	2·02	2·52	1·81	1·97	2·69	2·36	3·13
September ...	2·02	2·31	3·37	2·57	2·47	1·97	3·20	2·20	2·18	2·75	2·47	2·94
October	2·68	2·36	2·73	1·98	2·65	1·65	2·36	2·30	3·10	1·75	2·85	2·17
November ...	·72	1·44	·74	2·38	·77	2·05	·96	2·17	1·15	2·35	·97	2·70
December ...	1·20	·80	1·53	1·03	1·24	1·19	1·37	·95	1·34	·78	1·63	1·24
Totals	23·39	18·25	27·51	21·15	24·21	16·97	27·00	17·63	21·89	18·94	26·52	21·82

Division IV.—Eastern Counties (*continued*).

Height of Rain-gauge above	Essex (*continued*).				Suffolk.				Norfolk.			
	Bocking, Braintree.		Ashdon Linton.		Grundisburgh.		Culford, Bury St. Edmunds.		Diss.		Cossey, near Norwich.	
Ground ...... Sea-level......	3 ft. 0 in. 200 ft.?		1 ft 0 in. 300 ft.		4 ft. 1 in.		1 ft. 2 in.		0 ft. 6 in. 110 ft.		1 ft. 0 in.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	1·99	2·74	1·39	2·45	1·83	2·29	2·10	2·36	1·45	1·70	1·10	2·37
February ...	·58	·41	·35	·37	·62	·41	·41	·52	·60	·40	·40	·45
March	2·64	·89	2·29	·97	3·26	·70	2·40	·83	2·80	·70	4·16	·95
April	2·30	·83	2·44	·71	2·17	·64	1·41	·72	1·30	·80	·95	·98
May	2·09	·73	2·88	·68	2·85	·79	2·44	·99	2·30	1·30	2·71	·73
June	2·09	3·32	1·52	3·23	2·18	3·72	3·25	2·69	3·00	2·40	1·86	2·94
July	1·62	·64	1·94	·51	1·46	·79	2·20	·76	1·30	·70	1·03	·74
August	3·26	1·45	2·62	2·57	2·62	1·25	2·27	1·91	2·13	1·00	2·23	1·98
September ...	1·52	2·62	1·23	2·51	2·03	2·34	1·41	2·99	1·75	2·00	1·78	1·57
October	3·43	2·79	3·24	2·09	2·21	2·26	2·62	2·67	2·50	3·00	2·51	2·27
November ...	1·23	2·33	1·29	2·58	1·41	2·24	1·33	2·75	1·54	2·30	1·52	1·94
Decemb r ...	1·39	·97	1·34	1·17	1·97	·93	1·94	1·20	2·58	·90	2·01	1·09
Totals	24·14	19·72	22·53	19·84	24·61	18·36	23·78	20·39	23·25	17·20	22·26	18·01

ENGLAND AND WALES.

Division III.—South Midland Counties (*continued*).								Division IV.—Eastern Counties.					
Bedford (*continued*).		Cambridge.						Essex.					
Bedford.		Cambridge.		Wisbech Observatory.		Mid-level Sluice, Wisbech.		Epping.		Dorwards Hall, Witham.		Dunmow.	
3 ft. 6 in. 112 ft.		4 ft. 0 in. 46 ft		0 ft. 6 in. 10 ft.		4 ft. 0 in. 16 ft.		6 ft. 0 in. 360 ft.		2 ft 0 in. 20 ft.		0 ft. 6 in. 234 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1·39	2·08	1·32	2·12	1·42	1·96	1·64	2·20	1·64	2·74	1·69	2·11	1·93	2·18
·30	·35	·37	·33	·52	·36	·46	·14	·45	·45	·37	·36	·25	·16
3·14	·53	2·84	·83	3·02	·79	2·43	·79	3·65	1·06	2·76	1·01	3·25	·40
1·83	·82	2·29	·84	1·09	1·04	1·31	1·73	2·10	·50	2·08	·66	2·22	·65
2·93	·62	2·76	·75	1·98	·97	1·75	1·20	3·32	1·24	2·01	·78	2·23	·80
1·70	2·17	2·22	2·42	1·87	3·09	1·50	3·94	2·45	3·75	2·20	3·27	2·10	3·55
1·67	·46	1·88	1·09	2·09	·67	2·49	·58	1·96	·43	1·31	·62	1·78	·70
1·77	2·29	3·31	2·22	1·97	2·43	2·80	2·72	2·25	1·55	2·21	1·02	2·25	1·80
2·15	2·43	2·19	2·16	2·72	2·13	3·88	2·59	2·60	2·87	1·59	2·88	1·48	2·82
2·02	1·80	2·26	1·99	1·61	2·61	1·90	2·61	2·87	1·75	3·10	1·81	2·75	1·85
·91	2·24	1·13	2·65	1·51	2·50	1·49	2·78	·95	2·06	1·00	1·98	1·45	2·00
1·14	·96	1·29	·72	1·50	·81	1·61	·85	1·62	·85	1·46	·83	1·12	1·14
20·95	16·75	23·86	18·12	21·30	19·36	23·26	22·13	25·86	19·25	21·78	17·33	22·81	18·05

Division IV.—Eastern Counties (*continued*).				Division V.—South-Western Counties.									
Norfolk (*continued*).				Wiltshire.									
Egmere, Fakenham.		Holkham.		Alderbury, Salisbury.		Baverstock.		Longbridge, Deverill.		Marlborough.		Castle House, Calne.	
4 ft. 0 in. 150 ft.		0 ft. 0 in. 39 ft.		1 ft. 0 in.		3 ft. 0 in. 300 ft.		1 ft. 0 in. 400 ft.?		4 ft. 0 in. 500 ft.?		0 ft. 11 in. 251 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1·05	1·93	1·14	2·15	2·40	4·30	3·25	3·80	3·18	4·53	3·65	3·55	3·35	2·92
·72	·47	·50	·43	·49	·85	·40	·90	·78	1·89	·52	·69	·47	·71
3·49	·89	3·28	·80	4·61	·73	4·35	1·05	5·54	·40	4·31	·77	4·90	·90
1·82	1·28	1·37	1·45	2·18	1·15	1·80	·90	3·22	1·68	2·75	1·38	3·02	1·51
2·30	·53	2·50	·70	2·85	1·44	5·00	1·75	4·75	3·16	3·75	1·77	4·02	1·65
2·03	2·84	2·05	2·60	1·98	4·44	2·45	5·30	2·86	8·07	2·97	4·06	3·18	4·35
1·96	·42	1·75	·62	1·90	·81	2·60	1·00	1·13	} 2·12	{ 2·01	1·00	2·76	·76
3·16	1·70	3·25	1·70	1·67	2·35	1·25	3·50	3·11		1·70	3·73	2·00	3·01
2·34	2·24	1·60	1·95	1·26	3·38	2·10	3·55	2·46	7·07	1·61	3·47	2·16	3·00
1·83	2·63	2·08	2·58	4·86	3·56	4·30	4·20	6·68	3·39	4·94	4·42	4·66	3·54
1·37	2·23	1·50	2·15	·80	1·47	·55	1·85	1·23	2·12	1·04	2·32	·89	2·31
1·85	1·08	1·70	1·10	1·80	2·32	2·25	2·65	3·75	3·54	1·97	1·68	1·86	1·22
23·92	18·24	22·72	18·23	26·80	26·80	30·30	30·45	38·69	37·97	31·22	28·84	33·27	25·88

ENGLAND AND WALES.

Division V.—South-Western Counties (*continued*).

	Wiltshire (*continued*).		Dorsetshire.									
Height of Rain-gauge above	Badminton.		Portland.		Encombe, Wareham.		Little Bridy.		Bridport.		Ford Abbey, Chard.	
Ground	0 ft. 10 in.		2 ft. 0 in.		0 ft. 6 in.		0 ft. 4 in.		0 ft. 11 in.		0 ft. 8 in.	
Sea-level......	....		52 ft.		150 ft.		348 ft.		85 ft.		....	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	3·09	3·08	1·51	3·42	2·80	4·95	3·21	5·84	2·75	3·92	3·09	5·63
February ...	·45	·74	·92	1·02	1·08	1·27	1·15	1·09	1·05	1·15	1·09	·96
March	3·75	·93	4·43	1·69	6·10	1·88	6·40	2·55	5·35	2·19	7·22	2·20
April	2·80	1·92	1·75	1·33	2·45	·94	2·80	1·59	2·72	1·32	3·13	1·69
May	4·82	1·84	3·11	1·53	3·86	3·22	3·18	2·30	2·80	1·84	1·95	1·79
June	3·03	5·21	1·45	3·59	1·65	5·20	2·38	4·06	2·28	4·07	2·87	5·21
July	1·76	·54	1·82	·67	2·16	1·00	2·66	·97	2·24	·72	2·59	1·48
August	2·14	3·81	1·02	2·66	2·10	4·70	1·61	5·14	1·64	3·42	3·48	3·74
September ...	3·67	3·37	1·66	3·50	1·85	3·85	2·13	4·19	1·76	4·14	3·31	3·37
October	5·11	4·88	5·18	3·93	5·98	7·53	6·65	5·59	5·50	6·17	5·23	6·74
November ...	·82	2·62	1·12	2·23	1·51	3·56	1·22	2·44	1·02	2·18	1·15	3·14
December ...	1·70	1·74	2·25	2·55	3·25	3·10	3·83	2·86	3·01	2·78	2·60	2·27
Totals	33·14	30·68	26·22	28·12	34·79	41·20	37·22	38·62	32·12	33·90	37·71	38·22

Division V.—South-Western Counties (*continued*).

	Devonshire (*continued*).											
Height of Rain-gauge above	Edgecumbe, Milton Abbot.		Dawlish.		St. Leonards, Exeter.		Broadhembury.		Hayne, Tiverton.		Meshaw Rectory, S. Molton.	
Ground	0 ft. 8 in.		0 ft. 8 in.		0 ft. 3 in.		2 ft. 4. in.		0 ft. 3 in.		0 ft. 6 in.	
Sea-level......	....		62 ft.		140 ft.		600 ft.		400 ft.		472 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	3·43	4·70	2·43	4·56	2·92	4·11	3·26	4·97	3·22	5·08	4·36	4·74
February ...	1·82	2·10	1·17	·86	1·05	·58	1·10	·77	2·58	1·31	·94	1·70
March	4·35	2·90	4·92	2·63	4·59	2·71	5·07	2·14	5·33	2·42	3·16	2·42
April	3·54	2·35	3·30	1·65	2·99	1·69	3·15	2·11	3·38	1·96	3·67	2·10
May	2·50	1·14	1·81	1·25	1·84	1·34	2·68	2·07	2·63	2·04	2·87	1·95
June	5·24	2·18	2·98	3·93	2·71	3·69	3·46	4·92	3·66	4·46	4·42	5·46
July	4·68	2·85	1·53	1·24	2·15	1·09	2·83	·76	3·77	1·25	4·45	·75
August	5·28	4·15	2·13	3·24	2·19	3·16	2·57	3·90	1·97	2·69	2·86	3·45
September ...	4·32	5·12	2·30	2·95	2·79	2·51	3·57	3·23	3·76	4·12	4·57	5·24
October	7·88	7·60	5·99	5·10	4·93	6·64	5·18	5·92	6·80	7·02	8·10	6·07
November ...	2·78	5·55	·81	2·21	·84	2·57	1·12	2·89	2·42	4·09	1·73	4·24
December ...	6·20	1·32	2·79	2·62	2·40	2·06	2·78	1·60	3·20	2·50	3·89	3·29
Totals	52·02	41·96	32·16	32·24	31·40	32·15	36·77	35·28	42·72	38·94	45·02	41·41

ENGLAND AND WALES.

Division V.—South-Western Counties (*continued*).

Devonshire.													
Saltram Gardens, Plymouth.		Torrhill, Ivy Bridge.		Goodamoor, Plympton.		Lee Moor.		Highwick, Newton Bushel.		Dartmoor Prison.		Westbrook, Teignmouth.	
0 ft. 3 in. 96 ft.		0 ft. 4 in. 240 ft.		0 ft. 2 in. 580 ft.		0 ft. 2 in. 900 ft.?		1 ft. 6 in. 250 ft.?		0 ft. 2 in. 1400 ft.		0 ft. 3 in. 50 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
5·21	4·44	5·20	5·50	6·61	6·92	7·85	7·96	3·69	5·15	9·50	10·31	2·72	4·16
3·30	1·63	1·69	1·86	1·96	2·59	2·20	2·66	1·36	1·44	2·87	3·47	1·30	1·39
5·53	2·95	7·48	2·66	8·05	3·56	9·50	3·60	6·37	2·57	12·33	4·75	5·19	3·38
3·41	2·22	4·49	1·94	5·12	2·83	6·03	3·03	3·47	2·01	8·21	4·31	2·88	1·94
2·25	2·25	2·94	3·28	3·36	3·50	3·47	3·97	2·45	2·49	5·71	4·81	2·34	1·47
3·05	4·50	3·88	3·74	4·32	6·48	4·80	6·55	3·63	3·23	8·81	8·33	3·74	4·16
3·64	1·48	3·84	1·46	5·39	1·86	5·84	1·93	2·21	1·46	7·54	1·80	1·85	1·49
2·33	4·17	2·86	4·19	3·67	5·20	4·86	5·46	2·53	3·18	7·85	7·73	1·87	3·39
5·08	4·91	4·84	5·36	5·68	6·98	6·60	7·13	3·42	3·24	7·15	9·04	2·57	2·36
7·65	7·95	7·35	6·06	10·64	8·33	12·40	8·84	7·20	6·34	15·06	10·91	6·15	6·52
1·67	3·23	1·79	3·90	2·10	4·70	2·55	5·22	1·06	2·88	2·93	8·09	·83	2·66
3·80	3·95	4·13	4·31	6·24	5·85	8·47	7·20	3·06	3·30	10·55	8·59	3·17	2·45
46·92	43·68	50·49	44·26	63·14	58·80	74·57	63·55	40·45	37·29	98·51	82·14	34·61	35·37

Division V.—South-Western Counties (*continued*).

Devonshire (*continued*).				Cornwall.									
Castle Hill, S. Molton.		Barnstaple.		Helstone.		Penzance.		Tehidy Park, Redruth.		Royal Institution, Truro.		Newquay.	
3 ft. 0 in. 150 ft.		0 ft. 6 in. 31 ft.		5 ft. 0 in. 115 ft.		3 ft. 0 in. 94 ft.		0 ft. 0 in. 100 ft.		40 ft. 0 in. 56 ft.		3 ft. 0 in. 90 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
3·85	4·95	3·65	4·24	3·85	3·35	4·99	4·43	4·45	5·45	5·10	5·02	4·34	4·12
1·14	1·80	·95	1·28	1·11	1·37	2·13	1·48	2·10	1·50	1·51	1·11	1·35	1·27
3·87	2·23	4·06	1·93	4·81	2·73	5·06	3·29	4·13	3·04	5·07	2·57	3·72	2·18
3·65	1·99	3·28	1·88	2·63	1·52	2·91	1·60	2·83	·04	2·44	1·63	2·31	1·47
3·51	2·20	3·51	1·75	2·33	2·70	1·99	2·16	2·50	2·52	2·87	2·40	2·53	2·15
4·28	6·60	4·24	5·65	3·10	4·48	3·26	4·29	3·88	4·50	3·61	4·37	3·21	5·10
4·35	1·12	3·00	·79	2·90	1·75	3·59	1·44	3·35	1·10	3·01	1·58	2·93	1·33
3·73	4·60	3·79	4·09	1·83	3·96	1·81	3·91	3·30	2·50	2·04	4·01	2·00	3·88
5·03	6·81	3·89	6·61	4·13	3·58	3·47	4·09	4·07	3·85	4·69	4·45	3·35	3·68
8·65	5·87	6·90	4·64	5·07	3·59	6·83	3·36	6·30	4·60	6·34	5·13	6·30	5·00
2·08	6·34	2·53	4·48	3·51	3·16	4·05	3·75	3·80	3·68	3·82	3·82	2·52	3·31
4·72	3·81	3·98	2·83	3·16	3·77	4·55	4·20	4·99	4·10	4·15	4·19	4·06	3·91
48·86	48·32	43·78	40·17	38·43	35·96	44·64	38·00	45·70	36·88	44·65	40·28	38·62	37·40

ENGLAND AND WALES.

Division V.—South-Western Counties (*continued*).

Cornwall (*continued*).

Height of Rain-gauge above	Tideford, St. German's.		Bodmin.		Warleggan, Bodmin.		Treharrock House, Wadebridge.		Rosecarrock, Port Isaac.		Camelford.	
Ground	0 ft. 4 in.		2 ft. 0 in.		3 ft. 0 in.		3 ft. 6 in.		3 ft. 0 in.		3 ft. 6 in.	
Sea-level......	75 ft.?		325 ft.		800 ft.		303 ft.		210 ft.		580 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	5·04	4·70	5·52	4·35	5·91	5·54	3·59	4·59	4·30	3·96	5·67	4·46
February ...	1·37	1·11	1·86	1·15	1·43	1·40	1·45	1·77	1·48	1·43	1·99	1·17
March	5·34	3·00	5·63	3·51	6·20	3·89	3·38	1·97	3·06	2·18	5·48	3·10
April	3·11	2·02	2·65	1·69	3·00	2·30	2·79	1·93	2·96	1·82	4·44	2·23
May	1·65	1·74	2·73	1·96	4·00	3·02	2·68	1·85	2·79	2·31	2·99	2·88
June	3·95	3·41	4·59	3·66	4·51	4·47	4·22	4·51	4·08	4·98	5·76	6·34
July	2·57	1·53	3·34	1·39	4·57	1·64	2·85	1·41	2·60	1·39	3·18	1·19
August	2·66	3·47	2·38	4·49	2·98	4·51	2·61	5·29	2·42	4·88	2·36	5·98
September ...	4·95	5·25	4·45	4·77	5·64	5·97	4·62	4·01	4·91	3·97	6·42	4·99
October	7·37	4·82	6·88	6·75	8·92	8·21	6·65	5·56	7·13	6·08	8·46	7·11
November ...	1·82	2·95	2·13	4·51	2·26	6·81	2·07	3·71	2·32	3·67	2·22	5·46
December ...	4·06	3·99	5·20	4·12	6·19	6·16	4·13	3·82	4·22	3·47	5·66	5·67
Totals	43·89	37·99	47·36	42·35	55·61	53·92	41·04	40·42	42·27	40·14	54·63	50·58

Division VI.—West Midland Counties.

	Gloucester.										Shropshire.	
Height of Rain-gauge above	Bristol, Park-row.		Clifton.		Cirencester.		Quedgeley.		The Spa, Gloucester.		West Lodge, Leominster.	
Ground	6 ft. 0 in.		0 ft. 6 in.		1 ft. 2 in.		0 ft. 10 in.		3 ft. 6 in.		1 ft. 6 in.	
Sea-level......	140 ft.		192 ft.		446 ft.		100 ft.		50 ft.		229 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	2·86	3·88	3·20	4·09	2·70	3·30	2·64	2·62	2·32	2·15	3·07	2·87
February ...	·53	·92	·41	·81	·35	·72	·25	·70	·22	·58	·45	·68
March	4·88	·94	4·50	·83	4·70	1·25	3·70	·70	2·95	·56	3·56	·92
April	2·97	1·62	3·13	1·89	2·22	1·23	2·51	1·17	2·11	1·13	2·34	1·30
May	3·24	2·29	3·36	2·25	3·95	1·40	3·89	·94	3·33	·85	3·84	·71
June	2·64	4·36	2·73	4·65	2·97	5·32	3·75	5·20	3·51	3·96	1·98	3·61
July	2·44	·45	2·53	·51	2·08	·50	1·97	·44	1·64	·36	2·29	·71
August	1·42	4·08	1·45	3·88	2·25	3·65	1·38	3·67	1·51	2·79	1·48	1·45
September ...	2·36	3·28	2·39	3·58	3·87	3·00	3·16	2·49	3·10	2·11	3·68	3·18
October	5·02	4·92	5·72	5·20	4·72	3·75	4·13	3·08	3·85	2·98	3·59	3·93
November ...	1·48	2·98	1·47	2·90	·55	2·10	·78	1·90	·72	1·87	·85	1·77
December ...	2·11	1·17	1·98	1·67	2·10	1·73	1·80	·83	1·60	·72	1·96	1·02
Totals	31·95	30·89	32·87	32·26	32·46	27·95	29·96	23·74	26·86	20·06	29·09	22·15

ENGLAND AND WALES.

Division V.—South-Western Counties (*continued*).

Somerset.													
Taunton.		Long Sutton, Langport.		Street, Glastonbury.		Sidcot, Axbridge.		Sherborne Reservoir.		Batheaston.		Brislington, Bristol.	
1 ft. 6 in. 38 ft.		0 ft. 7 in. 170 ft.?		1 ft. 6 in. 100 ft.		5 ft. 0 in. 250 ft.		5 ft. 0 in. 360 ft.		2 ft. 0 in. 226 ft.		2 ft. 0 in. 181 ft.	
862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
2·34	3·97	2·55	3·50	3·11	3·80	2·14	3·42	3·38	4·29	2·90	2·56	3·42	3·50
·66	·53	·64	·52	·59	·56	·53	·78	1·07	1·43	·35	·57	·35	·70
4·15	1·43	3·98	1·26	3·61	1·54	4·66	1·32	4·56	1·17	3·91	·90	6·90	1·07
2·74	1·42	2·85	1·48	2·98	2·02	4·07	2·01	3·68	2·03	2·85	1·60	3·36	1·90
2·65	1·79	2·86	1·11	3·35	1·73	2·75	2·61	4·63	2·59	3·86	1·84	3·57	1·97
2·07	3·96	2·36	5·39	3·66	4·43	2·60	4·91	3·45	4·77	3·21	4·62	2·69	4·03
1·88	·54	2·47	·92	2·53	·50	4·09	·52	4·19	·52	2·69	·49	2·40	·32
2·22	4·14	1·95	3·88	1·71	4·04	2·01	4·41	1·60	3·55	·87	2·72	1·64	4·20
1·95	2·46	2·22	2·74	3·13	3·82	3·62	5·62	3·13	4·44	3·05	3·54	2·22	4·05
3·96	4·41	3·77	5·67	4·46	5·55	5·63	5·17	5·66	6·77	3·64	3·32	5·62	4·92
·85	2·51	·63	2·53	1·02	2·55	1·31	2·65	1·38	3·66	·73	2·34	1·52	2·64
1·85	1·38	1·94	1·42	2·07	1·64	1·77	·97	2·82	1·75	1·55	·96	2·25	1·62
7·32	28·54	28·22	30·42	32·22	32·18	35·18	34·39	39·55	36·97	29·61	25·46	35·94	30·92

Division VI.—West Midland Counties (*continued*).

Shropshire (*continued*).								Stafford.		Worcester.			
Cleobury Mortimer.		Haughton Hall, Shifnall.		Highfield, Shrewsbury.		Hengoed, Oswestry.		Wrottesley Observatory.		Northwick Park.		West Malvern.	
0 ft. 0 in. 600 ft.?		4 ft. 6 in. 450 ft.		5 ft. 6 in. 200 ft.		6 ft. 0 in. 471 ft.		0 ft. 0 in. 531 ft.		1 ft. 0 in.		1 ft. 3 in. 900 ft.	
862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
n.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
·90	2·47	1·99	2·18	1·95	2·88	2·67	5·27	2·00	2·01	1·97	3·45	2·11	2·99
·39	·54	·19	·44	·26	·40	·38	·89	·48	·30	1·20	·55	1·39	·66
·81	·91	2·60	1·03	2·52	·85	3·76	1·52	3·44	·83	4·67	·67	4·30	1·25
·35	1·09	2·08	·72	1·75	1·44	2·92	1·40	2·50	1·00	2·55	·72	2·76	1·31
·76	·71	4·14	1·27	4·83	1·03	4·43	1·59	3·84	·92	4·76	·68	4·05	·82
·13	4·55	1·73	3·67	1·93	4·36	2·86	2·89	1·53	4·86	3·41	4·63	2·47	4·87
·42	·88	2·27	1·16	1·65	1·50	2·52	1·28	1·75	1·23	2·33	·78	2·21	·92
·04	2·12	2·85	2·29	3·08	2·30	2·78	2·91	1·94	2·69	1·89	2·06	1·83	3·64
·21	3·79	2·75	3·05	2·72	3·56	3·45	3·67	3·61	3·26	2·07	2·60	4·34	3·17
·20	3·24	2·94	2·84	3·15	3·59	4·40	4·90	2·88	3·24	2·93	3·91	3·83	5·25
·93	2·02	·64	1·82	1·35	2·29	1·43	2·15	·99	2·47	1·00	2·70	·90	2·35
·69	1·18	1·52	·74	1·32	1·24	3·08	1·85	1·97	1·05	1·42	1·05	1·70	1·00
·83	23·50	25·70	21·21	26·51	25·44	34·68	30·32	26·93	23·86	30·20	23·80	31·89	28·23

ENGLAND AND WALES.

Division VI.—West Midland Counties (*continued*).

	Worcester (*continued*).				Warwickshire.							
Height of Rain-gauge above	Lark Hill, Worcester.		Orleton, Tenbury.		Leamington.		Rugby.		Edgbaston.		Birmingham.	
Ground ...... Sea-level......	1 ft. 0 in. 140 ft.		0 ft. 9 in. 200 ft.		0 ft. 8 in. 195 ft.		2 ft. 4 in. 315 ft.		1 ft. 6 in. 510 ft.		0 ft. 10 in. 340 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	2·66	2·92	3·33	3·48	2·54	2·60	2·29	2·07	3·49	3·08	3·12	3·12
February ...	·59	·72	·66	·82	·63	·45	·39	·45	·83	·57	·66	·58
March	4·02	·72	4·16	1·11	3·25	·67	3·58	·31	4·64	·92	4·44	·92
April	2·04	1·24	3·17	1·21	1·62	1·46	1·56	1·41	2·47	1·00	2·18	·96
May	5·44	·62	4·54	·91	3·82	·51	2·34	·44	3·86	·65	3·77	·52
June	2·15	3·73	2·30	4·66	3·31	4·88	3·32	3·72	2·52	3·96	2·23	4·21
July	1·89	·65	2·24	·86	2·14	·57	1·89	·66	2·08	·98	2·11	·96
August	2·01	3·46	2·27	2·57	2·06	2·44	1·90	2·02	1·85	2·93	1·71	3·38
September ...	3·75	3·07	4·22	3·97	3·06	2·26	3·28	2·23	4·51	2·86	5·01	2·33
October	3·49	3·32	4·14	4·09	2·58	2·90	2·59	2·13	3·63	3·78	3·11	3·95
November ...	·81	2·25	1·20	2·52	·70	2·23	·75	1·97	·85	2·54	·88	2·35
December ...	1·59	1·10	2·08	1·47	1·38	·80	1·30	1·10	2·13	1·48	2·05	1·28
Totals	30·44	23·80	34·31	27·67	27·09	21·82	25·19	18·51	32·86	24·75	31·27	24·56

Division VII.—North Midland Counties (*continued*).

	Lincolnshire (*continued*).											
Height of Rain-gauge above	Boston.		South Kyme, Sleaford.		Stubton, Newark.		Lincoln.		Market Rasen.		Gainsborough.	
Ground ...... Sea-level......	4 ft. 0 in. 20 ft.		0 ft. 0 in. 9 ft.		5 ft. 0 in.		3 ft. 6 in. 26 ft.		3 ft. 6 in. 100 ft.		3 ft. 6 in. 76 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	1·54	2·25	1·60	2·61	1·46	2·40	1·09	1·49	1·58	2·43	·97	2·09
February ...	·39	·33	·54	·27	·36	·33	·54	·11	·92	·42	·91	·22
March	3·22	·83	3·55	·63	3·86	·66	2·46	·59	2·72	1·09	3·04	·55
April	1·30	1·30	1·41	1·30	2·10	1·28	1·55	·92	1·76	·38	1·17	·66
May	2·06	·71	1·71	·71	2·27	·63	2·75	·42	1·82	·80	2·66	·41
June	1·98	1·75	1·71	1·91	1·36	3·32	1·56	2·36	1·79	1·78	1·29	2·42
July	2·22	·60	1·49	·71	1·18	·73	1·81	1·02	1·83	·94	1·83	1·78
August	1·70	2·75	1·68	1·61	2·45	2·26	2·11	2·09	1·29	1·78	1·25	2·86
September ...	1·47	1·90	2·21	1·49	3·13	2·37	2·72	2·56	2·98	2·54	4·47	2·02
October	1·84	2·47	2·09	2·37	2·47	2·31	1·71	2·34	1·77	2·02	1·97	2·36
November ...	·86	2·45	·92	2·06	1·05	2·51	·89	1·78	1·01	1·77	·72	1·78
December ...	1·35	·95	1·54	·80	1·28	·95	1·12	·96	1·84	·78	1·08	1·37
Totals	19·93	18·29	20·45	16·47	22·97	19·75	20·31	16·64	21·31	16·73	21·36	18·52

ENGLAND AND WALES.

Division VII.—North Midland Counties.

Leicestershire.										Lincolnshire.			
Wigston Grange, Leicester.		Leicester.		Thornton Reservoir.		Waltham Rectory.		Belvoir Castle.		Greatford Hall, Stamford.		Grantham.	
ft. 6 in. 220 ft.		1 ft. 6 in. 220 ft. ?		2 ft. 8 in.		4 ft. 0 in. 540 ft. ?		0 ft. 8 in. 237 ft.		0 ft. 9 in.		0 ft. 6 in. 179 ft.	
62.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
27	2·88	2·25	2·90	2·24	2·90	1·70	2·76	1·65	2·70	1·59	2·27	1·62	2·54
53	·48	·69	·45	·62	·35	·50	·47	·42	·26	·53	·30	·42	·23
31	·63	3·22	·64	3·40	·61	3·01	·54	3·20	·58	3·30	·36	3·55	·61
90	1·72	1·87	1·59	1·99	1·56	1·57	1·25	1·59	1·11	1·09	1·04	1·33	·85
30	·47	3·22	·78	3·35	·47	3·01	·60	2·88	·54	2·24	·73	2·12	·62
95	3·59	2·29	3·54	2·65	3·64	2·24	2·77	2·09	2·70	2·10	2·48	1·76	2·59
98	·74	2·54	·87	2·25	·91	1·95	·62	1·82	·93	1·62	·89	1·31	·76
49	2·41	2·54	2·48	1·64	2·43	1·83	1·79	2·77	1·58	1·92	1·39	2·06	1·00
94	2·63	2·90	2·49	4·52	2·35	3·00	2·40	2·59	2·52	2·05	1·72	2·84	1·99
91	3·07	2·97	3·84	2·74	2·75	2·72	2·55	2·08	2·63	2·06	2·42	2·22	2·39
90	2·04	·95	1·67	·90	2·81	·93	2·76	·92	2·40	·97	2·11	1·02	2·37
65	1·11	1·80	1·09	1·84	1·21	1·49	·88	1·34	·92	1·06	·65	1·30	·85
13	21·77	27·24	22·34	28·14	21·99	23·95	19·39	23·35	18·87	20·53	16·36	21·55	16·80

Division VII.—North Midland Counties (*continued*).

Lincolnshire (*continued*)						Nottinghamshire.							
Brigg.		Grimsby.		New Holland.		Highfield House.		Southwell.		Welbeck Abbey.		East Retford.	
ft. 6 in. 16 ft.		15 ft. 0 in. 42 ft.		3 ft. 6 in. 18 ft.		0 ft. 6 in. 162 ft.		1 ft. 0 in. 200 ft.		4 ft. 0 in.		2 ft. 0 in. 50 ft.	
2.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
4	3·72	1·16	2·97	1·38	3·09	1·56	2·00	1·03	1·49	·87	2·32	·67	2·14
9	·45	·65	·35	·92	·41	·84	·39	·57	·39	·56	·38	·64	·30
4	·76	1·68	1·83	2·90	1·36	3·38	·29	2·56	·46	3·68	·62	3·45	·58
4	1·07	·80	·36	1·36	1·17	1·58	1·42	1·18	·84	1·42	·48	1·45	·59
5	·67	·96	·49	1·21	·87	3·44	·54	2·72	·49	2·38	·53	2·58	·46
3	1·80	1·98	1·95	2·18	1·79	1·47	3·42	1·89	1·83	1·74	2·88	1·68	2·76
8	1·96	1·07	·43	1·72	1·65	1·40	1·25	1·37	1·05	1·83	1·34	2·04	1·37
9	2·79	1·31	2·59	1·93	2·80	2·41	2·70	1·40	1·53	1·95	2·53	2·06	2·57
0	3·57	3·52	4·11	3·46	2·21	3·80	1·80	3·63	1·76	3·78	2·78	4·14	2·65
8	3·10	1·29	2·36	2·15	2·78	2·43	2·32	1·82	2·24	3·14	2·85	2·15	2·91
0	2·74	1·21	3·08	·89	2·58	·46	1·43	·45	1·41	·98	2·21	·85	2·16
8	1·43	1·71	·96	1·52	1·81	1·11	·64	·94	·97	·44	·63	·98	1·14
2	24·06	17·34	21·48	21·62	22·52	23·88	18·20	19·56	14·46	22·77	19·55	22·69	19·63

ENGLAND AND WALES.

Division VII.—North Midland Counties (*continued*).

Derbyshire.

Height of Rain-gauge above Ground …… Sea-level……	Derby. 5 ft. 0 in. 180 ft.		Chatsworth Gardens. 6 ft. 0 in. 404 ft.		Chesterfield. 3 ft. 6 in. 248 ft.		Comb's Moss. 3 ft. 6 in. 1669 ft.		Comb's Reservoir. 3 ft. 6 in. 710 ft.		Chapel-en-le-Frith. 3 ft. 6 in. 965 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January ……	1·42	2·59	1·98	5·13	1·49	3·89	4·11	5·35	4·23	8·26	3·24	6·63
February …	·76	·49	1·10	·92	·66	·59	2·66	1·50	1·79	1·43	·92	1·38
March ……	3·53	·49	4·04	·80	3·88	·52	4·18	1·10	4·58	1·90	3·15	1·44
April ………	2·26	1·31	2·54	1·09	1·81	·68	2·43	2·65	3·12	2·32	2·53	1·94
May ………	3·70	·62	2·65	1·74	3·85	·77	4·68	4·07	4·21	3·54	3·98	3·12
June ………	2·35	5·52	2·21	4·30	1·97	5·04	8·79	4·80	7·23	4·37	5·51	3·86
July ………	2·21	1·33	2·64	1·84	1·65	2·06	5·06	3·66	6·67	3·31	4·79	2·34
August ……	1·76	2·72	1·46	2·36	1·82	2·26	3·71	7·03	3·80	7·05	3·08	4·3[illegible]
September …	3·73	2·26	3·44	2·83	3·54	2·20	5·39	6·58	4·71	6·25	3·71	6·8[illegible]
October ……	2·43	3·54	4·83	4·41	3·60	3·73	6·17	9·92	5·93	8·33	5·67	6·5[illegible]
November …	·61	1·61	1·21	2·61	·55	1·72	2·73	4·59	2·00	5·49	1·57	4·0[illegible]
December …	1·52	1·12	2·51	2·49	1·52	1·60	5·90	4·46	5·03	5·34	3·76	4·1[illegible]
Totals ……	26·28	23·60	30·61	30·52	26·34	25·06	55·81	55·71	53·30	57·59	41·91	46·6[illegible]

Division VIII.—North-Western Counties (*continued*).

Cheshire (*continued*). — Lancashire.

Height of Rain-gauge above Ground …… Sea-level……	Newton. 3 ft. 6 in. 396 ft.		Liverpool Observatory. 30 ft. 0 in. 52 ft.		Old Trafford, Manchester. 2 ft. 7 in. 106 ft.		Eccles, Manchester. 3 ft. 0 in. 115 ft.		Waterhouses, Oldham. 3 ft. 6 in. 345 ft.		Bolton-le-Moors. 3 ft. 6 in. 286 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	186[illegible]
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January ……	1·72	4·50	1·68	3·34	1·90	4·43	2·82	3·96	2·78	4·89	3·68	5·[illegible]
February …	1·09	·98	·26	·32	·96	·94	·80	·87	·65	·71	1·18	1·[illegible]
March ……	2·52	·78	2·63	·60	3·67	·80	4·39	·96	3·21	·72	4·62	1·[illegible]
April ………	3·10	1·62	1·61	1·32	2·72	1·39	2·46	1·26	2·45	1·30	3·36	1·[illegible]
May ………	4·07	1·35	4·68	1·53	4·47	1·72	3·82	1·79	5·28	1·76	4·93	3·[illegible]
June ………	3·10	3·71	1·10	3·70	3·07	4·63	3·25	4·36	3·28	4·15	5·33	4·[illegible]
July ………	3·62	1·50	3·01	1·53	4·53	1·63	4·22	1·69	4·55	1·44	3·90	1·[illegible]
August ……	2·93	4·75	2·16	3·18	2·35	5·03	2·22	4·74	3·01	4·67	5·30	7·[illegible]
September …	4·67	5·35	3·07	5·01	5·00	5·56	4·54	5·28	4·77	5·91	5·46	7·[illegible]
October ……	5·03	5·44	3·66	5·06	5·03	6·24	4·59	5·39	5·29	5·72	7·58	7·[illegible]
November …	1·21	2·89	1·54	2·97	1·68	2·90	1·67	3·16	1·35	2·16	2·69	5·[illegible]
December …	2·45	2·36	2·26	1·65	3·22	3·06	2·88	2·76	3·12	2·96	5·40	4·[illegible]
Totals ……	35·51	35·23	27·66	30·21	38·60	38·33	37·66	36·22	39·74	36·39	53·43	53·[illegible]

ENGLAND AND WALES.

Division VIII.—North-Western Counties.

Cheshire.

Bosley Minns.		Bosley Reservoir.		Macclesfield.		Kingsley, Frodsham.		Willaston.		Quarry Bank.		Thelwall, Warrington.	
3 ft. 6 in. 1210 ft.		3 ft. 6 in. 590 ft.		3 ft. 6 in. 539 ft.		0 ft. 8 in. 193 ft.		4 ft. 0 in. …………		0 ft. 8 in. 295 ft.		1 ft. 0 in. 96 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
2·68	4·21	2·40	5·10	2·49	4·41	2·12	3·71	1·51	2·15	2·50	3·94	2·14	3·71
·59	·69	·66	·82	·54	·86	·48	·73	·26	·40	·39	·87	·74	·81
3·18	·92	3·41	1·58	3·20	1·35	3·70	·91	2·44	·42	3·51	·95	3·94	1·00
2·30	·86	1·95	1·18	2·70	1·08	2·58	1·20	1·99	·99	2·37	1·38	2·34	1·39
3·59	2·08	4·17	2·32	3·71	2·27	5·50	2·38	5·46	·83	4·27	1·63	4·14	2·28
3·00	4·53	3·79	4·51	5·07	4·76	3·05	5·66	·87	3·49	3·26	4·26	2·66	5·64
4·06	2·75	4·25	2·47	4·83	2·09	4·43	2·07	2·08	1·72	4·55	1·90	3·97	1·98
3·73	4·04	2·51	4·09	2·56	4·28	3·16	3·25	3·04	3·54	2·91	4·49	2·96	3·90
3·88	5·18	5·07	4·54	2·99	5·52	3·56	5·42	3·12	3·80	3·33	5·02	3·40	5·13
3·88	6·31	5·24	4·63	4·18	5·35	4·55	6·45	3·29	6·87	4·27	5·47	4·92	6·80
1·00	2·98	1·40	2·80	1·61	2·57	1·44	2·96	·97	4·29	1·63	2·49	1·67	3·49
2·30	2·86	2·74	2·30	3·09	2·57	2·63	2·35	2·01	1·90	2·41	2·30	2·96	2·33
4·19	37·41	37·59	36·34	36·97	37·11	37·20	37·09	27·04	30·40	35·40	34·70	35·84	38·46

Division VIII.—North-Western Counties (*continued*).

Lancashire (*continued*).

Standish, Wigan.		Heywood Reservoir, Rochdale.		Rufford, Ormskirk.		Howick House, Preston.		House of Correction, Preston.				South Shore, Blackpool.	
0 ft. 6 in. 300 ft.		………… 900 ft.		0 ft. 8 in. 38 ft.		0 ft. 6 in. 72 ft.		1 ft. 1 in. 140 ft.		53 ft. 6 in. 187 ft.		1 ft. 8 in. 29 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
4·07	4·46	3·44	4·85	2·83	4·38	5·17	4·60	2·50	4·15	2·30	3·50	3·30	4·40
·86	1·11	·80	2·16	·58	·90	·70	1·25	·63	1·26	·47	·94	·70	1·00
4·15	1·66	4·57	1·20	3·79	1·33	5·00	1·38	5·00	1·15	4·12	1·01	3·90	1·10
3·24	1·26	3·40	1·36	2·54	1·14	3·15	1·60	3·40	1·70	2·79	1·39	2·60	1·25
4·39	2·82	5·70	1·64	4·44	2·43	4·00	2·75	3·97	2·78	3·51	2·37	5·35	2·40
4·83	5·49	4·62	5·00	3·17	4·46	3·15	4·80	3·44	5·10	2·69	4·64	2·60	2·60
4·54	1·79	5·77	1·16	3·59	1·85	4·47	2·00	4·98	2·17	4·25	1·75	3·45	1·05
4·09	4·91	3·05	5·77	2·95	4·37	3·55	4·95	3·08	5·00	2·72	4·52	2·65	4·10
4·90	6·77	4·43	8·04	3·80	5·62	3·68	5·65	3·94	5·62	3·47	4·77	2·30	4·90
7·13	7·02	6·68	7·25	5·00	6·57	6·37	6·94	6·23	6·05	4·69	5·15	6·00	6·10
2·43	4·21	1·85	3·92	1·91	3·89	1·99	3·10	1·90	3·98	1·55	3·02	1·50	3·90
4·38	3·20	5·55	3·90	3·10	2·80	3·10	2·85	2·69	3·14	2·12	2·14	3·20	2·50
9·01	44·70	49·86	46·25	37·70	39·74	44·33	41·87	41·76	42·10	34·68	35·20	37·55	35·30

ENGLAND AND WALES.

Division VIII.—North-Western Counties (*continued*).

Lancashire (*continued*).

Height of Rain-gauge above	Stonyhurst Observatory.		Lancaster.		Caton, Lancaster.		Holker.		Coniston.		Wray Castle, Windermere.	
Ground	0 ft. 6 in.		1 ft. 0 in.		1 ft. 9 in.		4 ft. 8 in.		4 ft. 11 in.		4 ft. 9 in.	
Sea-level......	381 ft.		114 ft.		120 ft.		155 ft.		150 ft.		250 ft ?	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	4·05	6·31	4·60	5·61	3·36	5·54	4·38	5·07	12·80	13·50	7·90	9·11
February ...	1·34	2·68	·46	1·89	·41	2·24	·44	1·69	1·50	4·50	1·39	4·34
March	4·70	2·30	4·49	1·27	4·34	1·47	4·87	1·30	6·00	2·80	5·78	2·83
April	4·47	2·50	3·57	1·92	3·72	2·63	3·85	2·15	8·20	4·70	7·55	4·92
May	5·23	3·90	3·96	3·26	3·80	3·33	4·42	3·22	5·00	5·30	4·77	4·90
June	4·90	5·08	4·55	4·30	4·89	5·07	3·39	4·10	7·50	5·20	5·91	4·73
July	5·48	1·99	4·25	1·05	4·15	1·15	3·99	·93	7·00	·50	6·70	1·20
August	4·87	5·73	4·66	5·40	5·12	5·24	3·50	4·09	6·70	6·40	4·00	5·44
September ...	3·71	8·01	2·65	6·67	2·23	6·03	2·26	6·20	4·50	11·50	3·00	9·67
October	7·98	6·39	7·10	6·59	7·17	7·61	9·11	5·84	17·50	8·50	14·45	6·80
November ...	2·58	7·68	1·95	4·45	1·94	4·96	2·02	5·09	6·70	12·00	2·77	7·89
December ...	5·09	5·49	4·07	3·37	3·53	3·61	5·35	3·52	13·00	9·00	10·50	6·51
Totals	54·40	58·06	46·31	45·78	44·66	48·88	47·58	43·20	96·40	83·90	74·72	68·34

Division IX.—Yorkshire (*continued*).

Yorkshire—West Riding (*continued*).

Height of Rain-gauge above	Ackworth Villa.		Longwood, Huddersfield.		Wakefield Prison.		Well Head, Halifax.		Ovenden Moor, Halifax.		Bradford.	
Ground	0 ft. 1 in.		4 ft. 6 in.		4 ft. 0 in.		0 ft. 11 in.		1 ft. 0 in.		48 ft. 0 in.	
Sea-level......	135 ft.		600 ft.		115 ft.		487 ft.		1375 ft.		370 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	1·51	3·79	2·07	6·56	1·30	4·46	1·87	5·91	4·20	7·00	1·62	5·12
February ...	·52	·38	·44	2·14	·56	·71	·52	1·68	1·00	3·70	·62	1·22
March	4·21	·74	4·27	4·65?	3·87	·86	4·39	1·23	5·30	1·30	4·12	1·17
April	1·33	·57	2·57	1·92	1·39	·86	2·16	1·34	4·20	3·00	2·01	1·17
May	2·43	·89	3·80	1·57	4·01	·94	3·76	1·72	4·90	3·00	4·14	1·69
June	1·90	3·04	1·98	3·84	1·97	2·95	2·74	4·02	4·40	4·50	2·34	3·87
July	2·24	1·58	3·13	1·87	2·56	1·63	2·60	1·37	3·60	1·50	2·15	1·37
August	1·59	2·98	1·94	4·46	1·88	3·08	2·14	4·50	3·20	5·40	1·98	3·51
September ...	4·09	2·30	3·22	5·33	2·83	3·02	2·50	5·24	3·10	5·90	2·31	4·58
October	3·05	3·32	6·13	4·98	4·27	3·57	6·17	5·52	8·50	8·50	5·57	4·84
November ...	·51	1·56	·91	2·15	·63	1·93	1·06	2·38	2·40	3·30	·79	2·90
December ...	1·41	1·40	3·62	2·61	1·57	1·51	2·31	2·67	5·20	6·60	1·68	2·08
Totals	24·79	22·55	34·08	42·08	26·84	25·52	32·22	37·58	50·00	53·70	29·33	33·52

ENGLAND AND WALES.

Division IX.—Yorkshire—West Riding.

Yorkshire – West Riding.

Broomhall Pk., Sheffield.		Redmires, Sheffield.		Tickhill.		West Melton.		Dunford Bridge.		Penistone.		Saddleworth.	
0 ft. 4 in. 337 ft?		4 ft. 0 in. 1100 ft.		0 ft. 1 in. 61 ft.		0 ft. 10 in. 172 ft.		3 ft. 6 in. 954 ft.		3 ft. 6 in. 717 ft.		5 ft. 0 in. 640 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
2·01	5·49	2·78	5·71	1·11	1·95	·78	4·51	3·98	9·82	1·59	6·25	2·36	5·69
·81	1·05	1·44	1·60	·75	·16	·90	·54	1·48	2·53	·63	·70	1·33	2·35
4·53	·96	4·63	1·40	2·85	·24	3·35	·68	5·85	1·57	4·73	1·17	4·30	·75
2·36	·94	3·03	1·47	1·27	·11	1·40	·89	4·61	2·46	1·67	·96	3·51	2·23
3·87	1·15	4·96	1·78	2·13	·45	3·38	·90	5·63	2·73	3·64	·97	4·87	2·04
2·17	5·59	3·92	4·50	1·56	2·23	1·43	2·87	3·83	5·63	2·13	6·44	4·73	6·25
2·08	1·94	3·86	1·94	1·30	1·89	·88	1·93	5·10	2·10	2·01	1·75	4·95	1·20
1·84	2·48	2·44	4·93	1·49	2·89	1·02	2·74	2·92	5·89	2·07	2·56	1·75	5·26
3·85	3·16	3·57	4·65	2·95	2·52	2·41	2·03	4·37	6·45	3·16	3·36	5·73	6·32
4·41	4·07	5·38	5·41	1·91	2·87	4·05	3·07	8·53	9·38	5·07	4·38	3·02	9·04
1·32	2·63	·96	3·30	·53	1·71	·64	·47	1·20	5·33	·66	1·51	1·65	2·63
1·62	2·16	3·09	4·01	·91	1·13	1·75	1·32	5·05	5·57	1·73	2·21	4·82	4·18
30·87	31·62	40·06	40·70	18·76	18·15	21·99	21·95	52·55	59·46	29·09	32·26	43·02	47·94

Division IX.—Yorkshire (*continued*).

Yorkshire—West Riding (*continued*).

eventhorpe Hall, Leeds.		Eccup, Leeds.		East Chevin, Otley.		Otley.		Boston Spa.		York.		Harrogate.	
2 ft. 0 in. 90 ft.		0 ft. 0 in. 340 ft.		4 ft. 7 in. 764 ft.		0 ft. 7 in. 206 ft.		0 ft. 11 in. 74 ft.		0 ft. 6 in. 50 ft.		0 ft. 6 in. 420 ft.	
862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
n.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1·05	3·64	1·56	4·32	2·09	5·92	2·23	6·18	1·53	3·55	1·99	2·81	2·09	6·32
·18	·58	·71	·85	·71	1·17	·71	·94	·69	·68	·64	·51	1·04	·98
2·57	·48	3·99	1·14	4·32	1·17	4·36	1·01	4·01	1·46	3·43	1·11	4·16	1·89
1·04	·53	1·79	·77	2·08	·80	2·85	·80	1·66	·74	1·30	·61	2·53	·88
2·84	1·32	3·23	1·53	4·19	1·59	3·56	1·19	2·77	·99	2·19	·95	3·25	1·93
1·71	2·57	2·27	3·07	2·68	3·08	2·60	3·16	2·40	2·20	2·59	1·98	2·41	3·56
2·16	1·27	2·10	·89	2·87	1·46	2·62	1·27	2·11	1·94	1·58	1·86	2·31	1·65
1·84	3·61	2·07	3·28	2·90	4·63	2·40	4·10	1·84	3·26	1·90	3·36	3·82	4·01
2·31	2·37	1·92	2·18	2·16	3·62	2·05	3·79	2·48	2·64	2·51	2·47	2·50	3·10
3·74	3·40	4·22	3·99	5·32	4·52	4·43	4·20	3·96	4·09	2·80	3·13	4·95	4·55
·56	1·63	·58	1·61	1·12	2·63	1·07	2·87	·60	1·85	·83	1·85	·89	3·35
1·18	·90	1·67	1·55	2·32	2·75	2·27	2·19	1·58	1·69	1·35	1·59	1·83	2·54
1·18	22·30	26·11	25·18	32·76	33·34	31·15	31·70	25·63	25·09	23·11	22·23	32·58	34·76

ENGLAND AND WALES.

Division IX.—Yorkshire (*continued*).

Height of Rain-gauge above	York—West Riding (*continued*). Settle.		Arncliffe.		York—East Riding. Patrington.		Hull, Barrly Road.		Holme, on Spalding Moor.		York—North Riding. Malton.	
Ground ...... Sea-level......	40 ft. 0 in. 498 ft.		3 ft. 0 in. 750 ft.		4 ft. 8 in. 32 ft.		3 ft. 10 in. 11 ft.		3 ft. 0 in. 30 ft.		1 ft. 0 in. 73 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	3·36	6·90	4·88	10·32	1·40	2·50	1·57	3·48	1·26	3·12	1·64	3·11
February ...	·84	2·71	2·34	4·36	·50	·32	·88	·42	1·65	·41	1·21	·63
March	5·38	1·75	5·67	2·53	2·46	1·12	2·76	1·61	3·46	1·18	3·85	·66
April	2·83	2·61	6·47	4·22	·64	1·18	1·31	1·49	1·33	·80	1·77	1·70
May	3·89	2·30	4·39	4·02	1·84	·46	2·04	·83	2·57	·74	2·08	1·13
June	3·60	4·05	5·01	5·07	1·74	1·68	2·06	1·99	2·00	2·35	2·76	1·82
July	3·52	1·03	5·23	1·51	1·36	1·72	1·84	1·73	1·94	2·12	3·01	2·16
August	2·98	3·43	5·95	4·84	1·14	2·26	1·59	3·25	3·13	4·14	1·92	5·32
September ...	1·95	5·59	2·12	8·97	3·42	1·60	4·51	2·35	2·70	1·74	2·80	2·16
October	8·43	5·39	12·50	6·92	1·70	2·20	2·57	2·94	2·22	3·94	2·33	4·36
November ...	2·30	4·49	3·06	7·70	1·26	2·40	1·04	2·85	·59	2·15	1·18	2·70
December ...	3·69	4·03	6·43	5·97	1·26	1·40	1·53	1·69	1·32	1·86	1·74	2·09
Totals	42·77	44·28	64·05	66·43	18·72	18·84	23·70	24·63	24·17	24·55	26·29	27·84

Division X.—Northern Counties (*continued*).

Northumberland.

Height of Rain-gauge above	Allenheads.		Shotley.		North Shields.		Stamfordham.		Alnwick.		Parkend, Hexham.	
Ground ...... Sea-level......	0 ft. 5 in. 1360 ft.		0 ft. 8 in. 309 ft.		1 ft. 0 in. 124 ft.		1 ft. 0 in. 400 ft.		0 ft. 6 in. 400 ft.		0 ft. 4 in. 277 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	4·17	9·00	2·44	4·54	2·50	2·97	2·43	3·63	2·14	3·16	4·00	7·73
February ...	1·75	3·20	1·22	·62	1·33	·40	1·20	·96	2·77	·34	1·23	2·49
March	4·29	2·40	4·27	2·24	3·43	1·48	3·28	2·05	4·65	1·21	3·26	1·23
April	3·00	4·24	·98	1·15	1·53	·70	1·48	1·64	1·17	1·44	2·18	2·87
May	3·85	2·64	2·89	1·53	3·09	1·43	2·73	1·83	2·11	1·62	3·51	2·53
June	5·27	4·03	2·42	4·48	3·30	4·12	3·91	3·90	3·08	4·08	2·93	6·52
July	3·14	1·38	1·84	1·71	2·01	·73	1·93	·89	2·21	·88	3·10	1·11
August	3·31	4·52	2·48	3·10	5·92	2·69	4·33	3·63	6·40	2·63	2·77	2·72
September ...	1·72	6·34	·81	3·01	1·09	1·97	·92	2·83	1·05	2·83	1·70	3·55
October	6·89	5·84	2·22	3·47	1·69	3·43	1·98	2·94	2·43	3·13	5·36	4·12
November ...	1·70	5·33	·86	2·86	·79	2·91	·83	2·98	1·14	3·52	2·13	3·62
December ...	5·12	5·10	1·61	1·75	1·34	1·88	·98	1·34	1·87	2·21	2·57	3·22
Totals	44·21	54·02	24·04	30·46	28·02	24·71	26·00	28·60	31·02	27·05	34·74	41·71

ENGLAND AND WALES.

Division IX.—Yorkshire (*continued*).						Division X.—Northern Counties.							
York—North Riding (*continued*).						Durham.							
Beadlam Grange.		Scarborough.		Redcar.		Darlington.		Stubb House, Winston.		Durham Observatory.		Sunderland.	
4 ft. 0 in. 200 ft.		8 ft. 0 in. 99 ft.		1 ft. 6 in. 20 ft.		4 ft. 0 in. 140 ft.		0 ft. 9 in. 458 ft.		1 ft. 0 in. 339 ft.		1 ft. 5 in. 85 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
2·20	3·02	1·35	2·63	1·20	2·73	2·01	2·41	2·00	4·15	1·79	2·89	1·97	2·58
·82	·49	1·00	·20	·92	·15	·79	·57	·99	·84	1·18	·42	1·48	·35
3·56	1·46	3·10	·60	4·15	1·49	3·48	1·54	4·11	1·75	3·98	1·86	3·21	1·13
1·60	1·05	1·24	·60	1·14	·63	·90	·55	1·88	·74	1·06	·63	1·07	·87
2·46	1·10	2·06	·58	1·78	1·25	1·82	1·29	2·72	1·32	2·17	1·42	1·79	1·33
3·16	2·44	1·34	2·03	1·79	3·45	2·22	2·29	2·19	3·20	2·17	4·41	3·28	3·68
2·97	1·60	3·05	2·16	1·76	1·64	1·99	·65	3·20	1·05	1·50	1·00	1·93	1·17
3·03	3·45	1·35	3·72	2·37	2·70	2·27	2·22	1·92	3·37	3·20	1·94	1·77	2·99
2·25	3·17	2·46	1·49	1·05	2·46	1·04	1·61	1·10	2·29	1·24	2·01	·98	2·15
3·11	3·43	1·34	3·18	·73	2·77	2·50	3·03	2·90	3·63	1·57	3·44	1·77	3·19
·93	2·55	·49	2·29	1·20	2·11	1·27	1·95	1·01	2·35	·89	2·54	1·00	3·15
1·86	2·00	1·05	1·42	1·05	1·96	·96	1·15	1·82	1·56	1·07	1·53	1·34	2·34
27·95	25·76	19·83	20·90	19·14	23·34	21·25	19·26	25·84	26·25	21·82	24·09	21·59	24·93

Division X.—Northern Counties (*continued*).													
Northumberland (*continued*).				Cumberland.									
Roddam Hall.		Lilburn Tower.		Seathwaite, Borrowdale.		Keswick.		Whinfell Hall, Cockermouth.		Mire House, Bassenthwaite.		Cockermouth.	
0 ft. 6 in. 545 ft.		6 ft. 0 in. 290 ft.		1 ft. 0 in. 422 ft.		6 ft. 3 in. 270 ft.		2 ft. 0 in. 266 ft.		0 ft. 5 in. 300 ft.		0 ft. 6 in. 158 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
2·81	4·68	1·68	3·42	16·78	20·65	6·38	11·79	5·83	8·71	5·48	9·21	4·93	7·48
1·94	·67	1·50	·50	5·50	14·25	1·92	4·06	1·66	3·79	1·52	3·65	1·39	3·45
5·15	·65	3·88	1·21	10·30	8·31	4·52	2·33	3·90	1·84	2·94	2·26	3·07	1·38
2·35	2·29	1·40	1·02	17·26	10·94	5·67	4·27	6·03	4·51	4·60	5·15	4·45	3·50
2·09	1·95	2·17	1·59	8·28	13·30	3·86	4·20	4·49	3·93	5·15	3·33	3·60	3·69
3·41	2·38	3·12	3·88	15·62	11·01	6·47	4·26	5·55	5·77	5·53	4·92	4·20	5·13
2·54	1·12	1·68	1·09	13·67	2·82	3·29	1·46	3·76	1·32	3·72	1·35	3·03	1·48
6·81	4·49	5·46	3·13	12·81	9·79	4·66	5·70	5·10	4·37	4·40	4·59	4·23	3·94
1·15	2·51	·68	3·19	6·38	25·03	2·16	11·40	2·59	9·99	2·15	8·68	2·24	7·97
4·14	2·77	5·86	1·93	32·13	14·86	11·77	7·64	10·89	6·81	9·98	6·10	10·38	6·09
1·21	1·73	·77	2·62	5·14	24·75	1·92	8·48	2·61	8·47	2·22	8·89	1·94	6·38
2·40	1·14	1·84	2·28	26·16	18·13	8·75	5·95	8·40	4·94	7·60	5·57	7·03	4·14
36·00	26·38	30·04	25·86	170·03	173·84	61·37	71·54	60·81	64·45	55·29	63·70	50·49	54·63

ENGLAND AND WALES.

Division X.—Northern Counties (*continued*). | Div. XI.

	Cumberland (*continued*).		Westmoreland.								Div. XI. Monmouthshire.	
	Silloth.		Kendal.		Lesketh How, Ambleside.		The How, Windermere.		Brougham Hall.		Chepstow.	
Height of Rain gauge above Ground ……	6 ft. 0 in.		4 ft. 6 in.		3 ft. 0 in.		1 ft. 2 in.		4 ft. 0 in.		2 ft. 6 in.	
Sea-level……	28 ft.		149 ft.		200 ft.		470 ft.		400 ? ft.		50 ft. ?	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January ……	3·13	7·12	4·75	7·72	9·61	13·14	12·12	12·02	3·47	6·32	2·39	4·53
February …	1·04	3·11	1·05	3·32	2·65	5·80	3·22	6·14	·78	2·90	·48	1·58
March ……	1·85	·69	5·10	1·37	6·26	3·66	9·04	3·34	2·55	·83	5·17	1·22
April ………	4·03	4·16	5·12	3·56	9·24	4·54	10·40	5·13	1·98	2·10	3·39	2·05
May ………	3·81	2·59	4·70	3·83	4·92	4·99	4·03	5·94	1·20	1·49	3·46	2·05
June ………	3·77	4·23	4·54	5·37	6·28	5·25	7·33	5·56	3·31	3·51	4·76	5·56
July ………	5·24	·76	4·30	·54	7·03	·79	9·53	1·36	3·36	·96	2·67	·64
August ……	3·58	2·88	4·73	4·47	4·74	4·63	5·36	5·02	2·61	2·91	1·98	4·46
September …	2·80	5·99	2·05	7·66	3·13	11·42	2·61	10·85	1·85	5·38	5·06	4·30
October ……	7·82	4·77	10·56	6·33	18·43	9·21	16·16	8·79	6·38	4·20	5·85	5·87
November …	2·63	4·52	2·19	5·99	2·91	11·44	2·75	11·35	1·20	2·60	1·85	3·15
December …	4·49	3·03	5·32	4·76	13·06	6·82	11·72	9·47	5·10	2·85	2·49	2·36
Totals ……	44·19	43·85	54·41	54·92	88·26	81·69	94·27	84·97	33·79	36·05	39·55	37·59

Division XI.—Monmouth, Wales, and the Islands (*continued*).

	Anglesea.		Carnarvon.		Denbigh.		Flint.				The Islands.	
	Llandyfrydog.		Bangor.		Llandudno.		Hawarden.		Maes y dre, Holywell.		Guernsey.	
Height of Rain-gauge above Ground ……	2 ft. 0 in.		5 ft. 0 in.		0 ft. 6 in.		1 ft. 0 in. ?		6 ft. 0 in.		12 ft. 0 in.	
Sea-level……	92 ft.		40 ft.		80 ft.		260 ft.		400 ft.		200 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January ……	3·46	6·07	5·06	5·75	2·80	4·53	1·92	3·02	1·86	3·38	2·31	3·81
February …	1·21	1·49	1·25	1·83	1·10	1·09	·58	·46	·31	·53	1·00	1·09
March ……	3·74	1·39	4·70	1·28	3·90	·88	3·10	·50	1·02	1·09	5·73	2·69
April ………	4·11	1·55	5·51	1·88	2·20	2·16	2·28	·90	1·99	1·39	1·48	·85
May ………	2·98	2·38	3·29	2·36	4·00	1·14	4·39	·70	2·52	1·07	2·36	2·87
June ………	2·65	2·59	}	{ 2·16	1·83	2·37	2·31	1·78	1·42	2·11	1·95	2·77
July ………	3·75	1·65	} 10·27	} 1·81	2·31	3·17	2·38	·89	3·04	1·70	1·86	1·22
August ……	2·78	3·67	}	{ 5·83	2·46	3·07	3·22	2·17	2·52	3·67	1·13	2·66
September …	2·48	5·50	2·67	6·34	2·64	3·95	3·25	2·88	2·62	3·74	1·27	4·49
October ……	5·61	7·38	5·14	7·20	3·75	6·27	3·00	4·97	3·04	5·80	6·89	5·22
November …	1·97	4·61	2·63	5·12	1·76	3·32	1·37	2·74	1·17	3·01	3·76	4·15
December …	5·40	2·55	5·00	3·38	3·20	2·17	2·57	2·05	2·58	1·49	2·76	2·98
Totals ……	40·14	40·83	45·52	44·94	31·95	34·12	30·37	23·06	24·09	28·98	32·50	34·80

ENGLAND AND WALES.

Division XI.—Monmouth, Wales, and the Islands.

Glamorganshire.		Caermarthenshire.		Pembrokeshire.		Brecon.		Cardigan.				Radnor.	
Ystalyfera.		Rhydwen.		Haverfordwest.		Buckland, Crickhowell.		Lampeter.		Goginan. Aberystwith.		Cefnfaes, Rhayader.	
4 ft. 0 in. 368 ft.		1 ft. 0 in. 150 ft.		2 ft. 0 in. 60 ft.		2 ft. 6 in. 190 ft.		5 ft. 0 in. 420 ft.		4 ft. 0 in. 290 ft.		2 ft. 0 in. 880 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
6·21	6·85	4·33	6·43	3·64	5·72	1·70	3·66	4·90	5·27	Monthly fall not received.	5·10	Return not yet received.	5·41
1·38	2·68	1·92	1·77	1·32	1·26	·85	2·18	1·97	1·67		2·12		3·20
6·84	1·41	5·86	2·42	5·37	2·72	3·66	·63	3·84	2·60		1·60		1·85
6·83	2·48	4·23	1·42	3·43	1·49	2·73	·07	3·86	2·16		2·12		2·24
4·36	3·13	3·52	2·12	2·82	2·09	3·57	·06	3·04	2·30		3·00		1·39
5·81	6·41	4·05	4·19	3·35	4·40	2·86	1·76	3·91	3·85		4·25		3·97
7·54	1·42	4·99	·61	2·00	·61	2·25	2·78	3·21	5·05		1·25		·72
4·23	7·24	4·09	6·17	1·40	6·05	2·67	4·12	2·71	·70		5·50		3·32
3·91	8·98	3·81	5·92	2·65	5·39	3·49	6·11	3·31	6·94		9·10		7·02
10·30	9·78	7·08	7·79	5·77	6·33	3·89	6·57	5·98	7·02		5·90		6·72
2·06	7·00	3·47	6·35	2·66	5·73	1·23	2·51	2·30	5·36		6·30		4·00
7·60	4·54	5·71	3·94	3·89	3·34	2·39	·67	4·19	2·46		2·61		2·88
67·07	61·92	53·06	49·13	38·30	45·13	31·29	31·12	43·22	45·38	46·50	48·85		42·72

ENGLAND AND WALES.

Division XI.—Monmouth, Wales, and The Islands (*continued*).

The Islands (*continued*).					
Jersey.		Calf of Man.		Point of Ayr.	
5 ft. 0 in. 45 ft.		0 ft. 10 in. 325 ft. ?		3 ft. 4 in. 27 ft. ?	
1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.
1·69	2·62	5·14	3·85	4·22	3·37
·67	·59	1·22	·65	1·43	1·40
5·04	2·56	4·35	1·09	2·27	1·81
2·07	·99	4·98	2·04	2·59	1·54
2·32	1·50	2·99	1·69	2·18	1·57
1·63	2·87	4·48	1·95	2·72	2·31
1·96	1·10	4·64	·66	3·30	·40
·95	2·78	2·98	3·52	3·11	3·50
2·00	3·30	1·24	2·75	1·01	2·74
4·46	3·91	4·10	5·20	3·68	5·48
1·80	2·74	2·46	2·67	1·47	3·83
2·25	2·58	3·91	1·80	3·75	2·96
26·84	27·54	42·49	27·87	31·73	30·91

SCOTLAND.

Division XII.—Southern Counties.

Wigtown.				Kirkcudbright.	
South Cairn, Stranraer.		Corsewall.		Little Ross.	
0 ft. 4 in. 209 ft.		3 ft. 4 in. 22 ft. ?		3 ft. 3 in. 130 ft. ?	
1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.
7·15	7·70	6·83	5·24	2·88	3·34
2·10	2·55	1·61	1·30	·90	1·10
4·00	4·35	3·01	2·29	1·38	1·56
5·00	3·65	3·44	2·56	2·03	1·84
5·25	4·65	3·84	3·48	4·40	2·52
5·15	4·85	3·47	3·47	2·53	2·81
6·50	1·10	3·95	·34	2·41	·49
3·10	4·65	2·24	3·21	2·46	1·85
2·10	4·75	1·18	3·66	1·75	2·35
6·95	7·50	6·51	4·63	2·73	4·20
2·70	4·45	1·82	3·87	·64	3·21
6·00	4·30	4·49	2·95	2·76	2·03
56·00	54·50	42·39	37·00	26·87	27·30

SCOTLAND.

Division XII.—Southern Counties (*continued*).							Div. XIII.—South-Eastern Counties.					
	Dumfries.				Roxburgh.		Berwick.				Haddington.	
Height of Rain-gauge above	Dumfries.		Wanlock Head.		Borthwick Brae.		Thirlestane Castle.		Mungo's Walls, Dunse.		Yester.	
Ground ...... Sea-level......	0 ft. 5 in. 70 ft.		0 ft. 4 in. 1330 ft.		0 ft. 2 in. 800 ft.		0 ft. 3 in. 558 ft.		0 ft. 6 in. 267 ft.		1 ft. 0 in. 420 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	3·91	7·10	8·52	7·02	5·00	8·50	3·20	4·55	1·82	3·36	2·84	3·20
February ...	1·50	2·90	1·92	2·07	1·50	3·10	1·50	1·50	1·72	·56	2·55	1·21
March	3·05	1·00	4·50	4·39	5·80	1·60	2·35	1·60	4·21	1·10	3·35	1·28
April	3·20	3·25	5·89	3·69	3·90	4·20	2·20	2·00	1·68	1·83	2·00	1·90
May	3·75	2·55	4·85	5·01	3·40	2·70	3·50	·85	3·06	1·63	3·40	2·00
June	2·65	4·10	8·28	5·34	5·40	6·10	3·50	2·00	2·48	3·50	4·15	3·65
July	3·45	·67	} 12·09	·80	3·10	·70	1·70	·50	2·62	·41	3·95	·45
August	4·47	2·10	}	6·92	4·70	4·10	3·30	3·40	4·10	5·23	4·60	4·90
September ...	1·70	4·00	2·15	6·89	2·70	6·20	1·65	3·00	1·41	2·51	2·50	2·45
October	7·10	3·70	10·86	5·16	9·20	3·70	4·00	2·60	2·78	2·40	4·15	3·80
November ...	1·30	2·90	3·22	6·25	1·20	4·40	4·60	2·80	·83	3·15	1·45	2·50
December ...	5·35	2·50	11·82	6·90	5·20	3·70	3·00	1·65	2·09	1·90	2·90	2·25
Totals	41·43	36·77	74·10	60·44	51·10	49·00	34·50	26·45	28·80	27·58	37·84	29·59

Division XIV—South-Western Counties (*continued*).												
	Lanark (*continued*)..						Ayr.				Renfrew.	
Height of Rain-gauge above	Auchinraith.		Bailliestown.		Hill End House.		Auchendrane House, Ayr.		Brisbane, Largs.		Nither Place, Mearns.	
Ground ...... Sea-level......	4 ft. 9 in. 150 ft.		0 ft. 3 in. 230 ft.		7 ft. 0 in. 620 ft.		2 ft. 3 in. 94 ft.		0 ft. 0 in. 125 ft.		0 ft. 9 in. 350 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	3·25	6·40	6·06	7·98	4·30	4·75	3·13	6·55	8·00	8·60	2·20	10·20
February ...	·76	2·45	1·91	2·78	1·45	1·69	2·67	5·15	2·20	3·30	1·40	5·75
March	3·55	1·00	4·91	1·76	3·08	1·11	3·29	1·28	3·90	2·70	5·20	2·00
April	2·90	3·00	3·62	4·32	2·82	2·49	4·15	4·23	4·50	4·10	4·00	5·75
May	4·07	2·10	5·69	3·85	3·33	2·70	4·95	3·17	4·80	4·20	3·20	4·00
June	3·34	2·80	5·92	3·63	2·97	2·72	3·33	4·75	4·70	4·10	2·50	4·13
July	3·80	·65	5·67	·48	4·80	·55	4·08	·22	6·50	·70	4·20	·50
August	2·77	2·75	4·69	4·38	3·21	2·77	3·62	3·22	4·20	5·20	3·00	3·75
September ...	2·28	3·30	3·52	4·93	2·32	2·85	2·88	5·82	2·70	6·50	1·40	7·37
October	6·76	4·05	9·32	5·21	6·25	3·77	8·24	4·57	7·70	4·60	8·30	5·50
November ...	1·87	2·60	2·84	3·72	1·85	2·84	3·55	4·61	3·00	4·60	2·20	5·75
December ...	5·05	3·95	6·52	6·28	4·71	3·18	6·28	6·38	7·50	7·00	5·40	8·75
Totals	40·40	35·05	60·67	49·32	41·09	31·42	50·17	49·95	59·70	55·60	43·00	63·45

SCOTLAND.

Division XIII.—South-Eastern Counties (*continued*).												Div. XIV.—S.-W. C.	
Haddington (*continued*).		Edinburgh.										Lanark.	
East Linton.		Glencorse.		Inveresk, Musselburgh.		Charlotte Square, Edinburgh.				Inchkeith.		Newmains.	
0 ft. 3 in. 90 ft.		0 ft. 6 in. 787 ft.		2 ft. 0 in. 60 ft.		0 ft. 6 in. 230 ft.		63 ft. 0 in. 300 ft.		3 ft. 0 in. 182 ft.		0 ft. 2 in. 783 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
3·23	2·75	3·15	7·00	2·67	4·03	3·83	} 4·66	{ 2·70	} 2·72	{ 1·26	2·68	6·05	10·69
1·45	·49	2·05	2·60	1·26	2·02	·90	}	{ ·30	}	{ 1·02	·56	2·45	5·35
3·72	1·11	4·60	1·00	3·58	·64	4·64	·74	2·40	·42	1·52	·24	11·41?	2·75
1·40	1·37	2·05	3·45	1·78	2·17	1·32	2·03	·90	1·60	·96	·80	5·39	5·21
3·14	1·32	3·40	2·15	2·98	1·24	3·71	1·62	3·05	1·22	3·63	1·24	4·66	4·90
2·80	2·62	3·30	3·85	3·63	3·18	2·80	3·50	2·14	2·90	2·56	1·60	4·97	4·90
2·46	·57	3·80	·65	2·59	·54	2·70	·65	1·90	·48	1·58	·24	3·97	1·95
3·00	4·96	6·00	4·25	4·14	4·67	3·70	3·47	3·08	2·90	2·87	2·56	5·12	5·25
2·49	2·43	2·10	4·80	2·13	3·21	2·10	2·65	1·73	2·30	1·53	2·59	2·25	5·75
2·39	2·18	6·25	3·15	3·96	2·36	} 5·42	{ 2·19	} 4·12	{ 1·68	3·14	1·95	11·36	6·27
1·20	2·19	2·00	2·80	1·52	2·49	}	{ 1·91	}	{ 1·37	·44	1·80	4·35	4·97
2·00	2·11	4·40	3·60	2·65	2·55	2·80	2·22	1·80	1·63	1·36	·76	8·94	7·01
29·28	24·10	43·10	39·30	32·89	29·10	33·92	25·64	24·12	19·22	21·87	17·02	70·92?	65·00

Div. XIV.—S.-W. Counties (*continued*).				Division XV.—West Midland Counties.									
Renfrew (*continued*).				Dumbarton.				Stirling.					
Ferguslie House, Paisley.		Greenock.		Balloch Castle.		Arddarroch.		Mugdock Reservoir.		Polmaise.		Ben Lomond.	
0 ft. 3 in. 88 ft.		0 ft. 6 in. 64 ft.		0 ft. 4 in. 91 ft.		1 ft. 0 in. 80 ft.		0 ft. 6 in. 320 ft.		0 ft. 1 in. 12 ft.		0 ft. 6 in. 1800 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
6·85	10·89	8·75	12·50	8·49	8·14	13·04	8·58	8·00	9·40	7·60	7·50	12·50	14·40
1·85	5·00	2·70	7·70	2·33	4·57	2·39	6·97	1·80	3·90	·80	3·00	4·50	12·20
6·13	1·82	6·00	3·80	4·80	3·00	5·42	5·84	4·30	3·10	4·20	2·00	2·70	4·40
3·85	5·20	4·60	6·15	5·34	4·24	7·31	6·95	4·30	4·30	3·50	2·05	11·80	9·80
5·43	2·47	5·30	4·20	5·33	2·87	5·77	4·53	4·80	3·10	3·30	2·00	10·80	4·40
3·40	3·82	5·30	3·95	4·49	4·30	6·86	4·91	4·10	3·60	4·20	3·80	6·20	8·20
5·54	·55	5·75	·80	6·95	·65	8·70	·33	6·30	1·10	4·30	·50	11·20	·80
3·71	3·35	4·10	5·70	4·90	4·82	5·40	6·06	4·20	4·30	3·00	3·70	7·20	11·70
2·45	6·03	2·95	7·97	2·61	7·40	2·89	9·56	3·00	6·40	2·50	3·80	6·20	15·50
12·20	5·00	13·20	6·86	9·90	5·55	14·40	7·58	8·40	4·00	7·50	3·50	14·60	14·20
2·66	3·02	4·45	6·10	3·83	4·70	5·21	6·47	3·00	5·00	2·70	2·50	8·50	8·30
7·96	8·49	11·15	9·83	8·71	7·67	7·74	10·85	8·40	6·60	5·70	4·50	18·50	13·10
62·03	55·64	74·25	75·56	67·68	57·91	85·13	78·63	60·60	54·80	49·30	38·85	114·70	117·00

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Division XV.—West Midland Counties (*continued*).

	Bute.		Argyll.									
Height of Rain-gauge above	Pladda.		Mull of Cantire.		Devaar, Campbeltown.		Rhinns of Islay.		M'Arthur's Head, Islay.		Stonefield, Tarbert.	
Ground	3 ft. 3 in.		....		3 ft. 4 in.		3 ft. 0 in.		0 ft. 4 in.		1 ft. 3 in.	
Sea-level......	55 ft.?		279 ft.?		75 ft.?		74 ft.?		106 ft.?		90 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	5·25	6·43	7·03	5·41	8·26	7·32	·64	4·41	9·80	7·70	8·80	9·40
February ...	2·21	3·05	2·09	·91	1·99	2·41	1·29	2·45	3·90	4·80	1·40	7·60
March	4·07	2·88	3·62	3·39	2·25	2·99	2·63	2·10	3·70	4·50	5·20	4·50
April	4·67	3·01	2·95	2·43	3·14	4·09	1·92	2·06	4·50	4·20	4·30	6·10
May	3·80	3·47	4·13	3·27	4·47	4·01	4·14	2·36	6·30	4·50	5·30	4·60
June	4·52	4·04	3·03	6·04	3·16	4·17	2·20	2·98	4·20	5·70	4·40	4·80
July	5·37	·66	4·37	·54	6·30	·41	3·37	·17	7·80	·50	5·90	·30
August	2·70	3·20	4·10	4·19	2·43	5·08	2·06	3·27	2·60	5·60	3·80	6·20
September ...	1·81	4·95	2·33	3·97	1·89	5·71	1·35	4·73	2·40	9·40	3·20	9·60
October	10·55	3·75	2·56	4·94	9·70	4·17	6·11	3·75	9·30	7·10	13·60	7·40
November ...	2·34	3·76	3·29	4·61	3·35	5·76	3·45	3·34	5·50	9·70	5·30	7·10
December ...	6·40	4·14	3·72	3·85	5·60	5·01	5·31	3·49	9·60	9·70	12·50	12·80
Totals	53·69	43·34	43·22	43·55	52·54	51·13	34·47	35·11	69·60	73·40	73·70	80·40

Division XV.—West Midland Counties (*continued*). / Div. XVI.—East Midland Counties.

	Argyll (*continued*).								Clackmannan.		Kinross.	
Height of Rain-gauge above	Lismore.		Corran, Loch Eil.		Torosay Castle, Mull.		Ardnamurchan.		Dollar.		Lochleven Sluice.	
Ground	3 ft. 4 in.		0 ft. 4 in.		1 ft. 0 in.		3 ft. 6 in.		0 ft. 4 in.		0 ft. 10 in.	
Sea-level......	37 ft.?		14 ft?		18 ft.		82 ft.?		170 ft.		....	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	5·42	6·42	7·65	13·45	12·60	14·60	6·42	6·63	7·45	5·28	5·70	4·70
February ...	1·79	4·81	2·60	9·05	3·30	12·60	1·44	4·58	1·58	·73	1·30	1·60
March	2·31	2·62	2·25	4·35	4·40	5·40	2·43	2·41	4·48	1·23	4·00	1·70
April	3·64	4·39	4·35	9·40	7·00	9·20	3·41	3·40	3·33	2·20	3·10	2·70
May	4·76	2·14	4·45	5·20	7·00	4·00	3·76	2·86	3·58	1·33	4·10	2·20
June	3·10	3·97	2·25	8·50	5·50	6·00	3·84	3·24	2·94	1·82	4·10	3·00
July	4·75	·63	4·90	·80	8·60	·20	5·32	·85	4·52	0·00	3·80	0·00
August	2·89	6·26	2·70	9·10	5·10	9·80	3·69	6·17	5·41	4·20	2·70	3·90
September ...	2·59	5·42	1·70	9·15	4·20	12·20	2·21	6·60	2·90	3·61	1·50	4·70
October	8·60	4·97	9·30	6·55	16·40	8·40	9·86	3·83	6·02	3·01	5·70	3·30
November ...	1·89	4·53	2·35	8·95	4·70	11·50	5·08	5·96	1·39	2·75	2·20	2·90
December ...	6·65	7·96	10·04	19·55	15·20	17·10	5·58	7·40	4·14	2·82	4·00	3·60
Totals	48·39	54·12	54·54	104·05	94·00	111·00	53·04	53·93	47·74	28·98	42·20	34·30

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Division XV.—West Midland Counties (*continued*).

Argyll (*continued*).

Castle Toward.		Hafton, Dunoon.		Otter House.		Fladda, Jura Sound.		Inverary Castle.		Drishaig, Dalmally.		Oban.	
4 ft. 0 in. 80 ft.?		4 ft. 0 in. 40 ft.		0 ft. 6 in. 130 ft.		0 ft. 6 in. 20 ft.?		0 ft. 0 in. 30 ft.		3 ft. 0 in. 250 ft.		0 ft. 4 in. 10 ft.	
862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
n.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
7·86	8·18	10·59	15·09	8·89	8·67	13·70	8·20	7·00	15·00	...	22·70	9·45	10·90
2·54	3·43	2·63	8·50	2·31	4·29	4·70	6·10	2·20	8·00	...	17·80	2·60	8·70
3·48	3·16	4·21	4·07	2·56	4·32	4·40	7·10	1·00	4·00	...	8·00	3·00	4·20
4·83	4·47	7·21	8·07	3·87	4·81	6·00	5·40	5·00	8·00	...	13·20	4·50	6·00
5·36	3·66	6·46	4·37	7·05	3·51	5·20	3·70	4·00	3·00	7·80	6·75	6·00	2·90
4·21	4·04	5·51	4·94	4·32	4·88	5·40	3·80	5·10	4·00	10·20	8·20	4·20	4·65
5·78	·41	9·23	·71	6·14	·47	7·10	·10	6·00	·20	15·70	2·00	6·20	·68
4·20	5·79	4·52	5·91	3·44	6·00	5·60	7·60	3·10	5·00	7·00	12·50	4·10	8·45
2·84	7·28	4·24	10·66	2·10	6·80	4·10	8·10	3·00	9·00	6·85	20·90	3·65	9·30
9·60	5·01	16·50	7·36	10·16	6·51	11·40	5·70	10·00	6·00	26·75	11·40	12·85	8·55
3·36	4·16	5·77	7·35	5·52	5·14	3·80	6·60	4·50	8·00	6·00	15·92	3·90	7·90
8·21	7·67	14·45	12·61	8·10	8·46	9·50	7·80	13·00	17·00	24·50	33·18	11·95	10·40
2·27	57·26	91·32	89·64	64·46	63·86	80·90	70·20	63·90	87·20	......	172·55	72·40	82·63

Division XVI.—East Midland Counties (*continued*).

Fife.						Perth.							
sle of May.		Nookton.		Pittenweem.		Ledard.		Deanston.		Bridge of Turk.		Loch Katrine.	
2 ft. 2 in. 182 ft.?		0 ft. 6 in. 80 ft.		3 ft. 0 in. 75 ft.		0 ft. 6 in. 1500 ft.		0 ft. 0 in. 130 ft.		0 ft. 6 in. 270 ft.		0 ft. 6 in. 830 ft.	
862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
n.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
2·73	2·27	4·62	3·92	3·62	3·15	7·70	9·40	6·30	8·00	10·60	10·60	14·00	14·50
1·70	·66	1·20	1·01	2·14	·81	5·80	6·20	1·35	3·40	1·90	6·20	3·20	7·40
1·82	·35	3·28	·79	2·70	·81	3·70	7·10	3·80	1·70	3·50	3·70	5·10	5·60
·91	1·24	1·95	1·94	1·55	1·59	9·80	7·00	3·60	3·30	6·10	5·60	7·50	6·70
3·09	1·59	3·79	1·79	2·63	1·45	8·20	4·00	3·90	3·60	3·40	2·50	7·20	3·20
2·33	1·35	2·81	1·77	2·26	2·14	9·50	8·90	3·60	3·45	5·30	4·50	7·20	4·90
1·92	·33	3·76	·49	2·17	·37	11·40	·20	5·20	·20	6·30	·20	8·50	·60
3·59	3·04	2·48	3·60	1·75	4·14	7·80	10·10	3·50	4·00	5·40	7·00	5·00	7·80
1·18	2·59	1·95	3·61	2·03	2·93	5·70	8·30	2·50	5·00	2·60	8·10	2·70	9·50
3·17	1·80	4·21	2·62	3·38	1·67	15·00	8·60	7·70	4·20	12·90	5·60	15·10	6·80
·76	1·83	1·15	2·34	·39	2·11	3·50	12·00	3·00	2·85	3·60	5·60	5·90	7·70
1·88	1·56	3·08	1·91	1·35	1·23	14·60	13·40	7·10	4·85	10·30	8·90	15·50	12·80
5·08	18·61	34·28	25·79	25·97	22·40	102·70	95·20	51·55	44·55	71·90	68·50	96·90	87·50

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Division XVI.—East Midland Counties (*continued*).

Height of Rain-gauge above	Perth (*continued*). Auchterarder House.		Stronvar, Loch Earn Head.		Trinity Gask.		Perth Academy.		Stanley.		Forfar. Dundee Water Work[s]	
Ground	2 ft. 3 in.		0 ft. 5 in.		0 ft. 1 in.		64 ft. 5 in.		1 ft. 0 in.		0 ft. 0 in.	
Sea-level......	172 ft.		463 ft.		133 ft.		105 ft.		200 ft.		60 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	186[3.]
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	5·89	5·08	12·10	15·70	7·35	4·80	3·52	3·03	5·02	3·65	5·24	3·2[illegible]
February ...	1·13	3·05	2·64	8·15	1·10	1·70	1·06	1·11	1·40	1·36	2·00	·4[illegible]
March	4·08	·95	8·82	4·50	2·50	1·20	1·56	·44	2·50	1·30	2·90	1·3[illegible]
April	2·59	2·24	8·10	7·20	2·10	2·20	1·47	1·78	2·21	2·11	1·76	1·4[illegible]
May	2·44	1·30	6·15	2·80	3·10	1·20	2·68	·88	3·53	1·65	3·92	1·6[illegible]
June	4·25	2·50	7·40	5·40	3·10	2·60	3·11	2·28	3·51	2·95	4·50	3·0[illegible]
July	2·70	·17	7·09	·40	3·80	·10	1·95	·19	2·50	·55	3·53	·1[illegible]
August	3·34	5·10	4·00	7·76	4·50	5·90	1·63	3·06	3·15	4·57	2·03	4·8[illegible]
September ...	1·15	4·05	3·78	9·26	1·90	3·40	1·89	3·03	1·35	2·92	1·65	3·1[illegible]
October	5·25	3·70	15·16	7·46	4·60	3·30	3·20	1·90	3·90	2·45	2·05	2·1[illegible]
November ...	2·05	2·15	5·35	8·92	1·19	2·55	1·23	2·13	1·45	1·87	·88	2·1[illegible]
December ...	4·10	3·00	17·25	12·25	4·10	2·10	2·67	2·16	3·55	2·37	2·80	1·9[illegible]
Totals	38·97	33·29	97·84	89·80	39·34	31·05	25·97	21·99	34·07	27·75	33·26	25·3[illegible]

Division XVII.—North-Eastern Counties (*continued*).

Height of Rain-gauge above	Kincardine (*continued*). Banchory House.		Aberdeen. Braemar.		Aberdeen, Rose Street.		Castle Newe.		Tillydesk, Ellon.		Buchanness, Peterhead.	
Ground	0 ft. 4 in.		1 ft. 0 in.		0 ft. 4 in.		1 ft. 0 in.		0 ft. 4 in.		3 ft. 4 in.	
Sea-level......	99 ft.		1110 ft.		95 ft.		915 ft.		349 ft.		35 ft. ?	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	186[3.]
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	4·10	3·20	4·26	5·91	4·18	2·58	3·77	3·54	3·16	3·29	3·23	1·[illegible]
February ...	1·50	·10	1·60	1·28	1·57	·40	1·66	·32	1·77	·40	1·43	[illegible]
March	2·50	2·10	2·33	1·08	2·50	2·50	2·83	1·97	3·33	2·41	1·47	1·[illegible]
April	·80	1·10	1·51	2·84	1·82	1·75	·65	1·94	1·39	2·01	1·36	1·[illegible]
May	3·50	·90	2·39	1·32	3·70	1·80	2·69	1·58	2·67	1·96	2·09	1·[illegible]
June	2·50	1·80	4·25	3·50	2·85	2·48	3·80	1·69	2·82	1·82	2·49	1·[illegible]
July	1·80	·30	2·23	·52	2·30	·97	2·13	1·03	2·00	1·00	2·09	1·[illegible]
August	1·90	4·20	3·84	4·43	2·50	4·86	3·21	3·92	2·30	4·42	1·71	2·[illegible]
September ...	1·30	1·10	2·08	3·59	1·90	2·11	1·94	4·02	2·09	4·96	1·39	2·[illegible]
October	2·70	2·80	4·36	3·77	3·00	2·52	2·35	3·63	2·84	3·03	2·37	2·[illegible]
November ...	1·10	·90	·99	2·25	1·70	1·17	·86	1·81	1·59	1·44	1·01	1·[illegible]
December ...	2·80	2·70	4·00	3·62	2·75	2·80	3·52	3·34	2·30	3·29	1·80	2·[illegible]
Totals	26·50	21·20	33·84	34·11	30·77	25·94	29·41	28·79	28·26	30·03	22·44	18·[illegible]

SCOTLAND.

Division XVI.—East Midland Counties (*cont.*).								Div. XVII.—N.-Eastern Counties.					
Forfar (*continued*).								Kincardine.					
Craigton.		Kettins.		Arbroath.		Montrose.		The Burn, Brechin.		Bogmuir.		Strachan, Banchory.	
0 ft. 0 in. 440 ft.		1 ft. 0 in. 218 ft.		2 ft. 0 in. 65 ft.		6 ft. 0 in. 21 ft.		0 ft. 6 in. 237 ft.		0 ft. 3 in. 200 ft.		1 ft. 6 in. 200 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
5·77	3·37	5·25	2·59	3·32	2·71	3·75	2·41	5·50	3·80	4·70	3·00	5·00	3·50
2·58	·68	1·81	·83	1·91	·54	1·46	·31	2·20	·50	2·00	·40	2·33	·30
3·87	1·30	2·30	1·45	3·20	·81	2·43	·80	3·30	1·00	3·00	1·60	2·72	2·15
1·48	1·89	1·71	1·56	1·40	1·32	1·09	1·55	1·80	1·80	1·80	2·70	·80	1·65
3·15	1·75	4·48	1·59	4·02	1·58	3·67	1·48	3·20	1·60	3·10	1·70	3·50	1·80
4·40	3·20	4·21	2·85	2·84	2·51	4·00	3·37	3·70	3·80	4·20	2·60	4·35	2·70
3·85	·85	2·45	·32	3·56	1·22	2·83	·45	2·40	·70	2·10	·60	1·58	·60
3·37	4·60	3·39	5·25	2·64	3·87	1·85	3·76	2·80	3·50	2·00	2·80	2·95	3·55
2·43	4·00	1·72	2·74	2·00	3·69	2·43	3·26	3·10	2·40	2·60	2·20	2·60	2·70
3·24	2·60	3·32	3·90	3·02	2·51	3·12	2·56	3·20	3·60	3·10	3·60	3·86	3·58
·97	2·54	1·16	1·45	·94	2·17	·74	1·67	1·10	1·60	1·10	1·60	1·30	1·70
3·13	2·07	2·69	1·79	2·48	1·80	2·90	1·85	3·90	2·30	2·70	2·00	2·40	2·70
38·24	28·85	34·49	26·32	31·33	24·73	30·27	23·47	36·20	26·60	32·40	24·80	33·39	26·93

Div. XVII.—N.-Eastern Counties (*continued*).				Division XVIII.—North-Western Counties.									
Aberdeen (*continued*).		Elgin.		West Ross.						East Ross.			
Kinnairdhead.		Elgin, Ashgrove.		Kyleakin, Loch Alsh.		Stornoway.		Berneray.		Tarbetness.		Ardross Castle, Alness.	
3 ft. 4 in. 64 ft.		0 ft. 3 in. 33 ft.		0 ft. 2 in. 3 ft. ?		3 ft. 4 in. 31 ft. ?		0 ft. 6 in. 15 ft.		3 ft. 4 in. 61 ft. ?		1 ft. 0 in. 450 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
2·57	3·06	1·79	3·77	7·02	11·40	3·50	6·51	10·20	10·40	4·88	7·82	2·65	7·07
2·11	·48	1·48	·87	3·15	7·45	1·00	3·18	2·30	5·10	2·06	1·21	1·61	3·42
1·51	2·30	2·56	1·16	1·45	3·05	1·17	1·72	6·10	6·30	3·98	1·39	3·41	1·82
1·57	2·12	1·10	2·38	4·63	6·90	3·81	3·67	7·20	4·40	3·02	4·30	1·55	4·09
2·51	1·57	3·61	1·43	4·90	2·80	2·57	1·22	8·40	6·10	5·74	4·50	3·16	1·83
2·27	1·37	4·14	1·86	5·59	5·15	3·30	2·19	9·20	6·40	4·54	4·53	4·11	1·83
2·03	1·28	3·45	·75	5·45	1·35	2·70	·44	10·20	7·30	4·35	·46	2·46	·55
2·71	4·15	3·89	4·32	3·30	10·04	2·26	3·18	11·40	10·10	5·16	6·65	2·88	5·94
1·31	2·84	1·98	4·10	4·35	11·92	1·53	4·22	9·30	11·20	·86	5·94	1·26	6·65
2·45	3·01	2·31	1·53	12·95	3·69	6·75	3·20	10·10	12·10	7·14	2·82	5·43	2·53
1·40	1·70	1·62	1·50	4·35	14·30	3·99	3·63	6·00	11·00	2·18	3·41	1·90	2·68
2·58	3·05	1·70	3·42	10·90	17·05	4·65	3·01	14·55	12·00	3·68	4·52	3·88	5·95
5·02	26·93	29·63	27·09	68·04	95·10	37·23	36·17	104·95	102·40	47·59	47·55	34·30	44·36

SCOTLAND.

Division XVIII.—North-Western Counties (*continued*).

	E. Ross (*continued*).		West Inverness.									
Height of Rain-gauge above	Cromarty.		Glen Quoich.		Oronsay, Isle of Skye.		Raasay.		Portree.		Barrahead.	
Ground	3 ft. 4 in.		......		0 ft. 6 in.		3 ft. 6 in.		0 ft. 1 in.		3 ft. 0 in.	
Sea-level......	28 ft. ?		700 ft.		15 ft. ?		80 ft.		60 ft.		640 ft. ?	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	1·93	3·89	10·25	16·24	4·77	11·85	8·70	13·25	13·50	20·14	4·27	2·91
February ...	1·03	1·21	4·38	14·12	2·54	8·50	2·50	9·10	5·29	15·19	1·08	1·26
March	1·36	·64	3·65	10·83	1·55	3·35	2·65	4·65	3·10	7·02	2·76	2·64
April	·57	2·26	8·32	10·55	5·00	5·93	4·25	6·65	7·19	10·81	2·04	2·30
May	2·19	·86	4·41	4·57	6·45	10·65	5·80	4·35	7·77	6·50	2·93	1·93
June	2·59	1·98	11·14	5·49	4·75	7·64	6·40	4·40	6·06	5·18	2·52	2·84
July	1·93	·06	11·57	1·25	6·20	3·92	8·75	1·95	10·07	2·84	2·36	·47
August	2·31	4·87	...	12·24	5·08	17·08	4·10	9·05	4·64	10·36	3·25	2·01
September ...	·90	4·54	...	17·16	2·25	15·48	5·55	10·20	8·35	13·76	1·69	3·82
October	2·48	1·47	...	9·22	13·10	11·06	13·80	5·95	18·82	8·72	4·82	1·53
November ...	1·82	1·69	...	11·34	5·55	8·80	5·40	9·10	9·22	15·94	3·65	2·81
December ...	1·25	3·16	...	24·43	10·26	19·55	11·30	11·70	17·18	32·43	3·28	2·21
Totals.........	20·36	26·63	...	137·44	67·50	123·81	79·20	90·35	111·19	148·89	34·65	26·73

Division XIX.—Northern Counties (*continued*).

	Sutherland (*continued*).		Caithness.								Orkney.	
Height of Rain-gauge above	Cape Wrath.		Nosshead.		Holburnhead, Thurso.		Dunnethead		Pentland, Skerries.		Melsetter Hoy.	
Ground	3 ft. 6 in.		3 ft. 4 in.		0 ft. 4 in.		3 ft. 6 in.		3 ft. 3 in.		0 ft. 2 in.	
Sea-level......	355 ft. ?		127 ft. ?		60 ft. ?		300 ft. ?		72 ft. ?		55 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	2·75	7·31	2·21	2·84	Return not yet received.	4·25	2·92	2·22	3·12	2·98	Return not yet received.	5·10
February ...	1·49	4·12	1·69	1·08		1·70	4·42	·51	1·26	1·46		2·60
March	1·85	1·95	1·39	2·37		2·70	·97	·53	2·27	1·66		2·70
April	2·96	4·09	1·12	1·98		1·29	1·57	2·60	·53	2·34		4·00
May	2·81	3·39	2·92	1·48		1·85	2·48	1·35	2·77	2·21		2·50
June	2·97	1·64	1·96	·91		1·29	2·21	1·23	4·03	·86		·60
July	4·16	·76	1·21	·77		·90	1·65	·53	2·20	·60		1·10
August	3·08	5·17	1·21	3·13		3·16	1·80	1·50	1·39	3·01		3·10
September ...	2·93	8·77	·67	2·59		4·33	1·16	3·16	1·45	2·34		5·10
October	6·61	3·01	2·87	2·35		2·63	2·73	4·37	3·16	1·69		2·30
November ...	4·28	4·13	·95	1·05		3·00	1·73	2·05	1·65	1·79		2·90
December ...	4·37	6·61	2·84	3·44		6·03	1·47	4·37	5·40	6·46		8·70
Totals.........	40·26	50·95	21·04	23·99	......	33·13	25·11	24·42	29·23	27·40	......	40·70

SCOTLAND.

Division XVIII.—North-Western Counties (*continued*).										Div. XIX.—Northern Counties.			
West Inverness (*continued*).						East Inverness.				Sutherland.			
Ushenish, S. Uist.		Loch Maddy, N. Uist.		Island Glass, Harris.		Beaufort Castle.		Culloden House.		Dunrobin.		House of Tongue.	
0 ft. 4 in. 157 ft. ?		2 ft. 6 in. 30 ft. ?		3 ft. 4 in. 50 ft. ?		4 ft. 6 in. 40 ft.		3 ft. 0 in. 104 ft.		0 ft. 6 in. 6 ft.		0 ft. 1 in. 33 ft.	
862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
n.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
4·50	7·10	11·30	8·20	3·03	1·80	2·33	9·81	1·79	6·02	1·70	5·38	2·40	7·50
1·97	5·58	2·05	3·25	1·56	2·33	·93	4·01	1·33	1·94	2·45	1·47	1·20	3·30
2·62	2·65	2·80	3·15	1·04	2·13	2·23	·90	1·48	·78	2·20	1·00	8·80?	2·50
3·85	5·20	4·35	5·80	1·88	1·77	1·22	3·42	·93	3·06	1·25	3·33	2·80	4·80
3·03	3·05	2·85	3·60	1·67	1·81	2·80	1·38	2·65	1·18	1·80	1·25	2·50	2·50
3·93	3·85	4·30	3·80	2·44	·99	3·60	1·44	2·92	1·91	2·75	1·22	2·10	2·80
5·22	·55	6·40	·20	2·49	·99	2·68	·23	2·57	·34	1·45	·30	3·00	·70
2·99	3·70	5·00	3·10	2·97	2·76	2·46	3·55	2·42	6·67	1·65	3·28	1·60	3·20
2·15	7·30	3·30	4·00	1·97	3·31	1·37	5·64	1·27	4·57	·85	4·95	·90	7·20
8·62	5·15	9·90	3·25	3·10	2·09	3·91	3·13	2·65	2·24	4·60	1·95	5·90	2·70
6·05	3·55	7·80	4·50	2·34	1·92	2·39	3·51	2·43	2·20	1·13	1·60	3·30	3·60
7·00	8·05	9·40	4·50	·65	2·00	4·15	5·74	2·19	2·97	1·82	6·30	3·00	·80?
1·93	55·73	69·45	47·35	25·14	23·90	30·07	42·76	24·63	33·88	23·65	32·03	37·50	41·60

Division XIX.—Northern Counties (*continued*).													
Orkney (*continued*).						Shetland.							
Kirkwall.		Sandwick.		North Ronaldsay.		Sumburghead.		The Manse, Bressay.		East Yell.			
0 ft. 4 in. 8 ft.		2 ft. 0 in. 78 ft.		3 ft. 4 in. 21 ? ft.		3 ft. 4 in. 265 ? ft.		0 ft. 4 in. 12 ft.		0 ft. 0 in. 273 ft.			
362.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.		
1.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.		
4·02	4·55	4·02	5·16	3·68	5·49	2·76	4·10	4·95	6·20	6·94	6·97		
·65	2·42	1·42	3·06	1·32	3·30	1·22	1·86	1·85	3·20	2·80	4·48		
1·63	1·84	1·85	2·60	1·23	2·47	·69	1·74	1·75	2·60	4·52	2·60		
3·28	2·76	2·27	3·24	2·50	2·88	2·12	2·93	2·85	4·10	4·44	5·10		
3·82	1·87	2·86	2·61	2·09	1·97	1·94	1·53	3·10	3·20	2·62	1·93		
·57	1·82	2·33	1·09	1·13	1·02	1·07	·72	1·75	1·60	2·60	2·47		
·75	1·28	2·52	1·21	2·37	·86	2·81	·36	4·10	·30	3·56	·97		
1·66	4·02	2·25	3·09	1·63	2·22	1·30	1·53	1·30	3·30	·95	4·18		
3·07	4·76	3·01	5·38	2·35	4·12	1·78	2·71	4·00	4·20	2·90	5·82		
·83	2·50	5·69	3·84	7·20	3·07	5·34	1·96	10·50	4·20	8·72	6·55		
·98	2·23	2·38	3·08	2·76	2·45	1·79	2·35	2·60	3·00	3·32	3·56		
·47	4·87	3·78	5·36	6·01	6·47	4·80	3·82	7·20	7·50	8·84	14·07		
·73	34·92	34·38	39·72	34·27	36·32	27·62	25·61	45·95	43·40	52·21	58·70		

IRELAND.

Division XX.—Munster.	Cork.		Kerry.		Waterford.				Clare.	
Height of Rain-gauge above	Queen's College, Cork.		Valentia.		Waterford.		Portlaw.		Killaloe.	
Ground	6 ft. 0 in.		2 ft. 6 in.		4 ft. 0 in.		20 ft. 0 in.		0 ft. 5 in.	
Sea-level......	65 ft.		40 ft.		50 ft.		50 ft.		123 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	6·72	3·41	8·22	5·32	7·34	4·13	9·43	3·60	6·17	5·40
February ...	2·49	1·32	2·11	3·30	1·42	1·47	1·81	1·44	1·36	2·90
March	4·27	4·70	4·86	8·23	4·35	3·67	4·68	5·38	4·61	3·95
April	3·01	2·01	5·14	3·27	4·86	·95	4·99	1·00	5·33	2·86
May	3·65	1·53	4·15	2·15	2·37	1·18	3·39	1·90	4·07	2·91
June	3·91	3·89	4·70	3·67	3·48	2·18	4·08	2·69	2·99	3·25
July	3·91	1·48	3·06	1·26	3·48	1·17	3·67	1·48	4·54	·86
August	2·57	4·77	3·57	7·67	2·63	4·64	2·61	4·84	2·42	5·60
September ...	3·07	1·80	3·33	5·94	3·24	3·82	2·33	3·48	1·98	6·23
October	5·22	7·24	10·03	8·56	4·32	6·60	4·42	8·26	8·07	6·27
November ...	3·38	3·96	6·02	8·76	2·70	4·05	2·64	4·81	2·96	7·27
December ...	5·07	4·07	7·00	6·51	5·04	3·24	6·05	2·86	5·35	4·62
Totals	47·27	40·18	62·19	64·64	45·23	37·10	50·10	41·74	49·85	52·12

Div. XXI.—Leinster (*continued*).	Longford.		Div. XXII.—Connaught. Galway.		Sligo.		Div. XXIII.—Ulster. Fermanagh.		Armagh.	
Height of Rain-gauge above	Edgeworthstown.		Queen's College, Galway.		Markree Observatory.		Florence Court, Enniskillen.		Armagh Observatory.	
Ground	....		6 ft. 0 in.		16 ft. 3 in.		0 ft. 11 in.		30 ft. 0 in.	
Sea-level......	333 ft.		25 ft.		145 ft.		300 ft.		236 ft.	
	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	......	5·00	7·31	8·52	4·64	4·14	7·34	5·24	5·76	4·95
February ...	......	2·31	2·36	5·02	·92	2·25	1·39	2·72	1·27	1·80
March	......	3·01	3·94	4·44	3·22	2·62	5·45	3·02	3·70	2·27
April	......	2·10	4·02	4·22	3·01	2·57	3·43	1·62	3·47	2·57
May	......	5·04	3·34	5·25	2·58	2·44	2·79	2·70	3·57	2·53
June	......	3·34	2·72	5·18	2·56	3·12	4·03	3·70	3·60	3·74
July	......	·21	4·20	·41	3·72	·23	5·04	·79	4·55	·26
August	·23	6·02	3·54	5·36	2·86	4·53	2·50	4·60	2·18	3·51
September ...	2·24	5·21	2·68	7·03	2·57	4·71	2·21	4·54	1·73	3·83
October	6·17	6·15	6·68	4·90	6·46	2·72	5·71	4·69	5·90	6·36
November ...	3·14	6·00	2·20	8·01	3·08	1·50	3·12	4·32	1·96	4·02
December ...	6·30	4·03	8·62	4·18	4·29	3·88	6·37	4·51	4·36	3·16
Totals......	......	48·42	51·61	62·52	39·91	34·71	49·38	42·45	42·05	39·00

IRELAND.

Divison XXI.—Leinster.											
Kilkenny.		King's Co.		Queen's Co.		Wicklow.		Dublin.			
Kilkenny.		Birr Castle.		Portarlington.		Fassaroe Bray.		Black Rock, Dublin.		O. S. Office, Dublin.	
0 ft. 6 in. 200 ft.		0 ft. 3 in. 202 ft.		9 ft. 0 in. 236 ft.		5 ft. 0 in. 200 ft.		28 ft. 0 in. 90 ft.		7 ft. 0 in. 166 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
......	3·34	3·58	3·12	5·41	4·11	6·54	6·14	3·38	1·64	2·91	2·13
......	·62	2·26	1·65	1·07	1·36	3·26	·58	·91	·36	·37	·58
......	3·95	3·84	2·53	2·51	3·90	4·34	3·31	2·59	1·38	3·04	1·12
......	·86	2·81	1·25	3·87	1·96	3·49	·74	2·40	·92	4·19	1·17
......	1·40	3·86	1·01	4·92	2·89	2·76	1·26	2·19	·56	2·76	1·46
2·73	3·12	2·73	·90	3·58	4·65	4·01	2·05	2·29	1·82	2·59	2·35
2·36	·94	3·76	·33	3·92	·70	3·23	1·40	2·40	·72	3·59	·87
2·57	3·30	2·92	3·77	3·81	5·64	2·53	3·20	1·94	2·25	1·33	3·99
2·26	2·42	1·51	3·67	2·91	3·87	3·01	2·26	1·50	3·29	1·78	2·73
3·89	7·89	4·86	4·21	5·54	7·92	4·39	8·07	1·95	5·41	3·13	5·75
1·63	3·23	1·95	4·07	2·95	4·83	2·91	2·74	1·49	1·59	2·45	2·22
3·57	2·59	2·20	2·30	4·66	3·48	5·33	4·12	1·94	3·13	2·04	2·04
......	33·66	36·28	28·81	45·15	45·31	45·80	35·87	24·98	23·07	30·18	26·41

Div. XXIII.—Ulster (*continued*).							
Down.		Antrim.		Londonderry.		Tyrone.	
Waringstown.		Linen Hall, Belfast.		Londonderry.		Leckpatrick.	
0 ft. 4 in. 191 ft.		4 ft. 0 in. 12 ft.		40 ft. 0 in. 50 ft.		0 ft. 5 in. 260 ft.	
1862.	1863.	1862.	1863.	1862.	1863.	1862.	1863.
in.	in.	in.	in.	in.	in.	in.	in.
......	2·68	5·32	4·56	4·60	4·57	4·88	4·18
......	·76	1·51	1·15	1·34	2·26	1·46	1·74
......	1·53	3·25	2·24	3·43	2·05	3·86	1·52
......	1·55	4·00	2·34	2·93	2·83	3·81	2·60
......	2·08	3·82	2·78	2·63	2·65	2·73	2·84
......	2·36	3·09	3·37	2·29	4·82	2·67	5·87
......	·52	4·00	·53	3·94	·74	4·00	·52
......	3·66	2·57	4·08	1·89	3·36	2·48	4·68
......	3·00	1·33	3·52	2·13	5·81	2·26	5·46
3·65	5·74	4·67	7·44	6·29	5·27	6·68	5·25
2·71	2·55	3·23	3·70	3·18	3·60	2·69	3·45
......	1·96	4·39	2·84	5·19	4·22	4·93	3·59
	28·39	41·18	38·55	39·84	42·18	42·45	41·70

Preliminary Investigation of the Mechanical Properties of the proposed Atlantic Cable. By WILLIAM FAIRBAIRN, *LL.D., &c., F.R.S.*

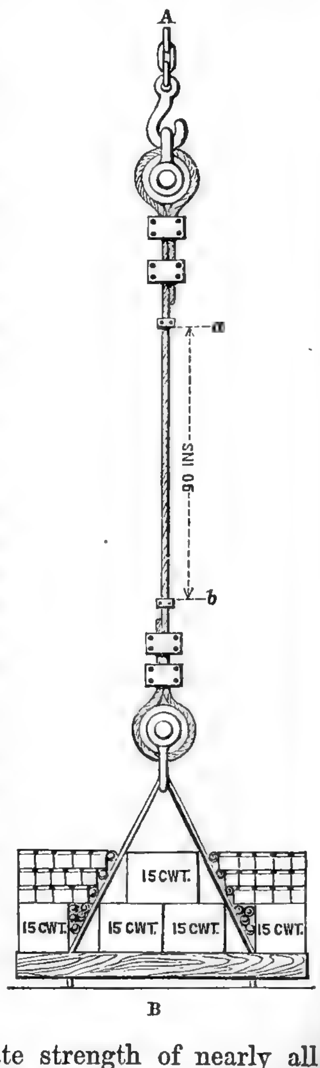
IT appeared essential to the public interest that the second attempt to submerge a telegraphic cable across the Atlantic should not be left to chance, that a close and searching investigation should be entered upon, and that nothing should be left undone that could be accomplished to ensure success. For the satisfactory attainment of this object, it was considered necessary—

1st. To determine by direct experiment the mechanical properties of every cable submitted for submergence in deep water;

2nd. To ascertain the chemical properties of the insulator, and the best means to be adopted for the preservation and duration of the cable; and,

3rd. To determine the electrical properties and conditions of the cable when immersed under pressure at great depths.

These varied conditions were left to a committee, on whom devolved the consideration of every question relating to the efficiency and ultimate security of the cable. That of its mechanical properties was left in my hands; and I was requested to undertake the first division of the inquiry, and to determine, by actual experiment, the strengths, combinations, forms, and conditions of every cable considered of suitable strength and proportion to cross the Atlantic. To fulfil these conditions and ensure correct results, a laborious series of experiments were instituted; and in order to attain accuracy as regards the resisting powers of each cable to a tensile strain, they were broken by dead weights suspended from a crab or crane A, by which they could be raised or lowered at pleasure. The weights were laid on one hundredweight at a time, and the elongations were carefully taken and recorded in the table as each alternate fourth hundredweight was placed on the scale until the cable was broken. By this process we were enabled to ascertain with great exactitude the amount of elongation in 7 ft. 6 in.—the length between the two iron clips screwed round the cable, near the ends of the loops by which they were suspended, as shown in the annexed figure at *a*, *b*. The hook and blocks to which the cables were attached belonged to a travelling crane that elevated or lowered the platform B, containing the weights, to heights corresponding with the stretch as the weights were laid on. Having adjusted the apparatus, the experiments proceeded in the order shown in the following Tables.



In this investigation it will not be necessary to give the experiments in detail, and for the present a summary of results will suffice.

In the following table will be found the ultimate strength of nearly all the differently manufactured cables of Great Britain, and it will be seen that they vary considerably as regards strength, ductility, &c. Several of these cables are of a high order of merit, and well entitled to special notice as they reached the required point of strength—a quality of great importance in cables for submergence in deep water.

TABLE of the Tensile Breaking-strain of Atlantic Submarine Electric Cables, as supplied by different manufacturers.

Summary of Results.

Number of detailed experiment.	Description of Cable.	Breaking-weight.		Diameter of Cable, in inches.	Elongation in 8 feet length of Cable, in inches.	Elongation per unit of length.
		lbs.	tons.			
12	Messrs. Silver & Co.	130	·058	·35	...	...†
13	" Silver & Co.	354	·158	·35	...	...
1	" Duncan	2146	·958	·77	17·10	·1781
10	" Allan	2258	1·008	...	6·75*	·0703 (*a*) ·1380 (*b*)
11	" Allan	2818	1·258	·67	1·67	·0169 (*c*)
2	" Hall & Wells	4946	2·007	·76	2·16	·0225
3	" Siemens & Co., B.	5394	2·408	·77	2·60	·0270
4	" Siemens & Co., A.	5730	2·553	·77	2·85	·0296
5	" Glass, Elliott	7690	3·433	1·10	3·77?	·0392?
6	" Glass, Elliott	7690	3·433	1·10	4·10	·0427
7	" W. F. Henley	9594	4·283	·85	1·85	·0191 (*d*)
8	" W. F. Henley	12786	5·708	·85	2·72	·0339 (*e*)
9	" Glass, Elliot, & Chatterton	14783	6·600	1·10	3·57	·0449

(*a*) For outside steel wires.
(*b*) For copper wires.
(*c*) The completed cable.
(*d*) Without outside covering.
(*e*) The completed cable.

From these considerations it was deemed advisable to select a description of cable containing this element, and all the requirements to meet the contingent forces to which it might be subjected. With these impressions on the minds of the Committee, it was found desirable to select that of Messrs. Glass, Elliott & Co., which stands highest in the order of strength in the foregoing Table, and from the results in p. 410, deduced from subsequent experiments on upwards of forty specimens manufactured by the same firm.

In this inquiry it will be observed that upwards of forty specimens of cables have been tested in their finished state, and this might have been sufficient for the Committee to determine the best description of cable; but it was deemed advisable to investigate still further, not only the cable as a cable, but to test experimentally each separate part, in order that every security should be afforded as to the strength and quality of the material to be employed in the construction. The whole of the specimens submitted by Messrs. Glass, Elliott & Co., were composed of the same sizes of conducting wire insulated within alternate layers of gutta-percha and Chatterton's compound, which formed the core of each. Surrounding this core, were lapped, in a spiral direction, nine and in some cases ten wires, of ·089 to ·098 inch diameter; and each wire was covered with Manilla-yarn, or St. Petersburg hemp, saturated with tar and other materials. Now, as these covering wires constituted the principal strength of the cable, it was found desirable to test them separately, for the purpose of ascertaining their tenacity, ductility,

* This elongation refers to the inside strand of Messrs. Allan's cable.

† The elongations of Messrs. Silver and Co.'s Cable, as given in the detailed experiments, are not reliable.

Summary of results of Experiments on the Submarine Electric Cable, of 1·10 inch in diameter, of the Atlantic Telegraph Company; Glass, Elliott, Manufacturers.

No. of Exp.	Description of Cable.	Diameter of exterior wire of Cable.	Breaking-weight.		Ultimate elongation in 90 inches in inches.	Ultimate elongation per unit of length.	No. of strands.	Length of spiral lay of Cable.	Specific gravity of Cable.
			lbs.	tons.					
1	No. 5 Manilla ...	·089	13,690	6·111	3·50	·0388	9	8½	1·61
2	No. 5 Hemp......	·089	11,424	5·100	4·19	·0465	9	8½	1·69
3	No. 9 Manilla ...	·083	13,104	5·850	3·75	·0416	9	8½	1·58
4	No. 16 Manilla ...	·095	15,882	7·090	3·78	·0420	9	8½	1·69
5	No. 16 Hemp......	·095	15,260	6·812	3·44	·0382	9	8½	1·76
6	No. 18 Manilla ...	·097	16,876	7·533	3·82	·0425	9	8½	1·77
7	No. 18 Hemp......	·097	13,104	5·850	2·97	·0330	10	10	1·81
8	No. 22 Manilla ...	·096	16,876	7·533	3·27	·0363	10	10	1·74
9	No. 22 Hemp......	·096	13,104	5·850	4·01	·0445	10	10	1·67
10	No. 23 Manilla ...	·096	12,868	5·744	3·34	·0371	9	8½	1·71
11	No. 23 Hemp......	·096	14,628	6·530	4·09	·0454	9	8½	1·75
12	No. 24 Manilla ...	·089	16,244	7·251	3·82	·0424	9	8½	1·63
13	No. 24 Hemp......	·089	12,432	5·550	3·68	·0409	9	8½	1·69
14	No. 25 Manilla ...	·089	16,876	7·533	4·05	·0450	9	8½	1·60
15	No. 26 Manilla ...	·093	14,628	6·530	3·57	·0396	9	8½	1·67
16	No. 26 Hemp......	·093	12,544	5·600	4·18	·0464	9	8½	1·72
17	No. 27 Manilla ...	·090	14,228	6·351	3·93	·0436	9	8½	1·70
18	No. 27 Hemp......	·090	11,760	5·250	3·42	·0380	9	8½	1·77
19	No. 28 Manilla ...	·095	......	......	......	......	......	...	...
20	No. 29 Manilla ...	·085	13,104	5·850	3·88	·0431	10	9½	1·65
21	No. 30 Manilla ...	·085	10,640	4·750	2·05 ?	?	10	9½	1·71
22	No. 31 Manilla ...	·095	11,312	5·050	3·30	·0366	10	9½	1·74
23	No. 32 Manilla ...	·095	12,432	5·550	3·01	·0334	10	9½	1·81
24	No. 33 Manilla ...	·095	11,760	5·250	2·77	·0307	10	9½	1·81
25	No. 34 Manilla ...	·096	13,104	5·850	3·27	·0363	10	9½	1·83
26	No. 18 *a* Manilla..	·097	15,260	6·812	2·32	·0257	10	9½	1·79
27	No. 35 Manilla ...	·092	14,628	6·530	4·07	·0452	10	9½	1·73
28	No. 37 Manilla ...	·091	13,552	6·050	3·25	·0361	10	9½	1·77
29	No. 38 Manilla ...	·094	13,552	6·050	2·98	·0331	10	9½	1·69
30	No. 40 Manilla ...	·095	13,226	5·904	3·02	·0335	10	9½	1·81
31	No. 42 Manilla ...	·095	13,104	5·850	2·94	·0326	10	9½	1·80
32	No. 43 Manilla ...	·097	17,358	7·749	2·92	·0324	10	9½	...
33	No. 46 Manilla ...	·097	16,414	7·327	2·65	·0294	10	9½	...
34	No. 47 Manilla ...	......	15,828	7·090	3·01	·0334	...	...	...
35	No. 48 Manilla ...	......	14,092	6·291	3·04	·0351	...	...	...
36	No. 49 Manilla ...	......	17,088	7·628	3·58	·0414	...	...	...

1. Broke in centre.
2. Broke at cramps.
3. Broke at cramps.
4. Broke 19 inches from cramps.
5. Broke 3 inches from cramps.
6. Broke 2½ inches from cramps.
7. Broke 9 inches from cramps.
8. Broke 3 inches from cramps.
9. Broke in centre.
10. Broke in bend of the barrel.
11. Broke 3 inches from cramps.
12. Broke 15 inches from cramps.
13. Broke 12 inches from cramps.
14. Broke at cramps.
15. Broke 27 inches from cramps.
16. Broke 12 inches from cramps.
17. Broke 8 inches from cramps.
18. Broke at cramps.
19. Not tested.
20. Broke in centre.
21. Broke 15 inches from cramps.
22. Broke in the centre.
23. Broke 1 inch from cramps.
24. Broke 8 inches from cramps.
25. Broke 3 inches from cramps
26. Broke 1 inch from cramps.
27. Broke 3 inches from cramps.
28. Broke 1 inch from cramps.
29. Broke 1 inch from cramps.
30. Broke in 3 places.
31. Broke near centre.
32. Broke 1 inch from cramps.
33. Broke 3 inches from cramps
34. Broke 3 inches from cramps.
35. Broke 1 inch from cramps.
36. Broke; not registered.

N.B. In this Table, the elongations are taken from the weight immediately preceding that whic fractured the Cable.

elasticity, &c. The wires were of three sorts, namely, steel and iron in its homogeneous or simple state of manufacture from coke, coal, and charcoal. From the samples the following results were obtained:—

Experiments to determine the Strength and other properties of Steel, Homogeneous, and Iron Wire, calculated to establish a secure and, as nearly as possible, a perfect Cable for an Electric Telegraph across the Atlantic.

Summary of Results of Experiments on Bare Wires.

Number of Exp. in Table of completed Cable.	Name of manufacturer.	Diameters of wire, in inches.	Description of wire.	Breaking-weight of wire, in lbs.	Ultimate elongation in 50 inches, in inches.
1 & 2	Messrs. Taylor & Co.	·087	Hæmatite	650	·280 (*a*)
4 & 5	,, Horsfa ls	·095	Homogeneous	950	·366 (*b*)
6 & 7	,, Horsfalls	·097	Special homogeneous	850	·267 (*c*)
8 & 9	,, Johnsons	·093	Charcoal	750	·173
10 & 11	,, Johnsons	·098	Galvanised...........	650	·198 (*d*)
12 & 13	,, Shortridge & Co. ...	·089	Homogeneous	650	·190 (*e*)
14	,, Smith and Houghton	·091	Homogeneous	1250	·712
16	,, Hughes	·091	Charcoal	600	·198
17 & 18	,, Firth and Sons	·088	Homogeneous	650	·218 (*f*)
20	,, Jenkins and Hill ...	·085	Soft patent steel ...	600	·264 (*g*)
21	,, Jenkins and Hill ...	·085	Annealed steel	450	2·760 (*h*)
22	,, Ryland Brothers ...	·093	Charcoal	550	·320
23	,, Taylor & Co.	·089	Hæmatite, S 3	550	·171 (*i*)
24	,, Taylor & Co.	·095	Hæmatite, S 4	750	·366 (*j*)
32	,, Horsfall, No. 7	......	Homogeneous, No. 7	1150	·480
33	,, Horsfall, No. 9	......	Homogeneous, No. 9	1050	·550
Extra. 1	,, Johnson, 1	·095	Steel wire	1950	·853
Extra. 2	,, Johnson, 2	·095	Patent steel	1950	·631
Extra. 3	,, Johnson, 1 A	·095	Homogeneous	950	·346
Extra. 4	,, Johnson, 2 A	·095	Homogeneous	550	·116
Extra. 5	,, Johnson, 3 A	·095	Special charcoal ...	750	·170

(*a*) ·087 inches at the fracture. (*f*) ·086 inches at the fracture.
(*b*) ·083 ,, ,, (*g*) ·083 ,, ,,
(*c*) ·092 ,, ,, (*h*) ·071 ,, ,,
(*d*) ·098 ,, ,, (*i*) ·082 ,, ,,
(*e*) ·088 ,, ,, (*j*) ·082 ,, ,,

From the above, it will be seen that, out of 21 specimens experimented upon, the maximum of strength rests with Johnson, and the minimum with Jenkins, Hill & Co., the ratios being as 1950 : 450, or as 4·33 : 1. The maximum of elongation to that of the minimum varies with a load of 550 lbs. as the numbers ·320 for Ryland's and about ·014 for Johnson's steel wire in experiment 2, being in the ratio of ·320 : ·014, or as 22·8 : 1, nearly. Softness and ductility have always been considered an important element in the construction; but this measure of ductility is probably overrated, as the Ryland wire, with the last weight laid on (50 lbs.), was sufficient to extend or stretch considerably before it broke. Viewing the subject in this light, it is obvious that a very high ductility with a low standard of strength is not what is wanted, but a combination of strength and ductility that will prevent snapping from brittleness, on the one hand, and give the requisite powers of elongation without material injury to the strength, on the other. What is therefore wanted in these wires is tenacity united to ductility in resistance to a tensile strain, without incurring fracture, up to at least seven-eighths of its ultimate strength.

From a long series of well-conducted experiments, it has been found that a good quality of ductile iron improves in strength by elongation, that is, the whole of its fibres are brought into action by the elongation of those first subjected to strain, or, in other words, they yield up only part of their strength until the force reaches the other parts, so as to produce uniformity of action throughout the whole section of the wire. This is a property of good iron which requires to be extended to the manufacture of both steel and homogeneous wire; and taking the experiments as they exist in the foregoing series of results, I find that with proper care in the selection of the material in the first instance, a judicious system of manipulation in the second, and a rigid system of inspection and check upon the quality as delivered, from time to time, during the manufacture, that wire of homogeneous iron, ·095 inch diameter, can be made of strength sufficient to sustain from 900 to 1000 lbs. with an elongation of ·0068 or $\frac{68}{10,000}$ per unit of length. This description of iron appears to be the most suitable for the Atlantic cable, as it combines strength with ductility, and may be produced at a comparatively moderate cost. Great care is, however, required to maintain, during the whole process of manufacture, the full standard adopted at starting, both as regards the strength and ductility of the wire.

It was, also, found desirable to test the separate strands of each cable, as well as the wires themselves. For this purpose a number of strands similar to those employed in the manufacture of the different cables were procured, and the tensile breaking-strain and elongations carefully observed and recorded. In order to ascertain whether the length of the lay of the hemp and Manilla round the strand was of that spiral which produced a maximum strength, the yarn separated from the strand was also tested, and, comparing the sum of the breaking-strains of the wire and yarn separately with the whole in combination, this object was approximately gained. The summary of results of these experiments will be seen in the two following Tables:—

Table of the Tensile Breaking-strain of the Yarn (twisted) composing the covering of the strands of Messrs. Glass, Elliott's Cables for the Atlantic Submarine Telegraph.

Summary of Results on Manilla and Hemp Yarn.

No. of experiment.	Description of material.	Mean breaking-weight, in lbs.	Elongation in 50 inches, in inches.	Remarks.
1 & 2	White Manilla ...	152	·81	Permanent set with 140 lbs. after removal of load =·52 inch.
3 & 4	White Hemp	166	1·36	Permanent set with 160 lbs. after removal of load, 1·32 inch.
5 & 6	Tarred Manilla ...	137	1·35	Permanent set with 120 lbs. after removal of load =·76 inch.
7 & 8	Tarred hemp	101	1·28	

Another very important question arises in the construction of this cable, and that is the strength of the core and its conducting wire, and how it is to be protected under a pressure of 7000 to 8000 lbs. per square inch when lodged at the bottom of the ocean. This appears a question well entitled to consideration; and provided a properly insulated wire of one or more strands can, without any exterior covering, be deposited in safety at these great depths, it is obvious that the simpler the cable, the better. Assuming, there-

Table of the Tensile Breaking-strain of the Strands composing the Cables of Messrs. Glass, Elliott and Co.'s manufacture for the Atlantic Submarine Electric Cable.

Summary of Results on Strands.

No. of experiment.	Description of strand.	Diameter of cable.	Description of wire.	Breaking-weight of strand, in lbs.	Ultimate elongation in 50 inches, in inches.	Gauge of wire, in inches.
1	Manilla. Strand of No. 25 cable	1·110	Smith and Houghton's homogeneous	1050	1·470	·089
2	,, ,, No. 18 cable	1·107	Horsfall's special homogeneous	1550	1·336	·097
3	,, ,, No. 22 cable	1·118	Johnson's charcoal	950	·462	·096
4	,, ,, No. 16 cable	1·105	Horsfall's homogeneous, KC	1750	1·366	·095
5	Hemp. ,, No. 16 cable	1·040	Horsfall's homogeneous, KC	1450	1·640	·095
6	Manilla. ,, No. 27 cable	1·140	Firth and Sons' homogeneous	1150	1·440	·090
7	,, ,, No. 24 cable	1·129	Shortridge and Howell's homogeneous	750	·432	·089
8	,, ,, No. 26 cable	1·150	Hughes's charcoal	1550	2·080	·093
9	Hemp. ,, No. 23 cable	1·062	Johnson's galvanized	1350	2·300	·096
10	Manilla. ,, No. 18a cable	1·106	Hentzman and Co.'s charcoal	1650	2·100	·097
11	,, ,, No. 37 cable	1·059	Shortridge and Co.'s homogeneous	1050	1·054	·091
12	,, ,, No. 35 cable	1·120	Cammell and Co.'s homogeneous	1450	1·630	·092
13	,, ,, No. 38 cable	1·096	Naylor Vickers's cast steel	1350	1·652	·094
14	,, ,, No. 40 cable	1·094	Taylor and Co.'s homogeneous	1550	1·824	·095
15	,, ,, No. 42 cable	1·078	Hentzman's charcoal	1150	·978	·095
16	,, ,, No. 32 cable	1·125	Taylor and Co.'s hæmatite, S 3	1450	1·340	·095
17	,, ,, No. 24 cable	1·129	Shortridge and Co.'s homogeneous	1150	1·260	·089
18	,, ,, No. 23 cable	1·150	Johnson's charcoal, galvanized	1250	1·352	·096
19	Hemp. ,, No. 24 cable	1·065	Shortridge and Co's homogeneous	850	·406	·089
20	Manilla. ,, No. 43 or 46 cable	1·094?	Horsfall and Co.'s homogeneous	1850	1·198	·097
21	,, ,, No. 46 or 43 cable	1·126?	Horsfall and Co.'s homogeneous	1650	·936	·097

fore, that gutta percha is the most desirable material that can be employed as an insulator, it then resolves itself into the question, What additional covering, and what additional strength, is necessary to enable the engineer to pay out of a ship a length of 1600 miles into deep water so as to deposit it without strain at the bottom of the ocean? This is one of the questions the Committee was called upon to solve, and for this very important object the following experiments were instituted:—

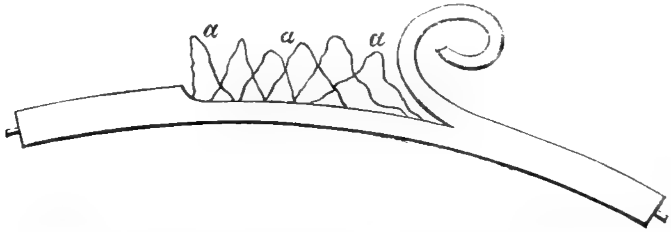
Experiments to determine the Strength of the Central Core, and the Materials of which it is composed.

Summary of Results.

No. of experiment.	Description of material.	Diameter of core.	Breaking-weight, in lbs.	Elongation in 30 inches, in inches.	Permanent set in 30 inches, in inches.
1	Central core	·464	650	7·00	6·90
2	Central core	·464	630	5·72	5·64 (*a*)
3	Copper wire strand	·144	450	6·71	6·71 (*b*)
4	Gutta-percha covering	·464	200	8·73	6·21

(*a*) In this experiment the core was not broken, but laid open for inspection.
(*b*) One wire broke first, and subsequently the others followed.

It is of considerable importance in marine cables to have all the parts as nearly uniform as possible, and in the foregoing experiments on the central core will be observed the difference of elasticity which exists between the copper-wire conductor and the insulator or gutta-percha covering. In the former case we have at the point of fracture an elongation of 6·71 inch and a permanent set of 6·71 inches in a length of 2 feet 6 inches, whereas in the insulating material there is 8·735 inches of extension and only 6·215 inches of a permanent set in the same length. These discrepancies of elasticity and elongation are of considerable importance, in so far as they show that in cables of this description we have to contend with materials of different properties, the first being to that of the second as 6·71 : 6·215, or as 1·08 : 1; in other words, the gutta percha is 8 per cent. more elastic than the copper conducting wire which it covers. These facts account for the extraordinary development which presented itself on cutting a slice of the gutta-percha covering from the wires which, on being liberated burst through the opening in the form of loops, as shown in the annexed figure,



the wire bursting out in this and in a former experiment, after being forcibly stretched and liberated from its confinement, in the form shown above at *a*, *a*, *a*.

From these experiments will be noticed the facility with which the copper wires elongate by tension, and that to a degree highly injurious to the gutta percha insulator, which contracts the already stretched wires, producing a tendency to force themselves in loops through the covering in which they are incased. To prevent these injurious effects it is necessary to protect the core by an outside covering of strong material, to relieve it from severe tension, and also to protect the gutta percha from injury.

Regarding this as a circumstance of great importance bearing directly upon the ultimate strength of the cable, the Committee arrived at the conclusion that the cable No. 46, composed of homogeneous wire, calculated to bear not less than from 850 to 1000 lbs. per wire, with a stretch of $\frac{5}{10}$ths of an inch in 50 inches, was the most suitable for the Atlantic Cable.

Impressed with these views the Committee therefore recommended this cable, the particulars of which will be seen in the following specification :—

Specification of No. 46 *Cable.*

The conductor consists of a copper strand of seven wires (six laid round one), each wire gauging ·048 (or No. 18 of the Birmingham wire-gauge), the entire strand gauging ·144 inch (or No. 10 Birmingham gauge) and weighing 300 lbs. per nautical mile, embedded for solidity in the composition known as "Chatterton's Compound."

The insulator consists of gutta percha, four layers of which are laid on alternately with four thin layers of Chatterton's compound, making a diameter of the core of ·464 inch and a circumference of 1·392 inch. The weight of the entire insulator is 400 lbs. per nautical mile.

The External Protection.—This is in two parts. First the core is surrounded with a padding of soft jute yarn, saturated with a preservative mixture. Next to this padding is the protective covering, which consists of ten solid wires of the gauge ·095 inch, drawn from homogeneous iron, each wire surrounded separately with five strands of Manilla yarn saturated with a preservative compound, the whole of the ten strands thus formed of the hemp and iron being laid spirally round the padded core.

The weight of this cable in air is 34 cwt. per nautical mile ; the weight in water is 14 cwt. per nautical mile. The breaking-strain is 7 tons 15 cwt., or equal to 11 times its weight per nautical mile in water, that is to say, if suspended perpendicularly, it would bear its own weight in 11 miles' depth of water. The deepest water to be encountered between Ireland and Newfoundland is about 2400 fathoms ; and one mile being equal to 1014 fathoms, therefore $1014 \times 11 = \frac{11154}{2400} = 4{\cdot}64$, the cable having thus a strength equal to 4·64 times of its own vertical weight in the deepest water.

In this report we have not entered upon the process of immersion, either in tanks or the sea ; we have confined our attention exclusively to the cable and the quality of the materials of which it should be composed, and the questions of coiling, shipping, submersion, &c., we have left for future inquiry.

NOTICES AND ABSTRACTS

OF

MISCELLANEOUS COMMUNICATIONS TO THE SECTIONS.

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MATHEMATICS AND PHYSICS.

Mathematics.

On a Formula of M. Chasles *relating to the Contact of Conics. By* Professor Cayley, *F.R.S.*

The author gave an account of the recent investigations of M. Chasles in relation to the theory of conics, viz., M. Chasles has found that the properties of a system of conics, containing one arbitrary parameter, depend upon two quantities called by him the *characteristics* of the system; these are, μ, the number of conics of the system which pass through a given point, and, ν, the number of conics of the system which touch a given line; or, say, μ is the *parametric order*, ν the *parametric class*, of the system. And he exhibited a transformation obtained by him of a formula of M. Chasles for the number of conics which touch five given curves, viz., if (M, m) (N, n) (P, p) (Q, q) (R, r) be the orders and classes of the five given curves respectively, then the number of curves is

$$=(1, 2, 4, 4, 2, 1)(M, m)(N, n)(P, p)(Q, q)(R, r),$$

where the notation stands for $1. MNPQR+2\Sigma mNPQR+4\Sigma mnPQR+\&c.$ The transformed formula in question was communicated by the author to M. Chasles, and had appeared in the 'Comptes Rendus;' but it is, in fact, included in a very beautiful and general theorem given in the same Number by M. Chasles himself.

On the Problem of the In-and-circumscribed Triangle. By Professor Cayley, *F.R.S.*

The general problem of the in-and-circumscribed triangle may be thus stated, viz., to find a triangle the angles whereof severally lie in, and the sides severally touch, a given curve or curves; and we may, in the first instance, inquire as to the number of such triangles. The first and easiest case is when the curves are all distinct; here, if the angles lie in curves of the *orders* m, n, p, respectively, and the sides touch curves of the *classes* Q, R, S, respectively, then the number of triangles is $=2mnp$QRS. The number may be obtained for some other cases; but the author has not yet considered the final and most difficult case, viz. that in which the angles severally lie in, and the sides severally touch, one and the same given curve.

On Stigmatics. By ALEXANDER J. ELLIS, *F.R.S.*

In ordinary analytical geometry, a point M, moving along the axis OM, is conjugated by means of certain equations, with one or more points P, P′ . . . so situated that MP, MP′ . . . are all parallel to a given line. In *stigmatics* the point M, called the *index*, may be situated *anywhere* upon a plane, and the points P, P′ . . . , called the *stigmata*, may be so situated that the angles OMP, OMP′ . . . are any whatever consistent with certain conditions. The position and length of MP, MP′ . . . , with respect to those of OM, are determined by a certain law for each particular case. The locus of P, P′ . . . for a given locus of M is a *stigmatic path*. The aggregate of all possible groups of conjugated points forms a *stigmatic*. Stigmatics are the general geometrical representatives of algebraical equations, and comprehend as particular cases all possible and imaginary results of ordinary algebraical geometry. If H and K be fixed stigmata, having the indices A and B, and the triangles HPK, AMB be always similar and similarly situated, M is the index and P the stigma of a stigmatic straight line, the theory of which embraces the whole theory of similar figures and of rays (real or imaginary) in involution. If E and F be fixed points, and the triangles EMP, PMF be similar and similarly situated, then M is the index, and P the stigma, of a stigmatic circle, the theory of which comprehends that of radical axes, and geometrical involution and homography of points on a plane. The mode of calculating the relations of stigmatics is by means of *clinants*. The clinant ab is the operation of turning the axis of reference, OI, through the angle (OI, AB), and altering its length in the ratio of the length of OI to that of AB, so that $AB = ab \, . \, OI$. The clinant $\frac{ab}{cd}$ is the operation of turning the straight line CD through the angle (CD, AB), and altering its length in the ratio of that of CD to that of AB, so that $\frac{ab}{cd} \, . \, CD = AB$. These clinants completely obey the laws of ordinary algebra. The clinant equations to the stigmatic straight line and circle, as just defined, are, therefore, $\frac{am}{bm} = \frac{hp}{kp}$, $\frac{me}{mp} = \frac{mp}{mf}$, respectively, whence all their properties may be deduced. If OI, OX, OY be radii of a unit circle, then, in ordinary analytical geometry, if OM, MP be the abscissa and ordinate of any point, P, referred to the lines OX, OY as axes, we shall have

$$om \, . \, OI = OM = x \, . \, OX = x \, . \, ox \, . \, OI,$$

and

$$mp \, . \, OI = MP = y \, . \, OY = y \, . \, oy \, . \, OI,$$

so that $x = \frac{om}{ox}$, $y = \frac{mp}{oy}$, and thus the ordinary algebraical equation to a curve, $f(x, y) = 0$, is converted into the clinant equation to a stigmatic $f\left(\frac{om}{ox}, \frac{mp}{oy}\right) = 0$, which is its general form, comprehending both the real and imaginary results of the former as particular cases. The constants of such an equation should also be transformed into clinants, so as to make the equations homogeneous. Thus the equation to the straight line $\frac{x}{a} + \frac{y}{b} = 1$, becomes

$$\frac{om}{ox} \div \frac{oa}{ox} + \frac{mp}{oy} \div \frac{ob}{oy} = 1, \text{ or } \frac{om}{oa} + \frac{mp}{ob} = 1,$$

which can be shown to be identical with that already obtained. The equation to the circle referred to rectangular coordinates, in which case $ox^2 + oy^2 = 0$, is $x^2 + y^2 = a^2$, whence

$$\frac{om^2}{ox^2} + \frac{mp^2}{oy^2} = \frac{oa^2}{ox^2} \text{ or } om^2 - mp^2 = oa^2,$$

which is identical with the former if $fe = 2oa$. Stigmatics, therefore, furnish the required complete generalization of algebraical plane geometry, comprehending all the results already obtained, explaining all the "impossibilities" hitherto encountered, and developing many new properties of plane figures.

On the Geometrical Transformation of Plane Curves. By Professor CREMONA, *of Bologna. Communicated by* T. A. HIRST, *F.R.S.*

In a note on the geometrical transformation of plane curves, published in the 'Giornale di Matematiche,' vol. i. p. 305, several remarkable properties possessed by a certain system of curves of the n-th order, situated in the same plane, were considered. The important one which forms the subject of this note has been more recently detected, and has reference to the Jacobian of such a system, that is to say, to the *locus* of a point whose polar lines, relative to all curves of the system, are concurrent.

The curves in question form, in fact, a *réseau*; in other words, they satisfy, in common, $\frac{n(n+3)}{2}-2$ conditions in such a manner that through any two assumed points only *one* curve passes. They have, moreover, so many fixed (*fundamental*) points in common that no two curves intersect in more than one *variable* point. In short, if, in general, x_r denote the number of fundamental points which are multiple points of the r-th order on every curve of the *réseau*, the following two equations are satisfied:—

$$x_1+3x_2+6x_3 \ldots\ldots + \frac{n(n-1)}{2}x_{n-1}=\frac{n(n+3)}{2}-2.$$

$$x_1+4x_2+9x_3 \ldots\ldots + (n-1)^2x_{n-1}=n^2-1.$$

This being premised, the property alluded to is, that the Jacobian of every such *réseau* resolves itself into y_1 right lines, y_2 conics, y_3 cubics, &c., and y_{n-1} curves of the order $n-1$; where the integers y_1, y_2, &c. also satisfy the above equations, and constitute a *conjugate* solution to x_1, x_2, &c., being connected therewith by the relation

$$x_1+x_2 \ldots\ldots + x_{n-1}=y_1+y_2 \ldots\ldots + y_{n-1}.$$

On a Generalization of the Method of Geometrical Inversion. By T. A. HIRST, *F.R.S.*

It is well known that Steiner, by assuming, instead of a conic, any fundamental curve whatever, succeeded in generalizing Poncelet's theory of reciprocal polars. The ordinary method of inversion is susceptible of a generalization of the same character, and may then be appropriately termed *Quantic Inversion.* A fixed origin o being taken, the radius vector from it to any point p in the plane is, of course, cut in $(m-r)$ points p' by the r-th polar of p, relative to any fixed *fundamental curve* of the m-th order. If p describe a *primitive curve* of the n-th order P^n, it can readily be shown that its *corresponding points* p' will generate a curve P^{mn}_{nr} of the order mn (independent of r) which, amongst other singularities, always possesses a multiple point at the origin of the order nr. The properties of the series of $(m-1)$ inverse curves corresponding to any primitive n-ic, and relative to the same origin and fundamental m-ic, formed the subject of the communication.

When $m=2$, the fundamental curve is a conic which is intersected in two, real or imaginary, points o_1 and o_2 by the polar of the origin o. In this case the first and sole *quadric inverse* of a given n-ic which passes a times through the origin o, a_1 times through the point o_1, and a_2 times through the point o_2, is (if the sides of the principal triangle $oo_1\,o_2$ be excluded) a curve of the order $(2n-a-a_1-a_2)$, which passes $(n-a_1-a_2)$ times through o, $(n-a-a_1)$ through o_1, and $(n-a-a_2)$ through o_2. As a simple illustration of the utility of this special case of quantic inversion, when employed as a method of transformation, it may be remarked that the number of double tangents to the quadric inverse curve, as determined by Plücker's formulæ, is equal to the number of conics which can be drawn through three fixed points so as to have double contact with the primitive curve. The results of quadric inversion are identical with those obtained by the somewhat more general, but less easily manipulated, transformations of Steiner and of Magnus. When the fundamental curve is a circle around the origin, the fundamental points o_1, o_2 coincide with the imaginary circular points at infinity, and we have the ordinary method of inversion as first proposed, in 1836, by Professor Bellavitis, of Padua, and now universally employed. When the fundamental curve is an equilateral hyperbola, with its centre at the origin, we have the *hyperbolic transformation* of Professor Schiaparelli, of Milan.

On an easy Mode of Measuring Heights. By M. MOGGRIDGE.

On Symbolical Expansions. By W. H. L. RUSSELL, *A.B., F.R.S.*

In this paper the author pointed out the connexion between his own binomial theorems and the general theorems of symbolical development, given by Professor Boole a long time ago. He also made some remarks upon the application of the calculus of symbols to the integration of linear differential equations. It would be interesting to know the real extent of the power of the calculus of symbols as applied to the latter subject. It is certain that many differential equations known to be integrable by other methods are solved with great facility by the calculus of symbols. The author particularly specified Laplace's equation, the well-known equation occurring in investigations respecting the figure of the earth, and a differential equation, integrated by Professor Stokes, relating to the pressure on railway bridges. The most remarkable instance, however, was the equation known as Pfaff's equation, which was of considerable generality. In this case, as had been ascertained by Professor Boole, the calculus of symbols gave the same conditions of integrability as had been previously ascertained by Pfaff, by an entirely different process.

ASTRONOMY.

On Methods of Detecting Changes on the Moon's Surface. By W. R. BIRT, *F.R.A.S.*

The author commenced by alluding to the theories that had been submitted for explaining the appearances on the moon's surface. One, he said, had reference to the fixity of those appearances; so that how long soever observations might be continued, no changes would be detected, all volcanic action on the surface (which appears to be admitted on all hands) having long ago ceased—the largest lunar forms having been the result of the most violent outbreaks, the smaller mountains, especially in the larger craters, indicating the last expiring efforts of this action. This theory, the author said, would not satisfy all minds; and accordingly astronomers were not wanting who leaned to the hypothesis that eruptive action still exists, although in a subdued form.

In order ultimately to set at rest the question as to whether the surface of the moon is in a state of quiescence or activity, the author recommended the formation of a catalogue of lunar objects, remarking that our existing records were inadequate to determine the question. He gave instances of lunar craters figured as far back as 1792, by the astronomer Schröter, which have been entirely overlooked by Beer and Mädler, and consequently omitted in their map, which is the acknowledged authority in lunar matters. These craters, the author said, he had himself seen very recently; and in order to assist in detecting future changes, should there be any, he had already commenced a catalogue in which 386 objects were entered, many of them very small.

On the present Aspect of the Discussion respecting the Telescopic Appearance of the Solar Photosphere. By the Rev. W. R. DAWES.

After reviewing the statements of Sir W. Herschel, Mr. Nasmyth, Mr. Stone of the Greenwich Observatory, and others, the author considered the discussion to be reduced to these alternatives:—Either, first, the objects described by Mr. Stone as like "rice-grains," are not identical with those Mr. Nasmyth has compared to "willow-leaves," and therefore can afford no corroboration of Mr. Nasmyth's "discovery"; or secondly, if they are the same, they are so easily seen as to have been well known to Sir W. Herschel seventy years ago, and to others more recently.

On the Possibility of constructing Ellipsoidal Lenses. By the Rev. Thomas Furlong.

If a circular disk be put in a convenient position, and a line be supposed proceeding from its centre, and perpendicular to its plane, an eye placed in that line will see the disk as a circle. If the plate be made to revolve on one of its diameters through a right angle, it will be seen edgeways as a line; as the disk so moves through 90°, the eye will perceive it assume every form of ellipse, from the circle, its limit on the one hand, to the right line, its limit on the other. The elements of those elliptic forms are easily found; for the radius of the disk is always the semiaxis major, and the natural cosine of the angle through which the disk (or the eye) moves multiplied by the number of inches or feet in the radius of the disk will be the semiaxis minor, from which, if the focus be given, the angle of revolution can be found, or, if the angle be given, the focus may be found; or, easier still, to the $\frac{1}{100}$th of an inch, by measuring off those numbers on the legs of a right angle on a scale of equal parts. The common slide-rest has two motions, one parallel to the bed of the lathe, the other at right angles to it; and if a cutting-tool be arranged as for boring a cylinder, that cutter will produce a cylindrical groove if the work attached to the slide-rest be moved parallel to the bed, or a line (like the cut of a circular saw) if moved across the bed. Now if the upper part of the slide-rest be made capable of moving in azimuth 90°, the cutting point, moving in a circle, can be made to produce grooves corresponding to the small end of the ellipse, or, by a vertical arrangement to the flatter side, of any eccentricity required. Crossed lenses, ground and polished in circular grooves (the discovery of a French gentleman, he believed), are well known and valued for flatness of field and good definition. His strong impression is that elliptic lenses could be produced in the same way. The only point of difference is that, while the circular groove permits the glass to be worked in it in various positions, the elliptic groove must have the glass worked in it always in the same plane. The paper read was not intended for the learned, but for a plain workman, and in the hope that some one would try the experiment. The author feels confident that, if ellipsoidal curves were introduced, great advantages are likely to arise.

On the possible Connexion between the Ellipticity of Mars and the general Appearance of its Surface. By Professor Hennessy, *F.R.S., M.R.I.A.*

The physical characters of Mars have attracted considerable notice, on account of the supposed resemblance of that planet to our earth, and at the same time one of the most prominent of these characters presents a striking contrast with its terrestrial counterpart, namely, its ellipticity, which is estimated by most astronomers at a higher value than mechanical theory would assign, if the planet had been originally in a fluid state. In accordance with hydrostatical laws, a planet similar to Mars, and rotatory around its axis in the same period of time, should have an ellipticity very nearly approaching to that of our earth. Two observers of great eminence, Bessel and Johnson, seem to have arrived at a similar conclusion. The observations made by the former were fully discussed by M. Oudemanns in the 'Astronomische Nachrichten,' No. 838, p. 352. After combining the results of different observed diameters with various angles of position, by the method of least squares, Oudemanns came to the conclusion that the observations gave varied and uncertain values for the diameters; and therefore that it was permissible to regard the planet as approximately spherical. Johnson, in the Radcliffe Observations for 1850 and 1853, discussed the results of measurements made with the heliometer, and arrived at substantially the same result. Although the late M. Arago referred to some of the author's views regarding terrestrial physics, as probably affording explanation for the anomaly of the large ellipticity which he assigned to Mars, in his posthumous publication on the structure of the planet, the author had heard the same eminent person express views almost identical with those flowing from the observations of Bessel and Johnson. At the same time, the simplification which the author endeavoured to introduce into the theory of the Earth's figure will not, if applied to that of Mars, suffice to account for the usually received high ellipticity of that body. Abstaining, for the present, from any attempt at an explanation of this peculiarity, let us endeavour to trace out its consequences with reference to the configuration of that planet. It seems to be generally admitted that there is, in the neighbourhood of one of the poles of Mars, a great mass of brilliant matter, analogous to a mass of terrestrial snow. This very substance is even supposed, with great probability, to seriously interfere with the accuracy of telescopic observations, owing to the optical disturbances arising from the irradiation of such an extremely bright object. It is also manifest that, if this substance should be snow, the varying seasons of the planet would cause its dimensions to vary, and thus the power of the disturbing influence. These circumstances show that great caution should be used in accepting any results which are liable to be affected by the presence of this snowy patch, and they also necessarily imply the existence of a fluid like water in that part of the surface of Mars wherever the temperature is above the freezing-point of the fluid. If this should be so, the generally assumed large ellipticity of Mars should be followed by another result. Several years ago, when controverting and disproving an erroneous theory of the Earth's figure, put forward by Playfair, and which has since acquired some importance by being reproduced by Sir John Herschel, in support of his general views, and appealed to by Sir Charles Lyell, the author obtained mathematical expressions for the equilibrium of a fluid like water spread over an exterior abraded spheroid such as this theory assumed the Earth to be. It follows from these expressions that if the Earth possessed a very small ellipticity, or were spherical, it would consist of two great circumpolar continents, with an intermediate belt of equatorial ocean. He has assigned the dimensions of these continents, supposing the ocean to have its present volume. It also immediately follows that if the Earth had a very great ellipticity, such, for example, as that so frequently assumed for Mars, the reverse would take place, and the dry land would form an equatorial belt, while the poles would be enveloped in water. The dimensions of these circumpolar oceans, with the assumed ellipticity of Mars, could be also assigned, and they should exist on its surface, unless there should be great irregularities in the density of the matter composing the planet. The mechanical theory on which these conclusions are based is simple, and therefore the attention of observers may be directed to the inquiry as to whether, compared with our Earth, a greater predominance of dry land exists at the equatorial parts of Mars compared to its polar regions. If the author might venture to draw any conclusion from the results hitherto observed, and especially from the drawings appended to Mr. Lockyer's paper, in the 'Memoirs of the Astronomical Society,' he would say that no such predominance of equatorial land exists on the surface of Mars, and therefore if its appearances are partly due to the presence of a liquid on its surface, we must conclude that its ellipticity has been generally exaggerated, and that the results of Bessel and Johnson's observations are, upon the whole, nearer to the truth than those of other observers.

Speculations on Physical Astronomy. By R. W. Hardy.

On an extensive Lunar Plain near the Montes Hercynii, which it is proposed to name Otto Struve. By Dr. Lee, *F.R.S., F.G.S.*

The paper which the author presented to the Section was intended as a supplement to those already brought before the Members of the British Association by the Rev. T. W. Webb and Mr. Birt. After alluding to the three large and beautiful drawings of the Mare Crisium by Professor Piazzi Smyth, Dr. Lee called attention to a large plain in the north-east quadrant of the moon, formerly designated "Lichtenberg" by the Hanoverian astronomer Schröter. It is situated between two mountain-chains, to the easternmost of which the German selenographers, Beer and

Mädler, appropriated the term "Montes Hercynii," at the same time transferring the name "Lichtenberg" to a crater some little distance from this plain. Dr. Lee illustrated his description of the plain and its surrounding mountains by copies of four delineations, which, with the one on Lohrmann's map, are all that are in existence—one by Schröter, made in the year 1792; the portion of Beer and Mädler's map of this region; a fine drawing of the northern part of the plain by Lord Rosse; and an unpublished drawing by Mr. Birt, executed during the present year. In these drawings, Dr. Lee pointed out the features that were common to them, especially a large crater on the north part of the west wall, which was very conspicuous in them all. The west wall Dr. Lee remarked is the most interesting of the two principal ones which bound the plain. This wall is shown by Schröter as being perforated by four craters, including the conspicuous one above mentioned. Of these craters the author said Beer and Mädler have but one on their large map. Lord Rosse's drawings of a part of the chain only have the nearest to the large crater, and Mr. Birt appears to have observed the four given by Schröter. After alluding to the confusion likely to arise from the changes in the names before mentioned, Dr. Lee suggested that in future this large plain should be denominated "Otto Struve," as commemorative of the extensive astronomical labours of the astronomer of Pulkova; and that the crater to which Beer and Mädler gave the name "Lichtenberg" should still retain it, especially as, according to the German selenographers, it is almost unique in exhibiting on some occasions a *red* tint.

Notice of the Physical Aspect of the Sun. *By* Professor Phillips, *M.A., LL.D., F.R.S.*

Since the author had been provided with the diagonal sun-glass adjusted to his equatorial by Mr. Cooke, he had taken many occasions for scrutinizing the aspect of the sun's disk in regard to spots, faculæ, and the general porosity of the surface. For tracing the path of a spot across the disk, a Kellner eyepiece was employed, with five engraved transit lines, the intervals being equal to 10° in the central part of the sun's circumference. In drawing, negative eyepieces of the ordinary kind were sometimes employed; at others, a peculiar kind, arranged by himself, with powers varying from 75 to 300, the best performances being usually between 100 and 200; the higher powers, however, being occasionally useful towards the limb of the sun. He described the bright streaks or faculæ as of diversified form and distinct outline, either entirely separate or coalescing in various ways into ridges and network. When the spots became invisible near the limb, the undulated shining ridges and folds still indicated their place, being more remarkable thereabout than elsewhere on the limb, though almost everywhere traceable in good observing weather. In a diagram made on the 29th of March last, faculæ are shown in the most brilliant parts of the sun. They appear of all magnitudes, from barely discernible, softly gleaming spots a thousand miles long, to continuous, complicated, and heaped ridges 40,000 and more miles in length, and 1000 to 4000 miles and more broad. They are never regularly arched, and never found in straight bands, but always devious and minutely undulated, like clouds in the evening sky or very distant ranges of snowy mountains. When minutely studied, the ridges appear prominent in cusps and depressed into hollows. By the frequent meeting of the bright ridges, spaces of the sun's surface are included of various magnitudes, and forms somewhat corresponding to the areas and forms of the irregular spots with penumbræ. Ridges of this kind often embrace and enclose a spot, though not very closely, the spot appearing the more conspicuous from the surrounding brightness; but sometimes there appears a broad white platform round the spot, and from this the white crumpled ridges pass in various directions. Towards the limb the ridges appear nearly parallel to it; further off this character is exchanged for indeterminate direction and lessened distinctness; over the rest of the surface they are less conspicuous, but can be traced as an irregular network, more or less disguised by that structure which has been designated as porosity. The faculæ preserve their shapes and position, with no visible change, during a few hours of observation, and probably for much longer periods. They do not appear to project beyond the general circular outline of the sun—a circumstance which the author explains, without denying that they actually do rise above the general surface, whether as clouds or mountains, to either of which they may be truly likened. In respect to porosity, the author had also devoted much time to a scrutiny of the interspaces between the faculæ towards the limb and the general surface towards the interior of the disk. Towards the interior the ground acquires more evident lights and shades, a sort of granulation difficult to analyze. Under favourable conditions for observation, there appears little or none of that tremor and internal motion described by earlier observers. What is then seen is a complicated surface of interrupted lights and shades, the limits of which appear arched, or straight, or confused, according to the case; and the indeterminate union of these produces sometimes faint luminous ridges, the intervals filled up by shaded interstices and insulated patches of illuminated surface. The best resemblance to these complicated small surfaces of light and shade he had been able to procure was a disk of a particular sort of white paper placed near the eye-end of the telescope, and seen by transmitted light. Heaps of small fragments of white substances, not so uniform in figure or equal in size as rice-grains, might also be suggested for comparison.

On a suspected Change of Brightness in the Lunar Spot, Werner. *By the* Rev. T. W. Webb, *A.M., F.R.A.S.*

The mysterious appearance of the Moon under high illumination, and the want of accordance between its actual relief and what may be called its *local colouring*, have by no means received a degree of attention corresponding with the present position and requirements of science, or with the unprecedented optical resources now at our command. The investigation would no doubt present many difficulties, but we ought not to be thus deterred from attempting the solution of so interesting a question; and a more persevering and minute examination of the topography of the full Moon could scarcely fail of meeting with its reward in a well-marked advance in the boundary of our knowledge. One probable result might be the discovery of variation in the brightness of the luminous markings. No reason can be given for acquiescing in the general supposition of their permanence, except the testimony of very inadequate representations. The changes remarked by Schröter and Gruithuisen are periodical, and therefore of another character; but a suspicion has begun to be entertained of more permanent alteration. Messrs. Birt and Hunter (the Earl of Rosse's observer), as well as the present writer, have found the interior of *Plato* different from the representation of Beer and Mädler; and the object of this paper is to bring forward evidence of another change, in the interior of the crater *Werner*. A small luminous spot at the foot of the wall on the N.E. side has been twice referred to by Beer and Mädler, in the most distinct and positive manner, as equalling the brightness of *Aristarchus*, and surpassing in this respect every other portion of the lunar disk. Such, according to the observations of the present writer, is no longer the case. In 1855 and 1856 its comparative inferiority was noticed with two achromatics of 3·7 inches aperture; and during the present year, a careful investigation with a 5·5-inch object-glass under very various angles of incident light, with many magnifying powers, and the occasional employment of coloured screen-glasses, leads to the same conclusion. So far from rivalling the intensity of *Aristarchus*, it never equalled that of *Proclus*, *Censorinus*, or *Dionysius*, all which are rated lower by Beer and Mädler. From its position it does not seem likely that other circumstances of libration would influence its apparent brightness; and since Beer and Mädler have studied the vicinity with especial minuteness (much more than they have bestowed on some other regions), it appears highly probable that the spot has decreased in brilliancy during the lapse of twenty years. A careful examination of other districts might probably detect similar changes. For this purpose, in place of vague and arbitrary estimations, a method of sequences similar to that adopted by Sir J. Herschel in stellar photometry might prove of great service, and coloured screen-glasses of various depths would be useful; but care must be taken to discriminate between the impressions of extent and intensity, and to avoid fragmentary comparisons with unequal apertures, as it is probable that the decrease of differences in apparent brightness with increasing light, which is known to obtain in the case of stars, may find place also in these observations.

On the Invisible Part of the Moon's Surface.
By the Rev. T. W. Webb, *A.M., F.R.A.S.*

Assuming the correctness, or at least probability, of Hansen's assertion that the centres of figure and gravity of the Moon are not coincident, and that consequently a different condition, both as to surface and atmosphere, might possibly obtain on its remoter side, an attempt was made to inquire whether there is any evidence of progressive change in proportion as we recede from the centre of the visible hemisphere; and it was shown that though there are departures of more than one kind towards the limb from the types of form prevailing in the centre of the disk, yet those variations are not sufficiently consistent to lead to any reliable inference; and that on the whole it is not possible, from what we see, to form any satisfactory conclusion as to the condition of the invisible region.

Light.

On a New Form of Spectroscope, in which Direct Vision is obtained with a Single Prism. By J. Browning.

Some time since it was suggested to the author by Mr. Huggins that a direct-vision spectroscope, more powerful than Hoffman's, would be a valuable addition to the instruments used for spectrum analysis. If made portable for travellers, it could be used in the manner of a telescope for observing differences in the solar spectrum at various elevations, for the spectra of flames, the absorption-bands produced by different liquids; and, above all, it would be most readily adaptable to telescopes for examining the spectra of stars. Whilst the author was engaged on various contrivances having this end in view, Mr. A. Herschel showed him a single prism he had contrived, which answered the purpose. It was of the form that has been termed 3 to 1 right-angled, from the hypothenuse being three times as large as the base. These proportions are very simple and easy of execution. In this prism, which was of crown glass 2·5 specific gravity, refraction occurs both in the ray of light entering at the face perpendicular to the short side, but near the point, and also on its leaving the prism by the short face, the correction of the inclination of the ray, so as to make it emerge in the same line as it enters, being effected by its performing two internal reflexions. In making this kind of prism of very dense flint glass, the author had found the task more difficult than he had anticipated: the acute angle required considerable modification, and it became very difficult to keep the path of the ray within the prism. The best results had been obtained by throwing the ray to the left of the prism, and correcting this by cementing a small crown-glass prism to the short face. The refractive angle, exercising a contrary dispersion, need not be more than 5°—scarcely more than a tenth of that employed by Hoffman in his construction. The three surfaces of this prism, being in use, must be all equally true, or the definition suffers. After the result of all the experiments he had made, the author would wish to express his conviction that whatever advantages may be gained on the score of portability or convenience in use, they were more than counterbalanced by the inferior performance of these arrangements, when compared with plain prisms of the best workmanship. In connexion with this paper, the author added some remarks on the great difficulty encountered in working plane surfaces on extra-dense glass prisms, and exhibited two wonderfully delicate instruments for measuring the irregularities. With the first, inequalities of $\frac{1}{20000}$ of an inch could be taken by direct reading, and of $\frac{1}{50000}$ of an inch by estimation; with the second, inequalities of the $\frac{1}{1000000}$ of an inch were discoverable. The common method is to take the reflexion of a distant image through a telescope; but the prisms Mr. Browning has produced fully justify his choice of direct mechanical means for proving the perfection of their surface-planes.

On the Connexion between the Form and Optical Properties of Crystals. *By* A. Catton.

It was the object of this paper to give an account of the results of investigations which have had for their object the discovery of the connexion between the form and optical properties of crystals. It is believed that, in the results here given, some of the principal difficulties of this important problem have been overcome. The first step towards the solution of this problem was made by Sir David Brewster in 1818. He discovered that crystals belonging to the prismatic, oblique, and anorthic systems are biaxal; those belonging to the pyramidal and rhombohedral systems uniaxal; while crystals of the cubic system do not possess double refraction (a fact which had been previously stated by Hauy). In this paper is considered in detail the connexion between the form and optical properties of crystals belonging to the prismatic system. The investigation of the optical properties of crystals belonging to the oblique system is still in progress. The following is the method employed in this investigation:—Each crystal is referred to three rectangular axes, one axis being perpendicular to the plane of the optic axes, the other two being the internal and external bisectors of the angle between the optic axes. The new parameters are calculated by means of formulæ investigated in a paper on the "Rhombohedral system;" and thence the angle between the optic axes is found, as if the crystal belonged to the prismatic system, by means of the formulæ given in this paper. The angle between the optic axes of one mineral belonging to the oblique system has been calculated by this process; and the calculated has been found to agree approximately with the observed angle. If this should prove to be generally the case, it will not only be a solution of the problem which forms the subject of this note for crystals of the oblique system, but it will prove that these crystals are formed according to the same laws of symmetry as crystals of the prismatic system.

Photo-Sculpture. *By* A. Claudet, *F.R.S.*

After having explained the advantages of photography and its progress, the author described in what manner it has been applied to sculpture.

This beautiful application of photography is called *Photo-Sculpture*, and is the invention of M. Willème, an eminent French sculptor.

The story of the invention may be told in a few words. M. Willème was in the habit, whenever he could procure photographs of his sitters, of endeavouring to communicate to the model the correctness of those unerring types. But how should he raise the outlines of flat pictures into a solid form?

Yet these *single* photographs, such as they were, could serve him to measure exactly profile outlines. He could, indeed, by means of one of the points of a pantograph, follow the outline of the photograph, while, with the other point directed on the model, he ascertained and corrected any error which had been communicated to his work during the modelling. What he could do with one view, or one single photograph of the sitter, he might do also with several other views, if he had them. This was sufficient to open the inquiry of an ingenious mind. He saw at once that if he had photographs of many other profiles of the sitter, taken at the same moment, by a number of cameras-obscuras placed around, he might alternately and consecutively correct his model by comparing the profile outline of each photograph with the corresponding outline of the model. Such was the origin of this discovery. But it soon naturally occurred to him that, instead of correcting his model when nearly completed, he had better work at once with the pantograph upon the rough block of clay, and cut it out gradually all round in following one after the other the outline of each of the photographs.

Now supposing that he had twenty-four photographs, representing the sitter in as many points of view (all taken at once), he had but to turn the block of clay, after every operation, $\frac{1}{24}$th of the base upon which it is fixed, and to cut out the next profile, until the block had completed its entire revolution, and then the clay was transformed into a perfect solid figure of the twenty-four photographs—the statue or bust was made.

As an illustration of the process, the author has executed a bust of the President of the Association, Sir Charles Lyell, which was exhibited to the Section.

On the Adaptation of Bisulphide-of-Carbon Prisms, and the use of Telescopes of Long Focal Distance, in the Examination of the Sun's Spectrum. By J. P. GASSIOT, *F.R.S.*

The dispersive power of sulphide of carbon has caused it to be generally used for producing the spectrum; and some time since the author had a battery of eleven prisms constructed, which has been used at the Kew Observatory in observing the spectrum of the sun. By means of this apparatus, the double D line was observed in a very remarkable manner, presenting an angular separation of 3′ 6″, while at the same time eleven other associated lines were counted which had not previously been detected. But although this great angular separation is a proof of the power of the instrument, spectrum observations made with sulphide-of-carbon prisms are attended with difficulties of the most perplexing and often annoying character. One of these is the necessity of readjusting their position whenever different portions of the spectrum have to be examined, the time thus occupied being often fatal to the securing of true and faithful results. Another and serious difficulty arises from the changes of temperature taking place during the period of observation. The author had been informed by Mr. Browning that Prof. Cook, of New York, who had a battery of nine prisms, made by Alvan Clarke, had found the influence of temperature so great as to render the battery unserviceable for long-continued and exact investigations. In order to test the effects of changes of temperature upon Mr. Gassiot's battery, a careful observation was made of the lines discovered in the space between the double lines of D. A tin vessel containing hot water was placed on the plate in the centre of the battery, the heat from which soon affected the fluid in the prisms, and the spectral lines gradually became confused and indistinct, travelling at the same time rapidly across the field of view; several hours elapsed before the prisms resumed their normal state. The fluid prisms are, notwithstanding all difficulties in using them, the author considered, an indispensable and most valuable adjunct to a complete spectroscope, as, by the enormous dispersive power of this sulphide, observations of lines in the spectrum are obtainable that otherwise would probably entirely escape notice; and if, as in the battery which Mr. Browning had constructed for him, the prisms have surfaces so perfectly plane as, at equable temperatures, to give such satisfactory definition, they become highly valuable for the purposes of comparison, and thus of determining in a remarkable manner the coincidence of certain lines, the accuracy of the results not being interfered with, as it is evident both sets of lines would be equally affected. The observers at Kew believe they have noticed the coincidence of several bright gold lines with corresponding dark lines in the solar spectrum, from which the presence of that metal may be inferred in the sun's atmosphere. If confirmed by further observations, this will be an important addition to our present knowledge. In order to increase the power of the author's unequalled battery of flint-glass prisms, Mr. Browning has recently adapted a pair of telescopes of three feet focal length, in place of those of two feet, formerly used. The improvement thus effected is very striking; and on the only opportunity for using it, the solar spectrum assumed an appearance far more nearly resembling that obtained by the battery of fluid prisms. This single observation, however, has been enough to show that the employment of telescopes of long focal length may be indispensable for minute and reliable research on the lines in the solar spectrum.

On the Transmission of the Red Ray by many Coloured Solutions. *By* DR. GLADSTONE, *F.R.S.*

The author has been in the habit of observing the absorption of the different parts of the prismatic spectrum by coloured liquids, by allowing a line of light to pass through the varying thicknesses of the liquid contained in a hollow wedge of glass and analyzing it by a prism. From the diagrams representing the phenomena thus produced, it was evident that in many cases the extreme red ray was capable of penetrating very far, while the less refrangible red or orange ray was almost immediately absorbed. The following instances were given:—Solutions of chromium salts, uranous salts, permanganates, blue salts of cobalt, ferric sulphocyanide, sulphindigotic acid, litmus, azuline, chinoline blue, bleu de Paris, ceruleine, acid nitrosonaphthaline, cochineal, chlorophyll, and the purple colour produced by the action of a sulphide on a nitroprusside. These solutions were exhibited; and two of them, litmus and chinoline blue, being placed in the hollow glass wedges, showed the phenomena of dichromatism—that is, the thin part of the wedge of liquid was blue, the middle part purple, while the thick part was red. This is due to the free transmission of the red ray, while the other parts of the spectrum are more quickly absorbed. Several of the other liquids are dichromatic from the same cause; for instance, the salts of chromium, which are either green or red, according to the quantity seen through. No probable cause was assigned for this double peculiarity —the very free transmission of the red ray, and the speedy absorption of the neighbouring ray; nor did the author see any chemical relationship between the substances that exhibit it.

On the Spectra of some of the Heavenly Bodies.

By Professor W. A. Miller, *V.P.R.S., and* W. Huggins, *F.R.A.S.*

The first part of the communication related to observations on planetary spectra. It was necessary to compare these spectra side by side with that of the sun; but here arose a difficulty, for a planet is not usually visible until sunset. Ultimately the plan adopted was to compare the light of the planet with that of the sun reflected from the sky in the immediate vicinity of the planet, just after the sun had sunk below the horizon. The object of this comparison was chiefly to ascertain whether the sun's light, after being reflected from a planet, and having passed through a portion of its atmosphere, contains any of those lines of absorption which are produced in the solar spectrum when the rays of the sun traverse a large extent of our earth's atmosphere. This was found to be the case, and one line in particular was much more powerfully developed by the atmosphere of Jupiter than by that of our earth. The colour of the light of Mars was in like manner found to be due to absorption exercised by something in the atmosphere of that planet.

The second part of the communication referred to the spectra of binary stars. These are most difficult of observation, as the two members of the system are so very near one another that it is difficult to obtain the spectrum of one without the other. This difficulty was, however, overcome in some cases, where the stars were not extremely close, by rotating the spectroscope in the tube of the telescope until the slit for admitting the light was at right angles to the line joining the two stars; the coloured appearance presented by some of these interesting bodies was found to be produced by peculiar absorption of certain parts of the spectrum, similar to that which, on a small scale, is produced by the atmosphere of our luminary.

The third and most remarkable part of this communication was that which referred to the spectra of nebulæ; and the observations in this field were stated to have been conducted solely by Mr. Huggins. The nebulæ examined were chiefly those denominated planetary nebulæ. It was scarcely expected that the extremely faint light of these bodies would be sufficient to produce any spectrum at all; nor would it have done so had their construction been that which has been usually assigned to them. But to the surprise of the observer he beheld, not a continuous spectrum such as that which proceeds from a solid body interspersed with dark lines due to atmospheric absorption, but a spectrum consisting of a few bright lines such as that which proceeds from an intensely heated gas. It was, indeed, the smallness in number of these component lines that enabled any success to be obtained; and the result from three or four of these nebulæ revealed the fact that they were in each case composed of glowing gas, probably hydrogen and nitrogen, without any solid nucleus whatever. But what can be the origin of this high temperature, since, upon the principle of the conservation of energy, some other form of motion must be destroyed in order to produce the luminosity? The origin of the light of the heavenly bodies thus becomes more perplexing than ever, and seems to point to some law regarding which we are yet in the dark.

On a recent Description of an Iris seen in the Lake of Lucerne. By Mr. J. J. Walker.

In a letter which appeared in the 'Athenæum' of September 3, the writer described the appearance of a splendid solar rainbow, and its "reflected image" in the Lake of Lucerne. This was an instance, seen under very favourable circumstances (from the calmness of the water, the low altitude of the sun, and the elevation of the observer above the surface of the lake), of that secondary iris, to the *rationale* of which the author had drawn the attention of the Section at the Aberdeen Meeting, 1859.

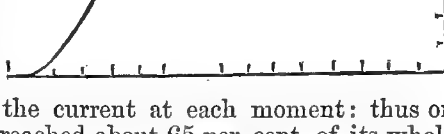
Electricity.

Description of a Cheap Form of Automatic Regulator for the Electric Light. By Samuel Highley, *F.G.S.*

The principle of this "Pneumatic Electric Regulator" was suggested to the author by Mr. Malden. The instrument is sensitive in action, and, from its simplicity, little liable to get out of order, and can be arranged for any length of carbon. The rod supporting the upper carbon is attached to a copper float, which rests upon a column of water, contained in a chamber communicating by an opening with an air-chamber, from which a pipe, terminated by a flexible tube of vulcanized rubber, is carried under a wedge-shaped piece attached to the rod holding the lower carbon, and which passes through a coil of stout insulated wire. When the carbons are brought into contact, the current passes through, and the coil becomes magnetic, pulls down the iron core, and separates the carbons, so as to produce the proper arc of light, at the same time forcing down the wedge upon the flexible tube, closing it as effectually as with a stop-cock. As soon as the distance between the poles becomes too great for the current to pass freely, the coil ceases to be magnetic, and the lower rod is raised slightly by means of a lever and counterpoise spring. Air is thus forced from the chamber by the column of water; the float sinks, bringing down the upper carbon into contact with the lower one: the current is thus again completed; the coil becomes magnetic, and pulls down the iron core, pressing the stop-cock wedge upon the rubber tube. These operations are repeated sympathetically as the carbon burns away.

On the Retardation of Electrical Signals on Land-Lines. By Fleeming Jenkin.

The retardation of electrical signals through submarine cables has been studied closely for some years; but on land-lines, owing to the difficulty of the experiment and small influence of the retardation on the signals usually employed, little attention has been paid to the phenomenon. The invention of automatic instruments, such as Prof. Wheatstone's transmitting signals, which succeed one another with great rapidity, now renders the retardation an important element of calculation, even on the common aërial lines. The electric current is never received at a distant station at the very instant of its transmission; it arrives gradually, as represented in the annexed curve, in which the horizontal ordinates represent the times after the circuit has been completed in terms of a quantity a; while the vertical ordinates represent the relative strengths of the current at each moment: thus on any circuit the received current will have reached about 65 per cent. of its whole strength after a period of $6a$. The quantity a varies with the circumstances of each case, and is equal to $\frac{kcl^2}{\pi^2}\log_e\left(\frac{4}{3}\right)$, where k= the resistance of the conducting wire



per unit of length, in electrostatic absolute measure; c the capacity per unit of length in the same measure; and l the total length of the wire; k is known for all the ordinary metals, but c has hitherto been undetermined; and the object of the paper was to deduce the value of c, from some experiments made by M. Guillemin, and fully detailed in the 'Annales de Physique et de Chimie' for 1860. These experiments gave with considerable accuracy the form of the curve for various lengths; but the experimenter had not applied his results so as to give the constants required for the mathematical theory. After describing the method employed by M. Guillemin with high commendation, Mr. Jenkin gave the results of his calculations. The electrostatical capacity per foot of the common No. 8 wire in the lines used by M. Guillemin must have been from 0·15 to 0·22 in British absolute electrostatic measure (feet, grains, seconds). This number is nearly three times that given by pure theory for a wire, stretched horizontally, without supports, at a uniform height of ten feet from the ground—a discrepancy probably to be accounted for by the induction occurring at each post. The form of the curve was also modified by imperfect insulation. The retardation due to the statical charge—the capacity for which is thus determined—not only delays the signals, but causes confusion and utter illegibility if they succeed each other too rapidly. A limit is thus put to the performance of signalling-instruments; and calculations made with the above value of c show that we must not expect to transmit by the common Morse instrument more than about twenty words per minute between stations 1300 miles apart; that the performance of Prof. Wheatstone's beautiful automatic transmitter may be limited to speeds below 120 words per minute when 530 miles are exceeded; and that the Chevalier Bonelli would have to diminish his speed of 400 words per minute (with five wires), even on considerably shorter circuits. It must be remembered that larger wires, fewer posts, and a better form of insulator may considerably extend these limits.

Description of an Electric-resistance Balance constructed by Prof. W. Thomson. *By* Fleeming Jenkin.

The author described an instrument made under the superintendence of Prof. W. Thomson, of Glasgow, for the purpose of practically carrying out the important improvements in the methods of comparing the electric resistances of short thick bars of wires of metal, as described in a paper by Prof. Thomson, published in the 'Philosophical Magazine.' The special merits of the method are, that the bars or wires to be tested do not require to be cut to any definite length, that they do not require to be soldered or joined by amalgamated terminals to the connexions of the instrument, and that any resistance due to slightly imperfect connexion between the bar tested and these connexions does not vitiate the measurements. This important practical improvement, by which the accuracy of the measurement and the ease with which it can be effected are alike increased, was explained by reference to the fine instrument exhibited, which has been constructed for Col. Douglas, Superintendent of the Telegraphs in India, by Mr. James White, of Glasgow.

On the Development of Electricity from the Rays of the Sun and other Sources of Light. By H. Keevil.

Descriptions of the "Liquid Steering Compass" and "Monitor Compass." By Professor H. D. Rogers.

The compasses described were constructed by Mr. E. S. Ritchie, of Boston, U. S. The distinctive peculiarities of the liquid compass are an air-tight metallic case, within which is placed the magnetic needle, and of such size and weight as to be of very nearly the same specific gravity as the liquid in which it is intended to float. The weight is thus removed from the pivot, and friction is almost prevented; certain modifications being introduced to provide against tilting and other emergencies occurring during the motion of the ship. The distinctive principle of the monitor compass is the separation of the magnet from the card or index, so that the magnet may be elevated above the sphere of disturbing attraction of the iron of the ship, while the card is brought to a convenient position to be seen by the pilot; and suspending the moveable portion in a liquid, so as to ensure entire freedom from friction, that the needle may obey the polar force, at the same time that great steadiness is secured for the card.

On the Mechanical Theory and Application of the Laws of Magnetic Induction and Electricity. By J. B. Thompson.

In this paper electricity and magnetism were considered as a force in the same way as heat and light; and electric and magnetic induction were treated in correspondence with mechanics. The summary of the author's theories is:—That the phenomena called electricity and magnetism are two forms of force which may either be in conatus or in act. If in conatus, they are in a state of tension; if in act, then in a state of fluxion. Electricity is in conatus when in the static form of excitation, or when the voltaic circuit is not completed; in act, when the matter highly excited is brought in contact with matter less highly excited, or when the voltaic circuit is completed. Magnetism is in conatus when the magnetic vortical sphere is held constant by a constant electric current, or by hardened steel or magnetic iron ore, so that the earth-magnetism may flow in; in act, on its electric projection and recession, or when iron or some other paramagnetic is moved through this sphere. That electric conduction is by certain molecular movements of particular portions of matter. Those wherein this movement is easily excited are called conductors, and those wherein it is with difficulty excited are called insulators. That magnetic conduction is by the symmetrical arrangement into a vortical sphere of spirals of a general medium, which pervades all matter, and holds it in that form for the time being. That particular matter wherein the sphere is easily excited is called paramagnetic, and that wherein it is with more difficulty excited is called diamagnetic. That this sphere can be fixed by means of hardened steel or magnetic iron ore. That the magnetic vortical can be excited by means of spiral currents of electricity generally, and even by a tangent to such spiral. Also it can be induced by magnetic conduction in paramagnetics. That the magnetic force is only in a state of fluxion on the projection and recession of this sphere. That this sphere is projected in the direction of the exciting electric current, and recedes in the opposite direction. That the electric force is induced on the projection of the magnetic vortical, and also on its recession. That, consequently, for one inducing current there are two induced currents; therefore, it would appear that by induction electric excitation is multiplied. Finally, that these inductions and conversions of force are in strict accordance with the laws of mechanical motion. In connexion with the paper an induction machine was exhibited, the chief points of novelty in which appear to be these:—that it is self-acting; the current of voltaic electricity which produces the induced current also drives the machine; that the machine can be so adjusted that the quantity and intensity of the induced current shall range from that of 10 Daniell's cells to that of 1000, and this without employing more than three or four cells. These are valuable properties to electricians who are engaged in experiments with electricity of high or even moderately high tension. Besides, it is applicable to whatever batteries are, having been used experimentally for telegraphy and for electro-depositing. For telegraphy through submarine and subterraneous cables there appears to have been a great objection to induction machines, or rather induction coils. The objection was, that these induction coils sent their electricity through the cables in sudden intense shocks, which injured the insulation of the cable. In this machine it is apparently a continuous flow, and no spark will jump from one electrode to the other, unless first brought in contact, as in batteries. When modified for electroplating it is much more efficient than the ordinary battery; for though it deposits the metal more slowly on any one article, yet it deposits it much more firmly and with a better surface than the ordinary battery does; and it will deposit the same quantity on a thousand articles at once, which enables it to deposit ten times more metal in the same time than its own exciting battery would do. The construction of the machine is simple, and will not be easily deranged or speedily worn out.

Meteorology.

On a New Anemometer. *By* C. O. F. Cator, *M.A.*

The object of this instrument is to obtain, by the wind acting on one surface only, a daily curve of its pressure in pounds on an area of a square foot, and the number of miles travelled by it in a horizontal direction in twenty-four hours, or any other given time, and thence its hourly velocity. The surface upon which the wind acts, or the pressure-plate, is the base of a cone, the axis of which is horizontal, and the area of the base equal to one square foot, the object of the cone being to offer as little resistance as possible that may be due to any air on the *leeward* side of the plate, and to neutralize the effect of any vacuum formed behind it. The pressure-plate is attached to the end of a horizontal bar, and with it is moved backwards and forwards, the bar resting on friction-rollers; this is the only portion of the instrument out-of-doors and exposed to the weather, and is connected by a chain and steel rod with the rest of the instrument within the building on which the anemometer is fixed. The pressure of the wind is measured by two curved levers of equal length acting against each other, their motion being in a vertical plane. At one end of the upper lever is a fixed weight, and to the opposite end of the under one is attached the end of the connecting rod. When there is a calm, the point of contact is at the fixed weight, and as the wind presses against the pressure-plate it causes the rod to lift up the levers, and then the point of contact moves along towards the other end, indicating the strength of the gale, and the levers return by their own weight as the pressure of the wind subsides. To the end of the under lever a cord is attached, carrying a pencil to and fro along a cylinder in the direction of its length, upon which a pencil will trace the pressure of the wind for twenty-four hours. The velocity of the wind is shown by a "gaining-clock;" a second cord attached to the end of the under lever is connected with the regulator of this gaining-clock, and is so arranged that as the wind blows more or less strongly it pulls the regulator more or less towards the fast end, and proportionally accelerates the gaining of the clock. A counterpoise weight brings the regulator back as the pressure decreases. This gaining-clock also shows the *true* mean daily pressure. This anemometer also registers simultaneously, and on the same paper with the pressure, a perfect record of the directional variations.

On the Earthquake and Storm in Sussex of 21*st August* 1864. *By the* Rev. E. B. Ellmar.

In this paper attention was directed to the following facts:—For the previous three months there had been scarcely a shower, and the wells were consequently very low, and watercourses dried up, when, towards the end of the week ending 20th August, in certain situations springs broke up, or increased in their supply of water (a circumstance not uncommon after a long drought, and which is always considered a prognosticator of approaching rain, but to which public attention is not known to have been directed). It was full moon on Wednesday the 17th, and consequently the highest tides were on the 18th and 19th, which are said to raise the level of the water in certain wells; but that the tidal pressure was not the only influence on this occasion to increase the supply of spring water was evident from springs largely increasing their supply, which had never been known to have been influenced by the tide. At last, on Saturday the 20th, there were copious showers; but in the evening it was fine and clear, and so continued, when, about 1.25 on the Sunday morning, the inhabitants of the district for about fifteen miles around Lewes were aroused by a shock of an earthquake, the wave proceeding from N.W. to S.E. The violence of the shock was manifested by bottles and even heavy stoneware being thrown down and broken, bells rung, walls cracked, &c. The time of the shock was coincident with that of high tide on that part of the Sussex coast, when, of course, the tidal pressure was the greatest. After the shock had passed, it was perfectly calm and clear for some hours; but about 8 or 9 A.M. a very heavy storm came from the S.W., the lightning being very vivid, and the hail coming down in such quantities as to lie on the ground in some places more than two feet deep. Two waterspouts were observed, which

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truments at the

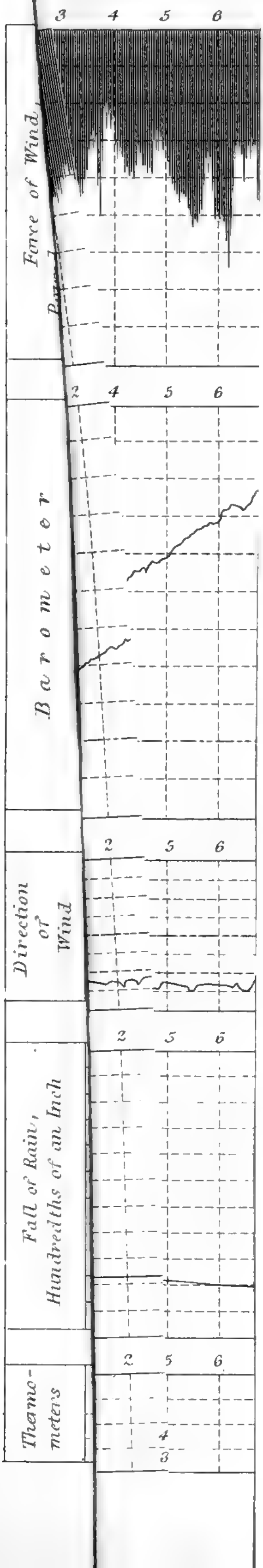
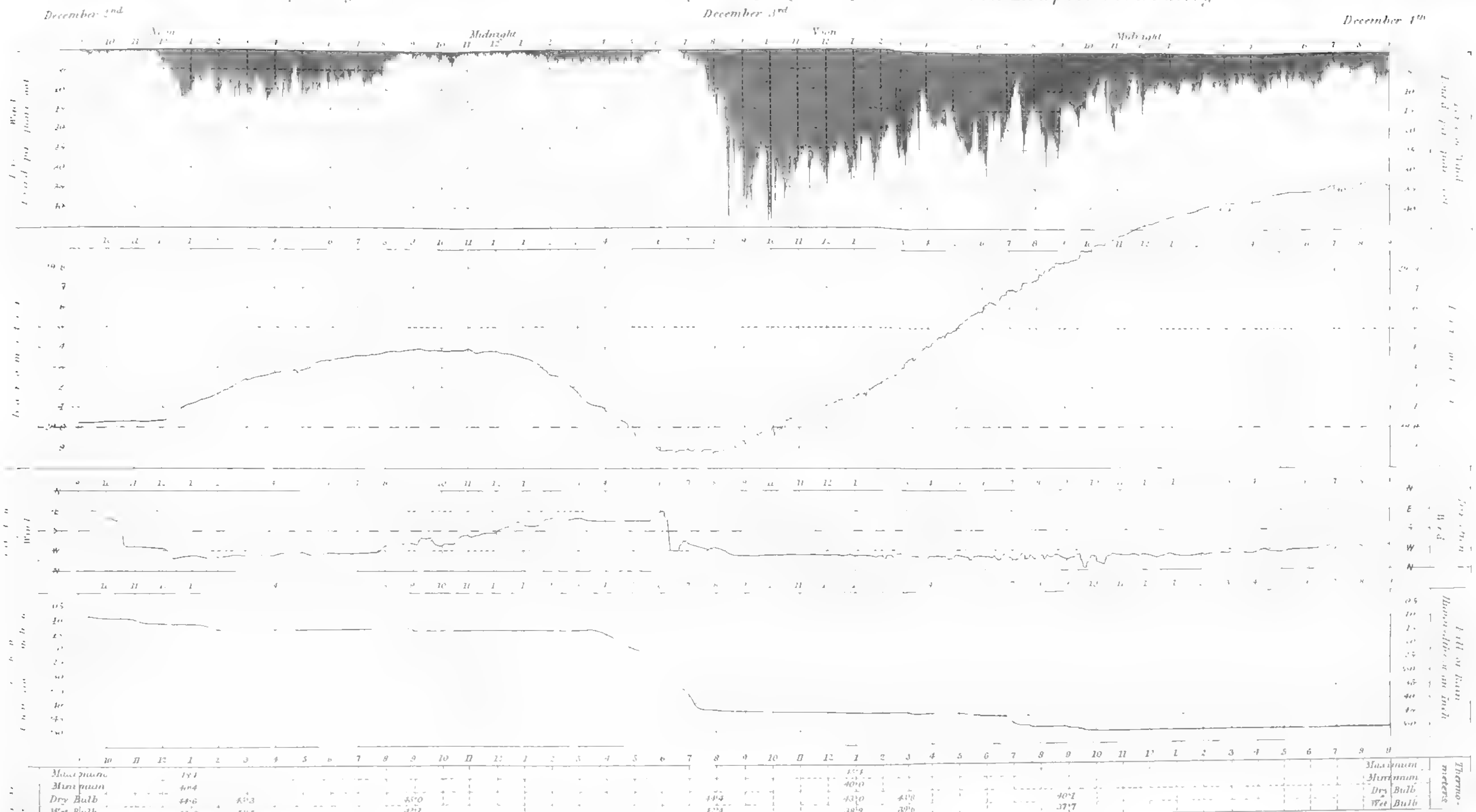


Diagram of the Storm December 1863 as recorded by the Self Registering instruments at the Liverpool Observatory



Engraved by J. W. Lowry

burst with terrific violence. The writer stated that these few facts led him to conclude that changes of weather are produced, not merely by aërial and electrical causes, but partly by subterranean causes. It was suggested that, if it were thought sufficiently important to investigate the subject, it would be desirable to obtain the magnetic disturbances at the time at the Kew Observatory, which is within fifty miles N.W.—the very direction from which the earthquake-wave proceeded. The writer's views were supported by an extract from a letter by Dr. Nicholson, of Framfield, in which, after alluding to this earthquake, he says, "I have frequently experienced in the West Indies similar shocks after a long drought, and am inclined to attribute some of them at least to electricity, as propounded by Dr. Stukely in 1749, when an earthquake was felt in London and other parts of England."

Diagram of the Great Storm of December 3, 1863, *from the records of the self-registering Instruments of the Liverpool Observatory. By* John Hartnup, *F.R.A.S., Director of the Observatory.*

It is scarcely possible, by means of tables of figures, to convey an idea of the way in which the different meteorological instruments are affected previous to and during these destructive gales of wind, and I have therefore endeavoured to make the subject more intelligible by arranging the records under each other in a diagram. See Plate III.

As is not unfrequently the case, the heavy storm of the 3rd of December last was preceded by a light gale on the 2nd, in which the fall and rise of the barometer, the calm, and the changes in the direction of the wind were somewhat similar to those which accompanied the heavy gale. The rapid fall of the barometer from midnight to 6 A.M. on the 3rd, the calm between six and seven, and the sudden shift of wind from east through south to west are all indications of the approaching storm.

The barometer-tracing has been taken from the original record produced by King's self-registering barometer. The strength and direction of the wind and the rain-fall have been taken from the sheets of Osler's self-registering anemometer and rain-gauge. The figures at the bottom of the diagram show the readings of the thermometers as recorded during the storm. The changes of barometric pressure, the strength and direction of the wind, and the fall of rain are shown on the diagram, from 9 A.M. on the 2nd to 9 A.M. on the 4th of December.

On the Regression of Temperature during the Month of May. By Professor Hennessy, *F.R.S., M.R.I.A.*

He referred to the various explanations offered with regard to this remarkable phenomenon. Dry winds from Asia and Eastern Europe appear to be the direct causes of high nocturnal radiation, as well as immediate cooling of the west of Europe during May. Why these winds should produce these results in a manner so remarkably periodical is the point requiring explanation. At this time the isothermals of mean temperature are nearly parallel to the equator in the greater part of our continent; therefore easterly winds could not directly arise from differences of temperature. These winds might, however, be northerly currents in Asia, which the earth's rotation had gradually transformed into easterly winds on reaching Western Europe. The Russian observatories in Siberia might furnish facts to verify this conjecture. Another operating influence might also arise from the diurnal variations of wind-force and temperature, both of which are very remarkable during May. If we conceive the distribution of atmospheric temperature to be represented by a system of synthermal lines, showing the actual temperature of different places at the same time, it appears from tables calculated by the author, as well as from a graphical projection, that such lines would deviate most from equatorial parallelism during May. The paper concluded by reference to the frequent occurrences of warm dry summers following marked regressions of temperature during the early part of May, and the remarkably cold and wet summer of 1860 was mentioned as preceded by precisely the opposite phenomenon.

The Temperature and Rainfall at Bath. By the Rev. L. Jenyns, *M.A., F.L.S., F.G.S.*

The author stated that no register of the weather at Bath appeared to have been kept for a sufficient length of time to determine the mean yearly temperature of the town itself. He was enabled, however, from observations of his own, combined with those of others, to correct a popular error respecting the summer temperature. Strangers often suppose that as Bath is milder than many towns in the midland, eastern, and south-eastern counties of England in winter, it must necessarily be hotter in summer. Several instances were adduced in which, during periods of very high temperature in most parts of England, the contrary was shown to be the case; and he stated generally, in reference to both summer and winter, that he found on an average a difference of 5° between extremes of heat and cold at Bath and the extremes of heat and cold registered during the same states of weather at those other places above alluded to. This difference increased as the seasons became more extreme, and diminished when they were of a more moderate character, sometimes being scarcely perceptible.

The towns in England cooler than Bath in summer were stated to be Liverpool, Manchester, York, and Scarborough. Those decidedly warmer than Bath in winter were considered to be Ventnor, Torquay, and Penzance.

If Bath, notwithstanding its lower mean summer temperature than many other places, has anything of a relaxing character at that season, as it is often considered to have, it was thought this might be due to its being situated at the bottom of a basin, surrounded nearly on all sides by high hills, which must necessarily check the circulation of the air, and render the atmosphere in the town, to a certain extent, oppressive in sultry weather. The same hills probably have an influence in moderating both the heat of summer and the cold of winter.

The average yearly rainfall in the town of Bath, calculated from the measurements of twenty years (1842 to 1861, both inclusive) by a gentleman whose gauge was on the top of his house, 90 feet above the sea-level, was stated to be 31·97 inches.

The following Tables give the rain at three other stations in the neighbourhood of Bath:—

The first of these stations is Swanswick Cottage, about two miles north of Bath, the measurements having been made by the Rev. F. Lockey for a period of thirty years, 1834–1863. Gauge 32 feet above the ground, and at the estimated height of 350 feet above the river at Bath.

The second station is Radstock, about eight miles south of Bath. Register kept by the late rector for ten years, 1841–1850. Gauge 250 feet above the sea-level.

The third is Batheaston Reservoirs, about three miles north-east of Bath, where a register was commenced by Mr. Mitchell in 1860, and is still carried on. Gauge about 2 feet from the ground, and 226 feet above the sea. The fall of rain in this locality for each month of the four complete years since elapsed, with the addition of the number of days in each month on which rain fell, is given separate in the second Table.

Table I.—Average Rainfall in inches.

	Swanswick. 30 years.	Radstock. 10 years.
January	1·85	2·76
February	1·30	2·66
March	1·41	2·54
April	1·48	2·48
May	2·11	2·47
June	2·67	2·33
July	2·47	2·70
August	2·47	2·94
September	2·79	2·98
October	3·04	4·03
November	2·60	3·71
December	1·59	2·99
	25·78	34·59

Table II.—Rainfall at Batheaston Reservoirs.

	1860.		1861.		1862.		1863.	
	Depth in inches.	Days of rain.	Depth in inches.	Days of rain.	Depth in inches.	Days of rain.	Depth in inches.	Days of rain.
January	3·41	21	·60	11	2·90	20	2·56	21
February	·86	4	2·23	16	·35	11	·57	10
March	2·29	13	2·50	19	3·91	21	·90	12
April	1·69	12	·43	4	2·85	13	1·60	12
May	3·00	11	1·07	9	3·86	18	1·84	10
June	6·82	27	3·36	16	3·21	15	4·62	19
July	1·94	11	3·24	22	2·69	19	·49	7
August	5·27	21	1·21	16	·87	10	2·72	16
September	2·46	14	3·12	19	3·05	16	3·54	19
October	1·80	13	1·33	16	3·64	24	3·32	21
November	2·17	10	1·78	21	·73	10	2·34	17
December	1·98	13	1·26	10	1·55	18	·96	15
	33·69	170	22·13	179	29·61	195	25·46	179

From the above Tables it appears that the average rainfall at Swanswick, amounting to 25·78 inches, is less than that at Bath by six inches or more, and less than that at Radstock by between eight and nine inches, this last being 34·59 inches.

The fall at Batheaston Reservoirs would seem to be intermediate between Bath and Swanswick; but it requires to be measured for a longer term of years to determine this accurately.

The above differences are considerable, regard being had to the proximity of the several stations, which are not many miles apart; but they are perhaps not greater than would arise from the difference of level and the configuration of the ground. Swanswick is on the slope of a hill, inclining down to Bath; Radstock Rectory, though moderately high above the sea, is situate in a valley close to a brook.

Taking the rainfall of the several seasons respectively, it appears that at both Swanswick and Radstock the autumn (probably the case in most other places) is the wettest season, and October the wettest month, in the year.

The driest season at Swanswick, or in which least rain falls, is the winter; at Radstock, the spring. But there is not a great deal of difference between the winter and the spring in this respect at either place.

The greatest yearly fall at Swanswick during the thirty years was 42·64 inches, in 1852. The least yearly fall at the same place was 18·58 inches, in 1854.

The greatest yearly fall at Radstock during the ten years was 44·85 inches, in 1848. The least yearly fall was 25·05 inches, in 1849.

The greatest quantity fallen in any one month at Swanswick was 8·32 inches, in November 1852.

The greatest quantity in any one month at Radstock was 8·33 inches, in November 1842, or nearly the same as that at Swanswick.

Mechanics, etc.

New Formula for calculating Steam Pressures, Steam and Volcanos, Bursting of Boilers. By R. A. Peacock, *C.E., Jersey.*

From 25 lbs. per square inch up to 411·6 lbs., the pressure of steam increases as the $4\frac{1}{2}$ *power* of the temperature, and the temperature increases as the $4\frac{1}{2}$ root of the pressure. Calculations thus made never differ as much as $\frac{1}{4}$ per cent., from the experiments of Dr. Fairbairn and M. Regnault, within that range. The author exhibited a MS. giving fifty cases where steam or hot water had been present in all the species of natural disturbances of the earth's crust. And if the same law of increase continues up to very high temperatures, steam would be powerful enough to cause earthquakes and volcanos. The heat of a common fire is known to be 1141° F., dull red heat 980° (difference 161°); and he thought boiler explosions were often caused by stirring the fire rapidly, and changing the latter temperature into the former, which would greatly increase the pressure.

On the Properties of certain Stream-lines. *By* Professor W. J. Macquorn Rankine, *LL.D., F.R.S.*

This paper was a summary of an investigation in continuation of one of which an abstract was read to the British Association in 1863, and which has been published in full in the 'Philosophical Transactions.' The new investigation consists of three parts. The first part relates to certain exponential stream-lines, suitable for the "buttock-lines" of ships, and resembling the lines introduced by Mr. Scott Russell for that purpose. It also shows that, by the action of certain pressures on the surfaces of water, waves may travel, which begin to break when the two slopes of their crests meet at right angles*. The second part relates to *Lissoneoïds*, that is, to those forms of stream-lines which are the fullest, consistently with not producing unnecessary disturbance in the water: it solves the problem in three dimensions, which in the previous paper had been solved in two. The third part relates to stream-line surfaces of revolution. (See Phil. Mag. October 1864 and January 1865.)

On a Mode of Determining the Velocity of Sound. *By* Dr. J. Stevelly.

Suppose a piece of clock-work prepared, for instance, to strike single strokes upon a bell each time the detent is set free; the detent to be under the control of an electro-magnet, which is instantly set in action by an observer, at a measured distance from the bell or other origin of sound, depressing a key, and thus completing a galvanic circuit. The observer, being furnished with a chronometer, depresses the key; the instant he hears the stroke of the bell he again depresses it; hears a second sound, and so goes on for 100 or 1000 times, carefully noting by the chronometer the instant at which he hears the last sound of the series. A trained observer would not make a probable error of one-tenth of a second in noting the whole time occupied by the whole series; and to avoid all chance of miscounting the number of sounds in the series, the clock may be readily made to keep count of the number of strokes it makes. The whole time occupied by the entire series is made up of the following portions:—1st. The time consumed in the mechanical work of the clock in producing the stroke, and of the key, from the instant the observer touches it until it has completed the circuit. 2nd. The personal equation of the observer. 3rd. The time the sound takes to travel 100 (or 1000) times the measured distance of the origin of the sound from the observer. 4th. The time the sound takes to travel 100 times (or 1000 times, as the case may be) the measured distance. Now the first, second, and fourth of these portions of time can be readily eliminated by repeating the same series of observations exactly (the clock being wound up at the commencement of each series exactly to the same extent); the observer, on the second occasion, placing himself at one-half, or one-fourth, or at any determined part of his previous distance from the origin of sound; or by placing himself close up to it, using the same wires for the galvanic circuit on each occasion, in order to eliminate the fourth portion. The author was not fully aware of the exact mechanism by which Professor Piazzi Smyth discharges the cannons which he has introduced as time-signals, but he had no doubt it could be adapted to this method, and thus determine experimentally whether the velocity of sound is affected by the violence of its originating cause—a question which Mr. Earnshaw has from theory decided in the affirmative. It would, however, involve, the author supposed, the use of two

* The author has since proved that the property of beginning to break when the two slopes of the crest meet at right angles belongs to all waves in which "molecular rotation" is null.

cannons, each alternately to be in process of being charged while the other was at work. This, however, either at Greenwich or Edinburgh could be readily accomplished.

On the Cohesion-Figures of Liquids. *By* C. Tomlinson, *F.C.S.*

This subject was introduced to the British Association at Manchester, in 1861. The author now stated the progress which had been made since that time, and introduced two new sets of figures. The principle of the examination by this method is to place a drop of a liquid on the surface of clean water in a chemically clean glass, when a figure is produced which was characteristic of the liquid so tested, and capable of being used for its identification. The figure formed is a function of cohesion, adhesion, and diffusibility. If any one of these forces be varied, the figure varies. The figures of alcohol, for example, on water, mercury, the fixed oils, melted lard, spermaceti, paraffin, sulphur, &c., are all different. A new set of figures is produced by allowing the drop to subside in a column of liquid instead of diffusing over its surface. These last the author calls "submersion figures of liquids." The figure of a drop of oil of lavender in a column of alcohol thus produced is singularly complicated and beautiful. A drop of oil of cloves or of cinnamon in a column of castor oil also forms a remarkable submersion figure. The test by cohesion-figures was stated by the author to be so delicate as to readily distinguish differences between oils so closely related as the oleines of beef-fat and mutton-fat.

CHEMISTRY.

Address by William Odling, *M.B., F.R.S., F.R.C.P., Secretary to the Chemical Society, Lecturer on Chemistry at St. Bartholomew's Hospital.*

At the Leeds Meeting of the British Association in 1858, Sir John Herschel, the then President of the Chemical Section, opened its proceedings with an introductory address of singular interest, and thereby established a precedent which, with a solitary exception, has been uniformly adopted by successive occupants of the position which I have now the honour to hold. Following in his footsteps, *longo intervallo,* I in my turn now venture upon a few words of introduction to the proper business that we have in hand. In the first place, I may congratulate the Section upon the presence among us of so many distinguished chemists, including several of my more immediate predecessors. I need scarcely express the personal gratification I feel at meeting them here, nor say how much their presence relieves me from the feeling of responsibility and self-mistrust with which I undertook the honourable office so kindly entrusted to me by the General Committee, feeling now that, upon any occasion of difficulty, I shall have them to apply to for counsel and assistance.

After the great diversity, or rather antagonism, of opinion which has existed for the last dozen years or so, I am almost bound to take a somewhat prominent notice of the substantial agreement which now prevails among English chemists as to the combining proportions of the elementary bodies and the molecular weights of their most important compounds. The present unanimity of opinion on this fundamental subject among those who have given it their attention is, I conceive, greater than has ever been the case since Dalton published his 'New System of Chemical Philosophy,' more than half a century ago. As yet, indeed, the unanimity of practice falls considerably short of the unanimity of belief; but, even in this direction, great progress is being made, to which the publication of Miller's 'Elements of Chemistry,' Watts's 'Dictionary of Chemistry,' and Hofmann's 'Jury Report on the Chemical Products in the Great Exhibition,' will doubtless give a yet stronger impetus. As was well observed by Dr. Miller at a previous Meeting of this Association, "Chemistry is not merely a science; it is also an art, which has introduced its nomenclature and its notation into our manufactories, and in some measure even into our daily life." Hence the great difficulty of effecting a speedy change in chemical usages alike so time-honoured and intimately ramified with the affairs of our everyday existence. I propose, by your permission, to make a few remarks upon the history of this chemical reformation, more especially in connexion with certain points which one or two of its acknowledged leaders have scarcely, I think, correctly estimated.

From the time when Dalton first introduced the expression "atomic weight," up to the year 1842, when Gerhardt announced his views upon the molecular constitution of water, there does not appear to have been any marked difference of opinion among chemists as to the combining proportions of the principal elements. That 1 part by weight of hydrogen united with 36 parts by weight of chlorine to form a single molecule of hydrochloric acid, and with 8 parts by weight of oxygen to form a single molecule of water, was the notion both of Berzelius and Gmelin, who may be taken as representatives of the two chief Continental schools of theoretic chemistry. Indeed, no doubts seem to have been entertained in their time as to the combining proportions of the three elements. Using the hydrogen scale of numbers, both chemists represented the combining proportion of hydrogen as 1, that of chlorine as 36, and that of oxygen as 8. Both, moreover, represented the molecular weight of hydrochloric acid as 37, and the molecular weight of water as 9. It is true that Berzelius professedly regarded the single combining proportions of hydrogen and chlorine as consisting each of two physical atoms; but, since the two atoms of hydrogen, for instance, which constituted the one combining proportion of hydrogen, were chemically inseparable from one another, they were really tantamount to one atom only of hydrogen, and, in point of fact, were always employed by Berzelius as representing the single chemical atom of hydrogen, or its smallest actual combining proportion. Distinguishing thus between the physical atom and the combining proportion, Berzelius's recognition of the truth, that equal volumes of the elementary gases contain an equal number of atoms, was utterly barren. But, identifying the physical atom with the combining proportion, Gerhardt's recognition, or rather establishment, of the broader truth, that equal volumes of all gases, elementary and compound, contain the same number of atoms, has been in the highest degree prolific. From Gerhardt's division of volatile bodies into a majority whose recognized molecules corresponded respectively with four volumes of vapour, and a minority whose recognized molecules corresponded respectively with but two volumes, and from his proposal, in conjunction with Laurent, to double the molecular weights of these last, so as to make the molecules of all volatile bodies, simple and compound, correspond each with four volumes of vapour, must, I conceive, be traced the development by himself and others of the matured views on chemical philosophy which now prevail. With every respect for my predecessor in this chair, and for the accomplished author of the 'Leçons de Philosophie Chimique,' from neither of whom do I ever venture to differ without fear and trembling, I cannot join with them in regarding the initiation of Gerhardt's system as an imperfect return, and its remarkable maturation in these recent days as a more complete return to the notions of Berzelius. Although, indeed, the elementary weights now employed, with the exception of those for some half-dozen metals, are identical with the atomic weights of Berzelius, yet so unlike are they to his combining weights that fully four-fifths of all known compounds have to be expressed by formulæ entirely different from his—namely, all those bodies, with but very few exceptions, into which hydrogen, fluorine, chlorine, bromine, iodine, nitrogen, phosphorus, arsenic, boron, and the metals lithium, sodium, potassium, silver, and gold, enter as constituents. Fully admitting that the new system of atomic weights, as it now exists, is the joint product of many minds—fully admitting that it owes its present general acceptance chiefly to the introduction of the water type by Williamson during Gerhardt's lifetime, and the recognition of diatomic metals by Wurtz and Cannizzaro, after his decease—and fully admitting, moreover, that some of Gerhardt's steps in the development of his unitary system were decidedly, though perhaps excusably, retrograde, I yet look upon him, not I trust with the fond admiration of the pupil, but with the calm judgment of the chemist, as being the great founder of that modern chemical philosophy in the general spread of which I have already ventured to congratulate the Members of the Section.

Prior to the time of Gerhardt, the selection of molecular weights for different bodies, elementary and compound, had been almost a matter of hazard. Relying conjointly upon physical and chemical phenomena, he first established definite principles of selection, by pointing out the considerations upon which the determination of atomic weights must logically depend. Relying upon these principles, he established his classification of the non-metallic elements into monhydrides, represented by chlorine; dihydrides, represented by oxygen; trihydrides, represented by nitrogen, &c.; and, relying upon the same principles, but with a greatly increased knowledge of phenomena, later chemists have given to his method a development and unity, more especially as regards the metallic elements, which have secured for the new system the impregnable and acknowledged position which it at present occupies. The comparative unanimity which prevailed before the time of Gerhardt was the unanimity of submission to authority; but the greater unanimity which now prevails is the unanimity of conviction consequent upon an intermediate period of solitary insurrection, general disturbance, and ultimate triumph.

Bearing in mind how much the origin of the new system by Gerhardt, and its completion by his colleagues and disciples, are due to a correct appreciation of the harmony subsisting between chemical and physical relations, we cannot but give a hearty welcome to any large exposition of mixed chemico-physical phenomena; and, whether or not we agree with all his conclusions, there can be but one opinion as to the obligation chemists are under to Professor Kopp, of Giessen, for the great addition he has recently made to our knowledge and means of obtaining a further knowledge of what has hitherto been but a very limited subject—namely, specific heat.

The agreement of chemists as to the elemental atomic weights is tantamount to an agreement among them as to the relative quantities of the different kinds of matter which shall be represented by the different elemental symbols; and this brings me to the subject of chemical notation. At one time many chemists, even of considerable eminence, believed and taught that Gerhardt's reformation had reference mainly to notation, and not to the association and interpretation of phenomena, and it became rather a fashion among them to declaim against the puerilities of notational questions. That the idea is of far greater importance than the mode of expressing it, is an obvious truism; nevertheless the mode of expression has an importance of its own, as facilitating the spread of the idea, and more especially its development and procreation. It has been well asked, in what position would the science of arithmetic have been but for the substitution of Arabic for Roman numerals, the notation in which value is expressed by the change in position for that in which it is expressed mainly by the repetition of a few simple signs? It is unfortunately too true that chemical notation is at present in anything but a satisfactory state. The much-used sign of addition is, I conceive, about the last one would deliberately select to represent the fine idea of chemical combination, which seems allied rather, I should say, to an interpenetration than to a coarse apposition of atoms. The placing of symbols in contiguity, or simply introducing a point between them, as indicative of a sort of multiplication or involution of the one atom into the other, is, I think, far preferable; but here, as pointed out by Sir John Herschel, we violate the ordinary algebraic understanding, which assigns very different numerical values to the expressions XY and $X+Y$ respectively. I know, indeed, that one among us has been engaged for some years past in conceiving and working out a new and strictly philosophical system of chemical notation by means of actual formulæ, instead of mere symbols; and I am sure that I only express the general wish of the Section when I ask Sir Benjamin Brodie not to postpone the publication of his views for a longer time than is absolutely necessary for their sufficient elaboration. In any case, however, the symbolic notation at present employed, with more or less modification of detail, must continue to have its peculiar uses as an instrument of interpretation; and hence the importance of our endeavouring to render it more precise in meaning and consistent in its application. Many of its incongruities belong to the very lowest order of convention; such, for example, as the custom of distinguishing between the representation of so-called mineral and organic compounds, one particular sequence of symbols being habitually employed in representing the compounds of carbon, and an entirely different sequence of symbols in representing the more or less analogous compounds of all other elements. Now that organic and mineral chemistry are properly regarded as forming one continuous whole, a conclusion to which in my opinion Kolbe's researches on sulphuretted organic bodies have largely contributed, it is high time that such relics of the ancient superstition that organic and mineral chemistry were essentially different from one another should be done away with.

Although, during the past year, the direct advance of that crucial organic chemistry, the synthesis of natural organic bodies, has not been striking, yet, on the other hand, its indirect advance has, I submit, been very considerable. Several of the artificially produced organic compounds, at first thought to be identical with those of natural origin, have proved to be, as is well known, not identical, but only isomeric therewith. Hence, *reculer pour mieux sauter*, chemists have been stepping back a little to examine more intimately the constitution both of natural organic bodies and of their artificial isomers. The synthetic power having been attained of putting the bricks together in almost any desired way, it is yet necessary, in order to construct some particular biological edifice, first to learn the way in which its constituent bricks have been naturally put together. We accordingly find the study of isomerism, or, what comes to the same thing, the study of the intimate constitution of bodies, assuming an importance never before accorded to it. Isomerism is, in fact, the chemical problem of the day, and concurrently with its rapidly advancing solution, through the varied endeavours of many workers, will be the advance in rational organic synthesis. It is curious to note the oscillations of opinion in reference to this subject. Twenty years ago the molecular constitution of bodies was perceived by a special instinct, simultaneously with, or even prior to, the establishment of their molecular weights. Then came an interval of scepticism, when the intimate constitution of bodies was maintained to be not only unknown, but unknowable. Now we have a period of temperate reaction, not recognizing the desired knowledge as unattainable, but only as difficult of attainment. And in this, as in many other instances, we find evidence of the healthier state of mind in which, now more perhaps than ever, the first principles of chemical philosophy are explored. Speculation, indeed, is not less rife and scarcely less esteemed than formerly, but is now seldom or never mistaken for ascertained truth. Scepticism, indeed, still prevails—not, however, the sterile scepticism of resignation, but the fertile scepticism which aspires to greater and greater certainty of knowledge. Chemical science is advancing, I believe, not only more rapidly, but upon a surer basis than heretofore; and, while with every advance the prospect widens before our eyes, so that we become almost alarmed at contemplating what those who come after us will have to learn, we console ourselves with the determination that their labour of unlearning shall be as little as possible—far less, we hope, than what we in our time have had to experience.

On some Bituminous Substances. By Dr. T. Anderson.

On the Utilization of Sewage. By Dr. Henry Bird.

On the Prismatic Formation of Ice in certain Ice-Caves and Glaciers. By the Rev. G. Browne.

The ice-caves to which the author referred were found in limestone rocks in various parts of France and Switzerland. The ice was found at depths of from 50 to 200 feet below the surface, and at altitudes varying from under 2000 to nearly 6000 feet above the sea, and appeared in the form of columns with spreading bases formed by the freezing of water which dropped from the roof; of ice cascades, supported by the sloping walls, and formed by water running into the cave from lateral fissures, and in other forms, which he illustrated by drawings. In visiting these caves he was struck by the columnar appearance presented by the fractured side of the ice; and, on examining it, he found that the whole mass was composed of a vast number of prisms closely compacted. He separated the prisms at the edge with the greatest ease, and thrust them out one after the other, as one might thrust out a knot of wood from the edge of a board. The prisms reminded him of the construction of a stone wall built without mortar in a slaty country. To complete the resemblance, the irregular stones should form a compact mass, and the surface of the wall should be ground smooth. This ice he always found to resist the effect of heat more successfully than ordinary ice. He observed that the axes of all the prisms, in the vertical columns of which he had spoken, lay horizontally.

On a New Method of extracting Gold from Auriferous Ores. By F. Crace-Calvert, *F.R.S., F.C.S.*

At the present time, when the auriferous ores of Great Britain are attracting public attention, it may be advantageous to persons interested in gold-mining to be made acquainted with a new and simple method of extracting gold from such ores, which presents the advantages of not only dispensing with the costly use of mercury, but of also extracting the silver and copper which the ore may contain. Further, it may be stated that the process can be profitably adopted in cases where the amount of gold is small, and the expense of mercury consequently too great. I need not enter here into all the details of the numerous (about one hundred) experiments which I made some years since, before I finally arrived at the new method of extracting gold, which I have now the honour of communicating. I therefore propose the following plan for extracting the gold on a commercial scale:—The finely reduced auriferous quartz should be intimately mixed with about one per cent. of peroxide of manganese; and if common salt be used, this material should be added at the same time as the manganese, in the proportion of three parts of salt to two of manganese. The whole should be then introduced into closed vats, having false bottoms, upon which is laid a quantity of small branches covered with straw, so as to prevent the reduced quartz from filling the holes in the false bottom. Muriatic acid should then be added if manganese alone is used, and diluted sulphuric acid if manganese and salt have been employed, and, after having left the whole in contact for twelve hours, water should be added so as to fill up the whole space between the false and true bottoms with fluid. This fluid should then be pumped up and allowed to percolate through the mass, and after this has been done several times, the fluid should be run off into separate vats for extracting the gold and copper that it may contain. To effect this, old iron is placed in it to precipitate the copper; and after this has been removed, the liquor is heated to drive away the excess of free chlorine, and a concentrated solution of sulphate of protoxide of iron, or green copperas, must be added, which, acting on the gold-solution, will precipitate the gold in a metallic form. By this method both gold and copper are obtained in a marketable condition. If silver is present in the ore, a slight modification in the process will enable the operator to obtain this metal also. It is simply necessary to generate the chlorine of the vitriol, manganese, and chloride of sodium process, taking care to use an excess of salt, that is, six parts instead of three, as above directed. The purpose of this chloride of sodium being to hold in solution any chloride of silver that may have been formed by the action of chlorine on the silver ore, and to extract the metal, the following alteration in the mode of precipitation is necessary:—Blades of copper must be placed in the metallic solutions, to throw down the silver in a metallic form, then blades of iron to throw down the copper, the gold being then extracted as previously directed. I think the advantages of this process are, 1st, cheapness; 2nd, absence of injury to the health of the persons employed; 3rd, that not only is the metallic gold in the ore extracted (as is done by mercury), but it attacks and dissolves all gold which may be present in a combined state, besides enabling the miner also to extract what silver and copper the ore may contain. I cannot, however, conclude without reminding you of what is generally underrated—that is, the heavy expenses which attend the bringing of the ore to the surface of the ground, and crushing and preparing it for being acted upon either by mercury or by any other agents.

On the Molecular Constitution of Carbon Compounds. By A. R. CATTON.

On the Direct Conversion of Acetic Acid into Butyric and Caproic Acids. By A. R. CATTON.

Description of an Apparatus for Estimating the Organic Impurities in Atmospheric Air and in Water. By STEWART CLARK.

On the Thermal Waters of Bath.
By Dr. DAUBENY, *F.R.S., Professor of Botany, Oxford.*

After alluding very briefly to the mineral constitution of the Bath waters as affording no adequate explanation of the medicinal virtues ascribed to them, the author proceeded to one point of scientific interest connected with their appearance—namely, the large volume of gas which they have gone on constantly disengaging, apparently from time immemorial. The nature and amount of this were made the subject of the author's examination, in the year 1832, during an entire month; and the result arrived at was that the gas consisted mainly of nitrogen, which is present, indeed, in most other thermal waters, but in none so copiously as at Bath. Judging from the circumstance that the majority of these springs are associated with volcanos, and likewise that the same gas is freely evolved from the latter both in an active and in a more dormant condition, we may fairly infer that the evolution of nitrogen at Bath is in some manner or other connected with the same widely-spreading and deep-seated cause. And, if this be the case, the phenomenon in question acquires an additional interest, as affording a possible clue to the true nature of the processes which give rise to volcanos as well as to thermal springs. Now this evolution of nitrogen seems best to admit of explanation by supposing a process of combustion to be going on in the interior of the globe, by which oxygen may be abstracted from the common air which penetrates to these depths, whilst the residuary nitrogen is evolved. What may be the nature of the bodies by which this process of combustion is maintained must, from the depth at which the latter is carried on, be ever shrouded in mystery; but it is at least certain that, whilst they cannot belong to the category of those which supply fuel for the ordinary processes of combustion of which we are ourselves eye-witnesses, there is nothing in the nature of the products resulting from volcanic action inconsistent with the idea that metals possessing a strong affinity for oxygen, but not already combined with it, might, if they existed in the interior of the earth, be instrumental in producing the supposed combustion. And, if we indulge in speculation, it may be maintained, with some show of probability, that the basis of the earths and alkalies which constitute the present crust of the globe would have existed originally uncombined with oxygen, and therefore must at one time have been subjected to that very process of oxidation and combustion which we imagine to be at the present time continued. The author therefore suggested that volcanic action may be owing to certain chemical reactions proceeding in the interior of the globe between the constituents of air and water, on the one hand, and the metallic bases of the earths and alkalies on the other. After developing this theory, the paper concluded with pointing out a practical use to which the waste waters of the thermal springs of Bath might be applied after they had fed the several baths, suggesting that, if, instead of being at once discharged into the river, they were first conveyed through underground pipes a few feet beneath the surface within a given area, the warmth imparted to the soil would prove highly favourable to the culture of tender exotics, and that, if the ground were further protected from cold by a glass roof, a winter garden might be obtained with scarcely any further expense beyond that of the original outlay.

On the Action of Hydrogen on Polycyanides.* By THOMAS FAIRLEY.

* Published *in extenso* in Journal of Chem. Soc., Ser. 2. vol. ii. p. 362.

On a Specimen of Tin-ore hitherto undescribed. By FREDERICK FIELD.

The author, some years since, purchased a specimen of what was called on the label "Slime Tin." In a matrix of quartz and fluor are disseminated streaks of cassiterite, and in immediate connexion with these are found similar streaks of an earthy-looking matter of a yellowish-brown colour. This matter is rather soft, and can be easily cut with a knife. Whilst arranging the mineralogical collection of the Bath Literary and Scientific Institution, he met with two specimens thus labelled :—"Tin Ore, new variety, Cornwall." The first of these (the gift of Mr. Fox) is a mass of a dull earthy appearance, yellowish brown in colour, and so hard in many places as to be with difficulty scratched with a file. Its specific gravity is 4·4. On examining with a lens, there are to be found, in some parts, specks of cassiterite and portions of what appears to be felspar. The second specimen (the gift of Colonel Page) is darker in colour than the first, but of equal hardness. Its specific gravity, however, is only 3·6, and from it the author could obtain no indications of tin. With regard to these specimens, the author thinks that the slime tin is a variety of what is called "toad's-eye wood-tin," and Mr. Fox's specimen is this form of cassiterite mixed with much earthy matter. As for the specimen of Colonel Page, it has no claim whatever to be called an ore of tin.

On the Artificial Production of Anhydrite. By ALPHONSE GAGES.

The circumstances under which natural anhydrite is formed have not yet been well determined. The experiments already made, and bearing upon the various properties of sulphate of lime, and its behaviour at various temperatures, although presenting great interest, have not yet given crystallized anhydrite under the same conditions as it occurs in the saliferous formations. Gay-Lussac had already observed that overheated gypsum partially lost its well-known properties, and he attributed the cause of it to the partial formation of anhydrite. The experiments of Graham proved, also, that gypsum passes into a kind of amorphous anhydrite at a temperature of 204° C. At the Meeting of the British Association in Dublin, Dr. Sullivan gave an account of some experiments by which he obtained anhydrous sulphate of lime from its solution in water, at a temperature of about 300° C.

A mixture of gypsum and common salt fused in a crucible, and treated by water, leaves undissolved prismatic lamellar crystals of anhydrite. Left for many days in water, the quantity of moisture absorbed did not exceed that which some varieties of natural anhydrite would have absorbed if placed under the same circumstances. I give here the results obtained :—

Water	0·472
Lime	39·531
Sulphuric acid	60·142
	100·145

Gypsum melted with anhydrous sulphate of soda gives also crystals of anhydrite; but the formation of anhydrite in sulphate of soda requires a higher temperature; the crystals of anhydrite, separated by water from the sulphate of soda, were, however, perfectly anhydrous. Analysis gave the following, namely :—

CaO	40·952
So3	59·085
	100·037

Mitscherlich fused gypsum at the highest temperature of the porcelain furnace, and obtained a white crystalline mass of anhydrite. The occurrence of anhydrite amongst rocks of an undoubted sedimentary origin, and the necessity of a temperature higher than melted lava, have been the great argument employed to prove the impossibility of anhydrite having been formed by fusion. If we could consider melted chloride of sodium as the solvent in which anhydrite has been produced, the problem would be solved at once, as gypsum dissolves and crystallizes in common salt at a temperature far below melted lava, and not rising above a dull red heat—a temperature to which local circumstances may give rise; at such temperature the liquid mass would possess a great fluidity.

Account of the Mode adopted at the Bradford-on-Avon Union for the Utilization of Sewage. By W. GEE.

The author stated that by the daily admixture of common earth, the excreta, liquid as well as solid, of forty-five children in the two schools at the workhouse had been wholly saved, with decency and without any offence, the operation being cleanly and the deodorization rapid and complete. A remarkable feature in this method (first published by the Rev. H. Moule of Dorchester) is the fact that the earth, when raked out from receptacles which at Bradford are completely above the level of the yards, may, if kept under cover till tolerably dry, be used over and over again; nor are paper fragments found to be troublesome, as they rot and become imperceptible. The result of this discovery is that an incredibly small quantity of earth is sufficient for a large household; three tons weight of earth (dry) used several times over having been the whole product of the schools in fifteen months. A sample produced was quite free from smell, and looked like mere earth in small nodules which crumbled on slight pressure into a very fine dust, fit for the turnip-drill or for mixing with water, like guano.

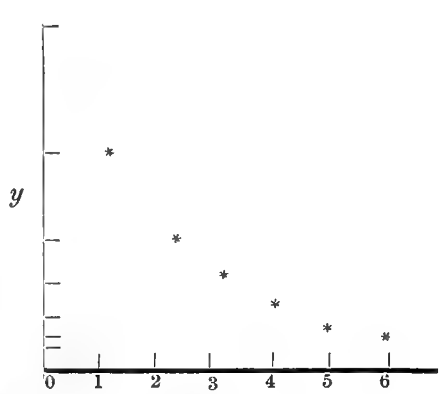
The author strongly urged Mr. Moule's plan upon general notice through the medium of the Association as a means, hitherto slighted, of meeting the great sewage difficulty in every dwelling in the kingdom not forming part of a close street; although the plan is not impracticable even in streets: it would be very superior to the cesspools in common use forty years ago, and would in fact restore the drains of towns to their legitimate purpose—the discharge of rain- and sink-water.

On the Rate of Chemical Change. By A. VERNON HARCOURT, *M.A.*

Two years ago, at the Cambridge Meeting of the Association, the author communicated to this Section a paper on certain cases of induced chemical action. In following up the course of experiments upon which he had then entered, he became engaged in the study of various chemical changes which take place more or less slowly, and has thus been led into an inquiry as to the rate at which those changes proceed. The principal case of induced oxidation, before described, was that which occurs when permanganate of potassium is added to a solution containing chloride of tin and oxygen. Under these circumstances, while a portion of the tin salt is oxidized by the permanganate, another portion is attacked by the free oxygen. A large number of similar cases have since been investigated by Kessler. The author's principal object was to determine what ratio existed between the two oxidations, and in scrutinizing the conditions of the experiment it occurred to him to try whether the sulphate of manganese, formed by the reduction of the permanganate in the acid solution, had any influence. He found, greatly to his surprise, that this fixed neutral salt has itself the power of determining the transference of oxygen. Sulphurous acid, as is well known, when mixed with a large bulk of water which has been exposed to the air, is but slowly oxidized, and this change proceeds still more slowly when the solution is freely acidified. But if to such a solution a minute quantity of sulphate of manganese is added, the oxidation of the sulphurous acid is at once determined. It is like, so far as the result is concerned, the effect of adding a drop of sulphuric acid to a mixture of chlorate of potassium and sugar. Sulphate of manganese has also the power of determining the action of various oxidizing agents, as well as that of free oxygen. Professor Kessler observes that the cause of a phenomenon known to all chemists who have tried a chameleon solution with oxalic acid—namely, that the colour of the portion of solution first added disappears very slowly, but that of succeeding portions more rapidly—is that the sulphate of manganese, formed by the reduction of the first portion, hastens the subsequent action. Chromic acid has apparently no action upon oxalic acid in a cold dilute solution. The addition to this mixture of pure sulphate of manganese determines, under proper conditions, an immediate reduction of the chromic acid. How the sulphate of manganese acts in these cases is, at present, matter for conjecture. We may compare the action of this salt in determining the union of sulphurous acid and oxygen with that of nitric oxide. Perhaps in this case, as in that, an alternate oxidation and reduction takes place. If we suppose that water can act to a small extent upon a manganese salt as it acts upon a bismuth salt, separate, that is, the base from the acid, then the hydrate of manganese thus displaced would absorb free oxygen, and the sulphurous acid at once reduce again the binoxide formed. At any rate, without insisting on so definite a hypothesis, it is probable that this action of the manganese salt is in some way related to the fact that the protohydrate of this metal has the property of absorbing oxygen from water, and parting with this oxygen to sulphurous acid. Similarly this protohydrate is readily oxidized by chromic or permanganic acid, and the resulting binoxide is readily reduced by oxalic acid.

Of these actions the author has selected for study that of permanganic upon oxalic acid.

When the four following substances, permanganate of potassium, sulphuric acid, oxalic acid, and sulphate of manganese, are brought together in aqueous solution, a chemical change takes place, resulting in the formation of sulphate of potassium, sulphate of manganese, carbonic acid, and water. The amount of change depends upon the amount of each of the first-named four substances, upon the dilution and temperature of the solution, and upon the time during which the substances are left in contact. As far as can be observed, these are *all* the conditions which affect the amount of chemical change in this case; it is not affected by light, nor by the agitation of the solution. The amount of change is greater, within certain limits, in proportion as the quantities of permanganate of potassium, sulphuric acid, and sulphate of manganese are greater, and the quantity of water less; in proportion also as the temperature is higher, and the time of mutual contact longer. It is greater, the larger the quantity of oxalic acid, up to that point at which the oxalic and permanganic acids are present in the proportions in which they act one upon the other; after that point, an increase in the quantity of oxalic acid diminishes the amount of chemical change. The author has made many series of experiments, in each of which all of these conditions, except one, were kept invariable, and that one was varied according to a regular progression. He hoped thus to determine what function of each of these variable quantities the chemical change is, and so to obtain a true expression of the reaction. He made, for example, a series of experiments, in all of which he took the same quantities of permanganic acid, oxalic acid, sulphate of manganese, and water, maintaining always a temperature of 16° C., and allowing each experiment to proceed for exactly five minutes; but in the second experiment he took twice the quantity of sulphuric acid used in the first, thrice the quantity in the third, four times the quantity in the fourth, and so on. When five minutes from the moment of mixing had expired, the action was stopped, and the amount of permanganate still remaining determined. A series of numbers was thus obtained, presenting a regular decrease, which should bear an ascertainable relation to the corresponding quantities of sulphuric acid, taken in arithmetical progression. This relation, however, the author has not yet succeeded in determining; but in this, as in other series, the numbers exhibit the most perfect regularity. This is best seen by representing the results graphically. Along the axis of x is measured that quantity, which is varied in each successive experiment; along that of y the quantity of changing substance which remains still unchanged at the close of the experiment. This quantity, it will be seen, varies rapidly at first, the differences becoming less and less as the total quantity of residual substance diminishes. The series of experiments which appeared most interesting was that in which, all other conditions being kept constant, the time during which the experiment lasted was varied. Such a series yields a curve similar to that which represents the effect of varying the amount of sulphuric acid. The curve above serves, therefore, as a general representation of such a series. It may be regarded in this case as exhibiting the course of a



single experiment, showing exactly how much of the substance measured remains after the lapse of any interval. The numbers, 1, 2, 3, &c., here represent the number of minutes during which the corresponding experiment was allowed to procee l. The mode of conducting an experiment was briefly as follows:—The solution containing all the substances except the permanganate was brought to the required temperature, and the permanganate added from a pipette exactly at the beat of a seconds' pendulum. When the time had expired, the temperature of the solution having been kept rigidly constant throughout, a solution of iodide of potassium was added again at the beat of the clock. During and after both additions the liquid was strongly agitated to secure rapid and perfect mixture. The addition of iodide of potassium stops the action. The remaining permanganate is at once reduced, and liberates thereby an equivalent of iodine which can be determined at leisure in the usual way. Of such series of experiments the author has made a great number. In the first instance he took the exact quantities of the different substances which react one with another, according to these equations:—

$$(1.)\ K_2Mn_2O_8 + 3MnSo_4 + 2H_2O = 2H_2SO_4 + K_2SO_4 + 5MnO_2;$$

$$(2.)\ 5MnO_2 + 5H_2SO_4 + 10H_2C_2O_4 = 15H_2O + 5MnSO_4 + 20CO_2;$$

i. e., $K_2Mn_2O_8$; $3MnSO_4$; $3H_2SO_4$; $10H_2C_2O_4$, $2H_2O$.

But he was led to abandon atomic quantities principally by two considerations: first, any error in the proportion of the substances becomes magnified as the experiment proceeds; secondly, the solution changes, not in one particular only, but in several. The quantities of sulphuric acid, oxalic acid, and permanganate diminish, the quantity of sulphate of manganese increases, while that of the water alone remains sensibly constant. In later experiments he had taken all the other substances in such excess, as compared with the permanganate, as to be practically, like the water, infinite in relation to it. Of all, he has taken 100 times the atomic proportion, so that the total change taking place in the solution from end to end of the reaction would be a diminution in the amount of oxalic acid and sulphuric acid from 100 to 99 parts, and an increase of 1 per cent. in the amount of sulphate of manganese. He found by an experiment in which the quantities at starting were varied 1 per cent., that such an alteration did not perceptibly affect the result. Under these conditions, then, one chemical substance gradually disappears, all around it remaining unchanged. A known quantity is introduced into the solution, which has from the first, where the oxalic acid and sulphate of manganese are in large excess, not a red, but a deep brown colour; the substance thus formed, and whose gradual disappearance we desire to trace, is in all probability binoxide of manganese. Having made a number of determinations after the lapse of various times, we can follow exactly the course of its diminution. At first the colour changes rapidly, but as it becomes paler it fades more and more slowly. The axis of x is, no doubt, an asymptote of the curve; theoretically the whole would never disappear. The problem, then, to be determined was to find the relation between these two series of numbers—or, in other words, given this curve to find its equation. Both in it and in many of the experiments already described, the author enjoyed the cooperation of Mr. Esson, Fellow of Merton College, Oxford. The result at which the author and Mr. Esson believe themselves to have arrived is, that the numbers representing the quantities remaining after equal intervals of time are in geometrical progression, and the curve consequently a logarithmic curve. This result admits of a simple and interesting interpretation. It is precisely that which would follow from the hypothesis that the dissolved binoxide exists in the fluid in the form of minute spheres upon whose unit of surface is performed a constant action. The total action thus at any moment varies with the surface exposed, and diminishes continually as the spheres, shell after shell, melt away. But the result may be explained without the introduction of an hypothesis. If we suppose the binoxide of manganese to be replaced as it disappears, so that the quantity present is always the same, chemical change will proceed, since no condition alters, at a uniform rate, a certain fraction of the whole amount disappearing in a unit of time. But since the relation between the binoxide and the solution in which it is, is not affected by a change in the quantity of the former, one of these magnitudes being infinite relatively to the other, this fraction will remain always constant when the binoxide is not replaced, but is allowed to diminish; that is to say, the amount which changes during a moment of time is directly proportional to the total amount existing in solution at that time; or, if we regard the binoxide as doing work—oxidizing oxalic acid—then the statement is that the amount of work done is directly proportional to the amount of substance which at any time is there to do it. It will be of interest to examine by similar methods other cases of chemical change in solutions. If it is found, as appears highly probable, that wherever the rate of change is measurable,—wherever, that is, it proceeds slowly, and can be started and terminated at a given moment, and the amount changed or remaining unchanged determined,—it follows the same law, then we may pass inductively to a generalization covering those cases of chemical change which take place with an immeasurable velocity, or which cannot be arrested at will, or for the determination of whose residues or products no exact methods are known; just as by the use of the pendulum or of Attwood's machine we may prove experimentally the laws of falling bodies, when in the common case of bodies falling freely the velocity with which they move is too great for measurement.

On a New Method of detecting Arsenic, Antimony, Sulphur, and Phosphorus, by their Hydrogen Compounds, when in mixed Gases. By Dr. W. Bird Herapath, *M.D., F.R.S. L. & E., F.C.S., &c. &c.*

Having to investigate a case of suspected poisoning by phosphorus, in which the traces of free phosphorus had disappeared during the long interval between administration of the poison and analysis, Dr. Herapath examined for phosphorous acid by Scherer's method; but as several of the hydrogen compounds of sulphur and arsenic, for instance, have the property of blackening the salt of silver, he eliminated these hydrogen compounds from the gas before its absorption by ammoniacal nitrate of silver, or tested the gas, as it was being evolved, for any of these compounds. He dissolved in dilute hot hydrochloric acid the organic matter, stomach, intestines, and contents; the room of operation being at the time quite dark; and to the flask an apparatus was fixed for exhibiting any phosphoric flashes of light, as in Mitscherlich's experiment: no flashes appeared. The acid solution might, however, have contained arsenic, phosphorus as phosphorous acid, antimony as chloride, and sulphur as taurine, &c. No chlorate of potassa could be employed in oxidizing the organic matter, or phosphorous acid would become phosphoric, and all evidence be lost, for sulphates and phosphates are not reducible in the hydrogen apparatus. To the liquid filtered there was added one-third of spirit of wine, and it was then ready for use. A gas evolution bottle, with funnel and pipe, armed with a tube containing chloride of calcium and chalk in coarse powder, for the preparation of pure hydrogen gas, was arranged and tested, as usual, for arsenic. To the exit-pipe was attached a green glass tube, well supported, passing over two or more spirit-lamp flames. The exit-pipe was bent at right angles, to go through a wide-mouthed bottle, containing slips of white filtering-paper, dipped in a solution of nitroprusside of sodium, made alkaline by ammonia, from which the gas was carried to the next bottle, containing ammoniacal nitrate of silver; and there was another exit-pipe leading to a bottle of some salt of lead, or armed with a jet for burning. The apparatus being at this period ready for use, pure zinc, sulphuric acid, and distilled water were placed in the hydrogen evolution bottle, and the stream of gas having been allowed to escape through the apparatus, to expel atmospheric air, heat was applied to the tubes with spirit-lamps. Now, if arsenic had been present it should have produced a crust in the usual place; and antimony would, if present, have been deposited at a spot near it; whilst sulphur would partly have been sublimed and deposited in front of the arsenic, and the remaining undecomposed sulphuretted hydrogen gas have communicated a deep purple-blue tint to the paper charged with the ammoniacal nitroprusside of sodium; whilst the phosphoretted hydrogen, passing unchanged through all these tests, would have been at once seized by the ammoniacal nitrate of silver and have produced the black phosphide of silver, and the free hydrogen have escaped through the lead solution without changing its colour, unless the evolution (supposing phosphorus to be present) of phosphoretted hydrogen should have been too violent for the perfect reaction of the silver salt. It was now possible to examine the prepared organic liquid with this apparatus: by inserting it in quantities of only a few drachms at a time into the hydrogen bottle, through the tubulated funnel, and by employing sufficient spirit, no frothing could occur to endanger the success of the experiment; but it might at any moment be checked by the addition of a little spirit down the funnel. If the tubes showed no deposit, and the paper remained white, neither arsenic, antimony, nor sulphur could be present. The black precipitate in the silver bottle would inferentially have been phosphide of silver, but it admitted of absolute proof by testing with Scherer's process. The operation being completed, the silver salt was passed through a filter previously washed with acetic or nitric acid, and afterwards with ammonia, and the collected black precipitate submitted to proof by burning the filter-paper. Acting on the ashes with nitric acid and heat until oxidized, the silver precipitated by pure hydrochloric acid, and the solution filtered, it contained all the phosphorus as phosphoric acid, which could be tested by the nitrate of magnesia or the chloride with ammonia, the characteristic crystals of triple phosphate of ammonia and magnesia examined in the microscope and identified by the action of polarized light, and the measurement of their angles in the goniometer, or by a solution of nitrate of silver added with ammonia, when the yellow phosphate of silver would be obtained, and the blue phosphate of iron, with a solution of its protosalt.

Memorandum on Ozone. By Dr. G. Kemp.

On the Production of Cold by the Expansion of Air. By A. C. Kirk.

On the Premature Decay of the Frescoes in the Houses of Parliament, its Cause and Remedy. By William Poole King.

The decay of frescoes first shows itself as a bloom, rendering the whole surface dull and clouded; soon after raised blotches appear, which become white and afterwards drop off in a dry powder, carrying off the colour in patches from the fresco. If walls built with mortar made from limestone of marine origin be examined in cold weather, the pointing of the wall will be found to be covered with a bloom which in places is lengthened out into needle-formed crystals, varying from $\frac{1}{100}$th of an inch to 2 inches long. These crystals in warm weather change into a white powder, and drop off, carrying much of the pointing of the wall with them. These crystals, when examined chemically, are found to consist, for the most part, of sulphate of soda, sometimes, though rarely, mixed with nitrate of potash and nitrate of lime, with small quantities of muriate of lime and magnesia. The droppings from frescoes are composed of nearly the same materials, and are brought down by the efflorescence of the sulphate of soda. To preserve frescoes, the sulphate of soda in the wall should be kept in a dormant state by being always dry and warm.

On an Apparatus for the Preservation or Disengagement of Sulphuretted Hydrogen, Carbonic Acid, or other Gases. By Maxwell Lyte.

On the Pollution of Rivers by the Sewage of Towns. By Dr. Stevenson Macadam, *F.R.S.E., F.C.S.*

The author recently undertook a lengthened series of experimental observations on the pollution of rivers by the sewage of towns, with special reference to the contamination of the Water of Leith by the sewage of Edinburgh and Leith. The principal points brought out in the course of the investigation were—

I. The chemical nature and condition of the Water of Leith as it arrives at Edinburgh, and before being contaminated by the sewage from the dwellings of 100,000 of the inhabitants of Edinburgh and Leith.

II. The chemical composition of the liquids conveyed by the main sewers of Edinburgh and Leith into the Water of Leith, by day and by night, during five weeks in spring and ten days in summer.

III. The analyses of the sedimentary matters found in the open sewers draining into the Water of Leith.

IV. The chemical condition of the Water of Leith, and the lakes connected therewith, as they receive successive quantities of sewage from 180 drains and sewers which discharge their contents into the stream at intervals from Coltbridge, west of Edinburgh, down to the harbour of Leith.

V. The analyses of the deposits of organic matter which are found in large quantities in the bed of the Water of Leith after the entrance of the sewage, and especially in rocky pools and above the dams; as also of the sediment in the Lades and in the harbour of Leith.

VI. The chemical nature of the gases evolved in large quantities from the putrefying sedimentary deposits in the Lades and Water of Leith, including the harbour.

VII. The nature and proportion of the gases dissolved in the waters of the river above and below the influence of the sewage. And

VIII. The degree of impurity in the atmosphere in the immediate neighbourhood of the Water of Leith conveying sewage, and including the open sewers, the Lades, and the harbour of Leith; and contrasting the air under the influence of the foul sewage and Water of Leith with the air in the centre of Edinburgh and Leith, and away from the immediate influence of sewage.

The author stated that the special part of the inquiry to which he wished to direct the attention of the Section was the proportion and nature of the gases dissolved in the waters which were contaminated with sewage, as contrasted with those which were uncontaminated by sewage. This department of the inquiry, in relation to the contamination of rivers by the sewage of towns, had not received that amount of attention which it apparently deserves. The presence of oxygen gas dissolved in natural waters aids in the decomposition of any organic matters which may pass thereinto, and all healthy waters contain an amount of oxygen dissolved therein which is equivalent to about 29 per cent. of the entire volume of the gases in solution.

The following Table gives the proportions of the gases present in one imperial

		Cubic inches of gas per gallon of water.	Percentage composition of the gases by volume.		
			Carbonic acid.	Oxygen.	Other gases.
Gases from spring water supplied to Edinburgh and Leith for household use.	*	10·01	9·59	28·77	61·64
	*	9·96	10·71	29·47	59·82
		9·33	8·70	29·40	61·90
Gases from water taken from the sources of the Water of Leith.	*	9·24	1·92	29·23	68·85
	*	9·69	1·89	28·87	69·24
Gases from water from Water of Leith, after receiving discharges from paper-mills, &c., and as the water arrives at Coltbridge, where the first portion of Edinburgh sewage enters.	*	9·30	5·88	22·06	72·06
		9·21	6·10	25·20	68·70
	*	9·60	7·41	22·22	70·37
		9·29	6·60	22·20	71·20
Gases from the liquids conveyed in the sewers of Edinburgh.	*	13·71	52·67	3·33	44·00
		9·77	50·00	2·70	47·30
		12·67	54·70	2·10	43·20
		10·74	42·30	2·80	54·90
		13·87	59·60	2·60	37·80
Gases from the water of the Water of Leith at various stations, after receiving the sewage of Edinburgh.		6·31	6·30	4·20	89·50
		7·22	14·30	5·70	80·00
	*	6·90	14·29	10·20	75·51
		7·29	22·00	6·10	71·90
		6·95	19·70	6·60	73·70
		5·60	24·60	4·10	71·30
	*	7·64	18·60	6·98	74·42
		8·87	25·80	4·10	70·10
Gases from the water of the Lade, which traverses Edinburgh, and which contains sewage.	*	6·47	9·52	4·76	85·72
		7·13	12·80	6·40	80·80
		7·64	14·20	5·40	80·40

gallon of the waters of the Water of Leith before reaching Edinburgh, of the spring water supplied to Edinburgh and Leith, of the liquids conveyed by the sewers, and of the Water of Leith after receiving sewage, and including the Lades and harbour of Leith. It may be stated that the analyses marked * were made on a day in spring, and the remainder were made on a day in summer.

From the above Table it will be observed that the spring water supplied to Edinburgh, as also the waters which form the sources of the Water of Leith, contain about 29 per cent. of oxygen in the gases dissolved therein; and as the Water of Leith passes several paper-mills and arrives at Coltbridge, where it meets the sewage of Edinburgh, the amount of oxygen is fully 22 per cent. of the gases. The gases dissolved in the liquids conveyed by the sewers contain only from 2·10 to 3·33 per cent. of oxygen; and when the sewage has mingled with the Water of Leith, the percentage of oxygen in the main stream falls to 10·20 and even to 4·10, and in the Lade to 5·40 and even 4·76.

These experimental facts demonstrate that the amount of oxygen dissolved in the water of the Water of Leith, after receiving the sewage of Edinburgh, is reduced to a minimum, and is practically of little use in consuming the large amount of organic matter in solution and suspension in the water; and moreover shows that, even were the more foul impurities to be separated from sewage and streams conveying sewage, the liquid, though it might be clear, would not contain that amount of oxygen gas dissolved therein which would admit of fishes living in it, and finding the air required for their respiration. Trials have been made by the author with water obtained from irrigating meadows, and with the water of the Water of Leith, after separation of the gross impurities by mechanical filtering-beds of sand and clay, and the water in either case did not possess the power of supporting the life of fish; and, indeed, when the fish were introduced therein, they quickly died.

A Suggestion on the Detection of Poisons by Dialysis.
By Dr. A. T. Machattie, *F.C.S., Lecturer on Chemistry, Glasgow.*

The author suggested that in some cases it might be of advantage to employ the coats of the stomach or intestines of an animal as the membrane or septum of the dialyzer, and in this way avoid interference with the organs themselves. This can the more readily be done, since the exterior of the stomach of animals is seldom coated with any appreciable amount of fatty matter, and therefore the whole preparation necessary seems to consist in thoroughly washing the exterior of the stomach or intestines to be examined; for thereafter the organ may be at once exposed to the external action of pure water, as in the commonly pursued methods of dialysis. This manner of detecting poison need not entirely prevent the previous examination of the interior lining of the stomach, provided that the opening be made so as to enable the stomach to be afterwards suspended in water without mechanical leakage. The intestines of an animal supposed to be poisoned scarcely require to be opened throughout their entire length, and accordingly a portion of them left untouched may be tied firmly at each end, washed carefully, and exposed to the external action of water for twenty-four hours, or longer if necessary, in the usual way. Into a portion of the duodenum of a sheep, one-half of a grain of arsenious acid was placed, dissolved and suspended in water. This part of the duodenum, after being washed, was tied at each end and suspended in eight ounces of water, in such a manner as to keep the tied ends entirely out of the water, and so prevent the contents from escaping by any opening that might still exist. The liquid, after twenty-four hours, yielded arsenic by Reinsch's process; but no appreciable precipitate was obtained by treating the liquids with hydrochloric and hydrosulphuric acids. The author described a similar experiment which he had made with strychnine.

On the Presence of Nickel in Metallic Lead.
By Dr. A. T. Machattie, *F.C.S., Lecturer on Chemistry, Glasgow.*

Having had occasion recently to examine several specimens of lead for commercial purposes, I was surprised to find that one of them contained a considerable quantity of metallic nickel; and as I am not aware that nickel is a commonly occurring impurity in lead, or, indeed, that it has been found in commercial lead before, I take this opportunity of recording the results of the analysis which was made by me of the sample referred to.

The composition of the sample analyzed was as follows:—

Lead	82·75
Antimony	10·86
Nickel	5·20
Iron	·86
Loss, including traces of arsenic	·33
	100·00

It will be observed that the above is a highly impure specimen of lead; for, besides the nickel which gives to it its present interest, the sample contains nearly 11 per cent. of antimony. The physical properties of the lead were such as to show, even previous to the analysis, that the sample was very impure. When attempting to divide a portion with an iron chisel, the piece broke with a highly crystalline fracture, and was not cut or beaten out by hammering like ordinary lead. The brittleness of the alloy is, no doubt, much more due to the antimony than to the nickel, but the latter probably assists in communicating this property to the metal. The specific gravity of this lead is 9·95, while that of pure lead is 11·4. Again, as nickel has a specific gravity of 8·8, and antimony of 6·8, the low density of the alloy is easily accounted for.

The source of the ore from which the metal was obtained I could not discover, further than that the lead is of German manufacture, which so far explains the presence of such a large proportion of nickel. The lead can scarcely be used for the ordinary applications of that metal; but the large percentage of antimony would probably recommend it in the manufacture of type-metal.

Chemical Examination of a Hot Spring in Wheal Clifford, Cornwall. By Professor W. A. Miller, *M.D., Treas. R.S.*

In the course of conversation with Sir C. Lyell a few months ago, he mentioned to me the occurrence of a remarkably powerful hot spring, at a great depth, in one of the Cornish mines, no detailed examination of which had hitherto been made. The interest of such an examination was obvious, and it was arranged that a supply of the water should be forwarded to me for analysis.

Wheal Clifford is a copper mine near Redruth in Cornwall. The lode, consisting of a porous pyrites, runs east and west, and the spring comes out in a fissure at the junction of the elvan or granitic porphyry with the killas or clay-slate; the mass of the lode, however, exists in the clay-slate itself. Mr. H. Davey, by whose kindness the water was obtained, estimated the flow of the spring roughly at about 150 gallons per minute. It occurs in the 230-fathom level, at a depth of about 220 fathoms, of 1320 feet below the sea. The water comes out at a temperature of 125° F., the temperature of the air in that part of the mine being 110° at the time that the water was collected. The water is nearly clear, but becomes turbid on standing, and deposits a scanty ochreous sediment. It has a strong saline taste, and when boiled does not give any fur. The gaseous components were the following at 60° F., and 30 inches bar.:—

	Cubic inches.
Total gas in cubic inches in 1 imperial gallon	8·91
Consisting of—	
Carbonic acid	1·89
Oxygen	1·72
Nitrogen	5·30
Ratio of oxygen to nitrogen	1 : 3
Specific gravity	1·007

The saline constituents were found, by evaporation, to amount to 646·1 grains per imperial gallon, consisting of—

Chloride of lithium	26·05
Chloride of potassium with a little chloride of cæsium	14·84
Chloride of sodium	363·61
Chloride of magnesium	8·86
Chloride of calcium	216·17
Sulphate of calcium	12·27
Silica	3·65
Oxides of iron, aluminum, and of manganese	in minute quantity
	645·45

The quantity of cæsium I have not yet had leisure to ascertain, but the amount must be relatively rather considerable, as the precipitate of the double chloride of platinum and potassium, from a quart of the water, gives evidence before the prism of the presence of cæsium. But the most remarkable point, chemically, in the constitution of this water is the unprecedented amount of chloride of lithium which it contains, and which no doubt will furnish an abundant supply of the compounds of this alkaline metal.

Lithium has been found in a great number of springs, but usually in quantity not exceeding one or two grains of the chloride per gallon. Its extraction from this water would not be very difficult. The water itself might undergo a preliminary concentration by boiling down in a steam-boiler; the absence of a deposit or "fur" would render this perfectly feasible; the concentrated liquid should then be boiled down till reduced to one-tenth or one-twelfth of its bulk; to the hot liquid milk of lime is added, till slightly alkaline, to separate magnesia, then a concentrated solution of carbonate of sodium is added cautiously to the boiling liquid as long as it occasions a precipitate; a granular precipitate of carbonate of calcium is produced, from which the mother-liquor, now containing alkaline salts only, is easily decanted. It is further concentrated, part of the chloride of sodium is separated by crystallization, and the lithium is then precipitated as carbonate, by the addition of carbonate of sodium in slight excess. The mother-liquor may then be used to furnish compounds of cæsium by the process of Bunsen and Kirchhoff.

Some Observations on the Constitution of the Atmosphere. *By* Dr. S. Mossman.

On Réaumur's Porcelain. *By* A. Noble.

Circumstances have put me in possession of some beautiful specimens illustrating the devitrification of glass. A drinking-glass, made of ordinary flint glass, was buried in fine sand and exposed to the heat of a pottery-kiln by Mr. Septimus Powell, of Temple Gate Pottery, Bristol, and cooled gradually with the kiln. It was perfectly devitrified. Glass containing the greater number of bases devitrified the most readily. I am also able to show some specimens of light-green bottle-glass which have cooled very slowly, and in which crystallization is very distinct. They are from the glass-works of Messrs. Powell and Ricketts, Bristol.

On the Disposal of Town Refuse. *By* Dr. Paul.

On Crude Paraffin Oil. *By* Dr. B. H. Paul.

The author remarked that very little attention had hitherto been paid to that portion of crude paraffin oil which was heavier than water, and its existence had been denied. He found, however, that the oil obtained from coal, or any similar material, by distillation at a moderate heat not exceeding low redness, always contains oils heavier than water and that these oils are precisely the same as the oils heavier than water, which are contained in the ordinary coal-tar of gas-works, consisting in both cases chiefly of carbonic acid and a thick pitchy substance. It was also shown that the product obtained by distilling different varieties of bituminous coal at a low heat differs very considerably in its character, according to the kind of coal it is obtained from, and that this difference is mainly due to the relative proportions of oil lighter than water and of oil heavier than water. In the case of the oil obtained from the kind of coal commonly used as fuel, the proportion of heavy oil is so large that the product closely resembles the coal-tar of gas-works in all its outward characters, although the oils lighter than water which it contains are identical with those contained in crude paraffin oil, as it is usually manufactured from particular kinds of coal and other bituminous minerals, which are exceptional in so far as they yield by distillation a product containing the light oils in much larger proportions than the heavy oils.

On Useful Applications of Slag from Iron Smelting. By Dr. B. H. Paul.

He said slag was of a nature between porcelain and glass. Attempts had been made to cast the slag into blocks as it issued from the furnace, to be afterwards used as artificial stone, but all attempts of this kind had failed. The application proposed with slag at the present time was to convert it into bricks for building. This was done by a simple and ingenious contrivance. A gentleman had succeeded in blowing the slag into a state of very fine division, by sending steam or air into it, just as it flowed from the blast furnace in the liquid state. It was thus blown into a substance resembling wool in appearance. This substance was taken and ground into dust, mixed with lime, subjected to powerful pressure, and made into bricks, of which he exhibited some examples. These bricks required no fire. After being pressed, they were allowed to dry, and could be used at once, the influence of the atmosphere producing a slow kind of hardening. It was also intended to use the powder as a manure.

On the Black Stones which fell from the Atmosphere at Birmingham in 1858. *By* Dr. T. L. Phipson, *F.C.S. Lond.*

These stones, which have hitherto been regarded as aërolites, fell at Birmingham in great numbers during a violent storm which broke over that town in the month of August 1858. Several of these stones have recently been forwarded to me by Mr. W. B. Beale, in order that I might submit them to analysis. They are small, angular, and black, presenting here and there a few indications of crystallization. They act very slightly on a magnetic needle, but the action is sensible. They give a lightish-coloured streak, and when finely pulverized are partially soluble in hydrochloric acid. The analysis which I have made of them has proved to me that these stones are *not* aërolites, but small fragments of basalt rock, similar to that which exists at a few leagues from Birmingham, near the parish of Rowley. They have given me—

Silica	46·13
Alumina	16·25
Protoxide of iron	8·86
Peroxide of iron	3·71
Lime	11·25
Magnesia	6·74
Alkalies (by difference)	3·76
Water	3·30
	100·00

The specific gravity of these stones is about 2·7; they fuse with some difficulty on the edges before the blowpipe; *when heated quietly in a platinum crucible, they emit a marked odour of ozone.* It is evident to me that these stones, which fell in great numbers in Ann-street and other adjacent streets of the town of Birmingham, were carried there by a waterspout; as was also the case, doubtless, with the curious fall of hay which I observed in London in June 1861, and described in the *Comptes Rendus* of the Paris Academy of Sciences, and the remarkable fall of ironstone which occurred in August 1841 at Iwan in Hungary. The sizes of the pieces of this ironstone which fell varied from that of a grain of hemp-seed to that of a nut. The black stones which fell in Birmingham are about the size of nuts, to judge from the specimens I have examined.

On the Medicinal Muds of the Island of Ischia, Bay of Naples. *By* Dr. T. L. Phipson, *F.C.S. Lond.*

Two specimens of these muds were forwarded, not long ago, to my laboratory. Invalids visiting Ischia plunge their arms, legs, or entire bodies into them, for various diseases, more particularly for scrofula and rheumatism. One of the bottles containing these muds was ticketed *Fango di Gurgitella*, the other *Fango del Aritta.* They differ very much in appearance and in smell, though they are essentially the same in composition and properties, being formed of volcanic or felspathic grains. The whole constitutes a volcanic sand rendered muddy by water, and a certain quantity of vegetable débris. The grains are composed of lava, green felspar, ryacolite in beautiful glassy grains, augite, quartz, mica, here and there a few grains of marble, &c.

My analysis of these muds gives them the following composition:—

Fango di Gurgitella.

Greenish grey; no smell; insipid; sandy, with little mud. Deposits sulphur on a plate of silver in twenty-four hours.

Water	30·00
Organic matter	4·00
Oxide of iron	1·40
Carbonate of lime	1·20
Bromine and iodine	none
Sulphur	traces
Volcanic sand as above described	63·40
	100·00

Fango del Aritta.

Black; smell of putrid Algæ and sulphuretted hydrogen. Gives PbS on paper imbibed with acetate of lead, when heated.

Water	42·85
Organic matter	4·05
Black sulphide of iron	1·36
Oxide of iron	2·00
Carbonate of lime	2·60
Bromine and iodine	none
Sulphur	distinct traces
Volcanic sand as above described	47·14
	100·00

The Italian bottles in which these specimens of the Ischia muds were forwarded to me, though corked with large glass stoppers, do not close hermetically; and I have no doubt that the water of these muds, in its natural state, is strongly impregnated with sulphuretted hydrogen, which has almost entirely escaped from the samples during the journey. The black colour of the *Fango del Aritta* is owing to a layer of black sulphide of iron, formed by the action of sulphuretted hydrogen upon the grains of green felspar, which it envelopes completely. When the mud is exposed to the air for some time, the black sulphide is gradually oxidized, and the grains assume their original green colour; in this manner the *Fango del Aritta* becomes similar to the *Fango di Gurgitella.*

It is remarkable that sulphuretted hydrogen, like carbonic and sulphurous acids, attacks the *iron* of the felspar rocks in preference to the alkalies, which are not attacked at all, for the glassy grains of ryacolite have undergone no decomposition whatever. Diluted hydrochloric acid dissolves this black sulphide of iron, formed on the surface of the green grains, with evolution of sulphuretted hydrogen gas. No iodine or bromine was detected in either of the muds; but, by passing a magnet through some of the *Aritta* mud, a number of brilliant black grains, which were proved to be *magnetic oxide of iron,* were extracted from it. The water separated by filtration from the sand, and merely gave indications of lime, sulphuric acid, and chlorine, and did not differ from ordinary river-water in composition, except by the presence of a small proportion of free sulphuretted hydrogen gas, which in that of the *Fango del Aritta* only amounted to $\frac{6}{100,000}$ths, but I believe the greater portion of this gas had escaped during the journey.

The curious custom of plunging the body into muds of this kind, as a means of restoring health, is not confined to the island of Ischia. I have lately found that a similar custom prevails in the neighbourhood of the Salt Lake, Balta Alba, in the Danubian provinces; and I have heard that the same practice was once resorted to in the south of England.

The beneficial effects that are said to follow such treatment are probably owing as much to the *cleansing* and *stimulating effect* produced by the friction of the grains of sand upon *the skin*, as to the presence of *sulphur* and *sulphuretted hydrogen* in the muds.

An Account of Apparatus and Processes for the Chemical and Photometrical Testing of Illuminating Gas. By Professor W. B. Rogers.

Professor Rogers stated that the instruments and processes, of which he proposed to give a short account, had been devised and employed by him as part of the system of gas inspection which he had organized for the State of Massachusetts, and which applied to the mechanical measurement as well as to the photometric and chemical testing of illuminating gas.

1. The entire plan comprises the primary determination of the cubic foot, standard measure, and its convenient adjustment for use in gauging the gasometers employed in meter-testing in different parts of the State. This differs chiefly from the apparatus in use in Great Britain in being moveably suspended, and expelling the measured volume of air by its descent in a tank, the final reading on the gasometer being taken, after adjusting to zero of pressure, by a pressure-gauge of extreme delicacy. Figures of the standard apparatus and the pressure-gauge were exhibited to the Section.

2. To give greater facility and certainty to the observations on the *registration* of meters, two contrivances were adopted, the one intended for a ready and secure adjustment of the connexions at the inlet and the outlet of the meter, and the other for indicating the temperature and the pressure of the air or gas at these points. The former apparatus consists of a clamp composed of two metallic limbs, hung by pivots on a central piece, and capable of being fixed at any required degree of opening by the action of a screw passing through the central piece. When thus firmly attached to the narrow or wide neck of the meter, as the case might be, the clamp is used as a gallows-screw, by having a second screw working within the screw of the clamp-head already described, which is made to bear upon the end of the connecting tube, so as to make the juncture unfailingly tight.

The other contrivance to be applied to the meter, in observing its registration, is a short horizontal connecting tube, whose opening at one end is in a flat surface at the lower side, capable of being secured by the apparatus just described upon the inlet or outlet of the meter. Near this end the tube enlarges to a little chamber, in which is inserted the small cylindrical bulb of a delicate thermometer and one end of a siphon-gauge, so as to enable the observer to read the *temperature* of the entering and issuing air, and to determine its *pressure*, or to test the meter for leakage. On the outlet side, this appendage is prolonged by a short rubber-tube, which can be closed by a clip at the moment of completing the registration. And the outer end of this tube is furnished with a disk-stopper, which, by turning more or less, varies the aperture to secure the proper rate of transit of the air or gas.

3. For the *chemical testing* of gas, Professor Rogers devised a form of simple eudiometer, which has been found to answer the purpose better than those usually employed in gas inspection, both on the ground of convenience and accuracy. It consists of a tube with a cylindrical enlargement at the closed end, the tube being graduated to $\frac{1}{100}$ths and tenths of $\frac{1}{100}$ths of the entire capacity. This at its open end is fitted with a hollow stopper accurately ground, and intended to hold the several liquid absorbents used in the successive experiments. The entire tube, with enlargement, is enclosed in a *water-case*, consisting of a slender cylindrical vessel of glass filled with water at the temperature of the room, the open mouth of the tube projecting slightly from the cork-stopper of the case. Through the great specific heat of water, it is found that the temperature of the gas, while submitted to successive testings, is almost completely protected from the effect of the necessary handling of the apparatus.

With this eudiometer it is quite easy to determine, first, the percentage of carbonic acid in the gas, then the illuminating hydrocarbons, and then the oxygen and the carbonic oxide, by introducing in the hollow stopper the appropriate reagents. The hydrogen and light carburetted hydrogen may be subsequently determined by explosion of the residue with oxygen, in an apparatus consisting mainly of two glass tubes, united below by a long loop of rubber-tube, one of the glass tubes which is fixed serving as the chamber for explosion and measurement, and the other moveable up and down on the vertical frame serving to adjust the level of mercury before and after the experiment, and also to bring the gas, after explosion, into contact with potassa for the removal of carbonic acid.

4. For determining the amount of sulphur present in gas, use is made of the ordinary process of slow combustion under a funnel-tube connected with a Liebig condenser; but an improved arrangement is adopted, by which a supply of ammonia is introduced, *at some distance above the flame*, where it is free from the danger of combustion, and, combining with the sulphur products of the combustion, secures their retention in the collected liquid. This is effected by causing the stream of water which supplies the condenser to draw a small amount of air by aspiration into the descending feed-pipe. This air, collected in a separate vessel, or in the enlarged head of the condenser, is, by its own compressure, driven through a small bottle containing dilute ammonia, and thence delivered by a slender tube into the neck of the condensing tube some inches above the gas-flame. This apparatus, as well as the improved eudiometer, besides their value in the ordinary routine of gas inspection, may, it is thought, be of use in various laboratory experiments.

5. The great difficulty of determining the illuminating power of gas depends, as all know, on the want of a reliable and uniform standard of light to which to refer. The uncertainty of the ordinary photometric determinations, by the use of the standard candle, resulting from the unavoidable variability of the candle, is further increased by the fact, that the unit is so small that the observer is confined to the part of the scale where a very slight change in the position of the disk makes a great difference in the reading. To secure a more uniform light, and a larger unit of comparison, Professor Rogers has used a kerosene lamp with a flat flame, limited at the sides and top by a strip of platinum foil. This he found capable of affording a very uniform disk of light equal to about $7\frac{1}{2}$ candles. The lamp is supported in a balance of peculiar construction, enabling the observer to mark exactly the rate at which the oil is consumed in each stage of the experiment, and to make such corrections as are needed on this account. Although far from affording a perfect standard, this arrangement promises much more satisfactory results than the ordinary method of observation.

Neither of the chemical processes referred to were put forward as replacing the refined and exact methods of gaseous analysis with which chemists are familiar. They have been found convenient for the purposes of ordinary gas inspection, and are of such accuracy as not only to serve this object, but to prove useful in the laboratory assays where the highest degree of exactness is not demanded.

In conclusion, Professor Rogers made a brief reference to his experiments on the influence exerted by the presence of carbonic acid in gas on its illuminating power. He found that even the small amount of this impurity, which in some manufactories is allowed to remain in the gas, produces a sensible diminution of the light. The effect varies with the quality of the illuminating gas, and was found to range from three to nearly five per cent. of the illuminating power for each per cent. of carbonic acid present in the mixture. In a series of experiments with gas successively mingled with larger and larger quantities of carbonic acid, it was found that 58 per cent. of carbonic acid, although it did not prevent combustion, rendered the flame so dim as to be inappreciable on the photometric screen.

On an Invention by Mr. Cornelius, *of Philadelphia, for Lighting Gas by Electricity. By* Professor W. B. Rogers.

The electrical apparatus was attached to a common gas-burner. It was an application of the principle of frictional electricity (the apparatus being a modified form of electrophorus), and, on the removal of a stopper of vulcanite, the friction generated an electric charge, and the gas was instantly ignited. It could be arranged so as at the same instant to light the whole of the burners in a room.

Contributions towards the Foundation of Quantitative Photography. By Professor Roscoe, *B.A., Ph.D., F.R.S., F.C.S.*

Our knowledge of the photographic processes has, as yet, attained only the qualitative stage; and the author communicated the results of experiments (carried out in his laboratory by Mr. A. McDougall, B.Sc.) instituted for the purpose of establishing facts upon which a quantitative photography might be founded, the method being based upon the experimental law, discovered by Professor Bunsen and himself, to the effect that a constant product of the intensities of the acting light into the times of exposure always corresponded to a constant tint on the photographic paper. Hence, if several differently sensitive prepared papers are exposed to a constant light for varying periods of time, until they all exhibit the same degree of tint, the reciprocals of these times of exposure represent the relative sensitiveness of the papers. By the help of the pendulum-photometer, the times during which the papers had been exposed were ascertained, and the degree of tint attained was read off by the soda light. Tables were constructed showing the variation in the sensitiveness produced by increasing the strength of the solution of salts employed, and curves drawn representing this relation. The salts used were chloride of sodium, chloride of potassium, chloride of ammonium, and bromide of potassium. The next point ascertained was the fact that the sensitiveness of the paper did not vary with variation of the base with which the chlorine or bromine was combined. The third portion of the experiments referred to the comparison of the relative sensitiveness of the chloride, bromide, and iodide, and mixtures of these.

Description of a Chemical Photometer for Meteorological Observation. *By* Professor Roscoe, *B.A., Ph.D., F.R.S., F.C.S.*

The author exhibited and described a modification of the pendulum chemical photometer, by means of which the meteorological registration of the chemical action of light may be accurately and easily carried on. No less than forty curves of the daily chemical intensity at Manchester, in the year 1863-64, have thus been made. The author believes that the method is now so simple that such a series of determinations may be carried on at any meteorological observatory.

Note on the Existence of Lithium, Strontium, and Copper in the Bath Waters. *By* Professor Roscoe, *B.A., Ph.D., F.R.S., F.C.S.*

At the request of Sir Charles Lyell, the author undertook the examination of the residue obtained by the evaporation of the Bath waters (King's Bath spring) by spectrum-analysis. No trace of barium was found; but strontium was present in quantities sufficiently large to enable it to be easily detected. The portion of the deposit soluble in dilute hydrochloric acid was freed from alkaline earths by several precipitations with carbonate and oxalate of ammonia, and in this precipitate strontium was again detected. The magnesium was next separated by ignition of the mixed chlorides with oxide of mercury; and, on examining the portions of the residue soluble in water, the red lithium line was plainly visible. In salts derived from twenty gallons of water the author was still unable to detect the smallest traces of either rubidium or cæsium. In the course of both analyses the presence of copper was detected.

On some probable New Sources of Thallium. *By* W. L. Scott.

Some time back, during the examination of a fine but highly ferruginous sand, obtained from the neighbourhood of Whitby, it struck the author as remarkable that a certain precipitate, which he knew to be entirely free from both barium and copper, should tint a hydrogen flame green. On going into the matter somewhat more carefully, he found that this precipitate exhibited the thallic spectrum very distinctly. From this he was led to examine other sands; amongst them, those from Alum Bay, Isle of Wight, and some others. The sands containing the thallium are the rock-sands; the sea-shore sand, as a rule, contains no thallium. Many of the deeply coloured clays which alternate with the sands at Alum Bay also give indications, more or less marked, of containing thallium.

On Copper-smelting. *By* P. Spence, *F.C.S.*

The author said he had for some years directed his attention to this subject, and his aim had been to erect works on sound chemical principles. The first furnace he erected was successful in calcining the small ores with a small expenditure of fuel and labour, with elimination of all the sulphur from the ores if that was required; and it enabled him to send all the sulphur so eliminated into the vitriol-chambers as sulphurous-acid gas. Very soon afterwards he erected additional furnaces, and all the sulphuric acid made at his works since the end of 1861 had been made from these small ores by similar furnaces. The amount of sulphur wasted in copper-smelting, and which could be economized for the use of such calcining furnaces as he had erected, was something enormous. It had been estimated at 70,000 tons per annum, which at the present time would be worth 455,000*l.* A more recent improvement, and which he has now in successful operation, is the combining of these calcining furnaces with the ordinary copper-smelting furnace, in such a manner that the flame of the smelting furnace, instead of passing directly to the stack or chimney, is made to pass under the calciner, and affords sufficient heat to effect the calcination of the ore required by the smelter; thus at once saving 30 to 33 per cent. of all the fuel required for copper-smelting, that being about the proportion required by the calcination part of the process. Another advantage of this mode is that the calciner is so placed that when a charge of ore is required for the smelter, it is at once passed in a red-hot condition by a shoot from the calciner directly on to the bed of the smelter. In the present mode of manufacture, the ore is dropped out of the calciner into a cave under it, and is there dredged with water until completely damp, and by barrows is then removed, and in this wet condition is thrown into the highly heated smelting furnace. The saving of fuel, labour, destruction of furnaces, and nuisance from escaping gases must be very evident.

On the Precipitation of Aluminous Silicates from Solution. By Dr. SULLIVAN.

On the Colouring of Agates. By Professor TENNANT, *F.G.S.*

Some details were given respecting the structure of agate, and the artifices resorted to by the workmen of Oberstein in colouring the agate ornaments manufactured at that place and distributed over Europe. A large number of specimens were exhibited, not only of ornaments, but of the stones, both cut and uncut, the former well adapted to show the structure. The black colour is produced by steeping the specimens in oil, and then blackening them by the action of sulphuric acid.

On the Rational Formula of Rosaniline. By J. ALFRED WANKLYN.

According to Hofmann, the empirical formula for anhydrous rosaniline is $C_{20}H_{19}N_3$; the salts being $C_{20}H_{19}N_3$, XH and $C_{20}H_{19}N_3$,3XH, whilst the base on being liberated from one of its salts takes the form $C_{20}H_{19}N_3$, H_2O.

It will be apparent that anhydrous rosaniline is just equal to a base consisting of two atoms of toluyl and one of phenyl along with three atoms of nitrogen,

$$C_{20}H_{19}N_3 = N_3 \begin{cases} C_7H_7 \\ C_7H_7 \\ C_6H_5 \end{cases}$$

This manner of constructing the formula of rosaniline, which appears to be adopted by some chemists, derives a remarkable confirmation from the circumstance discovered by Hofmann, that it is requisite to employ a mixture of toluidine and aniline in the manufacture of rosaniline, neither toluidine nor aniline alone being capable of yielding the dye.

Notwithstanding this capital fact, it is quite certain that rosaniline is not

$$N_3 \begin{cases} C_7H_7 \\ C_7H_7 \\ C_6H_5 \end{cases}$$

In several reactions rosaniline displays three atoms of easily replaceable hydrogen.

Thus, in the famous process for producing aniline blue three atoms of phenyl are changed against three atoms of hydrogen,

$$C_{20}H_{19}N_3+3C_6H_5H_2N=C_{20}H_{16}(3C_6H_5)N_3+3H_3N.^*$$

Hofmann's beautiful research relating to this transformation of aniline red into aniline blue leaves no doubt that three atoms of hydrogen are concerned.

Again, the iodides of the alcohol radicals react upon rosaniline, producing ethylated bases. Hofmann has not yet published his research on "Ethyl-rosaniline," but, judging from the quantity of iodide of ethyl actually destroyed in the operation, there can be little doubt that substitution goes on to the length of three atoms.

In order to judge whether this action upon the "hydrogen atoms" in rosaniline must be looked upon as a very close representation of the action upon the hydrogen atoms in common ammonia, I have inquired whether Carey Lea's method was applicable to rosaniline.

Carey Lea, as is well known, has shown that nitrate of ethyl occupies a place among the very few ethers capable of forming ethylated ammonias by reaction upon ammonia. I have recently succeeded in obtaining ethylated rosaniline by the action of nitrate of ethyl upon rosaniline.

From all this it results that the rational formula of rosaniline must display three atoms of hydrogen in association with nitrogen.

A consideration of the entire case leads me to propose the following formula:—

$$C_2\left\{\begin{array}{l}NHC_6H_5\\NHC_6H_5\\NHC_6H_5\\H\end{array}\right.\qquad\qquad \overset{\text{Type.}}{C_2\left\{\begin{array}{l}H\\H\\H\\H\end{array}\right.}$$

I here write rosaniline on the "ethylene" type, replacing three atoms of typical hydrogen by three atoms of phenylamid.

Just as ethylene tends to take up the representatives of two atoms of hydrogen, and thereby passes into a body of the "hydride of ethyl" type, so rosaniline tends to take up two atoms of hydrogen, thereby becoming a representative of hydride of ethyl.

$$C_2\left\{\begin{array}{l}H\\H\\H\\H\end{array}\right.+H_2=C_2\left\{\begin{array}{l}H\\H\\H\\H\\H\\H\end{array}\right.$$

$$\overset{\text{Rosaniline.}}{C_2\left\{\begin{array}{l}NHC_6H_5\\NHC_6H_5\\NHC_6H_5\\H\end{array}\right.}+H_2=\overset{\text{Leucaniline.}}{C_2\left\{\begin{array}{l}NHC_6H_5\\NHC_6H_5\\NHC_6H_5\\H\\H\\H\end{array}\right.}$$

The three atoms of hydrogen in union with the three atoms of nitrogen are, of course, easily replaceable.

The fourth atom of hydrogen, being in direct association with carbon, is not easily replaceable.

The power that nitrogen has of being either three or five atomic is, of course, the explanation of the mono-acid and tri-acid salts. There should be likewise bi-acid salts.

* The first suggestion of the kind of change which takes place when aniline red becomes aniline blue was, I believe, due to me. In the winter of 1862–63 I explained it by saying that aniline red lost hydrogen and gained phenyl; supporting my view by adducing the fact that the red gave more than its weight of blue while ammonia was evolved.

Quite in accordance with the formula is the fact that distillation with potash gives much aniline and a residue of carbon.

$$C_2\left\{\begin{array}{l}NHC_6H_5\\NHC_6H_5\\NHC_5H_5\\H\end{array}\right.+H_2O=C_2\left\{\begin{array}{l}O''\\NHC_6H_5\\H\end{array}\right.+2NC_6H_7$$

The group

$$C_2\left\{\begin{array}{l}O''\\NHC_6H_5\\H\end{array}\right.$$

would, on maltreatment, be very likely to carbonize.

A reaction which may be predicted is this. Careful treatment with alkali may be expected to give aniline and glycolic acid.

Note on the Probable Constitution of Kolbe *and* Schmitt's *Colouring Matter obtained by acting upon Carbolic Acid with Oxalic and Sulphuric Acids. By* J. ALFRED WANKLYN.

The production of a colouring-matter by the action of oxalic acid upon phenyl-alcohol in presence of sulphuric acid is a very remarkable thing. As yet no attempt has been made to give any explanation of the changes which take place during this process, and yet considerable quantities of a dye-stuff are now being made in France in this manner.

The following hypothesis may be offered to connect together the facts as they are at present known.

Kolbe and Schmitt give C_5H_4O as the result of their analysis, state of condensation being unknown.

$$C_{20}H_{16}O_4=C_2\left\{\begin{array}{l}C_6H_5O\\C_6H_5O\\C_6H_5O\\HO\end{array}\right.$$

The probable reaction in Kolbe and Schmitt's process is between carbonic oxide and phenyl-alcohol, thus:—

$$C_2O_2+3C_6H_5HO=C_2\left\{\begin{array}{l}C_6H_2O\\C_6H_2O\\C_6H_2O\\HO\end{array}\right.+H_2O$$

The colouring-matter is thus an "ethylene." Kolbe and Schmitt have observed that it is decolorized by means of nascent hydrogen. Explanation:—The ethylene becomes a hydride of ethyl.

As might have been expected, it is a weak acid.

The obtaining of a blue dye from it by the action of aniline may possibly be by this equation:—

$$C_2\left\{\begin{array}{l}C_6H_5O\\C_6H_5O\\C_6H_5O\\HO\end{array}\right.+\begin{array}{l}H_2C_6H_5N\\H_2C_6H_5N\\H_2C_6H_5N\end{array}=C_2\left\{\begin{array}{l}C_6H_5C_6H_5N\\C_6H_5C_6H_5N\\C_6H_5C_6H_5N\\HO\end{array}\right.+\begin{array}{l}H_2O\\H_2O\\H_2O\end{array}$$

On a curious Example of Etherification. By J. ALFRED WANKLYN.

Some years ago Frankland showed that iodide of ethyl and water yield hydriodic acid and ether, on being exposed to the action of a temperature of 150° C. under pressure:

$$2C_2H_5I+H_2O=(C_2H_5)_2O+2HI.$$

I have recently observed a somewhat similar reaction which, however, takes place at temperatures so low as 100° C.

When rosaniline, iodide of ethyl, and alcohol are heated together to 100° C. for about twelve hours, there is formed, in addition to the iodide of ethyl-rosaniline, a quantity of common ether. The production of this ether may be explained as follows:—

The three atoms of hydriodic acid resulting from reaction between three atoms of iodide of ethyl and one atom of rosaniline are thus appropriated; one atom goes to saturate the ethyl-rosaniline, and the remaining two react upon the alcohol:

$$2HI+2C_2H_6O=2HI+H_2O+(C_2H_5)_2O.$$

Or we may suppose that the production of ether takes place quite directly:

$$C_2H_5I+C_2H_6O=HI+(C_2H_5)_2O.$$

Whichever way we regard the reaction, the fact is deserving of attention. Reasoning upon it, we should be led to expect the production of ether in the process for the preparation of the ethylated ammonias, *i. e.* when we heat iodide of ethyl with alcoholic solution of ammonia. Common ether is likewise to be looked for in the preparation of various compound ethers by digesting different salts with iodide of ethyl and alcohol.

I am informed that this formation of ether as a by-product in the manufacture of ethylated rosaniline has also been noticed by Continental manufacturers.

On Isomorphism. By Dr. Williamson.

GEOLOGY.

Address by John Phillips, *M.A., LL.D., F.R.S., F.G.S., Professor of Geology in the University of Oxford, President of the Section.*

The age of geological discovery is by many persons thought to have passed away with Hutton and Werner, Humboldt and Von Buch, Smith and Cuvier, Conybeare and Buckland, Forbes and De la Beche; and they regard as almost final the honoured researches of Sedgwick and Murchison, and Lyell. Yet in this very district, the most carefully examined perhaps of all the richly fossiliferous tracts of England, our friend Mr. C. Moore is finding a multitude of interesting forms of life of the later triassic age, and is thus enriching in an unexpected manner the catalogue of fossils in Britain. Nor is the practical application of our science less actively exercised. In this very district Mr. Sanders has just completed that admirable Survey of the strata on the large scale of 4 inches to a mile, and showing every field, which is suspended before you. Sir R. Murchison has informed us of the further proof of the extension of coal under the Permians of Nottinghamshire; and at this very Meeting we receive through the same channel, from Mr. M'Kenzie, the news of the finding of an additional bed of coal in Australia, thirty miles from any former known site of coal, the bed being 38 feet thick and of good quality.

Nothing is better settled than the series of great events in our geological history; yet even now we are rejoicing over the large addition made to this history by the discovery of the richly fossiliferous beds of St. Cassian and Kössen, by which the triassic fauna is enlarged, and the means of comparing Palæozoic and Mesozoic life augmented by some hundreds of forms, including some genera of the older, and others of the newer systems. The Director of the National Survey has decided to give to these strata in England and Wales a distinct colour on his map and a definite name.

But a few years since, the varied strata of marine and freshwater origin above the chalk were carelessly, if not contemptuously, classed as 'superficial deposits;' now they have acquired a large and regular history, embracing a great succession of organic life, in the sea and on the land, which is appropriately crowned by the works of intelligent man. Not long since, the 'diluvium' or 'drift' was merely an ill-understood basis for ill-considered speculation: now we have classified its parts; have begun to survey the movements of land and sea which preceded and accompanied these latest superficial accumulations; and have even ventured to apply to them measures of time, in a continuous chronology.

The new problems opened by these researches, the inferences to which they lead, and the speculations which they suggest, require only to be named. How to explain the all but universal glaciation of the mountain regions of Europe—once, or perhaps twice, since the era of the Crag; how to trace the course and limits of those gelid waters which since that era rose to half the height of Helvellyn and Snowdon; how to account for the changes of physical geography which allowed Hippopotami to be buried in the sediments of a Yorkshire river, troops of Mammoths to crowd the Cotswold Hills, and the mingled remains of Reindeer and Man to fill the caverns of the South of France—these and many more questions of equal importance occupy the attention of geologists, and give a special interest to the later geological periods.

In each of these cases, and in all which come before geologists for interpretation, there is one general rule:—we compare always the ancient phenomena with the most similar effects we can find of forces now in action.

As in existing nature the amount of effect produced by known causes varies with the conditions of each case—as the sun's effect varies from hour to hour, from day to night, from summer to winter, and from year to year—as the force of moving water is greater or less according to the slope of the ground, and the sea's movement is modified by the age of the moon and the position of land—so in earlier nature the combinations of phenomena varied, and the measures of effect were modified accordingly. In another point of view the aspect of nature is found to be variable, and subject to cycles of change, periods of greater and less effect of particular forces which in their own nature are constant. The distance of the earth from the sun is not constant, the form of its orbit is not constant, it was not always nor will always be nearer to the sun in winter than in summer. From these varied conditions, which are measured by long astronomical periods, cycles of greater and less heating effect on the earth in general, and on parts of it in particular, arise; so that speculations as to the causes of the differences of climate during geological periods are entirely incomplete if we leave out of view these real and definite sources of terrestrial vicissitude. Whether they are sufficient, and justly applicable to the facts established in geology, is a proper subject of deliberate inquiry.

Among the facts put in evidence by geology regarding the former condition of the land and sea, none are so convincing of great change and systematic diversity as the remains of plants and animals. By appeals to these innumerable witnesses, conclusions of much importance are maintained, touching the greater warmth of the carboniferous land, and the colder climate of the later cænozoic seas. By the same testimony, it appears that over every part of the earth's surface, in every class of organic life, the whole series of created forms has been changed many times.

Have we measured these changes of climate, and assigned their true physical causes? Have we determined the law of the successive variations of life, and declared the physiological principles on which the differences depend? No! the variations of climate must be further investigated, the limits of specific diversity more surely defined, before we can give clear answers to these critical questions.

Late researches, partly archæological and partly geological, both in England and France, have been held to prove the contemporaneity of Man and the Mammoth in the northern zones of the world. Have we, then, been too confident in our belief that the human period was long posterior to, and strongly marked off from, that of the Cavern Bear and the woolly Rhinoceros? Did the races of Hyæna and Hippopotamus remain inhabitants of Europe till a comparatively modern epoch, or was Man in possession of the earth in times far earlier than history and tradition allow?

The prevalent opinion seems to be, that as variations of the forms of life are extremely slow in existing nature, for every case of considerable change in the predominant types of ancient plants and animals, very long intervals of time must be allowed to have elapsed. If in some thousands of years of human experience no very material change has happened in our wild plants or wild animals, or in cultivated grains, or domestic birds and quadrupeds, it is evident that no considerable changes of this kind can arise from such causes as are now in action without the aid of periods of time not contemplated in our chronology. Estimated in this way, the antiquity of the earth grows to be inconceivable—not to be counted by centuries, or myriads of years—not to be really compassed by the understanding of men, whose individual age is less than a century, and whose histories and traditions, however freely rendered, fall short of a hundred centuries. The whole human period, as we have been accustomed to view it, is but a unit in the vast sum of elapsed time: yet in all those innumerable ages the same forces were seated in the same particles of matter; the same laws of combination prevailed in inorganic and in living bodies; the same general influences resided on the surfaces or governed the masses of the planets, in their ever-changing paths round the sun.

All natural effects are performed in time, and when the agency is uniform, are in proportion to the time. And though the agency be not uniform, if the law of its variation be known, the time consumed in producing a given effect can be determined by calculation. Geological phenomena of every order can be expressed in terms of magnitude, as the uplifting of mountains, the deposition of strata, the numerical changes of the forms of life. The time required to produce these effects can be calculated if we know at what *rate* in time, whether uniform or not, they were produced: if we know, not the true rate, but the *limits* within which it must have operated, the result of the calculation will have a corresponding uncertainty; if we have no knowledge of the rate, calculations are out of the question.

In applying this general view to the history of the earth, philosophers of eminence in physical science have employed different considerations and obtained a variety of results. The conclusions of two eminent mathematicians which have lately appeared may be cited with advantage.

A careful computation by Professor W. Thomson, on selected data, which determine the rate of cooling of earthy masses, assigns 98,000,000 years for the whole period of the cooling of the earth's crust from a state of fusion to its present condition; so that, in his judgment, within one hundred millions of years all our speculations regarding the solid earth must be limited *.

On the other hand, Professor Haughton finds, from the data which he adopts, 1018 millions of years to have elapsed while the earth was cooled from 212° F. to 122° F., at which temperature we may suppose the waters to have become habitable; and 1280 millions of years more, in cooling from 122° to 77°, which is assumed to represent the climate of the later Eocene period in Britain. Computations of this kind cannot be applied except on the large scale here exemplified; and they lose all their value in the eyes of those who deny the general doctrine of a cooling globe †. Much as these periods exceed our conception, they appear to be in harmony with the results of astronomical research, which contemplates spaces, motions, and cycles of periods too vast for words to express, or numerals to count, or symbols to represent.

The greatest difficulty in obtaining trustworthy results as to elapsed time is found where it was least expected—among the later cænozoic deposits from rivers and lakes, and on the variable shores of the sea. This is the more disappointing because within this period falls the history of the human race. Taking as its earlier limit the latest wide prevalence of glaciers in Europe, attempts have been made to measure its duration by several processes. Quite recently Mr. Croll ‡ recalls attention to an astronomical cause of change of temperature—the varying excentricity of the earth's orbit—by which in a small degree the total *quantity* of heat received in the earth in a year, and in a much greater degree the *distribution* of this heat on the opposite circumpolar spaces, are altered §. The effect of this at particular epochs would be, on one hemisphere an approximate equality of summer and winter heat, on the other an augmented difference between them. If at the epoch of maximum excentricity the earth was in aphelion during our winter, a great accession of snow might arise and be continued for ages, and glaciers have a large augmentation; under the contrary circumstances, less snow and shortened glaciers. To this latter condition the present state of the north corresponds; and by consulting the astronomical tables, it appears that a condition of extreme glaciation, dependent on the maximum excentricity of the earth's orbit, cannot have

* Phil. Mag. Jan. 1863.

† Appendix to a Lecture on Geology, in the 'Reader,' Feb. 1864.

‡ Phil. Mag. Aug. 1864.

§ Consult on this subject generally the valuable communication of Sir J. Herschel to the Geological Society, Proc. vol. i. p. 244, for Dec. 1830.

happened within the last 100,000 years. This, it will be remembered, corresponds with the conjecture of our President regarding the possible antiquity of the fluviatile gravel-beds with flint implements at St. Acheul; and with the computation of M. Morlot, of the age of the oldest gravel-cone of La Tinière on the Lake of Geneva, which he supposes to have followed the latest extreme extension of glaciation in the Alps.

Quite a different conclusion, however, was presented a few years since by a German mathematician, Herr Adhemar*, who, reflecting on the difference of mean annual temperature of the two hemispheres of the earth—dependent on the inequality of the half-yearly periods, *our* hemisphere having now the advantage of position—finds that within each half 'tropical' period (about 10,500 years) snows would gather and glaciers thicken round one pole, to be afterwards melted while glaciation was spreading round the other. Thus, periodical deluges, at intervals of 10,500 years, are found by this inquirer to be part of the system of nature.

The opinion, however, has long been growing among geologists, that it is rather by rising and falling of the land, and displacement of the sea, that the alternations of snows and floods must be explained, which are admitted to have visited the mountain regions of the north. In Switzerland two great extensions of ice in former times have been traced by Escher and the eminent geologists of that country—the latter one corresponding perhaps to the age of our glacial drift.

The melting of snow and ice in the valleys of the Alps is far more rapid under the influence of certain winds than by the direct effect of sunshine. Withdraw the hot Föhn for a season, the glaciers would renew their advance; let it cease, or lose its specific action for a century, the progress of the ice would be considerable. In many centuries the Rhone glacier might reach again to Sion, Villeneuve, and Lausanne; in many thousands of years, all the valleys, and lakes, and borders of the Alps might be reoccupied by ice.

Now the southerly wind, which so rapidly strips the alpine peaks of their snows, draws its melting power from the hot northern tracts of Africa. Were these tracts again covered, as once they were, with an expansion of the Mediterranean, the wind would lose its excessive dissolving power,—snows would gather above, and glaciers extend below to levels and distances now quite unattainable without some great physical change.

Great physical change, then, is the inevitable antecedent to extensive glaciation and abundant dissolution of ice round the mountains of the north. Astronomical vicissitudes returning in cycles of long duration, changes of level of the land, expansions and contractions of the sea, deviations of the currents of the ocean, alterations in the prevalent direction and quality of the winds—whichever of these causes we assume, and however we combine them, it is evident that we are appealing from the existing order of nature and the present measures of effect in time, to some other combination of natural agencies, some other standard of physical energy. The conclusion is obvious. Inductive geology refuses to accept definite periods for phenomena produced under conditions not yet really determined.

I will not, by any further observations, discourage you from exploring this attractive field of research, or restrain the freedom with which you will desire to discuss it. Only let me add, that to one fresh from the Alps—from the old Pfahlbauten of the lakes, and much older monuments of overspreading snow and gliding ice, the later ages of geology and the earlier ages of mankind seem to be fairly united in one large field of inquiry. That it must be trodden with heedful steps, and demands all possible care in the scrutiny of facts, in the estimation of natural agencies, and in the choice of right measures of time, before the Pleistocene, Quaternary, or Human period can be said to be accurately known by natural phenomena, even in this the best-examined part of the world, is obvious.

But the same remark applies to every one of the many perplexing questions which have been considered by geologists. By following the same good processes of strict inquiry and cautious interpretation which have settled those difficulties, we may hope to settle this. Let every one join in the effort, and bring selected

* Revolution des Meeres. Leipzig, 1843.

materials to the growing fabric; so that we may not erect a rude and barbarous cairn, the memorial of dead opinions, but construct a temple of well-fitted stones, in which we may worship with delight the God of Truth, and be followed in the same pleasing duty by many successors.

On some New Points in the Structure of Palæchinus. *By* W. Hellier Baily, *F.L.S., F.G.S.*

The genus *Palæchinus*—a fossil Echinoderm of great beauty, which is almost entirely confined to the Carboniferous epoch—includes several species, all the described forms of which occur in Ireland. On examining a fine series of these fossils, including the original figured specimens in the 'Synopsis of Carboniferous Fossils of Ireland,' for the purpose of comparison, in the collection of Sir Richard Griffith, Bart., the author was fortunate enough to find amongst them one belonging to the species (*P. elegans*) which was sufficiently perfect to enable him to trace out the arrangement of the plates composing the apical disk—an important part of the test or shell, which had not, he believed, hitherto been described. The great difference between these ancient Echini and those of more recent date, consists in the possession by the former of a much more numerous series of interambulacral plates, and a corresponding larger number of rows of holes, or poriferous zones; the genus *Palæchinus*, as far as at present known, having from four to seven columns of these interambulacral plates, whilst the Echini of the Secondary, Tertiary, and Recent periods are confined to two rows only. It became, therefore, a matter of interest as to whether the plates composing the apical disk would exhibit any change corresponding with that of the great increase in the number of the interambulacral plates. By the fortunate discovery of this specimen, it was found that in the *Palæchinus* the principal plates are the same in number and position, although differing somewhat in their proportions; there are therefore five genital, including one larger than the others, which appears to be the madreporiform plate, but which is imperfect, and five ocular plates; the latter being much larger than usual in more recent forms, and the genital shorter in proportion to their breadth; there are inner circles of ten sur-anal and a similar number of anal plates. The great peculiarity, and most remarkable difference between this part of the structure of *Palæchinus* and the recent Echinidæ, consists in the double perforation of the ocular and triple perforation of the genital plates. Another addition to the structure of this interesting Palæozoic Echinus, not hitherto published, is that of the spines, which the author had some time previously observed on a specimen of the same species (*P. elegans*), in the collection of the Geological Survey of Ireland, from the same locality, Hook Point, County of Wexford, a number of the minute spines still remaining attached to the plates, the principal tubercles on which are seen to be distinctly perforated, and surrounded by a circle of smaller tubercles. He found these spines to be a little less than the tenth of an inch in length, and, on examination with the microscope, are seen to be longitudinally situated.

On the Occurrence of Fish Remains in the Old Red Sandstone at Portishead, near Bristol. *By* W. Hellier Baily, *F.L.S., F.G.S.*

The author stated that, having had occasion to visit Portishead about two years previously, he was invited to examine the collection of fossils made by the Rev. B. Blenkiron, a gentleman resident in that neighbourhood, now curate of that parish. Amongst those shown to him were some slabs which had been collected from the shingle of the beach. Upon these he observed bones and scales of fish, some of which he was enabled to identify with characteristic Old Red Sandstone species. On examining the cliff, he was successful in obtaining, from the base of a conglomerate bed, an additional scale to one he had identified as *Holoptychius nobilissimus.* On a subsequent and recent visit, he made a more detailed examination, collecting other fish remains, of a similar character, associated with plants, from red flaggy beds, exposed on the shore between high and low water. He described the geology of the parish of Portishead as presenting many features of interest, independent of its other local attractions, such as beauty of scenery, &c. Portishead Point, to the north, consists of a steep ridge of carboniferous limestone, the beds dipping at a considerable angle, about 60° N.N.E.; some of them being very fossiliferous. The lower beds, which occasionally appear, for a short distance, along the north shore of Wood-hill Bay, are of a reddish tint, and sometimes full of crinoidal joints, accompanied by a few corals, *Michelinea*, &c. Beyond this the shore of the bay becomes flat for about a quarter of a mile, the beach being covered with shingle, principally derived from the Old Red Sandstone cliffs, from whence the fish remains were obtained. The beds forming the cliffs, consisting of deep red shales and sandstone, commence a little to the south-west of Beach Cottage, rising gradually, and continuing, with tolerable uniformity, for rather more than eleven chains; their greatest height being about 34 feet. The ground above this, at the commencement of Portishead Down, attains, however, more to the south, a considerable elevation, 364 feet being marked on the map as its highest part, near Down Farm. This tract of Old Red Sandstone extends along the coast, to the south-west, for about four miles, being occasionally exposed on the beach, and sometimes covered unconformably by a great conglomerate, composed of angular and partially rounded blocks of limestone, &c., imbedded in a yellow cementing paste (one of these blocks measuring nearly 6 feet in length). This irregular deposit was formerly called Dolomitic Conglomerate, but is now considered to be part of the New Red Sandstone series. Diagrams, showing horizontal and vertical sections of the cliff, were exhibited, measurements of the principal beds having been taken at each chain for that purpose. The series of deposits were described as consisting of alternations of deep red, micaceous, flaggy beds, and shales varying in thickness, with thick-bedded compact red and yellow sandstones and quartzose conglomerates, the general dip being about 20° south. The fish remains alluded to in this communication, of which enlarged drawings were exhibited, were found both in the conglomerate and the micaceous flags; they consisted of scales of *Holoptychius nobilissimus* and *Glyptolepis elegans*, with detached bones, and a fragment of scale having an external ornamentation like that of *Bothriolepis* or *Asterolepis*; together with what appeared to be fin-rays of a fish like *Glyptolepis* or *Platygnathus*, in a yellowish sandstone.

On the South Wales Mineral Basin. By A. BASSETT.

On the Foraminifera of the Middle and Upper Lias of Somersetshire. By HENRY B. BRADY, *F.L.S.*

This paper was presented to the Section as a sort of supplement to Mr. Charles Moore's paper on the geology of the district. After enumerating the few scattered memoirs which form the scanty literature of the subject, the author gave a brief outline of the great Nodosarian group, to which almost all the Rhizopods of the Upper and Middle Lias belong, particularizing some of the more important forms which occur in the district. Passing allusion was also made to the so-called Nummulite of the Lias, and this organism was assigned to a much lower type (*Involutina*) than the true Nummulites. The author stated that he was at present engaged upon the Liassic Foraminifera generally, and exhibited a series of drawings, made from specimens in Mr. C. Moore's collection, of the species occurring in the upper and middle portion of the series.

On the Rhætic (or Penarth) Beds of the Neighbourhood of Bristol and the South-West of England. By HENRY W. BRISTOW, *F.R.S., F.G.S., of the Geological Survey of Great Britain. Communicated by* Sir RODERICK I. MURCHISON, *K.C.B., D.C.L., LL.D., F.R.S.*

In this paper the author stated that, having received orders from the Directors of the Geological Survey to ascertain whether the Rhætic beds were sufficiently developed in this country to be represented by a distinct colour on the one-inch maps, he visited several localities in the spring of the present year, and made detailed sections of the various beds at Saltford, Pyle Hill, and Uphill near Bristol; Aust and Garden Cliff on the banks of the Severn; Combe Hill near Cheltenham; Watchett in Somersetshire, and Penarth near Cardiff—in all which places, in addition to the strata being carefully measured bed by bed, the fossils were also identified and noted on the spot by Mr. Etheridge, the Palæontologist to the Geological Survey. The Rhætic beds, although not always exposed, or at times only imperfectly visible, after careful searching, were found to be of invariable occurrence over the entire area examined, between the Red Marls of the Keuper and the base of the Lias; and they were mapped by Mr. Bristow during the present summer, in the country round Bristol, as well as at Penarth and other places in the West of England.

The general section of the Rhætic beds was described as consisting of a central mass of black, thinly laminated shales (weathering into paper-shale), with thin occasional bands of hard and tough, blue-grey, coarsely-fissile limestone, very unlike those of the Lias in appearance, and containing great numbers of a highly characteristic shell (*Pecten valoniensis*), as also do the shales of the other eminently distinctive shells, *Avicula contorta*, *Cardium rhæticum*, &c.

At Aust, Patchway, and other places north of Bristol, and likewise at Penarth, a thin layer of sandstone is met with near the base of those black shales, which is often very pyritiferous, of a brecciated structure, and frequently crowded with bones, teeth, coprolites, and other remains of fishes, to which the name of "Aust Bone-bed" has been given by collectors, in consequence of its well-known occurrence in the cliffs of the locality in question.

The central mass of black shales rests upon a series of hard and soft greenish marls, which pass by an almost insensible downward passage into the red and variegated marls of the Keuper, so that it is scarcely possible to adopt any other line of demarcation on a map than the top of the great mass of the red beds of the latter series.

The uppermost division of the Rhætic beds, lying at the base of the Lias, consists of beds of marl and marly (argillaceous) limestone, composed in the upper part of beds of cream-coloured or nearly white argillaceous limestone, breaking with a smooth conchoidal fracture, and with sharp-cutting splintery edges (and closely resembling in appearance the lithographic limestone of Solenhofen), to which the name of "White Lias" is given by certain quarrymen in the West of England.

The curious stone called Cotham Marble, to which the name "Landscape Stone' has been given on account of the fanciful resemblance which the darker delineations shown on its fractured surface bear to a landscape, with trees, water, &c., is of almost invariable occurrence at the base of the White Lias series, and was found of much use in indicating the position of the upper boundary of the Rhætic beds, especially when (as is the case over a large part of the area north of Bristol and elsewhere) the "White Lias" beds of the quarrymen are altogether wanting, or only very attenuated and imperfectly represented.

Although the passage from the lowermost Rhætic beds into the Keuper Marls is very gradual, there are clear indications of a pause or break in the deposition of the beds forming the two overlying subdivisions, in the signs of erosion sometimes shown in the upper surfaces of the hard bands of limestones containing *Pecten valoniensis*, and commonly in that of the Cotham marble. The proofs are still stronger in the beds of "White Lias," which not only afford unmistakeable evidence of having suffered erosion since their deposition and prior to that of the superimposed Lias, but also of having been penetrated by boring mollusca, the cavities made by which are in many cases still remaining.

The palæontological evidence on this point tends equally to show that there is nothing in common between the fossils of the uppermost Rhætic beds and those of the overlying liassic strata; the former consisting of *Modiola minima*, *Pullastra arenicola*, *Axinus*, &c., the latter of *Ammonites planorbis*, at Watchett, and at Penarth of that shell together with immense numbers of *Ostrea liassica* in a remarkable state of preservation.

In conclusion, Mr. Bristow stated that, it being desirable that the Rhætic beds of this country should be distinguished in the maps of the Geological Survey by a synonym derived from a British locality where these beds are well displayed and fully developed, he was induced, at the suggestion of the Director-General Sir Roderick Murchison, to propose Penarth as a good typical name, in preference to many others which had been recommended, but which were for several reasons objectionable.

The term Penarth, to which no such objections would apply, is, besides, particularly appropriate, inasmuch as the beds in question are clearly exposed in the sea-cliffs of that and the adjacent headlands in a southerly direction, where (as well as in the railway-cuttings in connexion with the large and important docks now in course of construction) they are seen to attain a thickness of nearly 100 feet, resting upon the red marls of the Keuper, and capped by the lower lias, in which the fossils are altogether different.

Remarks on two outliers of Lias in South Warwickshire, and on the presence of the Rhætic Bone-bed at Knowle, its furthest northern extension hitherto recognized in that County. By the Rev. P. B. Brodie, *M.A., F.G.S.*

The Liassic outlier at Knowle was first described, and was shown to be of limited extent, and to consist of limestones and shales belonging to the zone of *Ammonites planorbis*, and equivalent to the Saurian beds, as seen at Brockeridge Common, near Tewkesbury. Lower beds, however, crop out near the canal, where dark laminated shales may be observed resting upon the Red Marl, and amongst them fragments of a yellow micaceous sandstone containing *Pullastra arenicola*, a shell which always occurs low down in the series, in close connexion with the bone-bed, and seems to have a very limited range. The section is very obscure, so that it was impossible to say whether any true bone-bed actually existed *in situ*; but the position of the dark shales, and the presence of a band of sandstone always associated with it, marks the existence of the Rhætic series at this spot, and not hitherto observed there. The larger outlier at Wootton Park was described, where similar beds may be traced, from the *Pecten-valoniensis* bed up to the *Lima* beds, with the usual characteristic fossils, including *Estheria* and *Naiadita* in the *Estheria* bed. Elsewhere insect limestone was observed unusually rich in wings and elytra of insects. This outlier is traversed by a line of fault running from N.W. to S.E. These two remnants of the Lias are the extreme limit of that formation in Warwickshire in a northerly direction, and no trace of it appears again nearer than the outlier in North Staffordshire, where Mr. Howell, of the Geological Survey, detected the yellow sandstone and black Rhætic shales above referred to, which seems to be their extreme northern limit.

On the Formation and Condition of the Ice in certain Ice Caves of the Jura, Vosgian Jura, Dauphiné, and Savoy. By the Rev. C. F. Browne.

On the Connexion between the Crag Formations and the recent North Pacific Faunas. By Philip P. Carpenter, *B.A., Ph.D.*

The object of this paper was to draw the attention of geologists to the evidence of ancient British species now living in the North Pacific. Many of these are sub-boreal, and may have travelled through Behring's Straits. Others belong to a warmer type, and seem to indicate a previous connexion between the two oceans through the Asiatic continent. Others have died out in the Atlantic, but reappear in Vancouver and California. The list of species will be found in Reports, 1863, pp. 682, 683.

On the Geological Formation of the District around Kingswood Hill, with especial reference to the supposed development of Millstone Grit in that neighbourhood. By Handel Cossham.

On the Cause of the Extrication of Carbonic Acid from the Interior of the Earth, and on its Chemical Action upon the Constituents of Felspathic Rocks. By Dr. Daubeny, *F.R.S., F.G.S.*

The author made some comments upon a theory advanced by Prof. Bischoff, of Bonn, in his work entitled "Elements of Chemical and Physical Geology," in which the elevation and dislocation of certain rocks were attributed to the decomposition of felspar, through the agency of the carbonic acid disengaged from the interior of the earth, seeing that the products of the decomposition of granite are found to possess a lower specific gravity, and therefore occupy more space, than the original materials of the rock. Such a change would, doubtless, occur in granite and trap, if acted upon by carbonic acid at temperatures below 212°; but above that point the very opposite would be observed, inasmuch as the silicic would then take the place of the carbonic acid, and consequently, if brought into contact with earthy or alkaline carbonates in the interior of the earth, would produce silicates and expel carbonic acid, as, indeed, was long ago pointed out by the author of this paper in his work on Volcanos, and is insisted upon by Prof. Bischoff himself in other parts of his volume. It seems difficult, therefore, to attach much importance to the cause assigned by Prof. Bischoff for the elevation of strata, especially considering that the loss of substance incurred by the rock, through the removal of its alkali by the agency of carbonic acid, would go far towards counterbalancing any expansion due to the lower specific gravity of the kaolin resulting, and moreover recollecting that no theory which professes to account for the elevation of certain portions of the earth's surface ought to be accepted if it does not embrace likewise the corresponding phenomenon of the sinking or depression of others.

On the Newer Pliocene Fauna of the Caverns and River-Deposits of Somersetshire. By W. Boyd Dawkins, *B.A., F.G.S.*

The author described the remains of the following newer Pliocene Mammalia, from the caverns of Banwell, Bleadon, Uphill, Sandford Hill, Hutton, Wookey Hole, Dudham Down, and Burrington; and from the river-deposits of the Tone, the Parrett, and the Avon.

Felis spelæa.
—— antiqua.
—— catus.
Hyæna spelæa.
  Var. α. H. intermedia (M. de Serres).
  Var. β. H. Perrieri (Croizet and Jobert).
Mustela martes.
Ursus spelæus.
—— arctos.
Meles taxus.
Canis lupus.
—— vulpes.
Arvicola amphibia.
—— pratensis.
—— agrestis.
Lepus timidus.
—— cuniculus.
Spermophilus.
Bos primigenius.
Bison priscus.
—— minor.
Megaceros hibernicus.
Cervus elaphus.
—— tarandus.
  Var. α. C. Guettardi.
  Var. β. C. Bucklandi.
—— capreolus.
Ovibos moschatus.
Rhinoceros tichorhinus.
—— hemitæchus.
Equus.
Elephas antiquus.
—— primigenius.
Hippopotamus major.
Sus scrofa.

On Fossil and Human Remains of the Gibraltar Cave. By Dr. Falconer.

On the Lower Silurian Rocks of the South-East of Cumberland and the North-East of Westmoreland. By Professor Harkness, *F.R.S., F.G.S.*

The district to which this communication has reference is an area in Cumberland and Westmoreland, about 15 miles in a N.N.W. and S.S.E. direction, along the western margin of the Pennine escarpment. Its breadth does not exceed 1½ mile, and in one locality it becomes a very narrow band. Its eastern boundary consists of the upper Old Red Sandstone and the succeeding carboniferous rocks—rocks of the same age also, in part, form its western border; but the south-west portion of the district has, as a margin, the upper Permian sandstones, from which the Lower Silurian rocks are separated by the great Pennine Fault.

The contour of the Lower Silurian rocks of the S.E. of Cumberland and the N.E. of Westmoreland is widely different from that of the strata which border them.

This consists of a series of conical hills, the outline of which is well marked in the Pikes of Knock, Dufton, and Murton. The rocks which make up the Lower Silurians in this portion of the North of England consist of sedimentary strata having the mineral nature and fossils of the Skiddaw slate series of the Lake country; and of these there are several anticlinal axes exposed. To the Skiddaw slates succeed greenstones, porphyries, and ash-beds, of great thickness; and these are the equivalents of rocks of the same nature which, in the Lake district, overlie the Skiddaw slates.

In the upper portion of this series, in the neighbourhood of Dufton, there is a considerable development of dark-coloured flaggy slates, and these abound in fossils; the most abundant being *Trinucleus concentricus, Calymene Blumenbachii, Beyrichia strangulata, Leptæna sericea,* and *Stenopora fibrosa.* These fossiliferous flaggy slates are succeeded by porphyries and ash-beds having upon them a limestone, which is worked near Keisley.

The mineral nature of this limestone shows it to possess a great affinity to the Bala limestone, or its northern equivalent, the Coniston limestone; and it is also very nearly allied to the Irish type of this series—that of the Chair of Kildare. Fossils are seen abundantly in this limestone of Keisley after it has weathered, and these fossils, of which about twenty-eight species occur, still further connect the Keisley limestone with the Bala or Coniston portion of the Caradoc group.

Immediately south of Keisley, a great fault brings the Skiddaw slates in contact with the representative of the Bala limestone. This fault, which has a downthrow towards the N.N.W., must be at least 10,000 feet in extent, as no portion of the greenstones, porphyries, ash-beds, or the intercalated fossiliferous flaggy shales which intervene between the Skiddaw slates and the Keisley limestone, is here seen.

The Skiddaw slates brought in by this fault, on its S.S.E. side, form the Lower Silurian area south of Keisley; and in this portion of the district the dip of the strata is entirely reversed, being N.N.W.

This Skiddaw slate, south of Keisley, forms Murton Pike, the highest of the conical hills in the area under consideration.

Besides the great fault, which brings in contact the Keisley limestone and the Skiddaw slates, and which is of an ancient date, as it does not affect the Old Red Sandstones or carboniferous strata under which it passes eastwards, there is another fault of a newer age having a N.N.W. and S.S.E. course, or being parallel to the great Pennine Fault. This latter fault has cut through the carboniferous rocks and their supporting Old Red Sandstones; and on the west of the Pennine chain, bordering the more northern portion of the Lower Silurian rocks, we have a detached area of Old Red Sandstones and the succeeding carboniferous series, the result of this fault, lying on its west side, and separated from the great mass of the rocks of the Pennine chain by subsequent denudation.

A Notice of the latest labours of the Imperial Geological Institute of the Austrian Empire. By F. von Hauer.

On the Geology of the Province of Otago, New Zealand. By Dr. James Hector, *F.G.S.*

In a letter to Sir R. Murchison, with maps, sections, and photographs of fossils, Dr. Hector briefly described the geology of the Province of Otago.

On the west rise mountains of metamorphic rock, cut into by fiords at the coast, and furrowed by long deep lakes on their eastern ranges. The base rocks are foliated and twisted gneiss, granite, syenite, and diorite; and are flanked by hornblendic slates, micaceous and hornblendic gneiss, clay-slate and quartzite, with felstone-dikes, serpentine, and marble which support sandstones, shales and porphyritic conglomerates possibly of Lower Mesozoic age. Further to the east, beyond a great valley, grey and blue gold-bearing schists form a wide flattened boss, and are seen to throw off the hornblendic slates and sandstones to the west, and to the east. These old slaty rocks, often micaceous, quartzose, or chloritic, were described, in some detail, as forming a triple series; they bear ancient lake-deposits with brown-coal, and the great gold-drift, as shown by special maps and sections. East of the schistose country are—(1) inclined sandstones, with estuarine shells, and excellent brown-coal; (2) marine clays, with septaria; and (3) the white 'crag.' Some marine beds, possibly contemporaneous, also occur near the coast. The carbonaceous beds may possibly be Upper Mesozoic, the others are Tertiary. There are also extensive alluvial deposits. Volcanic rocks occur at Otago Harbour, and elsewhere near the eastern coast, and are of late Tertiary age. The author thinks that the country was higher, and glacial action greater, in Post-tertiary times than now, but that no great or general submergence has taken place since.

On the Possible Conditions of Geological Climate.
By Professor HENNESSY, *F.R.S., M.R.I.A.*

It appeared to the author that we have now attained to a sufficiently complete knowledge of the causes which affect the earth's existing climate to attempt the investigation of the climatic condition of different geological epochs, with a view of arriving at results capable of being verified by the facts accumulated by geological observers. The principal active conditions upon which climate depends are (1) the temperature of space and the influence of stellar irradiation; (2) the sun's intensity and the earth's position in its orbit; (3) the amount of heat gained by the superficial parts of the earth from its interior. The secondary conditions of climate are the absorbing, radiating, and conducting powers of the matter composing the earth's exterior coating, as well as the state of consistence in the solid or fluid form of the several parts of this coating. The author referred to the possible variations of the first primary source of heat as suggested by Poisson—namely, that the temperature of space may be variable, and thus that the earth, moving with the sun and the rest of our system, might be alternately warmed and cooled by passing, after the lapse of ages, through regions of space with very different thermal conditions. He had already criticized this speculation at the Meeting of the Association in Manchester in 1861, when it had been referred to as a possible agent of geological change by Professor W. Thomson. The author pointed out that no evidence could be presented of variations of temperature in space, except those which may result from varying radiation. If the stars are heat-giving as well as luminous, they radiate heat to surrounding bodies inversely as the squares of their distances. The correspondence between this law and the law of gravitation would lead to the inference that our sun could not approach so close to another star as to influence terrestrial climate to the large extent required by many geological phenomena without producing a permanent connexion between the two suns, so that the double system would become, in fact, a double star. This objection could not be met, and it has been since reproduced by a recent writer in the pages of one of our scientific periodicals. The researches of chemists and physicists into the physical constitution of the sun present grounds for believing that the sun's intensity may possibly be a variable quantity. The ingenious speculation of Mayer, by which the sun's heat is attempted to be explained on thermodynamical principles, deserves notice, because it has been appealed to in order to furnish some presumption of past variations in solar intensity. The sun, according to this theory, is fed, and has been nourished for ages, by myriads of aërolites, such as we know to exist in space. It has been shown that the fall of a single aërolite on the sun would produce by its percussion a calorific effect so enormous that we may readily admit the efficiency of the cause, provided the asteroids are supplied to the sun in large quantities. But how does this theory, if true, tend to explain the past conditions of terrestrial temperature? The sun, on this hypothesis, draws to it, by the attraction of its overpowering mass, multitudes of those small planetary bodies which fall in smaller quantities upon the earth. The sun's mass, volume, and surface have, therefore, probably been on the increase since very remote epochs. The dynamical heat-producing energy of the sun, as well as its heat-radiating surface, would follow a corresponding law of increase. Thus it would seem to follow that the sun's intensity should, upon the whole, be greater at recent than at remote geological epochs. The growing mass of the sun would also slightly tend to shorten the earth's mean distance, and therefore to add to its temperature. Such results do not agree with the general mass of facts presented by geological inquiries, and we have, moreover, no geological evidence of the past existence of considerable groups of fossil aërolites. Had such bodies fallen upon the sun during its passage through space in much greater quantities formerly than now, we should expect to find some corresponding accumulations in the stratified deposits which form the outer crust of the sun's satellite, our earth; and their apparent absence shows that it is scarcely safe to use Mayer's theory for explaining such climatic changes as those under consideration. The varying position of the earth in its orbit around the sun was then referred to; and the author concludes that, in the present state of the question, our only reliable evidence is negative, or, in other words, the variations in the earth's position in its orbit are not proved to be sufficient to account for great changes in its climate. The author referred briefly to the proofs of the stability of the axis of rotation of the earth as eliminating a possible cause of changes of climate, and to the communications he published on the subject in the Proceedings of the Royal Society for 1852, and in the 'Athenæum' for September 1860. On the last occasion the same subject was treated by the Astronomer Royal, and with precisely the same results as those previously established by the author. The modes of accounting for the observed increase of heat in approaching the earth's interior imply a different order of increase or decrease of its influence during former geological epochs. The hypothesis of an incandescent nucleus of fused matter contained in a shell which had solidified from the fluid has been objected to on various grounds. These objections, when fully examined, tend to confirm the probable truth of the hypothesis. Thus, in 1857, Mr. Hopkins communicated to the Association an account of his experiments on the conductive powers of different rocks. He also compared the conductivities so found with the rate of increase of temperature in descending mines excavated out of rocks such as had been made the subject of experiment. It seemed to follow that no connexion was traceable between the increase of interior temperature and the conducting-power of different parts of the earth's crust. The conclusion was hence drawn that the supposition of a cooling central mass of matter in the earth was inconsistent with observation. The author now ventures to reproduce the remarks he then made on Mr. Hopkins's communication, as these remarks have never hitherto appeared in a printed form.

The author described the discontinuous and broken structure of the greater part of the rock-formations constituting the earth's crust. The propagation of heat throughout such a mass could not follow the same simple laws as in a continuous unbroken homogeneous solid. He showed that the rate of transmission of heat would be much slower than even the extremely slow rate assigned by mathematical analysis to a continuous mass. The amount of heat passing outwardly to the earth's surface through the dry rocks and soil would thus be generally so small as to possess no geological importance. By studying the actual conditions of the interior rocky masses rendered accessible by mines, we shall arrive at more valuable and trustworthy conclusions relative to terrestrial heat. The mines from which most of our facts regarding interior temperature have been collected are provided with extensive hydraulic apparatus for draining off the rapidly accumulating water. Many of our facts have been deduced from observing the temperature of artesian wells bored through water-bearing strata. Thermal springs, like those of Bath, would undoubtedly arise wherever we could bore downwards to similar depths. The constant percolation of superficial moisture tends to saturate the joints and fissures among the lower rocky beds as well as the more porous and permeable overlying strata. In limited masses of liquid, heat is propagated upwards, not by conduction, but by the far more energetic process of convection; and thus, while each piece of rock is bathed by water, it acquires a different temperature from what it would possess under the imaginary conditions of continuity and dryness. We should thus be led to expect no kind of definite connexion between the rate of increase of temperature and the conducting properties of the dry stone, although we might fairly expect to trace such a connexion between the permeability of rocks to moisture and the distribution of temperature in borings made through great depths. A consequence of primary geological importance appears to the author to be deducible from these considerations. The consequence alluded to is deduced from the probable past condition of the earth's crust, as inferred not only from the hypothesis of its consolidation from a fused nucleus, but from the accumulated facts of recent inquiries into the chemical and physical structure of rocks. The former condition of the solid shell should have been highly favourable to interchanges of heat between the earth's watery coating and its interior, while chemical geology seems to establish that multitudes of mineral products, previously supposed to be the results of dry fusion and solidification, have been really formed under conditions where both heat and water were abundantly present. Metamorphic actions especially, as alluded to by Sir Charles Lyell, have been shown to have been produced on a vast scale by the infiltration of water. The influence which water may have thus exercised as a heat-carrier is declared by Professor Hennessy to have been so great, that the effects of conduction through the crust considered as a dry solid may be regarded as comparatively insignificant. The author further considers how his views regarding hydrothermal action in the earth's crust would accelerate the cooling of the supposed interior source of heat, and he comes to the conclusion that this would take place much more rapidly than we have been hitherto led to believe from the calculations of mathematicians who considered only the unreal case of a dry continuous solid. He also points out that hydrothermal action, unlike mere conduction, might be intermittent in its energy, while the efforts of the latter must diminish continuously.

The remainder of the paper is occupied with a discussion of the relative influences of air, earth, and water on the reception, retention, and distribution of heat coming from exterior and interior sources. The author adduces further proofs of the conclusions to which he was led in his essay on the influence of the distribution of land and water on terrestrial temperature during different geological epochs, of which an outline had been communicated to the Association in 1856, although the paper itself did not appear in a complete form until three years subsequently*. One of these conclusions was subsequently adopted by Professor Phillips, and this is now further extended by the author. It appears to him that the distribution of land and water most favourable, upon the whole, to a general augmentation of terrestrial temperature arising from all possible primary sources, is that of a water-covered spheroid, with numerous small islands scattered over its surface. The physical conditions originating a low temperature are also examined, and finally the circumstances most favourable to the presence, at the same epoch of time, of opposite, contiguous, and simultaneous climatic conditions. Among other questions, the influence of dry and moist thermal currents of air upon snow and ice was discussed from considerations depending on the capacity of air and vapour for heat. From these considerations it follows that, while cold moist air favours the formation of snow and glaciers, warm moist air is highly favourable to their destruction compared with dry air at the same temperature.

The author has thus been led to adopt views as to the possible formation and development of glaciers at former epochs apparently in harmony with some of the conclusions of Charpentier, Tyndall, and Frankland. It seems to follow from the views developed by the author that epochs characterized by the simultaneous coexistence of very different climatic conditions over different regions would depend upon variations in the distribution of land and water, combined with obstructions of the hydrothermal agency, whereby the surface of the earth receives heat from its interior. Geological observation seems to point out that such conditions would be most likely to arise during the later and prehistoric formations, as well as during the period of the physical history of the planet which now witnesses the development of our own race.

Note on some of the Oolitic Strata seen at Dundry. *By* M. Hébert.

On Otolites. *By* E. S. Higgins.

On the Origin of certain Rocks, and on the Ossiferous Caverns of the South of Devonshire. *By* H. C. Hodge.

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* See Atlantis, January 1859; and Phil. Mag. vol. xvii. S. 4. p. 181.

Notice of some Geological Appearances in the North-west of Morocco.
By Dr. T. Hodgkin.

On the Coal-measures of New South Wales with Spirifer, Glossopteris, *and* Lepidodendron. *By* William Keene, *Examiner of Coal-fields and Keeper of Mining Records, New South Wales.*

A geological map of the country, as far as examined by the author, and a generalized section, illustrated this paper, which referred, first, to the existence of Belemnites (indicating Secondary rocks) near the River Belliando in Queensland; 2nd, the siliceous fern-shales, with dicotyledonous leaves, from the southern part of New South Wales, which the author thinks to be older than the Coal-measures; 3rd, the false Coal-measures, or Wyanamatta shales, in the upper part of the Sydney Sandstone; 4th, the existence of eleven workable seams of coal in the true Coal-measures of New South Wales, and the occurrence of *Vertebraria* and *Glossopteris* throughout the entire series. *Pachydomus* and *Bellerophon* (abundant) and *Spirifer* (rare) are found towards the lowest seams; and here, as well as lower down, *Spirifer*, *Fenestella*, and *Orthoceras* abound. A Heterocercal fish has also been found in the shale above the 'yard seam.' Siliceous grits underneath the lowest seam contain *Lepidodendron* (*Pachyphlœus*). 5th. The author alluded to the volcanic phenomena of the Peale Ranges, which have been upheaved since the Coal-period; indeed in some of the lavas Mr. Keene found a freshwater mussel of a probably existing species. 6th. Referring to the auriferous quartz-rocks, shales, and fossiliferous limestones, on which the Coal-measures lie unconformably, the author stated that he believed these older rocks were mutually connected, and belonged to one and the same system of strata; and that, besides gold, the quartz was rich with copper- and iron-ores. An illustrative series of specimens accompanied the paper; and the author referred to a still finer collection deposited in the Bath Museum in 1862.

On the Species of the Genus Pteraspis. *By* E. R. Lankester.

In this paper the author first reviewed the present state of our knowledge of those remarkable fossils of the Old Red Sandstone, the *Cephalaspis* and *Pteraspis*, which he stated was in a very unsatisfactory condition. *Cephalaspis* had been taken in hand by Sir Philip Egerton, but *Pteraspis* was in a state of complete confusion. His friend Prof. Huxley had intended to work at the latter genus, and had made drawings and notes for the purpose, but had finally relinquished his intention, and handed his material very kindly to the author. From this and other material at his disposal, the author was enabled to establish three genera, *Pteraspis*, *Cyathaspis*, *Scaphaspis*, in place of the one *Pteraspis*. In the first, the shield consists of seven separable pieces; it includes *Pt. rostratus*, Ag., *Pt. Crouchii*, Salter. In the second genus, *Cyathaspis*, the head-plate is separable into four pieces only; it contains *Cyathaspis Banksii*, and a new species, *Cy. Symondsii*. The last genus is characterized by the shield being composed of one simple, oval, indivisible plate. *Scaphaspis* includes *Sc. Lloydii*, *Sc. Lewisii*, *Sc. truncatus*, and *Sc. ludensis*.

On the Boulder-clay and Drift of Scarborough and East Yorkshire.
By John Leckenby, *F.G.S.*

The post-tertiary beds in the north-east of Yorkshire exhibit distinct traces of glacial action. At Scarborough they attain a thickness of rather more than 200 feet. The fossils collected in the boulder-clay at that place by the author, and in the same material at Whitby, by Mr. Jeffreys, represented thirteen species. All of them are marine; they inhabit high latitudes, and (with two exceptions, viz. *Astarte borealis* and *Tellina calcaria*) also the British seas. *Mya truncata* var. *uddevallensis* is also extinct as a variety in our seas.

On Organic Remains in Laurentian Rocks in Canada.
By Sir W. Logan, Dr. Dawson, *and* Dr. Sterry Hunt.

On the New South Wales Coal Field. *By* J. Mackenzie.

On the Geology of the South-West of England. *By* C. Moore, *F.G.S.*

The author pointed out certain physical features which led him to the conclusion that the Mendip Hills had performed an important part in modifying the physical geology of the West of England, and that it was probable that that range of hills had proved a barrier to the incursion of the Secondary seas which washed their southern slopes. He then observed that, whilst the Secondary rocks outside the coal-basin were generally deposited conformably, those on the outer edge, and within the Somersetshire coal-basin, afforded evidences of general unconformability, and were found under very abnormal conditions, his view being that the Mendips were at times only so far depressed as to admit of occasional irruptions of the sea within the coal-basin, the thick deposits of the New Red Sandstone and the Rhætic and Liassic seas being very thinly represented therein. The Rhætic beds were proposed by Mr. Moore for a group of rocks intermediate between the Lias and the Trias. Though thinly represented in this country as compared with the Continental beds, they were shown to be of great interest in a palæontological point of view. Mr. Moore described the contents of three cartloads of deposit of this age he had found washed into a fissure of carboniferous limestone near Frome. From this he exhibited twenty-nine teeth of the oldest mammals, three only having been previously found—together with nine genera of reptiles, most of them new to this country, and fifteen genera of fishes. Mr. Moore produced to the Meeting 70,000 teeth of the *Lophodus* alone as the result of his labour, and stated that the three loads of clay had probably yielded him one million specimens. He then referred to the ironstone of the Middle Lias in the North of England, and remarked that one landed proprietor alone possessed there a quantity which, it had been calculated, when converted into iron and sold at the present price of iron, would bring in money enough to pay off the national debt. The same beds, he remarked, occurred around Bath and in the West of England; but, from their not containing quite so much iron, and from their being thinner, the fair city of the West would be spared the mortification of finding blast furnaces springing up around. Passing to the Upper Lias, the author described a very remarkable bed containing insects, fruits, crustacea, fishes, and reptilia. In doing this he produced a number of nodular stones, and was enabled to say that one contained the tail of a *Pachycormus*, that a second contained a head of the same fish, a third a perfect fish, whilst another held in its stony embrace a cuttle-fish, which it was prophesied would contain the cuttle-bone and ink-bag. Mr. Moore proceeded to open them, when the fish he had previously indicated was discovered; and the most interesting specimen was that which contained the cuttle-fish. When Mr. Moore broke open the stone, not only was the cuttle-fish visible, but the inky fluid (the sepia) was discovered, as in a fish of the same kind that might be taken out of the sea at the present day. There was as much of it as would fill an ordinary-sized ink-bottle. He then produced some very perfect specimens of the Ichthyosauri found in the neighbourhood of Bath, and a specimen of a fish, about the size of a salmon, of six or seven pounds weight. It was so perfect in its form and appearance and shape that, but for its colour, as Mr. Moore said, it might be handed by mistake to the cook to dress; and yet millions and millions of years must have elapsed since this fish lived and moved about in the water. In the mammal drift, which entirely surrounded Bath, the remains of extinct mammalia were abundant, and Mr. Moore exhibited many specimens.

Note on the Occurrence of the same Fossil Plants in the Permian Rocks of Westmoreland and Durham. *By* Sir R. I. Murchison, *K.C.B., D.C.L., LL.D., F.R.S.*

Traces of Glacial Drift in the Shetland Islands. *By* C. W. Peach.

Having last summer accepted the kind invitation of Mr. J. Gwyn Jeffreys to be his guest on a dredging expedition to these northern isles, I was induced, by a request from Sir R. I. Murchison, to look out for traces of glacial action there. The result of my observations I have thought right to lay before the British Association, apologizing for the meagre story I have to tell. This poverty arises partly from my resolve to devote all the time possible to zoological work, and partly from the very small portion of the islands visited. Our first landing was at Lerwick, where little time was spent, either then or when returning. In a short walk that I took in the immediate vicinity of the town, at the Bay of Sclate, I found the sandstone on the top of the cliff deeply rutted, striated, and polished; and a little inland, on the side of the famed Loch of Clickamin, similar markings. These markings are again to be seen on the opposite side of this bay. The ruts, &c. are all in a north and south direction, with slight deviations to the east and west. The direction the drift came from is evidently northerly, and may be traced up the valley, as shown by the wide-spread ruin and large blocks scattered all over it, resting on striated and polished rocks. The hills on each side of this valley and those at the head beyond the docks bear unmistakeable evidence also of grinding and polishing. After leaving Lerwick the Out-Skerries of Whalsey became our home. The three small islands forming this group lie far out in the sea; they are called Gruna, Bruray, and Housay. There is an excellent harbour here, having two good entrances for vessels and boats, and a third into which boats can run when the tide answers. These entrances are triradiate, the harbour being in the centre, sheltered by the three islands from every wind. They have been the scene of great grinding, all being more or less rounded,—*roches-moutonnées* form of knolls being abundant,—whether composed of granite, gneiss, quartz, or limestone, all these being intermingled throughout the group. Although much corroded by atmospheric action, and the limestone much more acted on by sea-water, the rounding can be everywhere seen. By these agents the ruts, striæ, &c. are thus generally obliterated, and they are also further obscured by an overgrowth of lichen. I was fortunate enough to find a recently-bared rock near the Mill Cove on the island of Housay, from which I further removed the drift and washed the stone, and here *ruts, striæ,* and *polishing* could be as plainly seen as if just done. I also found on the highest part of this island, on a gneiss rock, some deep *ruts* and *scratches,* which, with those at the Mill Cove, ran nearly E. and W., this being the direction of the channel of the two principal entrances to the harbour which separates Gruna from Bruray. The cliff on the north side of the Mill Cove of Housay is about 200 feet high; the sea breaks on the top of it in heavy gales, and tears up the rock, and also throws up material from the deep. So great is the force, that large blocks are driven far back, a considerable distance from the edge of the cliff, into a semicircular-like wall. Between this wall and the cliff a deep river-like gully is scooped out, down which the water rushes again to the sea, at a great distance from the spot whence it was thrown up. The water left in depressions in this gully is brackish, and in it *Enteromorpha* grows. Mr. Jeffreys and myself gathered portions of limpets, mussels, periwinkles, rock whelks, and other sea shells, amongst the sand and gravel, both in and on the edge of this gully. The whole of the top of this cliff (much of it is now beyond the influence of the seas of the present day) is also strewn with proofs of similar action, some of the stones hanging in ridges on the rounded sides of the hill. All these loose blocks and stones rest on rounded knolls and polished rock—all so polished before the burthen they now bear was thrown on them. Although I know of many grand instances of such recent ruin both in Caithness and Orkney, this far exceeds them all. Every season the terrific seas which break on the whole of these islands, leave traces of their power of the most astonishing kind. As well as the markings on the rocks, I met with several deposits of drifted matter, in which rounded, striated, and smoothed stones were not uncommon. Some of these deposits were from 12 to 14 feet in depth. Perched blocks, but not in abundance, some of large size, were scattered over the whole group. Our next move was to North Unst, Baltasound being our headquarters. Here too the effect of glacial action was plainly to be seen. The serpentine rock had suffered seriously, and although much acted on by weather, the rounded outline of the hills and knolls tells clearly of the grinding they had been subjected to. *Ruts* and *striæ* are also rare here. They, however, fell under my notice on the cliff at Hagdale in Haroldswick Bay, on a recently bared rock underlying a thick deposit of drift, in which rounded and striated stones and blocks were plentiful. The whole of the rubbed serpentine enclosed in the drift shows small pieces of chromate of iron standing up beyond the matrix, proving that this mineral is very generally diffused throughout the whole of the serpentine of Unst. The direction of the *ruts*, &c. is nearly W.N.W. and E.S.E. The hills of the Muckle and Little Heogs lie to the north of this spot (Hagdale), and a slope, from about 20 feet above the level of the sea, rises gradually hence to the top of the Muckle Heog to the height of at least 500 feet. In this slope lies the famed chromate-of-iron mine. On reaching the top of this hill I found the W.N.W. end vertical and polished to the depth of at least 150 feet. The hill to the north of this slopes towards it. This *storm side* had evidently resisted a portion of the destroying force, and turned it on its western flank, and thus it swept down the valley towards Haroldswick Bay, evidenced by the greater destruction there than on the eastern side towards Baltasound. This is a fine instance of crag and tail, the north end of the Muckle Heog being the crag, the south with the Little Heog forming the tail. The scene from the top of the Muckle Heog, when looking towards Haroldswick, and then in the direction of Burrafiord, is one that tells of mighty agency long continued, powerful to crush and grind—so powerful that the really hard and massive hills of serpentine have been ploughed down and removed to below the sea-level in places near Haroldswick, the sea having since piled up a beach on these spots, through which the water percolates from the low peaty soil formed at the back at each recession of the tide. All over Unst the rocks show traces of abrasion, and in many places deposits of drift, enclosing stones of all sizes, some of which are rounded and striated. I mention a few of these spots where I got drift, so that any one desirous may see them. First, Hagdale, at Hammer, on the side of Baltasound. The haunted burn of Watlea, between Baltasound and Ueay Sound, and at the latter place on the sea-shore. On the south side of the Island of Ueay a similar deposit underlies a sandy raised beach, which encloses pebbles, whelks, oysters, and other sea-shells, as well as fish-bones, in abundance. Large perched blocks (some many tons in weight) lie scattered about everywhere. In none of the glacial deposits did I find a single organism.

Thus, then, at both ends and the middle of this interesting group of islands traces of glacial action have been found. I must, however, leave the filling up of the interspaces to others. I feel certain that, from the appearance of the islands as we coasted along them, the whole have been visited by similar action.

Additional List of Fossils from the Boulder-clay of Caithness. *By* C. W. Peach.

In 1862, at Cambridge, I had the pleasure of reading to this Section a list of fossils found in the Boulder-clay of Caithness. In consequence of the interest which it excited, I have since paid greater attention to this deposit and its organisms, and have been ably assisted by my friend Mr. Joseph Anderson of this place (who is also a hard worker in the Old Red Sandstone), and Mr. J. Miller Sutherland, of Lybster. These gentlemen have kindly brought all their gatherings to me for examination, and thus I find that they have also got nearly the whole of the organisms mentioned in both lists. Mr. Sutherland has found one shell and Mr. Anderson two, which have not occurred to me.

The Foraminifera, mentioned at the bottom of the list, were named by Messrs. Jeffreys and Waller, both excellent authorities. They were taken by me out of a very small nest of sand enclosed in the clay of the Burn of Haster. With these were portions of minute shells, and plates and spines of Echinoderms, and spicula of Sponges. Mr. Anderson has since obtained a great many Foraminifera, Entomostraca, &c., by washing the Boulder-clay itself, probably as many as ten or twelve genera. These all require careful examination by those conversant with such minute and difficult forms before they can be made use of. Mr. Jeffreys had suggested to me that very delicate organisms might be got by washing the Boulder-clay, but I thought it too hard and obstinate, so that to Mr. Anderson is the credit due of first proving Mr. Jeffreys's suggestion correct, although he had never heard of it. This washing test, if applied to deposits of clay apparently destitute of organisms, may lead to interesting results. Mr. Anderson and myself have washed clays from many localities, extending from near John O'Groats to beyond Wick, and all the samples tried have yielded more or fewer Foraminifera, Entomostraca, &c., from whatever part of the deposits the clay has been taken.

In my last paper I stated that in no case had I found two valves of a shell united in the clay. I have since got an Anomia with both valves in place, and in a beautiful state of preservation. It occurred in Boulder-clay containing the usual rubbed stones and broken shells. Mr. Anderson has a piece of shell, on which is a cluster of young Balani in excellent preservation. Such instances are so rare that I think them worthy of notice.

I may mention that, when dredging this summer with Mr. Jeffreys off Shetland, I was much struck with the *fossil shells* brought up at almost every haul, all so much like, in fact identical with, those found in the Boulder-clay of Caithness; and although some were broken, for instance, *Cyprina islandica*, the only difference that I could perceive in their appearance and preservation was that the dredged shells generally were more perfect than those in the clay. The fragmentary state of the clay shells, I believe, was caused by the rough treatment they had experienced in being removed from the original deposit in which many of them had been imbedded, and which was subsequently broken up before being removed to and lodged in the formation that now overlies the Caithness flags.

I think it right to mention that Mr. J. Cleghorn of Wick, and Mr. Dick of Thurso, were the first local geologists who found and made public the fact that this formation was fossiliferous—a fact previously doubted. I am again indebted to Mr. J. Gwyn Jeffreys for his kindness in naming the Mollusca and Cirripedia. For the rest I am answerable.

The following list contains 41 additions, which with the 42 in the first list gives a total of 83 species of shells, &c., from the Boulder-clay of Caithness as ascertained up to the present time:—

Univalves.

Fusus antiquus.
Buccinum undatum, var. depurator.
Bela pyramidalis*.
—— ginnaniana (nebula)*.
Natica pallida (grœnlandica).
—— affinis (clausa).
Cerithiopsis costulata.
Turritella (communis) ungulina.
Lacuna divaricata (vincta).
Litorina litorea.

Bivalves.

Ostrea edulis.
Anomia ephippium, var. squamula.
Pecten islandicus†.
Mytilus edulis.
—— modiolus.
Crenella decussata.
Nucula nucleus.
Leda pernula.
Cardium fasciatum.
Lucina borealis.
—— spinifera.
Astarte sulcata, var. scotica.
Venus lincta.
Donax vittatus.
Saxicava rugosa.
Mya truncata.

Brachiopoda.

Rhynchonella psittacea.

Entomostraca.

Some valves of Cythere?

Cirripedia.

Balanus crenatus.
Verruca stromia.

Annelida.

Sipunculus, case of, in the shell of a Dentalium.

Polyzoa.

Lepralia unicornis.
Tubulipora hispida?—very much rubbed.

Echinodermata.

Ophiocoma rosula, spines of.
Echinus neglectus, spine of, with others of at least two more species.
Spatangi, many spines of.

Foraminifera.

Cristellaria calcar.
Polystomella crispa.
—— umbilicatula.
Rotalia Beccarii.
Miliolina seminulum.

* Found by Mr. Anderson.

† Found by Mr. J. Miller Sutherland.

Recapitulation.

	New.	Varieties of species in last list.	Additions.
Shells—Univalves	8	2	10
„ Bivalves	15	1	16
„ Brachiopoda	1	—	1
„ Entomostraca	1	—	1
„ Cirripedia	2	—	2
„ Annelida	1	—	1
„ Polyzoa	2	—	2
„ Echinodermata	3	—	3
„ Foraminifera	5	—	5
Previous list of 1862			42
Making together of ascertained species and varieties			83

Of which in the present list 36 are British, and all are Scandinavian and Arctic.

On an Accumulation of Shells, with Human Industrial Remains, found on a hill near the River Teign, in Devonshire. By W. Pengelly, *F.R.S., F.G.S.*

In this paper the author described a large accumulation of shells, all of them such as were derivable from the estuary of the Teign, which had been found in a trench rudely but distinctly cut in the New Red Conglomerate at Rocombe, in the parish of Stokeinteignhead, about four miles from Torquay. A considerable amount of broken pottery of coarse character, a brass armlet, a bone hair-pin, and a portion of a quern, all of Anglo-Roman age, were mingled with the shells.

On Changes of Relative Level of Land and Sea in South-Eastern Devonshire, in Connexion with the Antiquity of Mankind. By W. Pengelly, *F.R.S., F.G.S.*

In this communication the author, having briefly noticed the characteristics of the existing general coast-line, described a series of phenomena which indicate that within what is known as the Quaternary Period, the whole of south-eastern Devonshire was at least 280 feet lower than at present; that by a series of slow and gradual upheavals, separated by protracted periods of intermittence, it was raised at least 40 feet above its present level; that these elevatory movements were followed by one of subsidence; that since the last adjustment of relative level, the waves have cut back the cliffs so as to form the existing strand, which in some instances is nearly half a mile in width. Having discussed the relative chronology of the facts described, he showed that the Mammoth existed in Devonshire so late as the era of the submerged forests of Torbay; and that this period had not closed before the advent of man in the same locality. Lastly, he produced a flint implement found in a patch of gravel on Windmill Hill, Brixham, and which, from its situation and character, must be of an antiquity greater than that of the submerged forests, or raised beaches, or ossiferous caverns, or even the *Betula nana* clays of the district.

On the Formation of Valleys near Kirkby Lonsdale.
By Prof. Phillips, *M.A., LL.D., F.R.S., F.G.S.*

The author called the attention of geologists engaged in considering the theory of the origin of valleys to the necessity of keeping in view not only all the real causes which have been concerned in changing the level and modifying the surface of the solid land, but also the peculiarities of the rocks themselves in regard to the resistance they might offer to the waste occasioned by the mechanical and chemical agencies of water. He proposed to show, in regard to certain great ridges and hollows which limited the drainage of the Lune and its branches, that these were plainly sketched out by ancient subterranean movements; that, in regard to particular streams, as the Lune and the Rother, there must have been valleys on part of their course before the age of the Old Red Sandstone; and that the courses of others, as Leck Beck and Barbon Beck, were marked out by great faults; while others, not in directions of such faults, were yet traceable to lines of weakness in rocks occasioned by joints, having a determinate relation to these fractures. The conclusion from the whole being that the main features of the inequalities of the earth's surface were always referable to displacements of the rocks and lines of weakness dependent on them; and that the agencies of waste along their directions were ancient operations of the sea, at the rising and falling of the level of the land, and other operations sometimes very ancient, but often still in force, depending on atmospheric vicissitudes. In reference to this latter operation the author gave proof from the upper part of Leck Beck that the narrow rocky limestone glen which runs up toward the "County stone" is nothing else than a line of ancient subterranean caverns, of which the roofs have fallen in, and that this process is still in progress, the water being received in swallows at higher levels on the slope of the moors, and employed in dissolving the calcareous rocks on its passage. Thus the valley in question, and many others similarly situated, were not excavated from the surface, but, after long ages of underground action of water, were formed by the falling in of the unsupported roofs. After this had occurred the usual surface action of running water had modified the sides and the slopes of the bed.

On the Measure of Geological Time by Natural Chronometers. *By* Prof. PHILLIPS, *M.A., LL.D., F.R.S., F.G.S.*

Distinguishing, in the first place, between the history of operations in the sea and on the land, by which the succession of ancient phenomena is determined, from the attempts to ascertain, first the relative, and finally the absolute chronology of these events, the author noticed several orders of natural effects which, being traceable through the later geological periods, and still in progress, seemed the fittest to be employed in the measure of Cænozoic time. Examples are found in the action of streams wearing away their channels, or depositing sediment; in the formation and growth of peat moor; in the filling up of lakes; and, finally, in the accumulation of detritus in conical mounds at the foot of precipices by falling of rocks or torrents of water. The last case was illustrated by drawings, and a description of the remarkable mounds of La Tinière on the Lake of Geneva, near Villeneuve, which had been investigated by M. Morlot. At this place one of the mounds, the least ancient, has been cut through by the railway to a depth of between 20 and 30 feet. The section exposes the materials usually found in such mounds (large and small pebbles and sand); but, in addition, three bands of loamy matter, 6 to 8 inches thick, are seen to range parallel to the general surface, one, 4 feet below the surface, another, 10 feet, the third 19 feet. The bands contain charcoal, and have rather the aspect of vegetable earth, in part stained yellow. With the upper one were found Roman reliquiæ—fragments of tiles and a coin; the middle one yielded no such objects, but some bronze fabrications; the lower one, coarse pottery, also fragments of bones of men and animals. Prof. Phillips was so fortunate as to obtain from this lowest band, by his own research, a portion of cranial bone, which, by the help of Mr. C. Robertson of the Oxford Museum, he finds to be, as he had conjectured, part of the occipital bone of man. From these facts M. Morlot inferred that at three successive epochs the action of the torrent spread the reliquiæ of human occupation over the growing delta of La Tinière—that the epochs may be approximately calculated at 1600, 3800, and 6400 years ago. And he refers these dates to particular points in the "Roman," "bronze," and "stone" periods; so that the earliest trace of man in this delta is between 6000 and 7000 years old. No stone implements occurred in this mound. The age of the whole mound is estimated at 10,000 years. M. Morlot also applied the same method of computation to the earlier and larger conical mound of La Tinière, which was deposited while the Lake of Geneva was maintained at a higher level. The result gives for this cone 1000 centuries; and M. Morlot regards it as a fair approximation to the length of "post-glacial" time—the term "post-glacial," as we employ it in England, being supposed to agree with the end of the last great extension of ice in the Alps.

Prof. Phillips then presented to the Meeting, on the part of M. Morlot, English translations, executed by that gentleman, of the interesting memoirs which he had read to the Academy at Lausanne, and to a meeting of the Society of Natural Philosophy at that place.

On the Distribution of Granite Blocks from Wasdale Craig. *By* Prof. Phillips, *M.A., LL.D., F.R.S., F.G.S.*

For more than thirty years the attention of the author has been earnestly fixed on the remarkable facts which have been observed by Prof. Sedgwick and himself in regard to the dispersion of granite blocks, from Wasdale Craig, over high and low ground across Yorkshire and certain tracts of neighbouring counties. While in the drainage of the Eden and the large tracts embraced by the northern and eastern branches of the Humber, and the long depression on the western side of the carboniferous chain of Yorkshire and Lancashire, these blocks occur even plentifully, they are quite unknown in every part of the country to the westward of the parent rock. In tracing the course of the blocks from the extreme south-east of Yorkshire back to their origin, it is found that they by no means follow the valleys and avoid the heights, but that, on the contrary, with little or no difference, they occur alike on hills and dales, though not on the very highest, till on Stainmoor, at the north-western extremity of Yorkshire, they appear on surfaces raised 1400 feet above the sea. Through this pass of Stainmoor, which, though so much elevated, is in fact a great transverse depression in the carboniferous chain, the blocks have passed on as through a strait of an ancient sea. At no other point have the blocks crossed the chain. Turning now from Stainmoor to the west, we remark that in all the intermediate country, whether elevated to about 1000 feet above the sea, or only to about 500, blocks of the granite are frequent; and on approaching the site from which all have passed, they grow so numerous as even to be counted by hundreds and thousands. The summit of Wasdale Craig, being elevated only 1479 feet above the sea, it is obviously not possible to explain the distribution of rocks which has been sketched, either by the movement of glaciers, or the floatation of icebergs, without some particular suppositions in regard to the relative levels of several tracts of land; even if we leave out of account any perplexity as to the relative levels of land and sea. During a few late years, the author has turned special attention to Wasdale Craig itself, and to the distribution of granite blocks in its immediate vicinity, and he presents a map, showing this distribution for a few miles from the Craig. As already observed, they are too numerous to be counted in all the country for one or two miles to the eastward, whatever be the aspect, or shape, or slope of the ground, while none occur to the westward. Wasdale Craig is itself within the drainage of the Lune. To the north and west of it the summit of drainage between the Lune and the Eden is traced over varying heights, greater and less than that of the Craig. This drainage summit is passed by the blocks, at a level below 1000 feet, on a line a little to the north of east. South-westward of the Craig is the watershed between the Lune and the Kent. This summit appears not to have been passed at all, though in many places it is much below the height of the granite Craig. The blocks are often of very large size: some within two or three miles of the Craig are 12, 14, 18 feet, and even more in the largest dimensions; and at Thirsk, seventy miles off, a block was found 13 feet in diameter. They seldom appear to have been rolled, but yet, perhaps by ordinary surface waste, they have often become blunted at the angles. The author is convinced, by his frequent examination of the phenomena, 1. that the distribution to such great distances, in directions not conformed to natural courses of drainage, can be best explained by the agency of ice; 2. that it cannot have been effected by glacier movement on the land at its present absolute elevation; 3. that it cannot have been performed by iceberg floatation on an ocean however elevated, if the present relative elevations of the country were then the same as now; 4. that the excessive abundance of blocks near the Craig, and in the region fronting it to the east, seems to require the supposition of a considerable disturbing force, which greatly shattered the Craig, and provided a large quantity of removable blocks before the ice action came on. On the whole, the author supposes that during the glacial period such a disturbance took place; that the lake district was depressed; that icebergs formed from shore ice, and at moderate depths in the sea, carried away many of the loosened blocks, over the region far away to the east, while that was relatively lower than it is at present, and that afterwards the distribution of the blocks near Wasdale Craig took place while the land was rising. And he computes roughly that if the blocks now visible in the region round Wasdale Craig were restored to it, and placed in the granitic area now exposed, they would cover it in every part to the depth of about 3 feet. The blocks of stone now seen to be loosened around the Craig, and lying against its steeps, would not amount to one-thousandth part of this quantity, from which the author draws an argument in support of his views, of the preparatory concussions necessary to produce enough masses for the ice to transport. On another point of some difficulty he offered a few remarks. Both near the Craig, and at small distances from it, the quantity of other stones distributed by the same agency as the granite is relatively very small, and the masses are of small magnitude. At very great distances, as sixty or eighty miles away in Yorkshire, this disproportion as to quantity is less remarkable, but the granite blocks are still usually the largest. The author believes that the difference of magnitude between the granitic and the schistose blocks may be understood by the much greater prevalence of joints in the latter, which produces now, in some sorts of schistose rocks, near Wasdale Craig, pretty extensive "screes," while the sides of the granitic cliffs are encumbered with large rock masses. The difference of quantity he supposes to be explicable by the peculiar conditions of the formation of the ice, which he conceives to have generally picked up the blocks by adherence to the lower surface of the freezing mass, and not, as in ordinary glaciers, to have received them on the upper surface.

Notes on the Volcanic Phenomena and Mineral and Thermal Waters of Nicaragua. By Commander B. Pim, *R.N.*

On the Position in the Great Oolite, and the Mode of Working, of the Bath Freestone. By J. Randell.

On a Peculiar Fossil found in the Mesozoic Sandstone of the Connecticut Valley, discovered by Prof. W. B. Rogers.

Professor H. D. Rogers of Glasgow, at the desire of his brother Professor William B. Rogers of Boston, United States, drew the attention of the Section to a cast in plaster of some fossil bones in the Mesozoic, probably Triassic, Red Sandstone of the valley of the Connecticut River in Massachusetts. The original flat block of sandstone imbedding these almost unique bones was discovered recently by the last-named gentleman in a pile of the material which he traced to the very quarry whence it has been lately extracted, thus identifying precisely the geological site of the fossil. Upon a careful scrutiny of the fossilized bones, competent zoologists have pronounced them to partake of both bird and reptilian characteristics. This lends to the specimens a high scientific interest; that very recently there have appeared other independent proofs of the reptilian or semi-reptilian origin of very many of those foot-marks on the Connecticut Red Sandstone, which, until the publication of these proofs in the beautiful posthumous work of Dr. James Deane of Greenfield, Massachusetts, have been mistakenly regarded as almost invariably the foot-steps of birds. (See 'Ichnographs from the Sandstone of Connecticut River,' by J. Deane, M.D.)

On the Relations of the Silurian Schist with the Quartzose Rocks of South Africa. By Dr. R. N. Rubidge.

The author drew attention to the two maps he produced; one, that of Mr. A. G. Bain, published by the Geological Society of London in their 'Transactions;' the other coloured, to show the changes rendered necessary by the discoveries of the last few years; the latest being the finding of Upper Silurian fossils at the Knysna, by Mr. Thomas Bain, and of a species of *Knorria* resembling one of the same genus from Port Francis, which prove the Palæozoic character of the clay-slate as far as Zwellandam at least, while the discovery of *Calamites* in Pegnet-berg proves that the Table Mountain sandstones are not older than the Silurian period. The author conjectured some years ago, from their unconformability with the slates of Cape Town, now shown to be probably Devonian, that they might be of Triassic age, or possibly outliers of the Lacustrine formation. By these discoveries an area exceeding that of the British Isles requires transferring to different formations. But this was considered of minor importance in comparison with the relations of the rocks which led Mr. Bain into error. The author had pointed out this relation some years ago, and predicted that the primary clay-slate (Silurian and Carboniferous beds of Bain) would probably prove to belong to one great Palæozoic formation. The relation alluded to was the conversion of beds of widely different ages, but contiguous, into a quartzose sandstone or quartzite, causing beds of Silurian rock to lie conformably on inclined quartzite, which was continuous with horizontal rock of like character resting unconformably on Silurian rock. The quartzite mountain-ranges extend from Table Mountain eastward to near the mouth of the Great Fish River; but, while the sandstones of which they are composed are unconformable in the west, they are interstratified with the Palæozoic schists in the east,—still, however, crossing their strike at an angle of 30° or more, and by spurs in other directions, so modifying the sections that two lines across the strike, distant only a few miles, often cross wholly different rock, one section being quartzite with but a few interlaminated schists, the other all schist. This was explained in the same manner as above, viz. by the silicification of the beds of schists, the mountain-chains originating either in the silicifying action taking certain lines, or in denudation into their present forms. Reasons were given for believing this silicification to be a surface-change due to aqueous action. There are no igneous rocks in the parts most affected by this change, and the cuttings made by rivers and by artificial means through the quartzite often expose the slate at the bottom.

On some New Forms of Olenoid Trilobites from the Lowest Fossiliferous Rocks of Wales. By J. W. Salter, *A.L.S., F.G.S.*

The grey rocks and black shales at the base of the Lower Lingula-flags, in which Mr. Salter discovered, two years ago, the great *Paradoxides Davidis*, are being fully explored (with the aid of a grant from the British Association) by Mr. Henry Hicks. His energetic work has already brought to light more than thirty species of fossils, most of them Trilobites. Some of these are quasi-embryonic forms, such as *Microdiscus*, which, like *Agnostus*, is a blind Trilobite without facial sutures; but it has four body-rings, instead of two. There are also species of *Conocoryphe* and *Agnostus*, both of them well-known genera, and others allied to *Arionellus* of Barrande; all of them have a 'primordial' aspect. Among the new discoveries is a genus named *Anopolenus*, a remarkable form, which at first seemed to have the head devoid of eyes and of any facial suture. Later observations, however, have discerned the cheeks, eyes, and head-spines in a most abnormal position—placed far forward on the head, and so easily separable as to justify the previous belief in their entire absence. In order to find a parallel for this bizarre form, the author was obliged to describe a new *Olenus*, or rather *Sphærophthalmus*, found by Mr. Turner, of Pauntley, in the Black Shales of Malvern. In this fossil the characters so much exaggerated in *Anopolenus* are less strongly pronounced; and the new genus is thus connected with the older and better known forms of the *Olenidæ*, the most ancient Trilobite family,—if we except *Agnostus* and its allies which were probably coeval with them. It is worthy of remark that in this earliest family (*Olenidæ*) the largest size attained by the group of Trilobites is reached, the great *Paradoxides Harlani* being nearly 22 inches long.

In reply to a question put by Mr. Pengelly, Mr. Salter stated that the exceptional blind species found in the latest formations known to contain Trilobites are degraded forms of the highest genera, namely, *Phacops* and *Phillipsia*, and that there is good evidence of a progression in the development of the group from its commencement in the Cambrian to its extinction in the Coal period.

On the Old Pre-Cambrian (Laurentian) Island of St. David's, Pembrokeshire. By J. W. Salter, *A.L.S., F.G.S.*

Having been occupied for a fortnight this summer in searching (with Mr. H.

Hicks) the Cambrian rocks of St. David's for the Olenoid Trilobites mentioned in the last paper, the author paid some attention to the relations of the central trap-rock of the district, which runs in a broad mass, a mile or two wide, from Llanreithan to the headland of St. David's, and is continued out to sea in Ramsey Island. As the purple rocks, sandstones, and slates of the whole Lower Cambrian division are thrown up at high angles, all but vertical, on either flank of this mass, which forms the axis of the whole country, there is no difficulty in studying its behaviour in contact with the Cambrians. If it were an intrusive trap of later date, it would penetrate them here and there, or at least alter them at the point of contact, as the neighbouring granite of Brawdy and Roch actually does. On the contrary, wherever the boundary can be seen, steatitic and felspathic schist unaltered, and beds of thick conglomerate, mark the line, and are often very conspicuous. These conglomerates—of quartz-rock, jasper, felstone, &c.—may or may not have been derived from the immediate neighbourhood. They are traceable along the south and north sides of the trap-region, and are followed by sandstones of various degrees of coarseness, but indicating by the ripple-mark, as well as the coarse material, that they were accumulated in shallow water; and as we know that pebbles, often as large as swan's eggs, are not carried far out to sea, but mark either a submarine shoal or a coast-line, we are compelled to assign them to a source near at hand. The upper beds of the Lower Cambrian formation are finer-grained and lighter-coloured, and pass insensibly into *grey* and then into thin *black* beds of the Lingula-flags, with trappean ashes and lava-flows—the great Upper Cambrian formation.

Comparing this order of things with what occurs in North Wales, one is struck with the wonderful similarity in the two regions; coarse conglomerate and purple shale, red sandstones, and then grey rocks, passing into black, deep-water shales. Crossing the channel it is the same; the Lower Cambrian rocks of Wicklow give evidence of accumulation in shallow water; and Sir R. I. Murchison has shown us exactly the same thing, even exaggerated, in the conglomerates of North-western Scotland; but these rest directly on the Old Laurentian rocks, from which they seem to have been derived. The Hebrides and the west coast of Sutherland were land or shallow water when the Cambrian pebble-beds were formed around them. We do not know the land which supplied the pebble-bands and sandstones of North Wales and Shropshire; but the researches of Dr. H. B. Holl have shown us that the Malvern Hills were a low reef of rocks at this time; and everything points to a shallow sea, studded with islets and reefs, as the condition of things which existed in our area, probably also in Normandy and the Channel Islands, at this time. Again, the old Laurentian gneiss is remarkable for its syenitic character. Syenite is common; true granite is comparatively rare in these old rocks. This is the case in Canada, where they are best seen. Dr. Holl has shown it to be the case at Malvern, and hence we should look for it in Wales. The mass of igneous rock, which forms the backbone of the St. David's peninsula, and which supports, without penetrating them, the shallow-water accumulations of the older Cambrian around it, is syenitic in character. The quartz-veins penetrating it may well have supplied the pebbles; and the felspathic matter was the origin of the softer schists of the rocks which lie around it. That there was shallow water, with rocky ground close by, is evident; and in the absence of any evidence to the contrary, the author suggests that the syenitic trap of St. David's is a part of the old pre-Cambrian land. As he did not visit Ramsey Island, the evidence is incomplete. It will be necessary to see whether the Cambrians there are affected by the trap, or lie upon it unaltered, as he believes is the case with those of St. David's.

A Brief Explanation of a Geological Map of the Bristol Coal-field. By W. Sanders, *F.R.S., F.G.S.*

This map has been constructed by reducing about 220 parish-maps to the scale of 4 inches to the mile, or 20 chains to the inch. The map comprises a large portion of the geological series, ranging from the Lower Silurian up to the lower division of the Cretaceous system. With respect to the coal strata, as the deposits of a later age occupy a large portion of the country, only one half of the coal strata of the northern part of the basin, and only a tenth or twentieth part of the southern part, are visible at the surface. The northern tract is about twelve miles in length, with a breadth of three or four miles. The Nailsea coal-field is of smaller dimensions. The Clutton coal-pits are in a central position. A southern coal-field adjoins the Mendip hills. The Radstock pits, which yield an abundant supply of excellent quality, are entirely concealed beneath liassic and even oolitic strata. The coal-measures proper have a thickness of about 5000 feet, divisible into an upper and lower series of coal seams, separated by the Pennant grit rocks. They contain about ninety feet of coal, of which about one half is workable.

Notice of Carnassial and Canine Teeth from the Mendip Caverns, probably belonging to Felis antiqua (syn. Pardus). *By* W. A. Sanford, *F.G.S.*

Among a quantity of *Hyæna* and *Felis spelæa* teeth, Mr. Sanford found the canines and carnassial, which presented precisely the characters, both in size and form, of *Felis Pardus*, which appeared to him identical with *F. antiqua* of Cuvier. These teeth were discovered by the late Rev. M. Williams, and are now with his collection in the Taunton Museum. From information obtained from Mr. Beard, the teeth came from the Hutton cave in the Mendip.

On the Pterodactyle as Evidence of a new Subclass of Vertebrata (Saurornia). *By* Harry Seeley, *F.G.S.*

The author gave an account of the entire skeleton, the history, and classification of Pterodactyles. In the head he described from Upper Greensand examples the following bones: basi-occipital, basi-temporal, basi-sphenoid, ex-occipital, supra-occipital, parietal, alisphenoid, squamosal, petrosal, quadrate, quadrato-jugal, orbito-ethmo-sphenoid, the vomer, os articulare, and proximal end of the lower jaw, and the premaxillary, maxillary, and dentary bones. The sutures were obliterated as in birds, the quadrate bone had the same double articulation with the cranium as in birds, the squamosal bone was the same; and the conclusion from the sum of the bones was that, excepting the teeth, there is no character in the skull to distinguish the Pterodactyle from a bird. It is peculiar in that the basi-occipital neither enters into the foramen magnum nor the floor for the brain or the base of the skull. And the quadrate and quadrato-jugal are anchylosed, the latter being squamous. The cranium approaches most nearly to that of the common Cock. The pectoral arch was described, the homology of the bones discussed, and the furcula shown to be attached to the radial processes of the humeri. The author went through the comparative osteology of the remainder of the skeleton, and showed that it supported the conclusion from the skull. The writings of Buckland, Owen, Huxley, Cuvier, Von Meyer, Goldfuss, Wagner, Quenstedt, &c., were reviewed, and shown to contain nothing to support the hypothesis that Pterodactyles were reptiles. The *Sauropsida*, therefore, were divided into three sections —Aves and Saurornia, and Reptilia—the *Saurornia* being birds with teeth, with peculiar wings, tarsus and metatarsus separate, and reptilian types of vertebræ, like the fossil birds *Palæocolymbus* and *Pelagornis* of the Upper Greensand. Mr. Seeley then described as new species—*Pterodactylus Huxleyi, P. machærorhynchus, P. Hopkinsi, P. Oweni, P. Carteri* (?), and completed the descriptions of Owen's species *P. Sedgwicki, P. Fittoni, P. Woodwardi, P. simus*, and identified *P. Cuvieri*—thus adding six; so that now there are ten species* from the Upper Greensand and one (*P. Cuvieri*) common to the Greensand and Chalk. In conclusion, he discussed the affinities of the known Pterodactyles with one another and their classification.

On the Significance of the Sequence of Rocks and Fossils. *By* Harry Seeley, *F.G.S.*

Assuming that the clays are the mud of rivers, that the sandstones are the detritus of old crystalline rocks, and that limestones were organically or chemically formed, the author contrasted the Cretaceous and Jurassic rocks, and the sequence of the beds they include, and, from the alternation of strata, deduced the alternations of upheaval of continents and the nature of the rocks presented for denudation. He

* Several more have been found since.

then, by way of illustration, worked out the physical geography of the Cretaceous period, using as data the rocks of the eastern and northern counties; and, having considered the effects of these physical revolutions upon the fauna of the ocean floor, it was concluded that the operation of elevation and depression, in the ways pointed out, might have produced all the phenomena of existing life-provinces on land and by sea, and similar life-provinces in the seas of past time. It was then shown that the breaks between strata do not generally indicate denudation or breaks in time, but merely upheaval or depression of old lands, bringing into wear new rock-material and causing the immigration of a new province of marine life. Mr. Seeley concluded by contesting the idea that *extinct* species could tell anything about the physical conditions under which they lived. All the different distribution of existing analogues, as compared with their fossil antetypes, was the result of migration of species, and not of changing climate.

On the Thermal Water of the Clifford Amalgamated Mines of Cornwall. By W. W. Smyth, *M.A., F.R.S., F.G.S.*

The North, or Hot Lode of the Clifford Mines, formerly known as that of the United Mines, is one of a group of east and west veins which are encased in the clay-slate or *killas*, on the east of the granite hill of Carn Marth. Mr. Henwood's observations, a quarter of a century ago, showed that water had been met with at several places, varying from 1104 to 1260 feet deep, of the temperature of from 90° to 100° Fahr. In 1839 a cross-cut at the United Mines intersected a large feeder of very hot water, and with it a rich lode of copper pyrites, which has since been continuously worked eastward and downward. The author found, in 1855, the chief spring welling upwards in a level 1510 feet deep, with a temperature of 114°. In July 1864, from the extension of the excavations in depth and eastward, he found, at 1620 feet deep, that three thermometers placed in the water marked 122°. The lode at this point was of moderate size, and improving as it was followed east; being in the 220-fathom level (1590 feet deep from surface) 12 to 16 feet wide, and yielding a very large amount of rich copper ore. The spring is estimated to give 150 gallons per minute; and although chloride of sodium is abundant in it, the low percentage of magnesian salts, as compared with sea-water, as well as the situation of the lode, render it unlikely that the water is derived directly from the sea. The absence of sulphates of iron and copper, as shown by Prof. Miller's analysis, seems to set aside the hypothesis of the heat being due to the decomposition of the sulphides.

The exceptionally high temperature of the water was not observable when the workings were shallow, partly perhaps owing to the closer texture of the vein, and partly to the large area over which the warm water seems to have been diffused.

An increase of depth of 180 feet in the point of issue of the water had raised the temperature 8° Fahr., showing the remarkable increment of 1 degree for $22\frac{1}{2}$ feet.

On the Conclusion to be drawn from the Physical Structure of some Meteorites. By H. C. Sorby, *F.R.S., F.G.S.*

The author had elsewhere* shown that the earliest condition of meteorites of which their microscopical structure furnishes evidence was that of igneous fusion. There are, however, some, like the Pallas iron, consisting of a mixture of iron and olivine, which apparently strongly oppose this view, if we merely judge from what occurs when such substances are melted artificially; for then the iron, being so much more dense, would sink to the bottom, and the olivine rise to the top, like slag in a furnace. The object of the paper was, however, to show that this difference in density depends on the force of gravitation, and that, on the surface of a small planetary body, or towards the interior of a larger, iron and olivine might remain mixed in a state of fusion long enough to allow of gradual crystallization. Such meteorites should therefore be considered evidence of fusion where the force of gravitation was very small; and this conclusion may be valuable in deciding between rival theories of their origin.

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* Proceed. Roy. Soc. vol. xiii. p. 333.

On the Lowest Beds of the Clifton Carboniferous Series. By W. W. STODDART, *F.G.S., Bristol.*

The author, after briefly describing the Clifton scenery, and the advantages that locality affords for geological study, gave a short summary of the rocks which range in one unbroken line from the Millstone-grit on Brandon Hill to the Old Red Sandstone below Cook's Folly.

It is to the lowest beds of these lying immediately on the Old Red that this paper referred.

The highest of the beds now in question is the well-known palate bed, containing a large number of the teeth and spines of fishes, Ichthyocopri, Brachiopoda, Pteropoda, Polyzoa, &c.

The principal fossils from the bed are—

Fenestella	Cladodus conicus.
Ceriopora rhombifera.	Chomatodus linearis.
Spirifera bisulcata.	Ctenacanthus tenuistriatus.
—— glabra.	Helodus lævissimus.
Discina nitida.	Psammodus porosus.
Lingula mytiloides.	Coprolites.
Conularia quadrisulcata.	

Under this are seen three beds of red crystalline limestone, the middle one of which the author described in the 'Annals of Natural History,' 1857.

It dips to the S.S.E. at an angle of 68°, and contains one of the most extraordinary assemblages of fossils perhaps ever seen. All of them do not exceed $\frac{1}{20}$th of an inch in diameter, and many are less than 100th of an inch. They are composed of a peculiar combination of peroxide of iron and silica, and are perfectly insoluble in cold nitric and hydrochloric acids.

The fossils constitute more than 20 per cent. by weight of the rock. From a pound weight of the limestone were obtained more than a million and a half of perfect fossils besides débris.

It was most probably a *bank* exposed to the littoral waves of a Carboniferous sea which would wash away the large shells, leaving the smaller—just as we now see going on at many places of our own coast, as Silsea Bill, Caldy Island, &c.

The fossils more commonly found are—

Poteriocrinus.	Ceriopora rhombifera (*Goldf.*).
Platycrinus	Pleurotomaria pygmæa (n. sp.).
Cythere ovalis (n. sp.).	Euomphalus triangulatus (n. sp.).
Cytherella lunata (n. sp.).	Natica plicistria (*Young*).

Passing downward through a thickness of 8 or 9 feet, the author found a bed of dark grey shaly marl. It probably corresponds to No. 428 in Mr. Williams's Section, and is the most important of the whole series to the geologist. It contains fossils that occur in no other of the limestone beds at Clifton. The principal of these are *Modiola Macadami*, *Avicula Damnoniensis*, *Natica plicistria*, *Spirorbis omphalodes*, *Cypridina Scotoburdigalensis*, *Cypridina subrectus*, *Knorria dichotoma*, &c.

The *Modiolæ* are in immense masses, and sometimes covered with the remains of Entomostraca and *Spirorbis*. Below this shaly bed continue 70 feet of alternating limestones, shales, and marls, and then 30 feet of passage beds into the Old Red, which properly commences by the well-known quartzose conglomerate.

The author then alluded to the corresponding Lower Limestone shales in the northern part of Derry, and the section described by General Portlock on the Moyola and Altagowan rivers, and pointed out the very great similarity both lithologically and palæontologically.

After comparing these with the Coomhola grits of Messrs. Jukes and Salter, and the Marwood Section of hitherto so-called Upper Devonian in Devonshire, the author showed that no doubt could exist of the *Modiola* shales at Clifton being a representative of them all. It is true that the larger Brachiopoda are missing at Clifton that are found in Ireland, where the thickness of the lower shales is enormous, as at Glengariff Harbour; but, on the other hand, in those Irish sections which are thin, as in Ballynascreen, the fossils are only those found at Clifton. Then, again, in the largely developed Glengariff beds are found fossils identical with those of the Marwood sandstone.

This is more easily seen by the following Table:—

Fossils.	Clifton group.	Marwood group.	Coomhola group.	Moyola group.
Filicites dichotoma	*	...	*	...
Knorria dichotoma	*	...	*	...
Platycrinus	*	...	*	...
Poteriocrinus	*	...	*	...
Rhodocrinus	*	...	*	...
Spirorbis omphalodes	*	*?	...	*
Cypridina Scotoburdigalensis	*	...	...	*
—— subrectus	*	...	...	*
Lingula mytiloides	*	...	...	*
Spirifera disjuncta	...	*	*	*
—— bisulcata	*	*	*	*
Streptorhynchus crenistria	*	?	*	*
Rhynchonella pleurodon	*	*	*	*
Cucullæa trapezium	*	*	...	...
—— Hardingii	*	*	...	...
Modiola Macadami	*	*	*	*
Avicula damnoniensis	*	*	*	*
Naticopsis plicistria	*	...	...	*
Amblypterus	*	...	...	*
Orthoceras gregarium	*	...	*	*

The author then asked, ought these shales to be classed with the Carboniferous or Devonian rocks? He submitted that the evidence produced clearly proved that they were the former.

1st. On account of the nature of the fossils.

2ndly. From the comparatively large extent of limestones and marls (70 feet) before the true micaceous beds begin, and 100 feet above the first bed of quartzose conglomerate. Another view was laid before the Association, viz., that these shales probably had as much right to be considered a distinct and intermediate series as the Rhætic of the Lias, which in the Rhætian Alps have little more thickness than the Lower Limestone shales, which in Glengariff Harbour range through more than 5000 feet.

On Agates found on our Coasts. By Professor Tennant, *F.G.S.*

On a Bone Breccia with Flints in Lebanon.
By the Rev. H. B. Tristram, *M.A., F.L.S.*

Close to the Nahr el Kelb, on its southern side, a spur of the Lebanon pushes boldly into the sea, standing out a promontory several hundred feet high. Above this the rock has been scarped for the inscription of those famous tablets which are known to every visitor to Beirut. The hard crystalline limestone was in one spot under this a complete mass of bone breccia, with fragments of flint mingled in the stalagmite. It seems probable that the stalagmite, of which not above twelve square yards remain, formed a portion of the flooring of an ancient cavern, the roof of which has probably been cut away, either to aid in the construction of the road, or to obtain a surface for the inscription of the tablets. The position of the breccia being several feet above the level of the roadway, the floor of the cave, no doubt, originally extended as far as the sea-face of the road. We therefore descended to the sea; and, amongst the heaps of rock, dashed by the waves and covered with fucus, we discovered several large fragments of breccia, corresponding exactly in composition with the mass above. The flints consisted almost entirely of elongated chips with very sharp edges; and the author remarked that he was not aware of any natural deposit of silex within three miles of this spot. Many of these chips are as dark as if they had been freshly broken from the matrix. One remarkable characteristic of this breccia is the extreme hardness of the crystalline limestone which forms it. If, as Mr. Dawkins considers, some of the teeth are identical with those of our existing Reindeer, with the Red Deer, Elk, *Bos primigenius*, and *Bison minor*, we have the ancient range of those quadrupeds extended to a point more southerly than any previously ascertained.

On the Sulphur and Bitumen Deposit at the South-West Corner of the Dead Sea. By the Rev. H. B. Tristram, *M.A.*, *F.L.S.*

The Mahawat is a broad, deep, dry ravine, commencing two miles to the south-west of the Dead Sea and running up to the westward, being the drainage debouch of the Negeb. The Wady is similar in character to the Wady Zuweirah—the same sharp cutting through the old limestone, only on a much larger scale, the same deposition of the post-tertiary marl, the same entire denudation of this latter. But, *since* the post-tertiary marl has been altogether getting washed out, there has been a second filling in of an extraordinary character, which is only now in course of being washed out. Masses of bitumen, mingled with gravel overlying a thin stratum of sulphur, which again overlies a thicker stratum of sand so strongly impregnated with sulphur that it yields powerful fumes on being sprinkled over a hot coal, are exposed on the sides of the Wady, chiefly on the south. Many large masses have been washed down, and are scattered on the plain. . . . . Here is the only trace of igneous action we have met with in our most careful examination of the coasts so far. The author had a dread of attempting to corroborate Scripture by natural or physical arguments which may be refuted; for the objector is apt to think that, when he has refuted the weak argument, he has refuted the Scriptural statement; but, so far as he understood it, if there be any physical evidence left on earth of a catastrophe similar to that which destroyed the cities of the plain, it is here. The whole appearance points to a shower of hot sulphur and an eruption of bitumen upon it, calcined and impregnated by its fumes, and this at a geological period quite subsequent to all the diluvial and alluvial actions. It may have been from a sulphur and bitumen spring on the spot, when the flow of water was more abundant; but of this we could detect no trace. Unfortunately no traveller has ever penetrated the Wady before us, and therefore we have no opinions of more competent observers to guide us. Robinson and Vandevelde passed to the south of it. De Saulcy, Porter, Wolcott, and Poole all went to the north.

On the Family of the Eurypteridæ, with Descriptions of some New Genera and Species. By Henry Woodward, *F.G.S.*

The author gave a sketch of the history of this group of Palæozoic Crustacea, and illustrated the peculiarities of each genus by a series of diagrams. He pointed out the close affinities which the *Eurypteridæ* display to the *Limulidæ* (King-crabs), a group which begins in the coal-measures and appears to have existed (with slight modifications in form) from that period to the present time. Mr. Woodward defined the forms belonging to the genera *Pterygotus, Eurypterus, Slimonia*, and *Stylonurus*, and described others belonging to the new genus *Hemiaspis*—in all, thirty-three British species. With the exception of *Hemiaspis* from the Lower Ludlow rocks of Leintwardine, Shropshire, the new material collected since the publication of Messrs. Huxley and Salter's Monograph in 1859 has all resulted from the independent labours of Mr. James Powrie, F.G.S., of Reswallie in Forfarshire, and Mr. Robert Slimon, of Lesmahagow in Lanarkshire.

On the Development of Ammonites. By Dr. Thomas Wright, *F.R.S.E.*, *F.G.S.*

The author first stated the difficulties the Palæontologist experienced in attempting to understand the synonyms of several species of Ammonites, as many of the species had been established on imperfect or transitional forms. By reference to the morphology of the Acalephæ, Echinodermata, Insecta, and Crustacea, he explained how many of the species in these classes pass through more or less extensive changes in form and structure between their escape from the egg and their adult condition, and proceeded to apply this law to the development of the shell of Ammonites. From an extensive series of specimens he had collected from the Lias and Oolitic formations, he could show, 1st, that one group of species exhibit very little change in their various phases of growth; and 2nd, that another group exhibits such diverse changes that their several stages of development have been assumed as permanent forms, and described as distinct species.

To the first group belong the following species from the Lias formation.

Lower Lias.

Ammonites Bucklandi, Sow.
—— *obtusus*, Sow.
—— *Conybeari*, Sow.

Ammonites Birchii, Sow.
—— *Sauzeanus*, d'Orbig.
—— *raricostatus*, Ziet.
—— *Bonnardi*, d'Orbig.

Middle Lias.

Ammonites ibex, Quenst.
—— *bipunctatus*, Rœmer.
—— *Loscombi*, Sow.
—— *Becheii*, Sow.
—— *fimbriatus*, Sow.

Ammonites Guibalianus, d'Orbig.
—— *natrix*, Ziet.
—— *Davæi*, Sow.
—— *striatus*, Renecke.

Upper Lias.

Ammonites bifrons, Brug.
—— *communis*, Sow.
—— *annulatus*, Sow.
—— *fibulatus*, Sow.

Ammonites Hollandrei, d'Orbig.
—— *complanatus*, Brug.
—— *hircinus*, Ziet.
—— *jurensis*, Ziet.

The second group in which important and varied changes take place are

Lower Lias.

Ammonites planorbis, Sow.
—— *angulatus*, Schloth.
—— *planicostatus*, Sow.

Ammonites semicostatus, Y. & B.
—— *bifer*, Quenst.

Middle Lias.

Ammonites Jamesoni, Sow.

Ammonites capricornus, Schloth.

The author gave a detailed description of the morphological changes exhibited by each of these species, and demonstrated that *Ammonites planicostatus*, Sow. was the young shell of *Am. Dudressieri*, d'Orbig. This species acquired spines on the dorsal border of the ribs in the second phase of its growth, which became tubercles in a third stage, and these it finally lost as it advanced to maturity. *Am. Jamesoni*, Sow., was shown to be the adult form of *A. Bronnii*, Rœm., with tubercles on the ribs, and a rudimentary keel; in a second stage of growth it became *Am. Regnardi*, d'Orbig., and afterwards changed to the elegant form figured by Sowerby. *Am. capricornus* in its different phases of development had been the type of six figured species: in early age it was *Am. maculatus*, Y. & B.; a little older it was *Am. planicosta*, d'Orbig., and *Am. latæcostus*, Sow.; in middle age, when the last whorl expanded somewhat abruptly, and supported two rows of small tubercles on the lateral ribs, it formed the *Am. heterogenes*, Y. & B.; and two-thirds of the last whorl in this stage of growth was figured by Sowerby as *Am. Henleyi*, Sow.

These facts were demonstrated by a series of specimens exhibiting the morphological characters of the different species described, and the important practical bearing of the subject on Palæontology was dwelt upon. Ammonites were now generally admitted to be the best indicators of the stratigraphical position of the different zones of life in the secondary rocks, and it was therefore all the more important to geology that the species of this group should be rigorously determined; which could only be done by a critical examination of their morphological characters; for mere species-making, without such knowledge, was hindrance, and not progress, in the present state of Palæontology.

On the White Lias of Dorsetshire. *By* Dr. T. Wright, *F.R.S.E., F.G.S.*

In this paper the author showed that the term White Lias, as used by Buckland, Smith, De la Beche and others, required a more correct definition than had been given to it hitherto, as it included beds of a light colour, which belonged to two distinct zones of life; the upper half consisted of light-coloured lias beds, with *Ammonites planorbis* and *Ostrea liassica*, forming the zone of *Ammonites planorbis*, whilst the lower portion of the White Lias was composed of a series of light-coloured concretionary limestones, having a rubbly character in parts, with a conchoidal fracture. These thick beds were at Up-Lyme, Axminster, and Pinhay Bay from 20 to 25 feet in thickness, and contained a great number of small shells in the form of moulds: *Pecten valoniensis, Axinus modiola,* and *Cardium rhæticum* had been found in them at Up-Lyme. Dr. Wright considered this lower portion of the White Lias belonged to the *Avicula contorta* beds, or infra-lias of some Continental authors, as no true lias fossil shells were found in it. He had correlated these beds with some of the upper beds of the *Avicula contorta* series, at Garden Cliff and Aust Cliff, on the Severn, and at Penarth, Glamorganshire, and he had come to the conclusion that the concretionary White Lias at the base of the Pinhay Bay section must be considered as the upper portion of the *Avicula contorta* series.

BOTANY AND ZOOLOGY, including PHYSIOLOGY.

Address by Dr. J. E. Gray, *President of the Section.*

Before entering upon the special business for which the Section has been called together, viz. the consideration of the Reports to be presented upon various zoological and botanical subjects, and the reading of the papers submitted by the members, I should wish to make a few general observations on some topics which appear to me to have an important bearing on the science which we study, in the hope that they may elicit some observations from the members present. I have always felt that one of the most important uses of the Association was the bringing together of so large a body of men engaged in kindred pursuits, and the consequent promotion of free personal intercourse between those who, not inhabiting the same locality or even the same country, were scarcely likely to meet except on such an occasion as the present. In such meetings the free interchange of thought by means of oral communication is most valuable; for it is in this way that facts are most readily brought into notice, and opinions most freely canvassed, that truth is most effectually elicited, and that erroneous or crude ideas are dissipated, corrected, and improved.

Some of my predecessors in this office have given a summary *résumé* of the recent progress of science in the departments over which I have now the honour to preside, and I had at first thought of attempting to follow their example; but I find myself precluded from so doing by the conviction that, in order to be of any real utility, such a Report should be of much greater length and fulness of detail than the time at our disposal would fairly admit for the reading, or than the few weeks which have elapsed since I was requested to undertake the office would allow of my preparing. This is, however, the less to be regretted, inasmuch as, in the course of each year, a body of laborious and talented German professors are in the habit of preparing a very full and complete Report of this nature for the Berlin 'Archives of Natural History,' after a plan similar to that which I myself commenced, more than forty years ago, in Thomson's 'Annals of Philosophy.' I have therefore abandoned all intention of attempting such a review, and proceed at once to speak of subjects having a more general bearing upon the interests of our science.

I should wish to say a few words on the subject of Public Museums. It may be imagined that, having the whole of my life been intimately connected with the management of what I believe to be at the present day the most important zoological museum in the world, it is a subject that has long and deeply occupied my thoughts; and it will also be readily believed that it is only after serious and prolonged consideration I have come to the conclusion that the plan hitherto pursued in their arrangement has rendered them less useful to science and less interesting to the public at large than they might have been made under a different system. Let us consider the purposes for which such a museum is established.

These are two: 1st, the diffusion of instruction and rational amusement among the mass of the people; and 2nd, to afford the scientific student every possible means of examining and studying the specimens of which the museum consists. Now, it appears to me that, in the desire to combine these two objects, which are essentially distinct, the first object, namely the general instruction of the people, has been to a great extent lost sight of and sacrificed to the second, without any corresponding advantage to the latter, because the system itself has been thoroughly erroneous. The curators of large museums have naturally, and, perhaps, properly, been men more deeply devoted to scientific study than interested in elementary instruction, and they have consequently done what they thought best for the promotion of science by accumulating and exhibiting on the shelves or in the open cases of the museum every specimen which they possess, without considering that by so doing they were overwhelming the general visitor with a mass of unintelligible objects, and at the same time rendering their attentive study by the man of science more difficult and onerous than if they had been brought into a smaller space and in a more available condition.

What the largest class of visitors, the general public, want, is a collection of the more interesting objects so arranged as to afford the greatest possible amount of information in a moderate space, and to be obtained, as it were, at a glance. On the other hand, the scientific student requires to have under his eyes and in his hands the most complete collection of specimens that can be brought together, and in such a condition as to admit of the most minute examination of their differences, whether of age, or sex, or state, or of whatever kind that can throw light upon all the innumerable questions that are continually arising in the progress of thought and opinion.

Every scientific student requires the cases to be opened, to allow him to examine and handle the specimens, and in the stuffed state this cannot be often done without injury; and an artist always requires them to be taken out of the case for his purpose.

In the futile attempt to combine these two purposes in one consecutive arrangement, the modern museum entirely fails in both particulars. It is only to be compared to a large store or a city warehouse, in which every specimen that can be collected is arranged in its proper case and on its proper shelf, so that it may be found when wanted; but the uninformed mind derives little instruction from the contemplation of its stores, while the student of nature requires a far more careful examination of them than is possible under such a system of arrangement, to derive any advantage; the visitor needs to be as well informed with relation to the system on which it is based as the curator himself; and consequently the general visitor perceives little else than a chaos of specimens, of which the bulk of those placed in close proximity are so nearly alike that he can scarcely perceive any difference between them, even supposing them to be placed on a level with the eye, while the greater number of those which are above or below this level are utterly unintelligible.

To such a visitor, the numerous species of rats, or squirrels, or sparrows, or larks that crowd the shelves, from all parts of the world, are but a rat, a squirrel, a sparrow, or a lark; and this is still more especially the case with animals of a less marked and less known type of character. Experience has long since convinced me that such a collection so arranged is a great mistake. The eye both of the general visitor and of the student becomes confused by the number of the specimens, however systematically they may be brought together.

The very extent of the collection renders it difficult even for the student, and much more so for the less scientific visitor, to discover any particular specimen of which he is in quest; and the larger the collection, the greater this difficulty becomes. Add to this the fact that all specimens, but more especially the more beautiful and the more delicate, are speedily deteriorated, and in some cases destroyed for all useful purposes, by exposure to light, and that both the skins and bones of animals are found to be much more susceptible of measurement and comparison in an unstuffed or unmounted state, and it will be at once apparent why almost all scientific zoologists have adopted for their own collections the simpler and more advantageous plan of keeping their specimens in boxes or in drawers, devoted each to a family, a genus, or a section of a genus, as each individual case may require.

Thus preserved and thus arranged, the most perfect and the most useful collection that the student could desire would occupy comparatively a small space, and by no means require large and lofty halls for its reception. As it is desirable that each large group should be kept in a separate room, and as wall-space is what is chiefly required for the reception of the drawers or boxes, rooms like those of an ordinary dwelling-house would be best fitted for the accommodation of such a collection and of the students by whom it would be consulted—one great advantage of this plan being that students would be uninterrupted by the ignorant curiosity of the ruder class of general visitors, and not liable to interference from scientific rivals.

There are other considerations also which should be taken into account in estimating the advantages of a collection thus preserved and thus arranged. A particular value is attached to such specimens as have been studied and described by zoologists, as affording the certain means of identifying the animals on which their observations were made. Such specimens ought especially to be preserved in such a way as to be least liable to injury from exposure to light, dust, or other extraneous causes of deterioration; and this is best done by keeping them in a state least exposed to these destructive influences, instead of in the open cases of a public and necessarily strongly lighted gallery. This is particularly the case with animals, or parts of animals, preserved in spirits, which ought to be kept in dark closets, or cases with opaque fronts, in cool rooms, as the light very soon destroys their colour, and the light and warmth cause the spirits to rapidly evaporate.

In imitating the French plan, the fact was overlooked that the French, and most Continental collections, are especially made for the use of scientific students, the pupils of the Professor, and not, as our National and local collections are, for the use of the public at large, including the students, who form a very small part of the visitors.

Again, the amount of saving thus effected in the cost of stuffing and mounting is well worthy of serious consideration, especially when we take into account that this stuffing and mounting, however agreeable to the eye, is made at the cost of rendering the specimens thus operated upon less available for scientific use.

All these arguments go to prove that, for the purposes of scientific study, the most complete collection that could possibly be formed would be best kept in cabinets or boxes from which light and dust would be excluded, in rooms especially devoted to the purpose, and not in galleries open to the general public, and that such an arrangement would combine the greatest advantage to the student and the most complete preservation of the specimens with great economy of expense.

This being done, it is easy to devise the plan of a museum which shall be the most interesting and instructive to general visitors, and one from which, however short may be their stay, or however casual their inspection, they can hardly fail to carry away some amount of valuable information.

The larger animals, being of course more generally interesting, and easily seen and recognized, should be exhibited in the preserved state, and in situations where they can be completely isolated. This is necessary also on account of their size, which would not admit of their being grouped in the manner which I propose with reference to the smaller specimens.

The older museums were for the most part made up of a number of the square glass-fronted boxes, each containing one, or sometimes a pair of specimens. This method had some advantages, but many inconveniences—among others, that of occupying too large an amount of room. But I cannot help thinking that when this was given up for the French plan of attaching each specimen to a separate stand, and marshalling them like soldiers on the shelves of a large open case, the improvement was not so great as many suppose; and this has become more and more evident since the researches of travellers and collectors have so largely increased the number of known species, and of species frequently separated by characters so minute as not to be detected without careful and close examination.

Having come to the conclusion that a museum for the use of the general public should consist chiefly of the best-known, the most marked, and the most interesting animals, arranged in such a way as to convey the greatest amount of instruction in the shortest and most direct manner, and so exhibited as to be seen without confusion, I am very much disposed to recur to something like the old plan of arranging each species or series of species in a special case, to be placed either on shelves or tables, or in wall-cases, as may be found most appropriate, or as the special purpose for which each case is prepared and exhibited may seem to require.

But instead of each case, as of old, containing only a single specimen, it should embrace a series of specimens, selected and arranged so as to present a special object for study; and thus any visitor, looking at a single case only, and taking the trouble to understand it, would carry away a distinct portion of knowledge, such as in the present state of our arrangements could only be obtained by the examination and comparison of specimens distributed through distant parts of the collection.

Every case should be distinctly labelled with an account of the purpose for which it is prepared and exhibited; and each specimen contained in it should also bear a label indicating why it is there placed.

I may be asked, why should each series of specimens be contained in a separate case? but I think it must be obvious that a series of objects exhibited for a definite purpose should be brought into close proximity, and contained in a well-defined space; and this will best be done by keeping them in a single and separate case. There is also the additional advantage that whenever, in the progress of discovery, it becomes desirable that the facts for the illustration of which the case was prepared should be exhibited in a different manner, this can easily be done by rearranging the individual case without interfering with the general arrangement of the collection. I believe that the more clearly the object is defined and the illustrations kept together, the greater will be the amount of information derived from it by the visitor and the interest he will feel in examining it.

Such cases may be advantageously prepared to show—

The classes of the animal kingdom.

The orders of each class.

The families of each order.

The genera of each family.

The sections of each genus, by means of one or more typical or characteristic examples of each class, order, or section.

A selection of a specimen of each of the more important or striking species of each genus or section.

The changes of state, sexes, habits, and manners of a well-known or an otherwise interesting species.

The economic uses to which they are applied; and such other particulars as the judgment and talent of the curator would select as best adapted for popular instruction, and of which these are only intended as partial indications.

No one, I think, who has ever had charge of a museum, or has noted the behaviour of the visitors while passing through it, can doubt for a moment that such cases would be infinitely more attractive to the public at large than the crowded shelves of our present museums, in which they speedily become bewildered by the multiplicity, the apparent sameness, and at the same time the infinite variety of the objects presented to their view, and in regard to which the labels on the tops of the cases afford them little assistance, while those on the specimens themselves are almost unintelligible.

When such visitors really take any interest in the exhibition, it will generally be found that they concentrate their attention on individual objects, while others affect to do the same, in order to conceal their total want of interest, of which they somehow feel ashamed, although it originates in no fault of their own.

I think the time is approaching when a great change will be made in the arrangement of Museums of Natural History, and have therefore thrown out these observations as suggestions, by which it appears to me that their usefulness may be greatly extended.

In England, as we are well aware, all changes are well considered and slowly adopted. Some forty years ago, the plan of placing every specimen on a separate stand, and arranging them in rank and file in large glass wall-cases, was considered a great step in advance, and it was doubtless an improvement on the preexisting plan, especially at a time when our collections were limited to a small number of species, which were scarcely more than types of our modern families or genera.

The idea had arisen that the English collections were smaller than those on the Continent, and the public called for every specimen to be exhibited. But the result has been that, in consequence of the enormous development of our collections, the attention of the great mass of visitors is distracted by the multitude of specimens, while the minute characters by which naturalists distinguish genera and species are inappreciable to their eyes.

It was not, however, the unenlightened public only who insisted on this unlimited display; there were also some leading scientific men who called for it, on the ground that the curator might be induced to keep specimens out of sight in order to make use of them for the enlargement of his own scientific reputation while the scientific public were debarred the sight of them, and that valuable specimens might thus be kept, as the favourite phrase was, "in the cellars." But any such imputation would be completely nullified by the plan which I have proposed of placing all the specimens in the scientific collection in boxes or drawers appropriated to them, and rendering them thus at once and readily accessible to students at large.

I may observe that the late Mr. Swainson, who was the first to raise the cry, lived to find that it was far more useful to keep his own extensive collection of bird-skins in drawers, like his butterflies and his shells; and that most scientific zoologists and osteologists are now convinced that the skins of animals unmounted and kept in boxes are far more useful for scientific purposes than stuffed skins or set-up skeletons.

So also, with reference to my proposal for the arrangement of the Museum for the general public, I find that those who are desirous of exhibiting their specimens to the best advantage are generally adopting similar plans.

Thus, when Mr. Gould determined on the exhibition of his magnificent collection of Humming-birds, he at once renounced the rank-and-file system, and arranged them in small glazed cases, each case containing a genus, and each pane or side of the case showing a small series of allied species, or a family group of a single species.

When lately at Liverpool, I observed that the clever curator, Mr. Moore, instead of keeping a single animal on each stand, has commenced grouping the various specimens of the same species of Mammalia together on one and the same stand, as several are grouped in the British Museum, and thus giving far greater interest to the group than the individual specimens would afford.

In the British Museum, as an experiment with the view of testing the feelings of the public and the scientific visitors, the species of Nestor Parrots and of the Birds of Paradise, a family of Gorillas and the Impeyan Pheasants, and sundry of the more interesting single specimens, have been placed in isolated cases; and it may readily be seen that they have proved the most attractive cases in the exhibition. A series of reptiles and fish, exhibiting the characters of the families and the more interesting genera, have been stuffed and exhibited, whilst the collection of those animals in spirits and in skins is kept arranged for the use of the more scientific student.

In the same manner, a series of the skeletons, showing the principal forms of each class of animals, has been set up, and the remainder of them kept in boxes, so that a series of the same bone of any number of animals may be laid out for comparison with either recent or fossil specimens, or to show the form the bone assumes in the different genera, which it is difficult to see in an articulated skeleton.

In the Great Exhibition of 1862, Prof. Hyrtl of Vienna exhibited some framed cases of skeletons like those here recommended: one contained the types of each family of Tortoises, another the principal forms of Saurians, &c. They excited much interest, and some cases were purchased by our College of Surgeons.

In some of the Continental museums also I have observed the same plan adopted to a limited extent.

I now exhibit a case of insects, received from Germany, in which what I have suggested is fully carried out. You will perceive that in one small case are exhibited simultaneously, and visible at a glance, the egg, the larva, the plant on which it feeds, the pupa, and the perfect moth, together with its varieties, and the parasites by which the caterpillar is infested. Such cases, representing the entire life and habits of all the best-known and most interesting of our native insects, would be, as I conceive, far more attractive and instructive to the public at large than the exhibition of any conceivable number of rows of allied or cognate species, having no interest whatever except for the advanced zoological student.

I will only add that I am perfectly satisfied, from observation and experience, and that I believe the opinion is rapidly gaining ground, that the scientific student would find a collection solely devoted to the object of study, and preserved in boxes and drawers, far more useful and available for scientific purposes than the stuffed specimens as at present arranged in galleries of immense extent, and crowded with curious and bewildered spectators; while, on the other hand, the general public would infinitely better understand, and consequently more justly appreciate, a well-chosen and well-exhibited selection of a limited number of specimens, carefully arranged to exhibit special objects of general interest, and to afford a complete series for elementary instruction, than miles of glass cases containing thousands upon thousands of specimens, all exhibited in a uniform manner, and placed like soldiers at a review.

The plan has the advantage of being as applicable to a very large as to a small local collection, for a few well-selected cases of animals of any parish or district will teach what they have been prepared to illustrate, and the addition of every well-selected series of specimens will extend the usefulness of the institution, and the better the animals are known to the visitor, the more is the interest they will take in the exhibition.

Specimens are much less liable to injury (and this is a great consideration in a small institution, where only a single curator, often an unpaid amateur, is employed) if they are kept in small well-closed cases, properly pasted up, than if they are kept in large cases that open, where the air changes with every change of temperature; for the air is expelled when the cases are warm, and it rushes in again, charged with dust and destructive gases, when the air within is cold and contracted.

I now turn to a very different subject—one which has always occupied a considerable share of my attention, and on which a few observations may not be out of place on this occasion—viz. the acclimatization of animals. This subject, which has been a favourite one with the more thoughtful student, appears all at once to have become popular; and several associations have been formed for the especial purpose of its promotion, not only in this country, but also on the Continent and in the Australian colonies.

I may observe that the acclimatization of animals, and especially the introduction and cultivation of fish, was among the peculiar objects put forward by the Zoological Society at the time of its foundation, nearly forty years ago—although, as we all know, it has been able to do very little for its promotion.

It would appear, from observations that are occasionally to be met with in the public papers and in other journals, to be a prevalent opinion among the patrons of some of these associations that scientific zoologists are opposed to their views, or, at least, lukewarm on the subject. But I am convinced that they are totally mistaken in such a notion, and that it can only have originated in the expression of a belief, founded on experience, that some of the schemes of the would-be acclimatizers are incapable of being carried out, and would never have been suggested if their promoters had been better acquainted with the habits and manners of the animals on which the experiments are proposed to be made.

The term acclimatization has been employed in several widely different senses:—1st, as indicating the *domestication* of animals now only known in the wild state; 2ndly, to express the *introduction* of the domesticated animals of one country into another; 3rdly, the *cultivation* of fishes, &c., by the restocking of rivers, the colonization of ponds, or the renovating of worn-out oyster- or pearl-fisheries by fresh supplies.

Commencing with the first of these objects, which is by many regarded as the most important, I would observe that some animals seem to have been created with more or less of an instinctive desire to associate with man, and to become useful to him; but the number of these is very limited, and as it undoubtedly takes a long period to become acquainted with the qualities and habits of these animals, and with the mode in which their services may be rendered available, it would almost appear as if all the animals which are possessed of this quality, and are worth domesticating, had already been brought into use. Indeed all those which are now truly domesticated were in domestication in the earlier historic times. The Turkey, it may be said, was not known until the discovery of America; but I think it has been satisfactorily proved that our domestic Turkey is not descended from the wild Turkey of America, but comes of a race which was domesticated by the Mexicans before the historic period. Again, the number of such animals is necessarily limited; for it is not worth while to go through a long process of domestication with the view of breeding an animal that is not superior in some important particular to those which already exist in domestication. For example, where would be the utility of introducing other Ruminants which do not breed as freely, feed as cheaply, afford as good meat, and bear the climate as well as our present races of domestic cattle?

It has been thought that some of the numerous species of African Antelopes might be domesticated here; but every one who has eaten their flesh describes it as harsh and dry, and without fat; and such being the case (even could the domestication be effected, which I very much doubt), such an animal must have some very valuable peculiarity in its mode of life, and be capable of being produced at a very cheap rate, to enable it to take rank in our markets beside the good beef and mutton with which they are at present supplied; and, even supposing it to be semidomesticated only for the park, it could not for an instant be put in competition with the fine venison which it is thought that it might displace.

I am aware that certain French philosophers have lately taken up a notion that it is desirable to pervert the true purposes of the Horse by cultivating him for food instead of work; and that a society of *Hippophagi* has been instituted with this view. Of course, under present circumstances, the flesh of old and worn-out horses is sold for much less than that of well-fed Ruminants; and the *miserable* classes in some countries are glad to obtain animal food of any kind at so low a rate: but whenever an attempt has been made to fatten horses for food, it has been found that the meat could not be produced at so low a rate as that for which far better beef and mutton could be bought.

There are also some small semidomesticated animals, such as the Porcupine and other *Glires*, which are said to afford good meat; but they have long been driven out of the market by the cheapness and abundance of the prolific Rabbit.

With regard to the larger Ruminants (such as the Giraffe, the Eland and some other foreign Deer, the Llama, and the Alpaca), which have been bred in this country, but never brought into general use, I cannot consider them as at all acclimatized. They have almost always had the protection of warmed buildings, especially in the winter; and though they may have lived through a certain number of years, they are liable to attacks of diseases dependent upon our climate, and generally die off before their natural term of existence is completed. I can only regard them as partially domesticated, and that only as objects of curiosity and luxury, and as incapable of being turned, in this country at least, to any useful domestic purpose.

With regard to those animals which may be considered as more or less completely under the control of Man, there exists considerable difference in the nature of their domestication.

The more typical among them, or truly domesticated, such as the Oxen, the Sheep, the Horse, the Camel, the Dog, and the Cat, like the Wheat and the Maize among plants, are never found truly wild; and when they are permitted to run wild, as in the case of horses and oxen in South America, they are easily brought back to a state of domestication, especially if caught young. What may be called the semidomesticated or domesticable animals, such as the Buffalo, the Goat, the Pig, the Rabbit, the Reindeer, the Yak, and some other Asiatic cattle, are found both in the tame and the wild state, and often in the same region and in close proximity to each other. The Asiatic Elephant, and a few other animals which can be made tractable under man's direction, never (or very rarely) breed in domestication; and all the individuals of these very useful races are caught wild and brought into subjection by training. The African Elephant is evidently equally amenable to man's control, and was equally domesticated by the Romans; but the negroes do not seem to appreciate the advantages which they might derive from its domestication, and only make use of its tractable disposition to keep it in captivity until such time as its ivory is best fitted for the market, when, also, they can feed upon its flesh.

All our domestic or semidomestic animals have their proper home in the temperate regions of Europe and Asia. They all, except the Ass, bear great cold better than excessive heat; and even the Ass suffers greatly on the coasts of the tropics. The Sheep, in the warmer regions, require to be driven to the cool mountains during the hot season. In the tropics they lose their wool, and, like the long-haired goats and dogs, change the character of their fur. The inhabitants of the arctic region or subarctic regions of Europe and Asia have partially domesticated the Reindeer.

Either Asiatics have a peculiar aptitude for domesticating animals, or the Ruminants of that part of the world are peculiarly adapted for domestication. In the mountain regions of Tibet and Siberia the Yak has been domesticated, and, like the Reindeer of the arctic regions, it is used as a beast of burthen as well as for milk and food. The steppes of Asia are the home of the Camel and the Dromedary. In the lower and warmer regions of central and southern Asia the Zebu has been completely domesticated; and the natives of India and of the islands of the Malayan archipelago have brought into a semidomesticated state various species of wild cattle, such as the Gyal, the Gour, and the Banting, and have even obtained some hybrid breeds between some of them and the Zebus, as well as the Buffalo, which they have in common with Africa and the south of Europe. In the park of the Governor-General of India there are large herds of the Black Antelope, the Axis Deer, and the Porcine Deer in a semidomestic state; and our officers found in the park of the Emperor of China at Pekin more than one species of domesticated native Deer. We have as yet received from Japan only one peculiar species of domestic animal, viz. a Pig with a plaited face (*Sus plicatus*); but it is not unlikely that the Deer called *Cervus Sika* is a domesticated species, like the *Cervus Swinhoii* of Formosa. In Celebes there is a small Buffalo called *Anoa*; and in the same island, as well as in Java and some of the other islands of the Indian Ocean, most of the aboriginal pigs, including the Babirussa, have been more or less completely domesticated. These numerous instances will suffice to show how largely Asiatics have been enabled to draw around them for additions to their domestic or half-domestic races; but a glance at the habits and manners of most of them will suffice to show how little they would be suited to our more northern climate, and how small would be the advantage gained were it possible to introduce them here.

Africa has only sent to Europe the Guinea-fowl, that vagrant from our farmyards; but it too has some domesticated animals of its own. In the more fertile and well-watered parts of that continent there exist at least five different kinds of domestic cattle:—the Buffalo (*Bos Bubalus*) and humpless cattle, which appear to be of the same species and to be derived from the same source as the Buffalo and domestic Oxen of Europe. The African Zebu (*Bos Dante*) appears to be distinct from the Zebu of India, and is probably an indigenous domestic race; and the long-eared bush-cattle, or Zamous (*Bos brachyceros*), are certainly an aboriginal species peculiar to tropical Africa. Besides these, it has, in the Desert regions, the Camel in common with Asia: this animal is also partially domesticated in the southern parts of Europe.

Captain Burton observes, "The Negro fails in domestication of lower animals, because he is deficient in forbearance with them; in a short time his violence will ruin the temper of a horse, and he will starve an English dog for which he has perhaps paid a high price."

America had only three or (if we reckon the Dog) at most four domestic animals belonging to the country before it was discovered by Europeans, who have, however, since introduced into it most of those which they themselves previously possessed. The Turkey was only domesticated by the native Mexicans; and it may be observed that in Europe these birds have only been imperfectly naturalized, requiring peculiar care and attention in their early stages to protect them from the effects of an ungenial climate. The Llama and Alpaca were also early domesticated by the native Peruvians; and it would appear as if these animals would not bear transportation to other quarters. All the attempts, at least, which have hitherto been made to introduce them into Europe and Australia have resulted in failure. The Esquimaux inhabiting the more northern regions have a peculiar race of dogs, which are in the highest degree useful to them; but it appears to be of the same original stock with the dogs of Europe, and had probably passed from one continent to the other.

In some parts of this vast continent, the Oxen and the Horse, since their introduction from Europe, have so firmly established themselves in a half-wild state as to be often hunted and killed for their hides alone.

Australia and the islands of the Pacific have no native domestic animals, if we again except the Dog; and Australia alone has any mammals sufficiently large to be hunted for their flesh. There formerly existed in New Zealand a large bird (the Moa) which was eaten by the natives; but it seems to have been exterminated, or nearly so, before the colonization of the islands.

European animals have been largely and advantageously introduced throughout the Pacific Ocean, and in some cases have become wild and even dangerous.

As in Europe, all the domestic animals of these various parts of the world appear to have been brought into their present condition for many ages, inasmuch as they were all found in a domestic state when the several countries were first visited by Europeans.

And an attentive study of the list, and of the peculiarities of the animals composing it, induces me to believe that, in attempting to introduce new domestic animals into some of our colonies, it would be desirable not to confine ourselves to the European breeds, but to ascertain whether some of the domestic races of Asia or Africa might not be better adapted to the climate and other conditions of the colony, although, for reasons to which I have before adverted, it would neither be worth the trouble, nor consistent with good policy, to attempt their introduction here.

There is evidently ample room for such experiments, which might be advantageously made, for instance, in the colonies of the coast of Africa, where our horse, ass, oxen, sheep, and goats, and even dogs have greatly degenerated, where the horse and the ass live only for a brief period, where the flesh of the ox and sheep is described as bad and rare, and the flesh of the goat, which is more common, is said to be tasteless and stringy. The pig alone, of all our domestic animals, seems to bear the change with equanimity; and the produce of the "milch pig" is often sold to passengers of the mail packets and the ships on the stations, as the milk of the cow or even the goat is rarely to be obtained. Unfortunately both the white and the black inhabitants are merely sojourners in the land, and do not seem to possess sufficient energy or inclination to make the experiment themselves.

Some persons have confounded the collecting of wild animals in menageries for show, or for the uses of the gladiator, with the acclimatization of them. The custom of collecting animals for this purpose is coeval with our earliest historical records. They are to be seen on the monuments of Assyria, Egypt, Rome, and Mexico; and the natives of some of the more uncivilized countries exhibit their love for wild animals, some women even going to the extent of suckling them like, or even with their children. Some domestic animals, as the Ox, the Cat, and even wild ones, as the Baboon, are considered as sacred by the Egyptians, Hindoos, and some of the negroes of Tropical Africa.

Secondly, as regards the *introduction* of the domestic races of one country into another, there can be no doubt that this is a much more important object in relation to our Australian colonies, and other settlements planted in waste lands, than it is to the old countries, such as all the European states, and that it has been pursued, as far as they are concerned, with great success. Dr. George Bennett, in the third annual 'Report of the Acclimatization Society of New Holland,' has well observed, "We have lately heard of acclimatization dinners in London and other places, but a dinner in New South Wales of food naturalized in the colony occurs every day, and a finer display cannot be surpassed in any country." Few countries were so badly supplied by nature with useful animals and plants as the Australian continent; and while we do not receive in Europe a single indigenous product for our tables, either animal or vegetable, from Australia, which in this respect has added nothing to the comfort of civilized man, no country has been more richly supplied with the useful products of other parts of the world; for not only have the natural productions of the temperate regions of Europe been largely introduced, but even the flowers and fruits of tropical and subtropical regions.

There is no doubt that the introduction into Australia of animals long domesticated in Europe is far more easy than that of semidomesticated animals from countries in a ruder state of society. Perhaps this may explain why the leading animals and plants to which Dr. Bennett refers in this Report, and which, be it observed, have all been introduced by individual enterprise, have succeeded so much better than the later attempts to introduce such animals as the Llama and various ornamental Mammalia and birds. Among other attempts referred to are the blackbirds, thrushes, starlings, and skylarks of Europe: these latter seem to be established in the Botanic Garden, but it is doubtful whether such birds can find their appropriate food except in cultivated gardens or near the towns.

On the other hand, it is to be observed that the introduction into a new country of domestic or semidomestic animals is not always an unmixed advantage. Thus, the domestic pig has been completely naturalized in New Zealand: there its great multiplication has rendered it so mischievous a pest to the sheep-farmer, from its following the ewes and eating the newly-dropped lambs, that the flock-masters have been compelled to employ persons to destroy the pigs, paying for their destruction at the rate of so much per tail; many thousands are thus destroyed in a single season. Indeed it has been proved by Dr. Hooker's interesting paper "On the Replacement of Species," that the introduction of a new animal or plant often results in its destroying and taking the place of some previous inhabitant, thus rendering its introduction a matter of doubtful advantage, or at all events a question to be approached with considerable caution.

It is, however, manifest that, on the whole, more useful results are to be obtained from the introduction of races already domesticated into countries to which they have not reached, than from the attempt to acclimatize animals for the most part either unsuited to the climate or capable only of an inferior degree of domestication, or inferior in quality to those which are already in possession of the ground.

Under the *third* head, the *cultivation* of fish, I have very little to observe, although the subject is unquestionably one of great importance. But as yet we have very little practical information upon the question; and I consider that the advocates of the system are only for the present feeling their way, as the experiments have not been pursued for a sufficient length of time to produce any positive or reliable results. To replenish rivers in which the fish which formerly inhabited them have been destroyed, it is necessary closely to study the habits of the fish, and to imitate as much as possible their natural proclivities.

Thus, for example, it appears to me that, when attempting to introduce young artificially hatched fish into a river, we should place them in the smallest streamlets, where the fish would themselves deposit their ova, and not in the wider parts of the stream, where they are liable to injury from various causes. Again, the notion of fishing the breeding-fish out of a river, collecting their eggs and artificially impregnating them, seems to me an unnatural mode of proceeding, and such as is not practised in the cultivation of any other animal. I cannot see any practical advantage that can possibly be derived from it.

For the replenishing of worn-out fisheries of oysters and pearl-shells, all that seems necessary or advantageous to be done is to place round the bed twigs and various similar substances so arranged as to retain the eggs when deposited, and to protect them by all the means in our power, leaving the beds undisturbed for a sufficient time to allow the new brood to become firmly established in them.

Besides the numerous attempts at home to replenish our rivers and oyster-beds, much has been written and large sums have been expended in trying to introduce salmon into the rivers of Australia; but the many failures show how little those who undertook the task were acquainted with the most common physiological questions connected with the removal of fish, and how small was their knowledge of the habits and peculiarities of the fish which they proposed to remove. To show this, I may mention that they first attempted to send the eggs of salmon to Australia packed in mass, but they soon rotted. I mentioned during a discussion on the subject at the Zoological Society, that the eggs would more likely arrive alive if they were packed in ice (as Dr. Davy had informed me that he had carried trout alive from the North of England to the West in that way). Some eggs were sent to Australia so packed in a ship called the 'Beautiful Star,' but the transporters had so little faith in my plan that the box was forgotten when the ship arrived in Australia, and was stumbled on much injured when the ice-house was visited some time after the arrival of the ship; fortunately the majority of the eggs were found alive, and they were the first salmon eggs hatched in Australia. What, indeed, could be more absurd than the attempt to introduce salmon into rivers which, for a considerable part of the year, are reduced to a series of stagnant pools. I think I may venture to predict that, if ever salmon are introduced into Australia, they are much more likely to succeed in the deep and rapid rivers of Tasmania than in the streams of Australia proper. At the same time, when we consider the very limited geographical range of the salmon in Europe, confined as it is to those rivers which have their exit into the Northern Seas, that the attempt to remove it from one river to another in Europe has always been a failure, and that it is not only necessary that the salmon should have a river similar to that which it inhabits here, but also the same food and other peculiarities, without which apparently it cannot subsist, I must confess that I have no great faith in the success of the introduction of the salmon into Australia. I think, therefore, that it is to be regretted that the Australian Acclimatization Society do not rather make some experiments on the introduction of the gouramy, or some of the other edible fish of countries nearer to and more resembling their own.

With other members of the British Association, I have received a reprint of the Rules of Nomenclature drawn up by Mr. Strickland and others, and printed in the Report of the Twelfth Meeting of the Association (1842), accompanied with a request to examine them carefully, and to communicate any suggestions to Sir William Jardine, Bart.

I can only repeat the suggestion I made when the rules were under the consideration of the Committee of the Natural History Section of Manchester, viz., that the rules be not adopted until they have been compared with Linnæus's 'Philosophia Botanica,' Fabricius's 'Philosophia Entomologica,' Illiger's 'Prodromus,' and DeCandolle's 'Théorie Elémentaire,' and that when they are not in conformity with the laws proposed by these authors, which have been accepted by all recognized systematic naturalists, the reasons for the proposed alterations should be given in detail. After some discussion, my suggestion was adopted, "and they resolved that the Committee of the Section of Zoology and Botany have too little time during the Meeting of the Association to discuss a Report on Nomenclature, and therefore remit to the Special Committee appointed to draw up the Report to present it on their own responsibility."

The rules were inserted in the printed Report, through the personal influence of Mr. Strickland, who was then a member of the Council, but they never received the sanction of the British Association.

In the 'American Journal of Science and Art' for March, 1864 [reprinted in the 'Annals' for June, 1864,] there are some admirable observations by Dr. Asa Gray on some of these rules, which entirely accord with my own views, and which I recommend to the consideration of the Committee.

In conclusion, I would request you kindly to bear in mind that I have simply thrown these observations together in the hope of eliciting the opinions of my colleagues in the Section.

My only desire is that we may all heartily concur in doing all that is in our power to render this and other institutions conducive to the increase of the knowledge, the happiness, and the comforts of the people.

BOTANY.

Notice of some Rare Scotch Plants. By Professor BALFOUR, *F.R.S., F.L.S.*

Some Scotch plants, especially Alpine species, are restricted in their localities from causes which are as yet imperfectly known. Peculiarity of soil and exposure may in some measure account for the restriction; but this does not seem to be sufficient. Some of the restricted species are common to Britain and Scandinavia and the mountains in southern Europe; and they have been looked upon as outposts of a flora which existed in the country when it was united geologically with other European countries. The author had lately visited some of the localities referred to. He exhibited specimens of *Sagina nivalis*, a Scandinavian plant which was gathered by himself in Benlawers in 1847, and supposed to be a variety of *Alsine rubella*. Mr. Syme, within the last year, when examining plants for his edition of Sowerby's British Flora, happened to fall in with some specimens of the above plant, as gathered by the author, and pointed out that it was a plant new to Britain. He took occasion to visit Benlawers in August, and he gathered numerous specimens of the plant. He also found it on Binnain, or, as it is sometimes called, Stobinnain, a mountain rising to the height of 3800 feet, near Ben More in Perthshire, and at the head of the Braes of Balquiddar. This is an interesting addition to the British Flora. Another station visited was the mountain called the Sow of Athole, in Inverness-shire, the locality for *Phyllodoce cærulea*, one of the rarest British plants. The plant had been nearly eradicated by a nurseryman many years ago, and it was feared that it had disappeared; the plant, however, still exists on the hill, although not in large quantity. Among other plants confined to single localities in Scotland he exhibited the following:—*Thlaspi alpestre*, Canlochan, Forfarshire; *Lychnis alpina*, Little Gilrannoch, Forfarshire; *Arenaria Norvegica*, Unst, Shetland; *Lathyrus niger*, Pass of Killicrankie; *Lathyrus maritimus*, var. B., Unst, Shetland; *Oxytropis campestris*, single rock in Glen Phu, Clova (this plant is found also on the southern Alps of Europe); *Pyrus fennica*, Island of Arran; *Saxifraga cernua*, Benlawers; *Pinguicula alpina*, Black Loch, near Nairn; *Convallaria verticillata*, near Blairgowrie; *Eriocaulon septangulare*, Isle of Skye; *Carex Grahami*, single rock in Clova; *Saxifraga cæspitosa*, Ben Avon, Braemar; *Monotropa hypopitys*, Cawdor Woods; *Eleocharis Watsoni*, near Taynlone, Argyleshire; *Eriophorum alpinum*, Durness, Sutherlandshire; *Kobresia caricina*, Perthshire; *Trichomanes radicans*, Island of Arran.

The following plants were also exhibited as restricted to a few Scotch localities:—*Draba rupestris, Alsine rubella, Oxytropis Halleri, Astragalus alpinus, Saxifraga Hirculus, Saxifraga rivularis, Mulgedium alpinum, Gentiana nivalis, Myosotis alpestris, Bartsia alpina, Ajuga pyramidalis, Orchis pyramidalis, Juncus castaneus* and *biglumis, Luzula arcuata, Carex rariflora, rupestris, leporina, Vahlii, vaginata, Poa minor, Cystopteris montana.*

On a Curious Form of Aquilegia vulgaris. *By* Professor BUCKMAN, *F.L.S., F.G.S.*

In the usual flower of the Columbine each petal is so spurred as to produce a form not unlike a cornucopia. In the example under notice, the claw and limb of each petal are so entirely flat as to give the flower the form and appearance of some of the more showy-coloured species of *Clematis*. This accidental form, so far assimilating itself with clematis, anemone, and others, gives rise to the following consideration:—Is not the patent unspurred form of Columbine its normal condition, and the spurred form a result of cultivation?

On Datura Stramonium *and* Datura Tatula. *By* Professor Buckman, *F.L.S., F.G.S.*

The object of this paper was to show that *Datura Stramonium* and *D. Tatula* were identical in points of structure, and therefore could only be considered as varieties of a single species. That the heightened colour in the flowers, stems, and leaf-nervures in the *D. Tatula*, when compared with *D. Stramonium*, will be a deeper purple in proportion to the warmth of the summer, the milder climate, and amount of sun to which it is exposed. That though identical in species, the fine forms of the *D. Tatula*, as much as six feet high, are very distinct in medicinal properties, as indicated by a more powerful smell, and evidenced by the almost disuse of the *D. Stramonium* and the increasing employment of *D. Tatula* in asthmatic and chest complaints.

On the Decay of Species, and on the Natural Provisions for Extending their Duration. By Dr. Daubeny, *F.R.S., F.L.S., Professor of Botany, Oxford.*

It may be assumed as an acknowledged fact, not only that every organized being has a limit assigned to its existence, but also that the species themselves, both in the animal and vegetable kingdom, wear out after a certain period. But it still remains to be inquired whether there may not be certain natural contrivances for postponing this inevitable termination to a later period than would otherwise happen. Confining himself to the vegetable kingdom, the author suggested that one of these provisions would seem to be the introduction of new varieties, which, by diverging somewhat from the original type, acquire fresh vigour, and thereby tend to prolong the existence of the species from which they are derived. One of the modes by which this variation in character is secured follows as a consequence from the mode by which plants are reproduced through the instrumentality of the floral organs, by the concurrent action of which an individual, intermediate in character between its respective parents, and therefore slightly diverging from both, is the result; so that this mode of multiplying the individuals of a species seems to fulfil an important subsidiary end, even in cases where, as in plants of low organization, the increase of the species is sufficiently provided for by means of buds. Accordingly plants propagated by cuttings seem in general to adhere more uniformly to the same type, and at the same time to be more limited in their duration than those produced from seeds. But this deviation from the primæval type is still more completely carried out when the pollen of one plant is made to act upon the embryo of another; and hence may arise those numerous contrivances for preventing self-fertilization which Mr. Darwin and others have pointed out. To the same cause, perhaps, may be owing the increased vigour which a plant acquires by being removed into a fresh soil, or into a distant country. Many, no doubt, will regard it as a sufficient explanation of these facts, to appeal to the changes produced in the constitution of a plant by such causes, as tending to multiply the chances of some members of the species becoming adapted to those alterations in the external conditions which occur in the course of time, and which might otherwise have proved fatal to its continued existence. There are, however, reasons for believing that this solution will not embrace all the facts of the case, and that, even when every facility for producing the utmost amount of variation of which a species is susceptible exists, a period at length arrives when a species dies out, although the climate, soil, and other external conditions continue, so far as we can perceive, propitious.

On the Old Welsh Mistletoe Cure for St. Vitus's Dance. By M. Moggridge.

On Euphorbiaceæ. *By* Dr. Müller.

On Balatta and other Gums regarded as a Substitute for Gutta Percha. By Dr. R. Riddell.

The author spoke of the gum as a very excellent substitute for, and quite equal to, the adulterated or reboiled gutta percha from Singapore. They were indebted to Dr. Van Holst, of Amsterdam, Berbice, for bringing this gum first to the notice of the Society of Arts in 1860. It abounded in the forests of British Guiana, and was especially prolific at the time of the full moon. On the day of the full moon the yield of gum was from six to ten times greater than at other times. After the tree had been tapped, it was said it could be tapped again every two months. The wood was used for building purposes and for furniture, and he was informed the tree was not injured by being tapped. A tree yielding a gum similar in every respect was discovered to exist, by Gen. Cullen and Col. Cotton, in 1853, growing along the whole line of the Western Ghauts on the Malabar coast, Southern India, from lat. 8° 30′ to lat. 10° 30′, at an elevation of from 2500 to 3000 feet above the sea. The climate of the country where the bullet-tree is found in Berbice is unhealthy; but, however that may be, probably some of the free slaves of America might be induced to settle there and become traders.

Mr. YATES exhibited specimens of *Cycas revoluta, Cycas circinalis,* and *Ceratozamia mexicana.*

ZOOLOGY.

On the Manatus Vogelii. *Extract of a Letter to* Sir JOHN RICHARDSON *from* Dr. BAIKIE.

Dr. Baikie is at present trying to get the skeleton of the Ayú, or *Manatus Vogelii,* of which Professor Owen described a skull. The true habitat of this animal is the Niger, below the rapids. Its existence in the upper country, where Vogel perished, has not been ascertained.

On an Ancient Cornish Barrow. By C. SPENCE BATE, *F.R.S.*

This paper refers to a mound in Constantine Bay, in which, on being cut, was found an irregularly shaped stone covering a pit about twenty inches deep, and fifteen in diameter. Within this was a rough earthen vase, containing a quantity of bones, both vase and bones being much broken; the latter were undoubtedly human remains. The bones had evidently undergone the action of fire.

On a Human Skull and the Bones of Animals found with Pottery in a Kjökkenmödden on the Coast of Cornwall. By C. SPENCE BATE, *F.R.S.*

The remains were found near the ruins of the ancient church of Constantine, on the north coast of Cornwall. The bones were those of a sheep, lamb, deer, and roebuck. The pottery consisted of three qualities. The author thought there could be no doubt that a small round islet in the middle of the bay, near the mound, at one time was a continuation of the sandhills upon the mainland. It was evident, therefore, that their separation had taken place since the beds of shells and bones were deposited. This circumstance afforded presumptive evidence that the site of the ancient occupation was anterior to the period when the land was swept away, and that in extent it must have been much greater than at present. From one extreme point to the opposite these mounds continue for half a mile along the coast. Taking into consideration that portion which has been washed away, the author thinks this old shell-mound must have been the site of a very extensive village of prehistoric man. The human skull was found not in the shell-bed, but in the sand a short distance from it.

Observations on the Spinnerets of Spiders. By RICHARD BECK.

The purpose of this paper was to draw the attention of naturalists to the aid afforded by the binocular microscope in the determination of the external forms of the spinnerets of spiders, which, when understood, will no doubt supply good generic and specific characters; but, to compare the details of their structure, it is necessary to make camera-lucida sketches from living specimens, and many of these the author had drawn to the same scale of 220 diameters. The following facts alluded to in the paper may be mentioned as of some importance:—The generic differences in the spinnerets relate to the form of the mammulæ or of the papillæ; the specific differences, to the number and arrangement of the papillæ. Different papillæ have distinct functions, which are referable to the habit of the spider. The features of the inferior mammulæ are the most constant, and supply the ordinary thread and the means for its attachment. The mammulæ of the *Ciniflonidæ* would be more correctly described as seven and not eight in number, and the spines forming the calamistrum of this family, as described by Mr. Blackwall, are not confined to two rows merely, but extend over one side of the leg. The superior mammulæ of *Pholcus phalangioides* have no papillæ on them. A spider's line is not generally formed of aggregated threads proceeding from numerous papillæ; and should more than one thread be present, they may be separated. The papillæ undergo great changes at every moult, but especially at the last one, when the male loses some of the more remarkable features, and the female acquires fresh ones, these results being perfectly consistent with the sexual requirements.

On the Testimony of Local Phenomena to the Permanence of Type. By B. Beddoe, *M.D.*

On the Natural History and Cultivation of the Oyster. By Frank Buckland.

The author began by stating that a new phase was now presenting itself in the study of natural history, viz. its application to practice; it costs just as much time and labour to examine useless things, as things which would be commercially beneficial to mankind, such as the salmon, the oyster, the herring, the sole, the turbot, &c. That it is, moreover, profitable to cultivate the waters he showed by instancing the Tay, the rent of which was said to be £15,000 per annum, and of the Spay, which produced £12,000 worth of salmon annually. Calculations he had made showed that the trawling-ground in the North Sea was worth tenpence the square acre, and that the Bay of Galway was worth more per acre than the land surrounding it. Having heard that there had been a general failure of spat this year on the English coasts, he had travelled over a large extent of seaboard to see if he could ascertain the cause; but the whole thing was enveloped in mystery. He then went, in company with his friend, T. Ashworth, Esq., to the Ile de Ré, near La Rochelle, where the breeding of oysters has been carried on so successfully for the last five years. He paid a high compliment to the sagacity and perseverance of Dr. Kemmerer, resident physician in the island, the statistics of which in wine, salt, and oysters he (Mr. Buckland) had tabulated; and to M. Bœuf, a stonemason, who was the first to hit off the method of cultivating oysters artificially. He then traced the oyster's history from its birth upwards, describing the mode in which the mother ejects the young in clouds like fine dust, and the perils and troubles to which the young and delicate creatures are subjected during the few days they had to swim about and amuse themselves before they became permanently settled for life; for, when once fixed to an object, they were never able again to change quarters afterwards. It has been said that it was impossible to cultivate oysters; but to prove that it was done in the Ile de Ré, he had brought over witnesses in the shape of tiles, stones, broken bits of pottery, and even glass, to which oysters had attached themselves, like grapes, in large bunches. All these were explained, and reasons given why the oysters chose one place and not another,—why they died here, and lived there,—and elucidated principles which he earnestly requested the audience to remember, as there could not be too many observers in this most important branch of natural industry, which he trusted would be shortly applied to British shores. With regard to the failure of spat this year, which was so general that it extended even partially to the Ile de Ré, he stated that hitherto the attention of scientific men had not been directed to the point. An event, moreover, which the Ladies would appreciate, had taken place in Ceylon, viz. the sudden death, from unknown causes, of whole banks of the pearl-bearing oysters, the consequence of which would be that the price of pearls would be enormously increased. He concluded by stating that, in consultation with the learned and energetic Prof. Coste and other French Government officers,—Dr. Grammont, M. Gerbe, M. Tayeau, M. Bourie, and Dr. Kemmerer,—he had submitted five principal causes of the failure of the young oysters in England and France. To these all had agreed; still there must be other causes as yet to be discovered; and he trusted this important national subject would be earnestly taken up by the numerous talented and highly scientific members of the British Association who were then present.

On Salmon-hatching and Salmon-ladders. *By* Frank Buckland.

The author said—Whereas the oyster is stationary, and is treated in its cultivation more like a mineral than an animal, the salmon is literally a vagabond, always on the move, and never remains long together in the same place. Upon this fact depend its preservation and multiplication, in spite of the many difficulties it has to contend with,—the greatest enemy being man. The conditions of a good salmon fishery are three:—1, the sea; 2, a river; 3, mountainous or hilly country. From careful observation of geological causes, especially of the watersheds of rivers, the elevations of land, it might be determined whether a river was or was not suitable for salmon. Such was the marvellous instinct which compelled the salmon to run up from the sea to the elevated ground fit for spawning, that the salmon caught at the mouth of the Rhine, and which are sold in the London market, run up that river no less than 630 miles to their spawning-ground, and, of course, 630 miles back again. Thus we may fairly conclude that a fish weighing twenty pounds has travelled in its journeys up and down the river no less than 6000 miles. The salmon hatched in the upper waters of the Rhine are caught at Rotterdam, where there are five fishing-stations: the annual produce of these fisheries is said to be 200,000 fish, which, calculated at 1*s.* 6*d.* per pound, would amount to an immense sum of money. These salmon are, however, stopped in their upward progress by the falls of Schaffhausen, and it was a great pity that some arrangement was not made to allow them to get up. The fish had very rapid currents to contend with, and at the mouth of the Rhine they were caught with gigantic nets that were payed out by a steamboat, and hauled ashore by horse-power. He then gave reasons why artificial hatching of salmon should be encouraged. First, because it might be said that the salmon did not know their own business, and were very bad nurses; for it has been calculated on excellent data, that out of one thousand young ones only one ever became human food. Salmon made their nests in the gravel one over the other, heaping up immense mounds, so that the bottom eggs would of necessity be crushed, and only those near the top ever hatch out. Secondly, there were so many enemies of the salmon, both when in the form of an egg and in the form of a young fish, that they required preservation and careful watching, like young pheasants. Several of these enemies were enumerated, and a good word said for the water-ouzel, who eats, *not* the salmon-eggs, but the insects that come to feed on the eggs. Artificial breeding had restored salmon to the Thames, for his esteemed and persevering friend Stephen Ponder, Esq., of Hampton near Hampton Court, had for the last three years, in his private greenhouse, been hatching out many thousands of salmon and trout, and turned them into the Thames. The consequence is that in the shallow waters above Hampton Court, great numbers of young salmon and trout, from 1 to 5 inches long, could be seen any fine sunny morning. All this was done on behalf of the Thames Angling Preservation Society, to whom the City of London had intrusted the twenty-two miles of this noble river, for the benefit of all anglers with rod and line; no netting, except for bait, being allowed. It was still a question what would become of these salmon; but in 1866 the main drainage would be finished, and then they would have a chance of returning from the sea. It had been stated that the French piscicultural establishment at Huningue, over which his friend M. Coumes, the eminent French Government Engineer, presided, was retrograding; but he could state that this year more than one million salmon-eggs had been collected, and a large proportion distributed gratuitously all over France, and also to many parts of England. The laws for the protection of fish in France were deficient; but M. Coste had informed him that a new law would be proposed next season enabling him to shut up the fishery, and preserve the fish of any river in France for three years. The salmon-laws in

England afforded protection for the fish; and his friend, Mr. Ffennel, Inspector of Fisheries, was always busy in obtaining facts, which would enable him to gain knowledge on which the laws for the future should be amended and regulated. He had tried last year to obtain a hybrid between a salmon and a trout, and had been much laughed at for his pains. Still he was pleased to inform the meeting that Thomas Garnett, Esq., of Clitheroe, had succeeded, not only this year, but also in previous years; and this gentleman was the first in England to obtain success in this curious experiment. M. Coste had moreover shown him, a few days since, in Paris, several specimens of hybrids between salmon and trout, and also one between the trout and the "ombre chevalier," or charr, the latter being a most curiously striped fish. M. Coste had also shown fish hatched from the eggs of a salmon *which had never been to the sea*, having been confined all its life in a freshwater pond, proving that even though salmon do not thrive without going to the sea, still they will carry eggs capable of producing young. Upon the subject of salmon-ladders Mr. Buckland was very earnest, pointing out that it was not only cruel, but exceedingly short-sighted policy not to assist the salmon to get to the upper waters to lay their eggs; it was just the same as not putting a ladder to allow the hens to get up to their roosts. How could salmon be expected to get over a wall any more than a human being, unless a ladder were provided for either fish or man? So with the salmon-ladders. He then explained other difficulties, particularly that of finding a grating to prevent salmon swimming up mill-races, and getting injured by the mill-wheels. No grating had hitherto been invented which at the same time would prevent the salmon running up and not lead back the water on to the wheel and stop its action. Mr. Buckland concluded his paper as follows:—"Thus, then, I have endeavoured to bring before the members of the British Association certain facts relative to two great branches of British industry—the cultivation of the sea and the cultivation of the rivers; the revenues derived from these, both to private owners and to the public in general in the form of food, would, if put together, amount to an enormous sum, and still neither industry is as yet half developed. As regards the artificial hatching of oysters, so that they should be taken inland like the salmon, the question presents enormous difficulties; the question of space, the quantity of water required, the temperature, and many other conditions are as yet undetermined, and I see at this moment a mountain of difficulties before me. I have, however, taken my staff in hand, and am preparing to ascend that mountain, at all risks. I am anxious, therefore, to bring the results of many hundred miles of travel and of many weeks of out-of-door observations in England, Ireland, and France, before the British Association, in order that the scientific men of England may know that the investigation into the habits and improvement of these two creatures—the salmon and the oyster—is no mere child's play nor simply amusement, but, on the contrary, the very foundation-stone of a very large and important British industry, to which the experienced minds of scientific men have only to be directed in order to produce great and beneficial good to the public, and especially to the poorer classes of society."

On a very Ancient Human Cranium from Gibraltar. *By* G. Busk, *F.R.S., Sec. L.S., F.G.S.*

The cranium that formed the subject of this communication was found in a quarry situated under the north face of the Rock of Gibraltar; and from the matrix with which it was thickly covered, and which contained a very large proportion of coarse rolled siliceous sea-sand, similar to that which is blown up in such large quantities against the north-eastern end of the rock, it was apparent that it had been lodged in the superficial part of the *talus* in which the quarry is worked. The remarkable form of the cranium, resembling that of the one found in the Neanderthal Cave, was described, together with the peculiar conformation of the face and jaw apart, which is wanting in the latter.

The general appearance and condition of the bone showed that it was of great antiquity, but from the absence of any associated remains, and of very precise information as to the site in which it was discovered, it was impossible to assign any approximate period to it.

The paper concluded with a comparison of the various proportions of the cranium with those of the *intertropical negro, Australian,* and *Tasmanian* races, and it was thence concluded that, of these three types, it most nearly corresponded with the Tasmanian, and with certain tribes of Western Australia, which are usually distinguished by the great comparative lowness of the skull, which was considerably less than the breadth.

Contributions to the Anatomy of the Quadrumana, with a Comparative Estimate of the Intelligence of the Apes and Monkeys. By EDWARDS CRISP, *M.D.*

This paper was illustrated by a large number of drawings and preparations, the object being to show the difference between the structure of Man and the Quadrumana. The tympanic bones of Man, the Gorilla, the Chimpanzee, and Orang were exhibited. The bones of a large Orang, brought from Borneo by the late Sir Stamford Raffles, the height of the animal being about four feet, whilst the expanse of the arms from tip to tip of the longest finger was seven feet eleven inches; the very thick pad at the flexures of the fingers and toes in this old animal was also pointed out, as was the twisted form of the gall-bladder in the Chimpanzee and Orang. The more rounded form of the eyelids, the absence of the pearly white of the eye, the great length of the spinous processes of the cervical vertebræ, especially in the Gorilla, the length of the intestinal tube in a great many species of apes and monkeys, the character of the intestinal glands, the relative weight of the brain and of the eye, the form of the larynx, and the number of rings in the trachea, and many other characters were alluded to. A comparison was also made between the diseases of man and of the quadrumanous animals, the author drawing his deductions from an examination of ten anthropoid apes, and 210 monkeys of various species that died in confinement in this country. In many respects it was inferred that the character of disease differed materially in these brutes from that observed in the human family. The presence of an *os penis* both in the Chimpanzee and Orang (not mentioned at the Meeting), discovered by the author, is considered a great mark of inferiority as regards position in the animal scale. As regards the intelligence of the anthropoid apes, the author thought that it was inferior to that of many of the lower monkeys, and in many respects to that of the dog and the elephant. The conclusions were as follows:—1. That the anthropoid apes, both anatomically and in reference to their amount of intelligence, are not entitled to the elevated position in which they have been placed by some anatomists. 2. That the line of demarcation between man and these brutes is so wide and clearly defined as to entitle the human family, as maintained by Blumenbach, Cuvier, and others, to a separate and *exclusive* division in the animal scale.

On the Anatomy of the Struthionidæ, *Ostriches, Rheas, and Casuaries. By* EDWARDS CRISP, *M.D.*

In this group of birds the author pointed out, from his own dissections of the Ostrich (*Struthio camelus*), *Rhea Americana, R. Darwinii,* the Casuary (*S. casuarius*), the Emu (*C. galeatus*), the Moruk (*C. Bennettii*), and the Double-wattled Casuary (*C. bicarunculatus*), the great and important differences in the visceral anatomy of these birds, more especially as regards the length of the alimentary canal, the character of the gizzard, the cæcal appendages, and the intestinal mucous apparatus. Thus, in the adult Ostrich, the intestinal tube, including the appendages, measured 70 feet 6 inches; that of the *Rhea Americana,* 15 feet 11 inches; of the Casuary, 14 feet 8 inches; of the Emu, 13 feet 4 inches; of the Moruk, 6 feet 7 inches; of the Double-wattled Casuary, 8 feet,—the length, as in nearly all animals, depending somewhat upon the age of the bird. The Ostrich had a very thick and heavy gizzard, that of the Rhea was much smaller, whilst the gizzards of the other members of this group were comparatively thin.

A paper was appended from Mr. Bartlett, of the Regent's Park Gardens, showing that the Ostrich and Rhea had yellow or yellowish-white eggs, whereas the Casuary, Emu, and Moruk had green eggs. The feathers of the Ostrich and

Rhea were single, whilst those of the Casuary, Emu, and Moruk had two feathers from each quill. The Apteryx, another member of this family, laid a white egg, the weight of the bird being 60 ozs., that of the egg 14 ozs., forming the most remarkable example in oology of the large size of the egg as compared to that of the bird.

On the Mollusca of Bath, and an account of Parasites found in Anodon cygnea. *By* J. E. Daniel.

The Bath Natural History and Field Antiquarian Club had invited the author to prepare a list of the mollusca found in the vicinity of the city. The list contained ninety species, included in twenty-eight genera. The *Anodonta* found in the canals in the neighbourhood present objects of great interest in the parasites with which they are infested. The number of animals found in *Anodon cygnea* varies from about five up to as many as thirty. The parasites found in *Anodon anatina* are not so numerous, and they vary slightly in form, are darker and not so brilliant, and the abdomen is longer and not so tumid. The author had seen an entozoon living within the fleshy parts of the branchiæ, which may possibly be the larva of which the parasite before described may be the imago.

Some Observations on the Salmonidæ, chiefly relating to their Generative Power. By John Davy, *M.D., F.R.S., &c.*

In this communication the author first noticed the remarkable fact that the young salmon, the male in its parr-stage, has its testes fully developed, and that its milt is shed before it becomes a smolt and leaves the river for the sea—a fact the more remarkable, as the female of the same age has the ovaries undeveloped, merely in a rudimentary state.

He next considered the question whether the sea-trout and the common trout resemble the salmon as to the preceding peculiarity of function in the young fish. From his own observations, the conclusion he has arrived at has been in the affirmative as regards the former, and the negative as regards the latter.

Thirdly, he offered some remarks on the age at which the salmon and sea-trout begin to breed, adopting the commonly received opinion as well proved, that the salmon spawns on its first return from the sea as a grilse; but, contrary to what is supposed, that the sea-trout does not spawn until after a second return from the sea.

Fourthly, he adverted to the question of the spawning of the Salmonidæ, whether yearly or only in alternate years, stating facts which had come under his own knowledge, inducing him to infer that all the several species, viz. the salmon, sea-trout, common trout, and charr, have a fallow season, and that the fish of each kind called barren are examples of this rest of the generative organs.

He concluded with some remarks on the interesting subject of the differences exhibited by the nearly allied species of the Salmonidæ, all of which have at least one quality in common, viz. that their ova cannot be hatched except in fresh and well aërated water, leading, as he thinks, to the inference that the migratory species have always been migratory, unless indeed the seas were at one time less salt than at present, and the lakes and rivers less fresh, and that then the habits of the fish might have been formed, and they might gradually have become divided into the migratory and non-migratory species.

First Steps towards the Domestication of Animals. By F. Galton, *F.R.S., F.G.S., F.R.G.S.*

A large number of instances were adduced from all parts of the world to show that savages were addicted to making pets of animals, and the author concluded that almost every animal had been frequently captured and tamed by them. He also showed, from the histories of all the early monarchies, that it was customary for kings to exact, and for barbarians to give, enormous numbers of wild animals as tribute. The amphitheatrical displays of Rome made a similar demand on an immense scale. Hence every animal appears to have been frequently under the power of man; but only a very few of them have proved capable of permanent domestication. The requisite qualities for domestication were separately discussed; they were stated as follows:—1, they should be hardy; 2, they should have an inborn liking for man; 3, they should be comfort-loving; 4, they should be found useful to the savages; 5, they should breed freely; 6, they should be gregarious. He believed that nearly every animal had had its chance of being domesticated, and that almost all of those which fulfilled the above conditions were domesticated long ago. It would follow as a corollary to this, that the animal creation possesses few, if any, more animals worthy of domestication, at least for such purposes as savages cared for. These qualities would be intensified by unintentional "selection:" the wildest members of every flock would escape; the wilder of those that remained would be selected for slaughter. The tamest cattle—those that kept the flock together, and led them homewards—would be preserved alive longer than the others. It is, therefore, these that would chiefly become the parents of stock, and bequeath their domestic aptitudes to the future herd. He did not believe that the first domestication of any animal, except the elephant, implied a high civilization among the people who established it. He could not believe it to have been the result of a preconceived intention, followed by elaborate trials, to administer to the comfort of man. Neither could he think it arose from one successful effort made by an individual, who might thereby justly claim the title of benefactor to his race; but, on the contrary, that a vast number of half-unconscious attempts have been made throughout the course of ages, and that ultimately, by slow degrees, after many relapses and continued selection, our several domestic breeds became firmly established.

Essential Points of Difference between the Larynx of the Negro and that of the White Man. By George Duncan Gibb, *M.A., M.D., LL.D., F.G.S., F.A.S.*

The author had examined the larynx of the negro in the dead and living, in fifty-eight instances, and the result justified him in arriving at certain conclusions, to be confirmed or modified by further experience. These were the almost invariable presence of the cartilages of Wrisberg, which were either quite rudimentary or absent in the white race, with some rare exceptions; they are present in the old and young of both sexes in the negro, probably more fully developed in the prime of life. Their general presence in the negro, and their absence or rudimentary condition in the white race, prove them to be characteristic of the former. The true vocal cords in the negro, instead of being horizontal and nearly in a plane with the general strike of the floor of the ventricles—a characteristic almost never varying in the white race—are represented by an oblique incline from within outwards, that is, their internal free border is elevated at a higher angle than their external or attached border, thus giving to each vocal cord a slanting or shelving direction outwards and downwards. This obliquity of the cords varies in degree and extent, but can be generally distinguished; the contrast, however, is striking between the flat horizontal surface and the oblique. In the white man the ventricle of Morgagni is situated external to, but immediately above, the plane of the true vocal cords; whilst in the negro, a long and narrow elliptical opening is seen leading downwards and outwards into the ventricle, the whole extent of which to its very fundus is visible in most black people. The change of position in the ventricle is most striking, for it hangs sidewise on the outer side of a shelving vocal cord, not unlike the saddle-bags on the side of a mule. The relative position of the thyro-arytenoid muscles is necessarily altered by the last-named condition. These facts the author brought forward regardless of any theory, and with no other object in view than to advance our knowledge of the anatomy of parts heretofore inaccessible to vision in the living. He had prepared, in a tabular form, all his examinations of black people, with the dates, country, and other points of interest, and the facts made out were explained by reference to large diagrams.

Dr. J. E. Gray exhibited Van Beneden's Work on the Marine Leeches of the Coast of Brest.

On the New Corals from the Shetlands. By Dr. J. E. GRAY, *F.R.S., F.L.S.*

The author mentioned that two rare and interesting corals had been presented to the British Museum by Mr. Jeffreys on his return from dredging in the Shetlands. They were *Stylaster Norwegicus* and *Lophophelia prolifer.*

Notes on the Whalebone Whales; with a Synopsis of the Species. By Dr. J. E. GRAY, *F.R.S., F.L.S.*

The paper was printed in full in 'Annals and Magazine of Natural History,' series 3, vol. xiv. p. 345.

On the Food of Birds. By C. OTTLEY GROOM.

The author exhibited tables of the food eaten by each bird, and showed that it varied very much, according to the season of the year. He had arrived at the conclusion that it was wise to protect insectivorous birds. Mr. Groom admitted that the buds of some trees were sometimes destroyed, but asserted that it was only when the birds were in search of a more destructive grub that lay concealed within these buds.

On the Pedicellariæ of the Echinodermata. By W. BIRD HERAPATH, *M.D., F.R.S. L. & E.*

These remarkable forceps-like bodies have not received that attention from microscopists which their beauty and peculiarities demanded, and many observers have wholly mistaken their significance, as even the names by which they are known bear witness. Pedicellus originally meaning a little louse or parasite, it is evident that these bodies were formerly considered parasitic to the animals on which they were found, and of independent vitality.

The pedicellariæ of some Echinoderms (more especially *Uraster rubens, Echinus sphæra,* and *Amphidotus communis*) have been partially described, and incorrectly figured by various observers—Müller, Sars, Munro, Oken, and Sharpey. Müller appears to have first given them the name by which they have been hitherto known, and he conceived them to be parasitic animals, which opinion Lamarck, Cuvier, and Schweigger more or less adopted; but Munro, Oken, and Sharpey regarded them as organs of the animal, of whose purpose and function we as yet know nothing. It appears to be generally established as a fact that the pedicellariæ continue their movements even hours after the animal has been crushed to pieces, and to all appearance dead; yet such apparently independent movements cannot be satisfactorily adduced at the present day as evidence of individual vitality, as the existence of such involuntary motions in the lower animals, depending on muscular irritability and reflex excito-motory actions, are well known to all physiologists, whilst even the leg of a man has been observed to move vigorously some time after amputation.

Some naturalists of distinction have so far mistaken these peculiar bodies as to describe one valve of a peculiar pedicellaria as "a microscopic marine mammalian jaw," from its remarkable similarity in form to the cranium of an animal.

With regard to the probable nature of the pedicellariæ, a growing feeling has arisen amongst naturalists that they are organs peculiar to the animals upon which they are found, and that, like the bird's-head forceps on the Polyzoa, they were organs of defence or prehension, which, although not absolutely necessary to the existence of the Echinoderm, were yet as peculiar and special to the genus, and even indicative of the species, as the form of a tooth or the character of a bone. It will be seen from these numerous photographs that these views are well supported by examples, and that whilst great general resemblance in form may be traced to the pedicellariæ of the various species comprising the genus *Echinus,* yet there are many which are capable of recognition as being indicative of the species, and totally different from those of the genus *Amphidotus, Spatangus,* or *Uraster,* with which they may be compared; so that the author has no hesitation in stating, that in the same way that an animal may be recognized by its tooth, or an *Echinus* by its spine, it would be equally possible to assert positively that a certain pedicellaria belonged to *Uraster glacialis*, to *Echinus sphæra*, or to *Amphidotus communis*. Further, that although the general form of pedicellariæ of *Uraster rubens* presents great similarity to those of *U. glacialis*, and those of *Echinus miliaris* agree remarkably in character with those of *E. lividus* or *E. sphæra*, yet there are abundant differences and peculiarities in their appearance to indicate to the practical eye to what particular species it may belong. The author has hitherto found only pedicellariæ in the genera *Uraster*, *Spatangus*, *Amphidotus*, and *Echinus*, having examined many other genera of Echinodermata for them ineffectually, more especially *Comatula*, *Ophiocoma*, and the Ophiuridæ. Amongst the family of the Asteriadæ, the genera *Cribella*, *Palmipes*, *Solaster*, *Goniaster*, *Luidia*, *Asteria*, and *Asterina* are apparently equally deficient in true pedicellariæ. Amongst the Echinidæ, the author has had no opportunity of examining *Cidaris*, *Echinocyamus*, *Echinarachnius*, or *Amphidotus roseus*; consequently he can give no definite opinion on these genera or species; but he thinks it probable that the latter at least may possess these pedicellarial organs. The Holothuriadæ, together with the other Cirrhovermigrade Echinodermata, also want pedicellariæ; for it is here scarcely necessary to remark, that the calcareous spicules and perforated plates existing in these Echinoderms are the analogues of the pentagonal plates constituting the shell of the *Echini*, whilst the oral tentacles are quite free from calcareous appendages. In the genus *Synapta*, the perforated plates and anchor-shaped appendages may possibly be thought to bear some nearer resemblance to pedicellariæ; but a closer inspection of these peculiar bodies will convince us that these perforated plates are also the analogues of the pentagonal plates of an *Echinus*-shell, whilst the anchors are merely modifications of the spines, and are used as organs for prehension or locomotion, and assist the animal in raising its vermiform body to the mouth of its tube, the anchors being withdrawn during the period of contraction of the *Synapta*, and contribute little or nothing to the powers of defending the animal from the attacks of its predatory enemies. It will be seen that the pedicellariæ of the genus *Uraster* have been well illustrated in two individual species, *Uraster rubens* and *U. glacialis*, and that they are very different in form from those of the genera *Spatangus*, *Amphidotus*, and *Echinus*, all of which possess pedicellariæ consisting of three calcareous blades, while the Urasters have invariably two blades in each pedicellarial head. Amongst the *Echini*, the species *miliaris*, *sphæra*, *Flemingii*, *lividus* (two varieties), and *neglectus* have furnished numerous illustrations, and an *Echinus* from the Mediterranean has also been examined, the pedicellariæ of which were also so closely analogous in form to those of the British *neglectus* that the author was fully prepared to find that a comparison of its other characters with those of that species would confirm their identity; and it subsequently did so without any possible doubt—an instance which may be considered the strongest possible proof of the truth of the proposition, "that the forms of the pedicellariæ are peculiar to the species."

All pedicellariæ agree in having a calcareous framework of great beauty, consisting of several pieces united together, and covered by a fleshy, sensitive, musculo-membranous envelope, continuous with the common integument of the animal. The pedicellariæ on the genera *Amphidotus*, *Spatangus*, and *Echinus* possess, in addition, a calcareous style or stem, which is also covered by a prolongation from the skin or gelatinous envelope of the animal; and the basal end of the style is enlarged for articulation with a small knob or elevation upon the shell, adapted to its reception in a ball-and-socket-like movement. Few objects are of greater beauty than the pedicellariæ of the Echinodermata, as the highly reticulated character of the structure, the brilliant transparency of the crystalline substance, and sparkling gem-like elegance fully testify. But all these characters may be elicited by ordinary examination in the microscope with transmitted, reflected, or oblique rays falling upon them. Yet the highly doubly refracting properties of carbonate of lime or Iceland spar, of which they are composed, make them still more lovely objects when they are examined by polarized light and the selenite stage, but without the analyzing crystal above the eye-piece: under these circumstances the pedicellariæ themselves become their own analyzers by double refraction, and the transparent colourless valve of pedicellariæ becomes either red or green, blue or yellow, according to the thickness of the selenite plate beneath them. Some *Echini*, as *E. lividus* and *E. neglectus*, are well supplied with a deep purple colouring-matter, which gives a beautiful tinge to the spines, which is not removed upon boiling in strong ley. The pedicellariæ under these circumstances also possess the purple tint of the spines, the colouring-matter existing in some sort of combination with the crystalline carbonate of lime. These coloured objects remind one of brilliant sapphire gems, profusely decorating the wondrously constructed Echinoderm, less costly and far more elegantly cut than the far-famed jewels of Her Majesty, but destined to be hidden in the dark abyss of ocean's depths, until brought to light by the researches of the naturalist, and rendered evident by the lenses and mirrors of the microscopist. When it is desirable to examine the movements of these organs, it is advisable to remove a portion of a living animal, and insert it in a small trough of sea-water, and watch the pedicellariæ with a low-power objective upon the stage of the microscope. But when it is only desired to examine the structure of the pedicellariæ, it is better to remove the organ with a scissors or small forceps, and having placed it on a slide with a small quantity of glycerine containing a little caustic potass, shortly the musculo-membranous indusium becomes transparent, if not dissolved, and all the calcareous elements become apparent, but still not sufficiently clear for photographic purposes. Under these circumstances, it is necessary to boil up each animal in distilled water containing a tolerable quantity of caustic potass, which dissolves all the fleshy coverings, and the calcareous pieces are made clean and transparent; in many instances, if the boiling has been carefully stopped at the proper time, the two or three blades constituting the forceps-like appendage remain in conjunction, and are then very much more instructive preparations to the microscopist. In order to remove these pedicellariæ from the other calcareous débris of the Echinoderm, it is necessary to allow all matter to subside, and decant the supernatant alkaline solution; and, having removed all traces of potass by frequent washing and subsidence with successive portions of distilled water, it only remains to agitate the whole well together with a steady circular motion, and, after some moments' repose, pour off the supernatant water, which contains the pedicellarial blades in suspension; on repose, these subside, and may be then removed by a dropping-tube, placed on a slide, dried, and mounted in Canada balsam in the usual way. The objects now exhibited in photographs have all been so prepared by the author himself, and are, consequently, authentic specimens, and have all been photographed to one scale for comparison with the same lens and camera. They are under the same identical circumstances in each particular case, so that relative size may be taken into consideration as one of the elements of difference. The writer then went on to describe the different specimens of which he exhibited photographs, many hundred examples of which were prepared for comparison.

On the Genus Synapta. *By* W. Bird Herapath, *M.D., F.R.S. L. & E.*

Having shown the paucity of information which existed in this country on the *Synapta*, the author next proceeded to refer to descriptions which had been given by different scientific men. M. Quatrefages, he said, had described a *Synapta* which he had found on the shore of the Chanssey Islands, a point off St. Malo, on the French coast, in the Channel, and he had entered minutely into the anatomy and physiology of the animal, and his paper was most exhaustive of the subject. There was also an admirable paper by Messrs. Woodward and Barrett on the *Synapta digitata* and *Synapta inhærens* in the Quarterly Journal of the Zoological Society for 1858. Other authorities mentioned by the author were Professor Wyville Thompson and M. Gallienne. The latter had, in the autumn of 1863, when he was in Guernsey, kindly shown him the locality and mode of finding a *Synapta*, which he thought to be *inhærens*, and had discovered in Bellegrave Bay, on the coast of Guernsey. Having visited the spot where M. Gallienne had obtained his specimens, they found several, a little below low-water level at spring tides, in a bed of sand about ten or twelve inches deep, and congregated in a space about twenty yards square, whence they were easily obtained by digging cautiously with a spade, the operator being guided in the task by the appearance of the funnel-shaped openings in the sand, marking the position of their burrows. On inserting the spade and elevating it quickly, the sand generally cracked through the centre of their perpendicular burrows, disclosing the animal in the canal, which appeared destitute of all lining material. The identity of the animal was readily found from its quickly adhering to the fingers by its anchor-shaped hooklets. Its appearance when placed in sea-water was at once indicative. It was a delicate rosy-pink colour, and having five white bands arranged lengthwise throughout the body from the oral to the anal apertures. The mouth was surrounded by a ring of twelve tentacles, which were pinnated, and appeared to have six pinnæ on each side, with one terminal digit, thirteen pinnæ in all. Some of these animals were distended with sand, and appeared darker in colour, but the anal extremity was generally enlarged, more transparent, and of the usual pink colour, from being inflated with sea-water. That distention was the means of retaining the animal in its burrow, by giving it a fixed fulcrum for the contraction of the longitudinal muscles. The sand bank was dark in colour, and fœtid, from the large quantity of decaying animal matter therein. The *Synapta* doubtless fed upon that refuse material by gorging itself with sand from time to time. The author said that the position of *Synapta* in the zoological scale, keeping strictly to the method of arrangement adopted by Professor Forbes, should be removed from the Holothuriadæ and placed in the Vermigrade order, as no pedal rows of ambulacral cirrhi existed, and there were no appearances of any protrusile branchial organs. The author concluded that the Guernsey *Synapta* was a new species, being distinguished by the preceding zoological characters, and by the peculiarities of the anchors and the anchor-plates, which have the following characters:—

Anchor-plates ovate, shaped with a process or arch, each plate being concavo-convex like a spoon, having serrated external margins when perfect, and one central round aperture with seven oval openings surrounding it, and two or three oval apertures at the junction of the arch; the lesser end of plate minutely perforated.

Anchors serrated, occasionally plain; three to seven serrations, with the flukes reflexed; anchors longer than bucklers, to which they are articulated at the lesser end of the plate, and upon its concave aspect. The anchors are generally elevated at an acute angle with the buckler, and in adult specimens are arranged in five longitudinal rows between the muscular bands. They are more numerous at the anterior extremity of the *Synapta*, and comparatively deficient at the small bulging portion. There appears to be a thin epidermis over both anchors and plates very commonly, and these appendages are produced in layers as in any other epidermis, the outer layers wearing away and new ones taking their places; occasionally miniature and imperfect anchors are to be found with incipient plates only.

The author proposed for this animal the name of *Synapta Galliennii vel Sarniensis*, and concluded his paper by expressing his acknowledgments to both M. J. P. Gallienne and to Professor Wyville Thompson for the kind assistance which they had rendered him in his investigations.

[This paper will be found *in extenso* in the Microscopical Quarterly Journal, new series, No. 17, January 1865.]

On the Application of Photography and the Magic Lantern to Class Demonstrations in Microscopic Science and Natural History. By SAMUEL HIGHLEY, *F.G.S., F.C.S., &c.*

The author called attention to an extensive series of photographic transparencies illustrating nearly every department of science, but especially zoology and microscopy, which had been prepared for demonstrating by aid of an *achromatic* magic lantern. Truthfulness to nature, even to the most minute details,—the impressive character of the image projected, being often stereoscopic in aspect,—the lecturer being able to fix the attention of the student upon *one* object at a time,—portability and cheapness—being claimed as advantages over ordinary diagrams.

On some New Hydroid Zoophytes, and on the Classification and Terminology of the Hydroida. By the Rev. THOMAS HINCKS.

On the Medusoid of a Tubularian Zoophyte, and its Return to a fixed Condition after the Liberation of the Ova. By the Rev. Thomas Hincks, *B.A.*

The author recorded in this paper observations which he had made on the reproductive zooid of the *Podocoryne carnea*, Sars. Specimens which he had kept for some time exhibited the following changes. After a while the umbrella was thrown back and turned inside out, occupying the position which it does permanently in the free gonozooids of some of the *Laomedeæ.* It then collapsed and shrivelled up, the remains of it hanging at the base of the peduncle, and the tentacles streaming out behind. The gonozooids (the so-called Medusæ) had returned to the polypite condition. In this state they lived healthily for a time, the lobed mouth being frequently moved about, as if in search of food. The ovaries were laden with eggs. Similar observations had been made by Dujardin and Peach, and by the author, in the case of *Coryne eximia.* The changes subsequently witnessed had not been recorded hitherto. The peduncle became inactive, and, with the remains of the umbrella, sloughed off, the ova probably being liberated at the same time. The tentacles were then left, with their bulbous bases. The latter coalesced, forming a hemispherical, orange-coloured mass supporting the arms, and around this mass an ectodermal covering was developed. In this condition they continued for a while, the tentacles being freely moved about. At length some of them became attached by the base, and a thin rim of transparent matter formed round the edge of the disk. The tentacles withered away, and in one or two cases an ascending shoot sprouted from the centre of the orange mass. Observations were not carried further; but, to all appearance, a polypite was in course of development.

Remarks on Stilifer, *a Genus of quasi-Parasitic Mollusks, with particulars of the European Species,* S. Turtoni. *By* J. Gwyn Jeffreys, *F.R.S.*

This paper was illustrated by a diagram, representing a pair of Stilifers (male and female) crawling among the spines of an *Echinus Dröbachiensis,* with magnified drawings of the animal and its embryo. They had been carefully examined alive, and under favourable circumstances. *S. Turtoni* is exceedingly prolific. The whole of its body is finely and closely ciliated, and the foot and mantle are constructed so as to prevent the animal or its delicate shell being injured by the spines of the sea-egg. The *Stilifer* was observed to feed not on the membrane or any other part of the Echinoderm to which it attached itself, but apparently on its secretions, having thus the scavenger habit of a dung-beetle. It therefore could not be reckoned a true parasite. The history of the genus and a synopsis of all the known species were given, as well as a detailed account of the animal of *S. Turtoni.*

An Account of the Successful Accomplishment of the Plan to transport Salmon-Ova to Australia. By T. Johnson.

The preparations for the fourth attempt to transport from this country the ova of the salmon were completed in January of the present year (1864). The plan adopted upon this occasion differed in detail from those of the previous expeditions, being chiefly confined to depositing the ova amongst ice. Upwards of 103,000 ova, obtained from fish taken out of English and Scotch rivers, were placed in small deal boxes on beds of moss, and deposited in layers amongst the ice in the ice-house which was built on board the ship 'Norfolk.' The expedition left this country on the 21st of January, 1864, arriving out at Melbourne on the 16th of April. Several of the boxes were opened, and the ova appeared in most cases in an excellent condition. The ova in the boxes near the bottom of the ice-house were not so healthy. By the 20th of April the whole of the boxes, excepting those detained at Melbourne, were safely deposited in the breeding-boxes on the River Plenty, Tasmania. The analysis of the boxes showed that, out of 103,000 ova sent out, some 31,000 only were deposited. On the 4th of May the fish began hatching out; and by the 6th of June the whole, together with the few trout-ova, had thrown aside the shell and were dissporting in their native element. The total number of fish up to the latest advices was numbered at between 3000 and 4000. Several reasons have been given as the causes of the great loss of ova, as also the probable results of the experiment. The official reports, however, set aside the many doubts which have been expressed, showing very clearly that the temperature of the rivers in Tasmania is suitable for the propagation of the salmon.

On the Genus Pteraspis. *By* E. R. Lankester.

The author of this paper first reviewed the labours of previous writers on the subject, remarking that little had been done of a very definite nature with regard to the systematic arrangement or description of the species. He then minutely characterized the various species of the genus, two of which, the *Pteraspis Crouchii* and the *P. Symondsi*, were previously undescribed. He proposed also to divide the genns *Pteraspis*, as it present exists, into three sub-genera, based upon the more or less complex constitution of the cephalic buckler, thus:—

Pteraspides.

Pteraspis. Shield separable into seven distinct pieces, viz. a central disk, an anterior rostrum, two lateral orbital plates, two lateral "cornua," and a posterior spine.

Species, P. rostratus, *Ag.*; P. Crouchii, *Salter MS. & Lank.*

Cyathaspis. Shield separable into four distinct pieces; viz. a central disk produced at one point into a short spine, an anterior rounded rostrum, and two large closely attached lateral cornua.

Species, C. Banksii, *Huxley & Salter*; C. Symondsii, *Lankester.*

Scaphaspis. Shield not separable into distinct pieces, but oval, and with an acute posterior spine.

Species, S. Lloydii, *Ag.*; S. Lewisii, *Ag.*; S. truncatus, *Hux. & Salt.*; S. Ludensis, *Salter*; S. Dunensis (?), *Huxley.*

The views advanced in this paper were based upon a very considerable amount of evidence, in the form of specimens and drawings, some from the author's own cabinet, some transferred to him by Professor Huxley. The discovery of the scales of *Pteraspis* by the author, previously announced at the Geological Society, was alluded to, and the geological range and palæontological relations of the genus considered.

Notice of a New British Rhizopod and some other Marine Animals. *By* W. A. Sanford.

On the Turdus torquatus *as observed in Devonshire.* *By* Dr. Scott.

The *Turdus torquatus* pays an annual visit to Devonshire, but it confines itself to the tors and rocky valleys of Dartmoor. It lays four or five eggs, resembling those of the *Turdus merula*, save that they are a little lighter in colour, and a little more elongated in form. Its flight is darting and irregular, and, when on the wing, it utters a chattering note of alarm; but it has no prolonged song, like the sylvan thrushes generally. It feeds chiefly on the *Vaccinium Myrtillus*; but when these are scarce it is seen feeding on the berries to be found in the hedgerows adjacent to the moor. Its habits more nearly resemble those of the *Petrocincla* than those of the true thrushes, and in Devon it is known by the name of the Rock-Ouzel. It arrives in the end of April, breeds in June and July, and leaves in the beginning of October.

On the Significance of the Septa and Siphuncles of Cephalopod Shells. *By* Harry Seeley, *F.G.S.*

"As the chambers are always empty, the animal must have moved forward, leaving a vacant space behind; so the question to be solved is, Why did the creature always make the septa shut off spaces which progressively enlarged? In certain gasteropod shells there is something analogous. The genera *Murex, Triton, Ranella*, for instance, after making their shells uniformly for a third or half of a whorl, then begin thickening the lip into a varix. In other genera, as *Bulimus,* *Conus, Turritella*, species or specimens are found with the earlier part of the spire partitioned off. The same phenomena of varices is seen in many bivalves; and a process of shutting off cells in the lower valve is characteristic of several oysters." These structures were then shown to result from the periodic enlargement of the generative organs. "On examining a *Nautilus*-shell, two large muscles are seen to have been placed in the lower part of the body-chamber, and connected round the involute spire by a narrower muscle—an arrangement to which the shell may owe its involute form. Beneath the muscles are the liver, which overlaps the spire, the ovaries, which abut on a large part of the septum, and certain digestive organs above these. Before any new chamber can be made, the shell-muscles must have moved forward; and before any increase in the ovaries can take place, a space must be formed behind. As the animal steadily grows, all its organs would enlarge; and, with each successive brood, the distended ovaries would require more space. There is a similar gradual increase in the size of the air-chambers. And, since the development of ova would necessitate a forward-growth of the mollusk, the discharge of the ovaries would leave an empty space behind, into which the creature could not retire, which would then be shut off by a septum moulded on the animal's body. The *Argonaut* similarly accumulates its eggs in the involute part of the shell, but, not being attached to it, does not form septa. In the male *Nautilus* the testes are placed in exactly the same position as the ovaries of the female, and, excepting the liver, form the largest organ in the body. It may therefore be concluded that the development of the male organs would produce results similar to those in the other sex, and likewise end in the formation of chambers. There are no other organs of the body which are liable to periodic changes in size; and therefore, as the position and progressive enlargement with age of the generative apparatus necessitate results like those seen in the chambers and septa, I regard one as the cause of the other." The author then applied his theory to the Dibranchiata. Connecting the chambers is the tube known as the siphuncle, running through every septum to the first, but not through the nidimental capsule. Seeing the extreme elasticity of many membranes of invertebrata—as, for instance, the oral membrane of a starfish—the author pointed out that, when ova were discharged by the *Nautilus*, there must remain the empty membrane, which, being attached to the base, could not but contract into a tube, smaller or larger, according to its tenuity or vascularity. The fine siphuncle of the *Nautilus* would indicate a single highly contractile membrane; the large siphuncle of *Actinoceras* may indicate two or three membranes contracting differently.

Mr. R. F. Wright exhibited some Trap-door Spiders from Corfu.

Dr. E. Perceval Wright exhibited Professor T. Huxley's and Mr. Hawkins's 'Comparative Osteology.'

Physiology.

Address by Dr. Edward Smith, *LL.B., F.R.S., President of the Subsection.*

It has been customary for the President of this Subsection, on taking the chair, to deliver an address, less pretentious and of a less general nature, perhaps, than he would have considered it his duty to prepare for the General Section, but always offering observations on the progress of the science, whether in its entire aspect, or in some points of view which would be the most interesting to his audience; and a custom so valuable and time-honoured must not, even in less able hands, be permitted to lapse. I purpose, therefore, to open the Meetings of this Department with some introductory observations; and taking the special rather than the general plan of procedure, I shall confine my observations to a question limited in its range of knowledge, but scarcely limited in its importance and universal interest—to a statement of the present condition of the dietary question, considered, first, in its practical aspect in public and private dietaries, and, second, in its scientific aspect. Dietary, regarded in its scientific aspect, is both advanced and retarded by the popular knowledge which exists respecting it. The universal necessity for food gives interest and importance to the subject, and thus, attracting the attention of inquirers, advances the science; but the personal experience of individuals limits progress by leading to the belief that each one knows what is practically valuable for himself, and thence what is likely to be proper for others. Hence the scientific aspect of the question has not the interest to the public which the practical application of it affords; and practical knowledge is possessed (so it is said) as much by an observing non-scientific as by a scientific man. Each person so far regards himself as his own authority; and in reference to the dietaries of those who are not fed from their own resources, it may be stated that they are almost universally framed by those to whose charge these dependent persons are confided.

We have a vast mass of paupers in this country, partially fed at home, or entirely fed in workhouses at the public expense. With whom do the dietaries of the latter class originate? From some responsible and well-instructed public officer who has gained high repute in this branch of knowledge? No, but with the guardians of the poor; the greater portion of whom are shrewd and intelligent men, who with the aid of their medical officer, arrive at a decision as to an amount of food which shall not be in excess of the requirements of the paupers. Hence it is that there are in England and Wales 700 poor-law dietaries, and not two of them are alike. Can it be safely assumed that with this diversity all are sufficient to sustain health and strength? and derived from such authorities, could we fairly infer that any are exactly adapted to the wants of both sexes and of all ages?

The condition of the dietary of the Army and Navy was, until recent years, deplorable. At the latter end of the last and the early part of this century, scurvy, due to ill-selected food, was rife even in our National Navy; and inquiries made by Dr. Budd some twenty years ago, and by Dr. Barnes this year, have shown that this disease is still not unfrequent in the fore cabins of our Merchant Navy. No fact is better established than this, that both sea scurvy and land scurvy are due to deficient and ill-selected food; and striking evidence is afforded by the fact that in our merchant ships it is not found in the master's cabin, whilst it may be rife in the forecastle—not among the well-fed officers, but amongst the ill-fed seamen. Is there no one set apart by the Government to advise upon so important and yet so simple a question? No. In former years the dietary of the Navy was varied at the instigation of the principal medical officer, and modified by those having the command of the Fleet in active service; and whilst it was varied towards improvement, the changes were often most incongruous and unscientific. The Government has no direct control over the dietary of seamen in the merchant service, but each master and ship-owner does that which he thinks proper; and whilst in emigrant ships a stipulated quantity of food must be provided for each passenger, the defective arrangements in respect of cooking greatly lessen the value of this precaution.

The state of the dietary of our soldiers has attracted deep attention since the disclosures of the Crimean campaign, and by the aid of scientific men improvements of the most valuable kind have been introduced, both in reference to the variety of food supplied and the mode of cooking it. The time will probably never arrive when the dietaries of our army and navy shall be models for the general community, since in time of active service the kind of food must be varied with the abundance or deficiency of certain foods, and the cooking be interfered with by other duties; and in times of peace the arrangements can never be so varied and economical as may be found in a private family; and hence limitation in variety and excess in quantity (seeing that the full economical value of a given food cannot be obtained) must, and perhaps should, prevail. The supply of meat is much larger than is found in the homes of the working classes, and more than the working classes require (although they may perform much more labour than falls to the lot of a soldier in time of peace); but it is a compendious food, and one which may be cooked in different ways and for separate purposes, or for combined masses with ease and with few utensils, and hence a large quantity of it should be allowed.

The state of the dietary of our prison populations is not only less satisfactory than that of the army and navy, but is very unsatisfactory. The aim in the feeding of this class is to maintain health and strength on the least quantity of food, and on the food the least palatable; and some would even risk the health and strength for a certain limited time in order to add more effectually to the punishment of the prisoner. At the same time the conditions under which the prisoners are found are most various, both as regards the personal ones of age, sex, health, state of constitution, sensibility, and previous habits, and the penal ones of duration of imprisonment, closeness of confinement, employment, and labour. Here then we have a combination of circumstances demanding all the knowledge which both science and practice can afford for their proper combination, estimation, and application to dietary purposes, many (perhaps all) of which may be so estimated and combined that several well-defined classes may be arranged, and food provided which shall be so adapted to each, that prisoners, however variously employed, may be fed with equal sufficiency. Can we conceive a case in which the value of a public officer, thoroughly acquainted with the subject, would be so great as this, or one in which the conditions under which exact knowledge can be gained would be so perfect? But no such officer exists in connexion with this or any other department of the Government, and there is no official person to whom the Government may turn for advice, except the medical officers of each separate prison, or an inspector of prisons, who may or may not be a medical man, and who, as a medical man, may or may not be an authority on this question among his medical and scientific compeers. It seems almost past belief that in so great a country, with so enlightened a state of public opinion, and with so great a mass of persons who are fed under the direct or indirect supervision of the Government, there should not be a place for an officer possessed of this special and abstruse knowledge.

Convict prisons are so far distinct from county prisons that they are under the direct control of the Government, and for every detail in their management the Government is responsible. Yet even here, with all the advantages of a central and common authority, the state of the dietary question is very unsatisfactory. The time has gone by when death, or even extensive and important disease, can occur as the result of the want of food; but one need not to have far advanced in life to be able to remember the prevalence of scurvy in convict establishments, and the great defect of sanitary rules. Since that period attempts of a convulsive nature have been made to more exactly fit the dietary to the requirements of the convicts, so that, on the discovery of evils from defect of food, a large increase in the dietary was made, and, this having attracted attention, in a similar convulsive manner a great diminution of food was ordered. On the opening of the Portland prison in November 1848, a diet was ordered which was in excess of that of free working men; but in a few months afterwards, on the complaint of some of the prisoners that they were insufficiently fed, a considerable increase in the quantity of meat was made, and in the year following the dietary was again further increased. There have been of late almost incessant complaints on the part of the public that the dietary in use in this and other convict jails was excessive, because it was better than the diet of free working men, and particularly that so large a quantity as 36 to 40 ozs. of cooked meat (equal to 48 or 54 ozs. of uncooked meat) was supplied weekly; and although prison officials, for the most part, have been of opinion that the dietary was not in excess, another change has just been made, by which no less than about one day's food in seven has been withdrawn from the convicts employed on public works. Consider for a moment the vast importance of the question which is thus made to oscillate from one extreme to the other. If the convicts are too well fed, the evil of waste of food is caused, with its consequent burden to the hard-working and honest community, in addition to its evil influence upon the mind of the convict in preventing the due appreciation of his punishment and the recurrence of crime, and the origin of reasonable complaints on the part of honest and hard-working men, and the temptation to the unstable to fall into crime. On the other hand, if the quantity of food allowed be not excessive, how great the responsibility of those who lessen it, and how great the crime even of those who, by thus lessening it, offer something like a reasonable ground for mutinous conduct on the part of the sufferers! What can afford greater grounds for the request, on the part of the public, that the highest scientific knowledge shall be applied, in order to determine the grounds on which a fitting dietary shall be based in the several conditions of labour and confinement in which it shall be used, and that no change shall be made tending to lower a dietary until by the same method it has been proved that the proposed dietary would be sufficient. This is not, however, the method adopted; but dietaries were framed, as they have been recently altered, upon the intimations of non-scientific men, upon the guesses of medical men, or upon a general and inexact appreciation of the results of those which preceded them. In no instance has such a proof been sought for as would satisfy the requirements of exact research.

Thus in the most recent change, viz. that effected during the present year, we find the grounds most unsatisfactory. The Committee appointed to investigate the subject having ascertained that a certain scheme which had been provided for county jails in 1843 is still in use in forty to fifty county jails (that is to say in only one-third of the county jails), they infer, in their own words, "that in these instances the diet was believed to be sufficient for the maintenance of the health of the prisoners, and for their support under the labour to which they were subjected;" and having found, as they say, that these inferences were confirmed in the instance of some large prison (Wandsworth) open to the inspection of the Committee, there were reasonable grounds for attempting a reduction of the ordinary dietary in the Convict Prison. You will observe that the conditions which they inquire into are not those in which the dietary to be recommended by them is to be used; and even those conditions are not to be subjected to a rigid scientific examination, but the Committee, in their own words, simply "inspected several of these prisoners, both male and female, and found them in a fair state of health considering the length of their imprisonment;" and from these two facts alone, viz. the continued use of this scheme in a minority of county and borough jails, and their inspection of a few prisoners in one county jail, they proceeded to vary the dietary in convict prisons, and to reduce the cooked meat by 16 ozs. per week.

The point to which I wish to draw your attention is not whether the dietary formerly or now in use is or is not exactly adapted to the wants of the convicts, for upon that important point there is no sufficient information, but that changes are made under the pressure of mere public opinion, by medical gentlemen, on grounds which are not logical, and without making use of the only plan by which the fitness could be proved—that of scientific inquiry into the conditions in which the dietary is to be used. It could not excite surprise that with such a basis on which to ground changes in dietary there should appear, even to non-medical men, sufficient reason to distrust the results. The Board of Directors of Convict Prisons accordingly append a letter, in which they state, 1st, that "experience can only decide whether the dietary is sufficient to keep able-bodied men in good health during a confinement of many years in prison;" 2nd, that they reserve to themselves the definition of light and hard labour; 3rd, that they reject the proposition that boys under æt. eighteen, and men above æt. sixty-five years should be placed upon light-labour diet; and 4th, that they modify the formula for thickening the soup.

In the absence of the necessary proofs on which to exactly adjust the dietary to the wants of the convicts, the only safe plan is to allow an amount of food greater than that which falls to the share of equally hard-working and more honest labourers.

Our county and borough prisons offer far greater diversity of dietary than is found in convict prisons; for the dietary of each jail is arranged by the magistrates, and the Government, whose assent must be obtained, has no standard dietary which it can enforce, and no dietary which has been proved on scientific grounds to be adapted to the different states of prison discipline, and no officer who, being specially acquainted with the subject, has been appointed to advise either the Government or the magistrates in their search after truth. Hence, whilst from one-third to one-half of the jails have adopted a scheme of dietary which the Government has recommended since 1843, but which the late Committee of the House of Lords, with Lord Carnarvon as Chairman, have affirmed to be eminently unscientific and unsatisfactory, the other half have dietaries which differ each from the other in almost every particular.

In none, whether the Government scheme or others, has there been a scientific attempt to apportion the dietary to the different conditions of separate confinement in cells, of activity, and of forced labour of most varying degree; but schemes have been in use, some of which are very far below the food obtained by the worst-fed men in freedom, and others quite equal to that of the labouring middle class in this country. One having committed a small offence against the law will be fed upon a dietary of bread and water or bread and gruel, and be compelled to carry on the hardest labour known; whilst another, and perhaps an old offender, having committed a serious breach of the laws, will be fed upon food much better than he ordinarily obtained in freedom, and be kept in inactivity, or engaged in light handicraft or in occupations which are not laborious.

The Earl of Carnarvon's Committee, fully impressed with these defects and anomalies, recommended that a Commission should be issued with power to determine various questions of dietary by exact research—a Commission which, from the difficulty of the inquiry, must have comprehended some of the best men of the day; but instead of this a Committee of medical officers of convict prisons was appointed, who, without experiments of any kind, omitting the chief subjects of inquiry, and avowedly discarding scientific knowledge, have recommended a new scheme, which in its nutriment leaves the dietary much as it found it—lowering, however, the low, and raising the high dietaries, whilst they believed that they had effected the converse—but which throws upon the medical officers of the prisons the most serious responsibility of deciding whether a given prisoner shall be submitted to the "progressive dietaries" which they have ordered, and of bringing down the labour to the dietary if, *after* trial, the dietary which they have ordered with labour should be found insufficient to maintain health and strength.

In this, as in other changes, the order of things has been inverted, and instead of proof being first obtained as to the fitness of a dietary, the change is made and the proof of its fitness sought afterwards. Hence the whole procedure has increased the anomaly; for the magistrates have now before them the old government scheme which has been decisively condemned by the Committee of the House of Lords, and a new government scheme, confessedly not built upon exact scientific research, fenced about by several restrictions, left to the discretion and responsibility of the surgeons of jails, submitted for a trial of nine months' duration, and to be judged of by gentlemen who do not claim any special knowledge on the subject.

Did I say too much when I affirmed that the state of the dietary in prisons is very unsatisfactory? The subject of dietary in hospitals involves too many purely medical details to justify me in discussing it here; but I may remark that, although each case of disease must be considered on its own grounds only, it has been found possible to arrange several classes of diets in all hospitals under some such heads as low, middle, and high diets, and consequently there can be no reason why each one should not be arranged according to the nutriment required under the conditions in which they are severally used; and it is clear that an approach to uniformity is possible in all our English hospitals. At present the amount of nutriment in each diet is only inferred in a general way; and if there should be found two hospitals having the same dietary tables, it is from the accident that one has been copied from the other. I will also add that the amount of nutriment contained in many low diets (often called tea diets) is so low as to bear no proportion whatever to the daily requirements of a man, and would justify any medical man in calculating the amount and calling the attention of his professional brethren to the result.

As each hospital has and recognizes its own medical authorities in the formation of such tables, and as each medical man must be allowed to exercise his own discretion in the treatment of disease, I doubt if the uniformity which seems to me to be so important will ever be attained except after full inquiry made by some central authority which has power to remunerate those who would undertake so large an amount of labour; and hence the public and the profession are justified in looking to the Medical Department of the Privy Council for the performance of this service.

There is, I think, the best reason to believe that the dietary of our private schools and colleges, and of our charitable institutions for the maintenance and education of the young, has greatly improved in our day; but it is a subject which still demands public attention. There are multitudes of cheap schools throughout the country in which the sum paid with the pupils is manifestly inadequate to remunerate the proprietors of the schools. A very striking illustration of this occurred a few months ago, where two ladies with their mother received children for board and education at a sum which yielded only about 4½d. per day per head in the family for all the expenses of rent, taxes, clothing, service, and food required by the family. A public investigation of this case was made, and the following was given in evidence on the dietary in the school in question:—

"For breakfast milk thickened with flour and water, and a round of bread; and when they had not this, there was nettle- or onion-broth made with oatmeal and water. For dinner on Sunday there was meat and plenty of vegetables and pudding; on Monday pudding alone; on Tuesday cold meat and vegetables; on Wednesday boiled rice and treacle, or treacle-pudding; on Thursday meat; on Friday rice-pudding; and on Saturday perhaps boiled bacon, or pig's face with boiled peas. There was also broth made from sheep's pluck. For tea, a cup of tea and a round of bread and lard, or more if they wanted it."

This may perhaps be regarded as an extreme case; and whilst not insisting too much upon it, we may fear lest it should represent more or less correctly the state of all the cheap schools throughout the country.

But to take a higher class of scholastic institution. I know an institution receiving perhaps 150 boys, of ages varying from ten to sixteen, and having all the staff of a college, in which the following is the daily outline:—

They rise at 6 A.M., and engage in studies until 8 A.M. without receiving any food. At breakfast they have a mug of cold milk and half a round of bread placed before them, and, after a time, the bread-basket, containing quarters of slices, is passed round, from which the pupils may take a piece. After the morning's studies, the dinner consists of meat, of which a quantity is given which the boys whom I know state is much less than they receive when at home, and to which none is usually added. The quantity of potato is very small generally, and bread is not given. Pudding is sometimes added, and sometimes bread and cheese supplies its place. Only one other meal is allowed in the day, and that is similar to the breakfast. Thus there are only three meals a day allowed, two of which are cold; and the meat is practically much limited in quantity. There are moreover more than two hours in the morning during which no food is supplied, and during part of which the brain must be at work; and there are fourteen hours between the meagre supper and the following breakfast. Such a dietary must be an insufficient one in the total quantity of nutriment, and particularly in the fat which is supplied; and it cannot be a matter of surprise that the boys which I saw were very spare, and very tame and quiet, both in body and mind.

There is one source of importance which in this matter is common to all these institutions and to workhouses, viz. that they have charge of children and youths during the period of growth—a period which once passed over never recurs, and each year of which has its own special duties, of which, if any remain unperformed in one year, most rarely can the defect be compensated for in the following years. Hence, if there be deficient food at this period, the body either falls rapidly into disease, which terminates fatally before an adult age is attained, or both body and mind grow up without that force and vigour which is characteristic of health, and in which the future man is less fitted than others for the duties of life. An emaciated frame will probably be associated with a feeble and dull mind, and the sufferer will rarely attain a position among others in life beyond that of low mediocrity.

At the period in question, whether we regard the boy physically or mentally, it is of highest consequence that he be supplied with an abundant and well-arranged dietary, and in nearly all cases the prime elements of diet should be given without stint. The appetite is not, however, always a sufficient guide; for a boy having been accustomed to take only a small quantity of food, the desire for a larger quantity is either lost or was never obtained, and in such cases with plenty within his reach he will remain underfed. Encouragement to eat is as important in many boys at school as encouragement to study.

I am convinced that even yet the full importance of dietary during the period of growth is most imperfectly understood, and hence I have thought it right to bring it distinctly before the attention of this Section, and shall be glad if it should attract the attention of the press, and of gentlemen engaged in the duty of training the young.

I would also add a word in reference to the monitors and others found in normal training schools and national schools. The duties which devolve upon the master or mistress of a national school in giving extra and special instruction to the monitors, apart from the ordinary duties of the school, excite a most prejudicial effect upon the appetite for and digestion of food, by limiting too much the period allowed for exercise, and extending too far the time devoted to brain-work and the period of respiring warm and foul air. The monitors themselves are, however, the greater sufferers, for they are younger, and are still at a period of life when the evils just referred to exert a tenfold influence. Moreover they are always the children of the poor, and were ill-fed in earlier years, and upon this basis have undertaken a new set of duties, which withdraw them from the fresh air, and supplant muscular exertion by mental strain; and, at the same time, they have an income so small, that it does not suffice for them to obtain nourishment at all adequate to the requirements of mental labour and of bodily growth. I have had my attention drawn to this class of persons in a painful way in connexion with the occurrence of consumption, and I should be glad if public attention could be drawn to their condition.

A consideration of the dietary of the general community must have regard to two classes at least, viz. the well-fed middle and higher classes, and the moderately fed or ill-fed labouring classes; but time will not allow me to refer to the former further than to offer a few observations on "Bantingism," whilst I shall describe the latter in some detail.

The attention which has recently been called to Bantingism has, I think, been advantageous to the community, by showing the effects which flow from a regulation of dietary, and by gaining the confidence of the public in the science of the question. The names of the components of food are now far more widely known than before, and we may almost assume that all persons know the difference between carbon and nitrogen in their ultimate use in the animal system. I am not here concerned with the medical question, as to whether it is desirable to reduce the bulk of a given individual—a circumstance which must always be left to the judgment of the medical man in charge of the case; but I feel compelled to state, that it would be an evil to this nation, both physically and mentally, if the system of reduction were to become at all general; and that, on the contrary, regarding the whole population, we need to add to, rather than take from, the weight of the body. I would also add my experience as a physician, that even in the well-fed classes I have seen very serious diminution of both bodily and mental vigour follow the working out of the plan.

Omitting, therefore, any reference to the question of health, and considering the subject scientifically, we must admit that in a full-fed and fat man the fat and fluids of the body may be lessened, and the whole bulk and weight proportionally reduced by this system, and that upon principles which have long been well established. The whole plan is to reduce the carbon or fat-forming elements in the food to a point much below the daily wants of the system, so that a portion of the fat already in the body may be consumed daily, whilst at the same time the nitrogenous elements are supplied with at least their usual abundance. This is effected by withholding separated fats, as butter and the fat of meat, and by very greatly restricting the analogous food, starch, which enters largely into the composition of flour and all grains. The supposed necessity for giving a very large supply of meat is based upon incorrect reasoning, and in reality is owing to the fact that the carbon which is found associated with the nitrogen in lean flesh is required from the too great reduction which has been made in the sugar, fat, and starch in other food. For the purpose in hand it is more consistent with sense and science to allow the usual variety of food, but to limit the total daily amount of it, so that the quantity of carbon shall be in defect of the daily wants, and the quantity of nitrogen remain as before. There is no necessity for the absolute excision of fat and sugar, and the extreme reduction in the quantity of bread, any more than for the great increase in the quantity of meat. The bulk of the body may be reduced simply by lessening the amount of the kinds of food usually taken; and as the reduction is more slowly effected, it is a process attended by less danger to the health.

It may not be doubted that in proportion as the system is extensively adopted, and, in a given case, is worked out rapidly, so will be the prevalence of heart-diseases, derangement of digestion, and gout. Seeds are now sown which will yield a plentiful harvest to medical men.

To turn now to the dietary of our labouring population. An inquiry of a character unique, at least in extent, has just been completed by me for the Government, which will afford a clearer insight than has hitherto been obtained into the dietary of our labouring populations, and will enable us to appreciate both its merits and defects. It has been made at the homes of the agricultural labourers in every county in England, in Wales, in the west and north of Ireland, and in the west and south of Scotland; at the homes of certain town populations, as silk- and cotton-weavers, seamstresses, kid-glovers, shoemakers, and stocking-weavers, with all the care and minuteness which science could suggest; and without burdening this address with the details, which may be found in the Sixth Report of the Medical Officer of the Privy Council, I may describe the results under the two general heads of the quantity of food and nutriment, and the nature of each class of food.

In doing this I must beg of you to bear with quotations of figures to an extent greater, perhaps, than I should think appropriate to an address of this nature.

I will now offer some observations upon the separate classes of foods already referred to.

1*st, Breadstuffs.*—The coarse kinds of bread which were in ordinary use by our forefathers, even to the early part of the present century, are now very rarely eaten. *Barley bread* is still used in the houses of labourers in South Wales, and in the farmhouses of North and South Wales and Anglesea; also by the labourers in Northumberland in the north, and in Cornwall and Devon in the south of England, and in the southern parts of Scotland; but, except in certain poor districts in South Wales, it is not anywhere now used as a principal member of the class of breadstuffs. In nearly every locality it is now mixed with rye-meal, or with various proportions of wheaten flour. *Rye* bread is nowhere eaten alone, but the meal is mixed with barley meal; and in the north of England rye is grown with wheat in the field, or the grains are subsequently mixed together in the proportion of 1 part of rye and 3 parts of wheat, and known as *marlin.* It is also added in small proportions to brown wheat meal in London to give a moist condition to the bread. *Oatmeal* is used by 20 per cent. of the farm labourers in England; but only in Northumberland, Cumberland, and Westmoreland is it eaten as a breadstuff, and there it is not a principal member of the class. In the west of Scotland it is still the principal breadstuff, and in the south it is extensively but not so exclusively eaten—barley meal and wheaten flour being also used. It is now more largely eaten in the north and west of Ireland than was formerly the case, being preferred to Indian corn, and occupying a middle position between that and wheaten flour. *Indian corn* is eaten exclusively in the south and west of Ireland, where exceeding poverty is an incubus upon the people, and is eaten alone or with the addition of oatmeal. *Pea meal* is never eaten alone as bread, but in the north of Scotland it is sometimes added to oatmeal for that purpose. *Wheaten flour* is now exclusively used to make bread for all the town populations, and in nearly every district of England for the farm-labouring populations, and, with the exception of the Western Highlands of Scotland, the south and west of Ireland, and certain portions of South Wales, is universally the principal breadstuff obtained by the population. The abundant supply, the fine quality, and the low price of it of late years have even induced the poor to discard the use of the brown wheaten meal which was so commonly eaten when I was a youth, and nowhere now is brown or whole-grained wheaten flour the ordinary breadstuff of even single families, much less of small communities. In all the inquiries throughout England I found but one or two families who commonly purchased it.

This is a striking change in the habits of the people, and we may well ask what is the reason for the exclusion of the low-priced breadstuffs, and the universal use of an article which until recently was only within the reach of the better classes. The reasons are sound.

1. The low price of good white flour, and the very small difference between that and the price of coarser foods; nay, brown wheat meal is now charged at as high a price as the white flour, and oatmeal is everywhere dearer than wheaten flour.

2. The flavour of the white wheaten flour is more agreeable than that of any other breadstuff; and this is of the highest importance in point of economy, for the children of the poor will eat dry white bread; but with brown wheaten or rye or barley bread they must have treacle or some kind of fat.

3. Its use may be constant, whilst that of the coarser foods must be intermittent, both because the latter rather repel the appetite, and because the husk of the brown flour, or the barley meal, and often of the oatmeal also purges unduly, and particularly in children and sensitive women.

4. The income of the labourer has increased of late years, and he is now better informed and more observant, and has also improved in his tastes and habits.

In Western Scotland oatmeal has held its place in the belief that it is a stronger food than wheat meal; but more probably because wheat does not grow there generally, and from the fixedness of the national character. In Ireland the maize is a very modern innovation, but it is the cheapest breadstuff which can be supplied, and extreme poverty compels them to take it gladly, whilst at the same time they detest it. They cannot afford to purchase wheat flour in the quantity which their wants demand; but they long for it, and with improved means will obtain it.

In the districts where the coarser grains are still used, the labourers obtain them as a part of their wages, or have some special privilege allowed to them by the farmer in the purchase of them, and hence the use of them is only in small part voluntary.

Rice was used by about 58 per cent. of the population, but never in the place of bread, or as a principal breadstuff. Its price is high, and it must be cooked, whilst good bread is cheap, ready for eating, and universally procurable. *Dried* peas are eaten only under two circumstances—when there is broth, and when fresh vegetables are scarce or absent, and hence are eaten almost exclusively in the winter. They do not constitute anywhere an important part of the dietary. It must, however, be added that in the cotton and silk districts the example which has been offered to the poor has induced them to eat both rice and peas more abundantly than heretofore.

Of these various breadstuffs the farm labourers and their families, in the average of all England, obtain per adult weekly $12\frac{1}{3}$ lbs. of breadstuffs, those of Wales 14 lbs., of Scotland $12\frac{3}{4}$ lbs., and of Ireland $20\frac{1}{2}$ lbs.; so that England and Scotland stand at the foot, and Ireland at the head of the list. Of indoor operatives, silk-weavers obtained $9\frac{1}{2}$ lbs., needlewomen $7\frac{3}{4}$ lbs., kid-glovers $8\frac{3}{4}$ lbs., shoemakers $11\frac{1}{4}$ lbs., and stocking-weavers nearly 12 lbs.—quantities below those of outdoor labourers, and differing as 9·6 lbs. to $13\frac{1}{4}$ lbs.

Fresh Vegetables.—The operatives in towns obtain a somewhat uniform quantity of fresh vegetables all the year round. Potatoes are there the chief article of this class; but when cabbages are cheap they are frequently eaten, and cauliflower or some other luxury is obtained for the Sunday. Farm labourers almost universally grow potatoes and other vegetables. As a rule, they eat potatoes from the early gathering in June or July until about the following Christmas to March, when their stock ceases, and a little time elapses before green vegetables are procurable. When cabbage is plentiful it is eaten in large quantities daily, but when otherwise its use is restricted to Sunday, and perhaps one or two other days of the week. Rhubarb, fruits, new peas, onions, &c. are obtained in their season, but to supply nutriment cabbage and potatoes are alone relied upon. Hence there are three to six months in the year when a large mass of farm labourers do not obtain potatoes, and perhaps only one or two months during which they use cabbage very largely. When fresh vegetables are scarce, more breadstuffs are consumed.

In Ireland there are two distinct and alternate dietaries, one with and the other without potatoes. When potatoes are in use the usual allowance is $3\frac{1}{2}$ lbs. per head, thrice a day. I found families eating 440 lbs. per week. Universally it is of the highest importance that the farm labourer may grow an abundant supply of potatoes, since it converts his otherwise unprofitable time into money, or saves the expenditure of money in more costly foods.

Sugars.—Cane-sugar or treacle, or both, are almost universally used; the latter in the place of fats chiefly, and the former almost exclusively with tea or coffee. Treacle, at the high price charged for it in villages, is not regarded as a cheap food, since it sinks into the bread and the children cannot taste it; and wherever milk is very abundant, as in Devonshire, the use of sugar is almost restricted to the baby. It is eaten in Ireland with the maize when made into stirabout, but in England it is less eaten by the poorer than by the better-paid labourers. Thus, only 4 oz. per head were eaten in Wilts and Somerset, whilst 16 oz. were consumed in Lancashire. Sugar is everywhere regarded as a luxury.

Separated sugars were obtained by 98 per cent. of the farm labourers in England, 92 per cent. in Wales, 96 per cent. in Scotland, and 82 per cent. in Ireland; and the quantity per adult weekly was—England $7\frac{1}{2}$ oz., Wales $7\frac{1}{2}$ oz., Scotland $5\frac{3}{4}$ oz., and Ireland $4\frac{3}{4}$ oz.; so that Wales occupied the head, and Ireland the foot of the list, both in frequency and quantity. Of indoor operatives, silk-weavers obtained $7\frac{1}{2}$ oz., needlewomen $7\frac{1}{4}$ oz., kid-glovers $4\frac{1}{4}$ oz., shoemakers 10 oz., and stocking-weavers 11 oz.; and hence the average was higher than that of outdoor labourers, as 8 oz. to 6·6 oz. The frequency with which they were obtained was the same in both classes on the whole average.

Fats.—These are butter, dripping, lard, and suet. *Butter* is obtained almost universally, and in the villages is dearer than in towns. In some Welsh farm-houses it is made from the skimmings of the buttermilk. *Dripping* can be obtained only in towns, or by the favour of some wealthy person in the neighbourhood; and hence, although highly prized and by far the most economical fat, its use is very partial and uncertain. *Lard* is the most largely obtained where the farm labourer is happy enough to keep and kill a pig; but such cases are a minority. In South Wales the labourer reserves it for sale, or to sharpen his tools, and considers it too valuable for him to eat. When it must be bought, the supply is very intermittent and small. *Suet* is generally bought with the meat, in quantity sufficient for the Sunday's pudding; and where pudding is a daily item of dietary, as in Somerset, the use of suet may be extended to one or two other days. Its use is very general both in town and country populations. Fats are regarded as a luxury, and cut off when pressure occurs, but not in quite the same degree as sugar. Hence the least supply is in the poorest, and the greatest in the better class districts, varying in the different counties from less than 3 oz. to more than 10 oz. per adult weekly.

Separated fats were eaten less universally and in less quantity than sugars. Thus, of farm labourers in England 99 per cent., in Wales 92 per cent., in Scotland 93 per cent., and in Ireland only 42 per cent. obtained separated fats; and the weekly quantity per adult was—England $5\frac{1}{2}$ oz., Wales $5\frac{3}{4}$ oz., Scotland 4 oz., and Ireland $1\frac{1}{4}$ oz., showing great disparity in the quantity and frequency between Ireland and England; but placing them in the same order as in that of sugars, silk-weavers obtained $4\frac{1}{2}$ oz., needlewomen $4\frac{1}{2}$ oz., kid-glovers 7 oz., shoemakers $5\frac{3}{4}$ oz., and stocking-weavers $3\frac{1}{2}$ oz.—quantities much below those of out-door operatives in England, but identical on the average of both classes.

Meat.—Speaking generally, butchers' meat is the kind used in towns, and bacon in the country; 30 per cent. of the latter never eat butchers' meat, but 99 per cent. obtain one or the other kind.

In towns, butchers' meat can be obtained at any moment, in small quantities and in cheap pieces; but in villages the supply is only weekly, and the price of the inferior joints is greater than in town. Some buy half an ox-head or a sheep's head, weekly, and make broth and skim off the fat for future use. Bacon may sometimes be fed by the labourer; and when otherwise, it can be bought at any time—often bought at the grocer's shop on credit—can be cut into small portions, supplying meat to the parents and dripping to the children—is fat, and thus sooner satisfies—is more relishing than butchers' meat, and can be readily fried with cold potatoes or with cabbage. The American bacon can be bought at half the price of the English bacon, but the poor prefer the latter.

A meat dinner is universally obtained on the Sunday, and in turns is renewed four to six times a week; but in the country, if the farm labourer be poor, the remainder is reserved for the husband during the week; and if less poor, and the wife be a good manager, a morsel is obtained three or four times a week, or even daily. When the husband cannot return home to dinner, he takes his cold meat or bacon with him, and a hot supper is provided on his return. The same occurs when the wife and other members of the family work in the fields and cannot return to cook food. In certain counties, as Somerset, Dorset, Norfolk, Suffolk, Essex, Bucks, Herts, Hunts, Cambridge, and Beds, pork is the sole meat eaten, and is generally fat and pickled. In Anglesea the animals are slaughtered in the summer, and the whole meat is salted for the winter. In the Highlands of Scotland the shepherds and others have only braxy mutton—that of lambs and sheep found dead. The use of the meat of calves &c. which have died a natural death is not uncommon in South Wales and in many parts of England. Fish is chiefly eaten on the coast; but red herrings are a common food both in town and country, and especially in the winter, and fresh herrings and other fish when very cheap. Herrings packed in barrels and newly salted are a very common food in the Western Highlands of Scotland; but, generally speaking, fish is not an important article of food throughout England.

The husband obtains the lion's share of the meat or bacon, and the wife says that he wins the bread and needs it.

Meats were eaten among farm labourers by 99 per cent. in England, 84 per cent. in Wales, 72 per cent. in Scotland, and 59 per cent. in Ireland, in quantities per adult weekly of 16 ozs. in England, $12\frac{3}{4}$ ozs. in Wales, $10\frac{1}{4}$ ozs. in Scotland, and only $4\frac{1}{2}$ ozs. in Ireland, yielding a higher return in reference to England than was expected, and showing how low Ireland stands both in frequency and quantity.

Of indoor operatives, silk-weavers obtained $7\frac{1}{4}$ ozs., needlewomen 15 ozs., kid-glovers $18\frac{1}{4}$ ozs., shoemakers $15\frac{3}{4}$ ozs., and stocking-weavers $11\frac{3}{4}$ ozs.—quantities relatively high, but on the average very slightly less than those of outdoor labourers.

Milk.—In a butter country the only kind of milk attainable is skim milk and buttermilk, and when the former is cheap, as in Devon (one farthing per pint), the latter is not eaten by the labourers. Skimmed milk is usually poorer than buttermilk in fat. In hot weather it is kept so long that it turns on boiling, and cannot therefore be cooked. Buttermilk is used largely in South Wales and in Ireland, and in the former is often given to those who help to churn; but, except in those localities, it is not so highly appreciated as it should be. In a cheese country only whey can be had, and the poor rarely regard that as human food. In arable districts milk of every kind is exceedingly scarce, so that even the farmer cannot obtain it for himself. In some pasturage districts the whole land is devoted to feeding animals, and then no milk can be obtained; but usually a district of pasturage is favourable to the supply of milk to the labourer. New milk is always attainable in towns, but generally almost or quite unattainable in the districts and localities whence it is sent to towns. It is abundant in the Highlands of Scotland, and a Scotch pint, or $3\frac{1}{5}$ English pints, is the daily allowance to a labourer. In many parts of England the farmer feeds his calves and hounds with it, and denies it to the labourers, because it is inconvenient to find some one to measure it out when asked for. Many gentlemen distribute skimmed milk gratuitously, and others supply new milk at a low price. A few labourers keep a cow in the lanes of their district, and then have plenty of milk; but generally speaking, the supply of milk is quite inadequate to the wants of the country. Some farmers who do not sell milk, allow their labourers to have a quarter of a pint of cream on Saturday for one penny.

Of outdoor labourers 72 per cent. obtained milk in England, 100 per cent. in Wales and Scotland, and 98 per cent. in Ireland; and whilst the quantity per adult weekly was only 32 ozs. in England, it was 85 ozs. in Wales, $124\frac{3}{4}$ ozs. in Scotland, and 135 ozs. in Ireland—quantities greatly in favour of the Irish and Scotch peasantry. The quantity obtained by indoor operatives was very small, viz. 22 ozs. by silk-weavers (including those at Macclesfield), 7 ozs. by needlewomen, $18\frac{1}{4}$ ozs. by kid-glovers, 18 ozs. by shoemakers, and $24\frac{3}{4}$ ozs. by stocking-weavers. The amount was very small in London.

Cheese.—In the poorest districts of England and in South Wales cheese is eaten very largely by the labouring population, whilst in the better-paid districts, as Yorkshire, it is regarded as a luxury, and eaten rarely. In the west of Ireland, where the people are so poor, they say cheese is too dear for them, and I scarcely found a family which purchased it. The explanation of this anomaly is the price charged for the kind of cheese in question. In Dorset, Somerset, and Wilts, and in South Wales, the cheese which is so largely eaten is made from skimmed milk, and is highly nitrogenous, but it is tough if too new, and hard if more than one year old. It is sold retail at $2\frac{1}{2}d.$ to $3\frac{1}{2}d.$ per lb. I found a man and his wife in Wales who ate 1 lb. a day each, and lived almost entirely on bread and cheese. In other districts this kind of cheese is unknown, and when 8*d.* to 10*d.* per lb. is charged for it, the poor rightly regard it as wasteful. It should be well understood that the cheap cheese contains more nitrogen than dearer cheese, but is deficient in fat (carbon) and flavour, and when it is in a digestible state, it is three times as cheap food as the richer kinds. Cheese is eaten generally by indoor operatives living in country districts or country towns. Those living in London eat it less abundantly.

Among farm labourers 57 per cent. obtained cheese in England, 72 per cent. in Wales, and 48 per cent. in Scotland, whilst its use was almost unknown in Ireland. The quantity per adult weekly was $5\frac{1}{2}$ ozs. in England, $9\frac{1}{2}$ ozs. in Wales, and $2\frac{1}{2}$ ozs. in Scotland. Of indoor operatives, shoemakers ate about $3\frac{1}{2}$ ozs. per adult weekly, stocking-weavers $2\frac{1}{2}$ ozs., and kid-glovers in Somerset 10 ozs., whilst silk-weavers and needlewomen scarcely ever purchased it. Its extensive use was restricted to South Wales, Dorset, and Somerset, but it was generally eaten in Gloucester, Durham, Sussex, Surrey, Hants, and Rutland.

Tea.—Tea is used almost universally both by indoor and outdoor operatives, except in the very poor districts of South Wales and the west of Ireland. It is drunk very weak, and the infusion is little more than hot water flavoured. In many districts it is drunk with sugar, as in Devon, in others without milk, and the very poor—cutting off milk and sugar rather than tea—drink the infusion alone. Its use supplies a warm fluid in a palatable form, which is necessary and agreeable in both hot and cold weather alike, and a meal is made by it for the wife and children, when bread, with a little treacle or fat, is added. In a very few cases, the husband takes a cold infusion with him to his work, and one family consumed $\frac{3}{4}$ lb. of tea per week. It is very desirable in the poorest districts that tea should not be introduced, since it is a dear food in relation to its cost, and most important everywhere that it should not supplant milk in the dietary of children. Many needlewomen—the poorest class of operatives—take tea thrice a day, and buy $\frac{1}{2}$ oz. daily. This is the most ill-fed class, and the one which spends money with the least economy. When the pressure of want is not so great, it may well be admitted as a luxury, and as supplying a warm agreeable fluid with the bread. Coffee is used by 44 per cent., whilst tea is drank by 99 per cent.

Beer and Cider.—In the cider districts two to four pints of cider are allowed daily to each labourer, and in harvest time the quantity is increased to one and even to two gallons. Half that quantity is allowed to each woman. Beer is not usually given except during harvest time and on occasions of special labour; but whenever either cider or beer is given its value is estimated and considered as a part of the wages; hence it cannot be doubted that, regarded as food, they are dear, and it would be much better to allow their value in money, and leave the labourer to drink as he pleases. This is indeed done in a very few places. When the wife does not work in the fields, she most rarely obtains either beer or cider; for whatever may be the quantity allowed to the husband, it is quite exceptional to find a man who takes any portion of it home. I have been exceedingly struck with the very small quantity of beer which is drunk by farm labourers' families. In towns it is far more general for the operative and his family to obtain beer, and usually it is drunk at suppertime, and particularly on Saturday nights and Sunday. In some country villages I found a weak beer which was sold at 2*d.* per gallon, and which was the ordinary beverage of the operative.

Hence, in reference to luxurious foods, as sugar, fats, meats, and tea, England and Wales stand at the head, whilst in reference to breadstuffs and milk, England is at the foot. A comparison of the diet of indoor and outdoor labourers shows that the former obtain far less breadstuffs and milk, but both are equal in reference to luxurious foods, as sugar, meat, fat, and tea. When we regard the returns as a whole, it will be seen that an outdoor (farm) labourer's family obtains $13\frac{1}{4}$ lbs. of breadstuffs, $6\frac{1}{2}$ ozs. of sugar, 5 ozs. of fats, 14 ozs. of meats, 52 ozs. of milk, 5 ozs. of cheese, and $\frac{1}{2}$ oz. of tea per adult weekly; whilst an indoor operative eats $9\frac{1}{2}$ lbs. of breadstuffs, 8 ozs. of sugars, 5 ozs. of fats, $13\frac{1}{2}$ ozs. of meats, 18 ozs. of milk, and $\frac{3}{4}$ oz. of tea per adult weekly.

The amount of Carbon, Hydrogen, and Nitrogen.—The amount of carbon and nitrogen which is contained in the above dietaries, reckoned per adult weekly, is as follows:—

Farm labourers obtained in England 13·2 ozs., in Wales and Anglesea 15·8 ozs., in Scotland 16 ozs., and in Ireland, with the maize dietary, 14·1 ozs., yielding an average of 14·8 ozs. of carbon. The free hydrogen, when reckoned as carbon, makes the following additions:—England 0·84 oz., Wales and Anglesea 0·89 oz., Scotland 1·09 oz., and Ireland 1·17 oz. Scotland thus stands at the head and England at the foot; but a yet higher amount is found in the Anglesea dietaries, viz. 19·8 ozs. of carbon. Indoor operatives universally obtained a less amount of carbon; even the well-fed cotton operatives in times of plenty obtained only 13·4 ozs.—a quantity almost identical with that of English farm labourers, but stocking-weavers had 10·9 ozs., shoemakers 10·3 ozs., needlewomen 9·4 ozs., kid-glovers 9·3 ozs., and, least of all, silk-weavers 9 ozs. Hence the farm labourer occupies a much higher position in his dietary than has heretofore been assumed, a position also somewhat higher than the standard quantity which I estimated to be necessary from experiments upon myself and others, viz. 12·5 ozs. of carbon for the hard-working classes. Whilst the grand average in farm labourers was nearly 15 ozs. of carbon, that of three classes of indoor labourers was $9\frac{1}{4}$ ozs., and the average of the whole was only 10 ozs. As to nitrogen, the farm labourers in England obtained daily 242 grs., in Wales and Anglesea 290 grs., in Scotland 335 grs., and in Ireland, with the maize dietary, 347 grs., yielding a grand total of 300 grs. daily. Anglesea, again, stood the highest of the large divisions of the kingdom, and offered 360 grs. daily. There is a marked contrast between these returns and those of the indoor labourers, if we again except the well-fed cotton operatives, whose dietary furnished 249 grs. daily—a quantity almost identical with that of the English labourer; for stocking-weavers obtained only 188 grs., shoemakers 190 grs., kid-glovers 175 grs., silk-weavers 164 grs., and needlewomen 135 grs. Hence, whilst the average consumption by farm labourers was 300 grs., that by indoor labourers was less than 200 grs., and thus, contrary to general belief, the inhabitants of country districts obtain more food than those of towns.

Such is the statement of the food obtained by different classes of the community, some doubtless as a whole, and others in part, containing members which are ill-fed. It must, however, be added that a subdivision of the class of farm labourers, viz. those living at the farmhouses, obtain far more food than the above quantities represent, and are doubtless amongst the most fully-fed persons in the kingdom. The quantity of carbon and nitrogen contained in the food of a labourer in Yorkshire was $26\frac{1}{2}$ ozs. and 570 grs. There were also some labourers found who, living at home, ate very largely, as in Ireland 35 ozs. of carbon and 645 grs. of nitrogen, in Scotland 27 ozs. of carbon and 500 grs. of nitrogen, and in England 23 ozs. of carbon and 430 grs. of nitrogen per adult daily. On the other hand, some of this class in England obtained only $6\frac{1}{2}$ ozs. of carbon and 125 grs. of nitrogen.

Extremes yet wider apart are found when both indoor and outdoor labourers are considered together. Thus, one needlewoman ate less than 4 ozs. of carbon and less than 100 grs. of nitrogen, and many of that class obtained less than 5 ozs. of carbon and 120 grs. of nitrogen daily. So wide apart are these numbers, that the highest is nine times greater in carbon and twelve times greater in nitrogen than the least, and yet both alike are the daily food of an adult human being.

The Lancashire operatives offer, however, the least exceptionable information as to the diverse quantities of food which the human body can take for lengthened periods and yet remain in good health under both conditions. Thus, on the average of the whole inquiries, they obtained $13\frac{1}{2}$ ozs. of carbon and 250 grs. of nitrogen daily in good times, whilst lately the quantities were reduced to $9\frac{1}{2}$ ozs. and 185 grs. Even the same person ate at one time 20 ozs. of carbon and 373 grs. of nitrogen, and at another 11 ozs. and 188 grs., whilst another person reduced her dietary from $14\frac{1}{4}$ ozs. to $6\frac{1}{3}$ ozs. of carbon, and from 233 grs. to 108 grs. of nitrogen daily.

With such facts as these, how difficult it is to prove what food is really required even by the classes from which they have been derived! We cannot assume that 35 ozs. of carbon are necessary for a farm labourer, when others placed in very similar circumstances obtain only one-fifth of that quantity; neither are we entitled to affirm that the least quantity is sufficient, seeing that such small quantities are but rarely found. The proper quantity lies somewhere between the two, and possibly where the average is drawn; but since men are not fed on the average, but as individuals, to assume that is to almost assume the whole argument. When different classes of persons are included in the inquiry, we may be prepared from general knowledge to find some difference in their wants; but can it be assumed with safety, that because some needlewomen live on 4 ozs. to 5 ozs. of carbon daily and keep in moderate health, so small an amount only is necessary?

The extent of this abstract precludes my offering further observations upon the dietary of the poor, but I would add in a line that the children and wives are almost universally ill-fed; that a large proportion of the infant mortality and of deaths from consumption before adult life may be properly traced to the tea and sop—the wretchedly innutritious feeding in very early life; that the poor of our day are in danger of placing mere taste and flavour before nutrition, as in the purchase of high-priced bacon, fresh butter, and of high-priced food in general; and that it is not at all so thoroughly understood as it should be, that a man's first duty is to provide sufficient nourishment for his family, and, if necessary, to do this should limit them to dry bread, or bread and dripping, or to the stirabout and skimmed milk and the potatoes and buttermilk of the Irish peasantry. He should be taught how to place supply of nourishment first, and variety of food and pleasure of the palate second. It is also to be much regretted that so much of his wages are spent in beer and cider, either voluntarily or involuntarily, and that he has not universally the opportunity of purchasing cheap milk and of growing an abundant supply of potatoes.

I will now indicate in a few words, and therefore very generally, the present state of the dietary question in a scientific point of view, and in doing so we shall find this satisfaction—that whilst more remains to be done than has hitherto been effected, much of the knowledge which has been acquired is conclusive in its nature.

The chemical constitution of foods has been determined in an exact manner and on a scale of great magnitude both in this country and abroad, and although in calculating the nutritive elements in foods it is still desirable to quote the authority on which we rely, this is less owing to errors in the analyses, than to the qualities of the various samples which are in actual use. Thus the composition of the lean and fat of meat is well known, as is also the proportion which these bear to each other in the whole of a well-fed or a moderately-fed animal; but an approximation to the truth only can be made when we apply this knowledge to a particular joint of meat, or to the various joints which are commonly consumed by the poorer or the richer sections of the community respectively. So with regard to other foods. Milk varies in the amount of all its constituents according to the particular cow and to the food which is supplied to it, so that one cow yields more butter and another more cheese, whilst the grass of the rich lowlands affords far richer milk than that of the hills and mountain-sides. Bacon varies according to its degree of dryness; butter according to the quantity of salt and of water which it contains, and cheese according to its quantity of fat. Hence, whilst the analyses of foods under many conditions have been accurately made, there is and always will be, in the application of this knowledge to the dietaries of individuals, a certain error; but it is not to an amount which in the least interferes with the truthful application of this knowledge on the large scale which is needful in a daily or weekly dietary.

There is a suspicion that the analysis of a few foods, as, for example, some of the very great number of varieties of these, requires correction, and in reference to the odours of alcohols and of fragrant substances but little advance has been made. There seem also to be grounds for the belief that our knowledge of the active properties of tea and coffee is not yet complete. It is singular that in the market the only test applied by the merchant is the flavour, which doubtless mainly depends upon the essential oil of the leaf, whilst in the laboratory the test is the quantity of theine; the former, viz. the aroma, varies greatly in the different specimens of tea, whilst the latter (the theine) may be as abundantly found in the low-priced as in the high-priced teas. There is an agreeable effect produced by tea which the theine does not account for, and thence it is inferred that there must be some hidden quality in tea which produces it; but when we refer to the poor man's tea, to 2 ozs. of tea per week for a family, used thrice a day, affording not more than half a teaspoonful of tea for the whole meal of a family, it is difficult to believe that much more influence is found in the cup than that of a pleasant warm drink, and one the use of which is universal and fashionable.

The physiology of foods is in a less satisfactory state than that of their chemical constituents, and as it is a much more recondite question, the latter has perhaps too exclusively usurped its place in determining the value of foods.

Thus, the husk of grains, even the inner part which is directly in association with the fecula, contains a larger proportion of nitrogenous matter than is found in the fecula, and thence it has been inferred—nay, in spite of every exposure of the fallacy, it is still maintained by those interested in bread companies, that the meal derived from the whole grain is more nutritious than that obtained from the fecula alone. In periods of famine the bark of trees has been selected for food, because it contains a certain amount of starchy matter, and the wood of plants, when sawn into a fine powder, has been mixed with other substances and eaten as food; but because the sawdust is rich in nitrogen, as rich as is the husk of seeds, would it not be repugnant to common sense to affirm that it is not only a good food, but that wheaten flour would be a better food with a portion of sawdust added to it? Yet such is precisely the state of the question with regard to the bran or the husk of grain; it is indigestible in the human stomach, and when eaten as food, all the indigestible part remains unused, and in passing through the bowel acts as an irritant and laxative. Hence the digestibility of various foods is a prime element in the calculation of the nutritive values of foods. This quality varies somewhat according to the individual, so that foods which are useful to one are injurious to another. Moreover, our knowledge of the degree of digestibility of any food is a matter rather of inference than of fact; still, when foods are mixed as in ordinary diet, the amount of unused matter in the daily supply has been ascertained with an approach to truth, and suffices for comparison when changes of mixed foods are made. The extension of this knowledge is of the highest importance in physiology, and particularly in reference to those who are fed at the public expense, and whom it is a public duty to feed sufficiently at the smallest cost. The problem is one very easy of solution under proper conditions, and consists simply in determining, under certain typical conditions, what proportion of a given food leaves the body unused. The method is accurate, and not difficult of application, and of all conditions in which it could be used, that of human life is probably the best, since typical men could be selected, and every other condition, except that under inquiry and the effect of season, could be kept uniform from day to day. I am very desirous to impress this part of the subject upon the public mind, for in no other way can the information which is so essential to the public weal be acquired. Had the recommendation of Lord Carnarvon's Committee of the House of Lords been adopted by the Government, and a suitable Commission been issued, the whole question of the digestibility of foods might have been set at rest in the course of two years.

As to the chemical constitution of foods, there are certain leading facts relating to this subject which have been under constant inquiry for some years past throughout Europe and America, and much information has been gained. These refer to the transformations of foods, and to the outlets by which they finally leave the body. Thus the experiments of the late Dr. Dundas Thompson, Messrs. Lawes and Gilbert, myself, and others, have, I think, proved that, whilst nitrogenous foods supply the nitrogenous tissues, and ultimately leave the body chiefly as urea, they have the further quality of stimulating all vital actions, and thereby of increasing the transformation of other and carbonaceous foods. The transformation of the vegetable acids, and of starch and sugar, and the deportment of fat whilst in the body, and its final transformation, seem to be well established; but it yet remains to show why so many substances, as fat, starch, and sugar, having an analogous composition, should be found so universally in the foods provided for man, and why he seems to need a portion of each of them. The fact also that certain substances leave the body without having experienced any change whilst passing through it, is established, as, for example, odours of almost every kind, and, so far as our knowledge now extends, we may add alcohol also. I do not say "alcohols," since that class embraces many fluids differing much from each other, and all except alcohol itself containing elements which do undergo the process of transformation; but I refer only to alcohol, whether taken alone, or with colouring and flavouring matters in spirits, or with these and certain nutritive substances in all spirits. There can be no doubt that alcohol, as alcohol, leaves the body by every outlet for many hours after it has been taken, and for a period of at least thirty-six hours may be found in the tissues of the body, and, so far, is conclusive proof that alcohol passes through the body unchanged. The defect in the proof is, that in no case has the whole of the alcohol which was taken been collected from the excretions, and therefore some may have been transformed; and the only answer to this assumption is, that it is and will be impossible to collect all the products of excretion for so long a period as the alcohol has been found in the body, and that as some alcohol is proved to leave the body by every outlet for the longest period during which an experiment can be made, and after this is found in the tissues of the body unchanged, it is highly probable that the whole does pass out unchanged.

It is no objection to this statement to affirm that alcohol is an active agent in the body, for a substance may act physically as well as chemically, and it does not follow that it must change its composition in order to act. The action of alcohol over the heart, the skin, the brain, and other organs is fully admitted; but this fact simply lies parallel with the other, viz. that it is taken into the body as alcohol, and leaves it as alcohol.

The digestibility and assimilability of foods must be regarded in three aspects: 1st, the kind of food under inquiry, or its absolute digestibility; 2nd, the quantity of a given food which is digested; and 3rd, the conditions under which the food is acting. In reference to the quantity of food which can be assimilated, I cite the instance of cheese; for my own experiments have shown that beyond a very limited amount, the nitrogenous elements of cheese do not reappear as urea—that is to say, whatever may be the quantity of cheese eaten, only a very limited amount of it is digested and assimilated. This is important in the case of persons who, not accustomed to the use of cheese, are compelled to make a large part of their meal of it, as in prisons where, by the recent alterations, 3 to 4 ozs. of cheese with bread constitutes the whole of the Sunday's dinner. If only a small portion of the cheese be digested, there will be a serious waste of food and also a deficiency in the nutritive value of the dinner; and if, as doubtless was the case, the Committee regarded the cheese as equivalent to a proportion of meat, they have greatly erred. It is one thing to add a piece of cheese, which may only in part be digested, to a good meal (and it will be noticed that wherever meat can be obtained, it is eaten first and the cheese supplements it), and quite another to make cheese a prime constituent of the meal. It has been already shown that there are certain poor districts in the kingdom, as South Wales, Wilts, Dorset, and Cornwall, where a very large quantity of a very low-priced cheese is eaten largely—in quantities which, measured by their nutritive elements, might well supplant meat; yet the people eat it, not because they prefer it to meat, and are themselves the worst fed of the whole agricultural country. This is not in favour of the digestibility of cheese, and yet it is under the advantage that the persons eating the cheese have from their childhood been accustomed to its use. The same argument might be used in reference to fat, for it is proved by the excretions that the quantity of fat which can be digested at a time is very limited; but I shall not pursue this argument further.

The effect of the conditions under which foods are digested and required is now much better known than heretofore. The views of Liebig as to the influence of climate now require much modification; for the abstract of the Report on the dietaries of India, which I prepared the last year, and which is now published in the Transactions for 1863, shows that the absence of meat and fat from the Indian dietaries is far less the effect of the climate than of poverty, and that, with the exception of the high castes, as Brahmins and others, who reject meat from religious scruples, flesh of almost every kind is eaten throughout that vast empire when it can be obtained. The rivers are scoured for fish so small and insignificant as would be rejected by our poor, and is eaten both in its fresh and putrid state. Beasts of prey, carrion birds, nay, even snakes, and the most repulsive kind of flesh, are eagerly sought for by the low-caste Mahomedans and eaten, whether it has died a natural death or otherwise; nay, in Burmah the inhabitants refuse to take life, but the animal having died, its flesh is eagerly eaten. Moreover, the quantity is as large as the supply will afford, without any reference to theories as to the requirements of climate. Similar information has been afforded by Dr. Livingstone in the hot climates in which he has travelled, but there the mania for flesh-eating was far greater than anything shown in the Indian Reports. So, on the other hand, the Reports of Dr. Kane and other Arctic travellers have abundantly proved that the absence of vegetables in the food of the Laplanders is because such food is not obtainable, for they enjoyed the white bread of the travellers; and the exclusive use of flesh and fat is not only because it is appropriate to the climate, but because it alone can be procured. In the northern and less rigorous climate of Sweden the peasantry take mixed food very similar to that of the people of our own country.

The effect of exertion over the transformation of food is now well and precisely established, and our knowledge differs somewhat from that of an earlier period. Thus, because the muscles are used in making exertion, and they are composed of nitrogenous tissues, it was affirmed, with a great show of truth, that the excretion of nitrogen in the form of urea must thus be increased; but it has been proved that the excretion of carbonic acid by the lungs is the measure of the exertion (for you cannot move your finger repeatedly without increasing the quantity of carbonic acid evolved), whilst the urea is not at all or only slightly increased with the most severe exertion. The former has been most minutely proved by my own experiments, and the latter has been established not only by myself, but by Bischoff and Val on the Continent; for, singularly, whilst I was proving this by experiments on prisoners at the tread-wheel, they proved it by a dog working a spit-wheel until exhausted—both similar and most severe kinds of exertion. The explanation of this latter fact was given by me in the 'Philosophical Transactions' for 1861, viz. that urea is a mixed product of food and tissue, and if muscles during action throw off a larger quantity of nitrogenous material than occurs at rest, they must absorb and appropriate an equally large quantity of nitrogenous food, or they would diminish in size and weight, and hence the total excretion of the mixed product, viz. of urea, will be the same.

On the Alimentary Character of Nitrogen Gas. By Francis Barham.

On the Physiological Aspect of the Sewerage Question. By J. Hughes Bennett, *M.D., F.R.S.E., Professor of the Institutes of Medicine in the University of Edinburgh, &c.*

In recent times it has been maintained that the gases originating from decomposing animal and vegetable matters, bad drains, overcrowding, &c., are not only injurious to health, from the deterioration of atmospheric air, but that they are the especial causes of certain specific fevers. It has also been supposed that bad smells, especially the smell of fæcal matters or of drains, are the evidence of the existence of these specific morbific causes. Sanitarians and municipal authorities have succeeded in exciting at the present time a public *furore* on this subject, and a result which, for extravagance and uselessness, can only be compared with the railway mania which existed some years ago. Gigantic works are being constructed, having for their object, not the utilization of human excreta, but channels by which they may be effectually wasted. Millions of pounds are thrown away in conveying that matter, so necessary for the land and for agricultural purposes, into our rivers and seas, under the idea that the smells and emanations arising from it are the source of pestilence, and that it should be removed at any cost. The following considerations may perhaps serve to correct erroneous views on this subject:—

1. *Atmospheric Air, strongly impregnated with Odour of various kinds, is not necessarily injurious to Health.*—This is shown, 1st, in various parts of the world where odorous flowers are largely cultivated for the manufacture of perfumes. Strangers, indeed, often complain of headaches in such districts, but anything like epidemic diseases are unknown. 2. At Paris there is an establishment at Montfaucon for converting ordure into a dry mass by simple evaporation. It is then called *poudrette,* and sold for agricultural purposes. The smell to visitors is at first almost intolerable; but the inhabitants of the neighbourhood are unconscious of it, and it occasions no disease. 3. The state of the Thames, in 1858, was loudly complained of in consequence of its putrid odour; but no disease was caused by it. 4. The Craigintinny meadows, near Edinburgh, have for 200 years been rendered fertile by causing the drainage of the city to flow over them. The odour is often very bad, but they occasion no unhealthiness. 5. The drains in Naples run down to the sea, having large slits in them opening into the streets; and the beautiful bay is rendered foul, close to the shore, with the drainage of the city. This, combined with the sulphuretted hydrogen given off from the volcanic soil, renders the atmosphere so unpleasant, that the rents of the dwellings, unlike what exists in other cities, augment as the apartments ascend in the stair. The latrines in the public hospitals also exhale the most fœtid ammoniacal gases. Notwithstanding, neither in the city nor in the hospitals is fever, and especially typhoid fever, so common as in other cities of the same size. 6. Drs. Livingstone and Kirk informed me, that in Africa the smell of the mangrove-swamps was often intolerable, but never productive of disease.

2. *Atmospheric Air, productive of the most dangerous Epidemics, may be quite Inodorous.*—This has been proved in various parts of the world, as in the marshes of Essex and Lincolnshire, the low grounds of Holland, the Campagna of Rome, the Delta of the Ganges, the swamps of Louisiania, the Guinea coast, Jamaica, and many other places. It has never been known that those who catch intermittent, remittent, or continued fevers, on visiting such localities, have connected the morbific causes with peculiar smells. It follows that—

3. *There is no necessary Connexion between Smells and deleterious Gases.*—Some of these have smells, such as sulphuretted hydrogen, whilst others are inodorous, such as carbonic-acid gas. Now it is to be observed, that what makes these and other gases injurious is their being so concentrated as to exclude atmospheric air, or their being pent up in confined places, from which they escape in injurious quantity. Hence why workmen going down into pits expire, for the same reason that dogs do in the Grotto del Cano. It has been asserted, however, that smells, though not injurious in themselves, give indications of danger. One chemist has maintained that during putrefaction the smell was given off first, and the noxious vapour afterwards, whilst another declared that the smell was given off last, and was the proof that all danger had ceased. The first likened smell to the tail of the lion, which, when seen, gave evidence that the claws and teeth were not far off; while the second, continuing the simile, declared that a sight of the tail was the best evidence that danger was departing. I do not believe that smells, as smells, are injurious to health, nor are they a nuisance to those who live among them; yet one of the great difficulties in making the sewerage of towns useful in agriculture has arisen from exaggerated notions as to the danger of smells, and the necessity of deodorization.

4. *Fresh Sewerage entering into running Streams is not dangerous to Health.*—This is shown, 1st, by the state of the Thames in 1858; 2nd, by the condition of the water of Leith, which has been proved by the statistics of Dr. Littlejohn, officer of health for the city of Edinburgh, to be a more healthy district than others in proportion to its population, and by Dr. Miller to be equal, in point of health and as regards death-rates, to the best parts of the town; 3rd, it is not destructive to the fish, for, according to Dr. Elliot of Carlisle, the salmon have increased in size and weight since the drainage of that city was conducted into the Eden, while it is shrewdly suspected that the famed whitebait of Greenwich and Black-

wall actually owe their existence to the peculiar condition of the neighbouring Thames.

5. *Typhoid or other Fevers cannot be proved to originate from Fæcal Fermentation or Emanations.*—It is true that Dr. Murchison has collected numerous cases where the exposure to such emanations has been coincident with the outbreak of fever; but numerous striking exceptions exist which are opposed to his conclusions. In Edinburgh, typhoid fever has increased as the drainage of the town has extended and been improved—a result which has been attributed to an imperfect water-supply, rendering the water-closets the means of diffusing fæcal emanations through the interior of the houses. If such were the case, fever should increase largely in autumn, when the supply of water is scarce, whereas it is always most prevalent in winter, when the water is abundant. Formerly also typhoid fever was as unknown among those who had water-closets as those who had not. Further, it should be remembered that the men who are employed almost constantly in the great London drains, though so much exposed to their emanations, are not particularly liable to fever.

6. *Epidemic fever, and especially typhoid fever, must originate in other causes,* amongst which, besides contagion and infection, may be cited starvation, improper quality of food, bad water—especially from springs arising in the neighbourhood of cesspools or churchyards—overcrowding, bad ventilation, and the numerous ills arising from poverty and dissipation. Some, like Dr. W. Budd, of Bristol, place the cause in a specific virus, always emanating from the body, which may be conveyed by, but never originates in, drains. For my own part, I believe we have yet to discover the cause producing essential fevers. But while there are so many sources of fallacy, we cannot be too cautious in accepting plausible explanations, or in acting upon them in our efforts to improve the drainage of towns.

Description of M. Marey's *New Sphygmograph.* *By* J. Hughes Bennett, *M.D., F.R.S.E.*

The instrument is placed on the wrist, held by a light clip, the spring acted upon resting on the artery. A slip of white paper mounted on a steel plate is placed horizontally in the line of the vessel, and is moved onwards by clock-work. The paper is brought into communication with a pen connected with the spring on the pulse, and the pulsations are marked upon the paper in wavy lines.

Observations on the Measurements of the Head and Weight of the Brain in 696 *cases of Insanity.* *By* R. Boyd, *M.D.*

On the Lymphatics in the Liver of Man and the Pig. *By* Dr. L. T. A. Carter.

The author explained and illustrated by drawings the extent of penetration of various injecting preparations. From these preparations he concluded that the blood-vessels and lymphatics are in direct communication with each other. He also described a peculiar relation of the branches of the hepatic artery to the lymphatics.

On Food as a Source of Entozoa. *By* T. Spencer Cobbold, *M.D., F.R.S.*

This subject was brought before the Association in three papers, treating, severally, of meat, fruit and vegetables, and drink, all of which materials were stated to be more or less liable to harbour parasites of some kind or other. The author dwelt upon the *Tæniæ* in their mature state, and spoke of their introduction into the body in a larval condition. There was no doubt that entozoa were introduced with vegetable food. Small mollusks harboured larval parasites in prodigious quantities; and they were the source of one or more of the parasites that occasionally invaded the human form. These entozoa might be swallowed from water-drinking; but they were more likely to be taken from water-cresses, or other vegetables of the kind. It was necessary, with all vegetables, that the greatest cleanliness should be observed in preparing them for the table. A small species of fluke-worm, discovered in Egypt, had been brought to this country; and if it became acclimatized, it would be difficult of extermination. Eggs and living specimens had been found in this country, both in men and monkeys, but only to a very small extent. He was the first to discover it in the monkey. As to the little thread-worm, he had never been able to rear it in apples and pears; and there was no evidence to show that any species of entozoa was derivable from fruit. It was not likely that fruit was ever an intermediate habitation for any of the parasites which ordinarily occupied the human body. A great many evils in children were charged to eating unripe fruit; but, as far as entozoa were concerned, that fear was entirely groundless. With regard to celery, cabbages, and all the ordinary market-garden vegetables, he might say that all decomposing animal and vegetable matter sustained entozoa; and the more filthy the water or liquid manure employed to secure the fertility of the garden, the more likely were entozoa to be supplied with the vegetables grown upon the land. The most careful washing was therefore desirable. Parasitic larvæ might be found in water that was, to all appearance, perfectly pure; but, speaking generally, spring-water was perfectly innocuous. The same thing could not be said of water stored in large tanks in hot climates. The people of these islands suffered from entozoa, which must be introduced by drink in some form or other. The presence or absence of the larvæ of human entozoa in water was dependent upon the place from whence the supply came, and upon the condition of the water. The pork measle might be readily communicated to human beings in this way, and it was apt to ensconce itself in the brain, causing death, which the Registrar-General invariably set down to cerebral disease. The way in which it reached the brain was from the coats of the stomach, through the circulating medium. There was one kind inhabiting dogs, which was often communicated to the human being. One-sixth of all persons who died in Iceland perished from a little creature so small that, in its adult state, it could scarcely be seen. If neither dog nor wolf existed, we should get rid of these species altogether. No one need drink water impregnated with these entozoa. Water to which dogs had no access could not contain them; neither were they likely to be found in spring or well water. Open waters into which the carcases of dogs were occasionally thrown would probably contain them, and the eggs might be carried to food washed in such water. The danger would be got rid of if the water was always carefully boiled, filtered, or distilled; but a filter, to be effectual, ought not to pass anything larger than one-thousandth of an inch. Sand and charcoal filters were of very little use. Paper filters should be employed. All entozoa not preserved for scientific experiments should be destroyed by fire, and under no circumstances should they be thrown aside as harmless refuse; and he would press upon butchers, knackers, and others not to throw doubtful offal to dogs. Then as to beer, porter, &c. All he need say with regard to these fermented drinks was that he believed them perfectly harmless. Even though impure waters should have been employed, the boiling of the wort would be alone sufficient to destroy any number of parasites. Unfortunately, we cannot be perfectly certain about unfermented drinks, such as ginger beer, lemonade, and the like. All must depend upon the source and the supply of water. They might, however, conclude that the manufacturer got his supply from the purest source open to him, and that, therefore, we need be under little or no apprehension. In regard to wines, the same remarks were applicable. Alcohol, added to water, was sufficient to destroy the parasitical eggs; but he questioned whether the amount of spirit in our home-made wines was sufficient for the purpose.

Valves in the Abdominal Veins. *By* Edwards Crisp, *M.D.*

Up to 1852, the author said, all physiologists had denied the presence of valves in the abdominal veins, when he discovered them in the Giraffe; since this period he had found them in the splenic, mesenteric, and renal veins of many animals. So numerous were they in some mammals, that the left renal vein of the Nylghau (*S. picta*), which was exhibited, contained ten valves, two single and four pairs. It was thought by the author that the presence of these valves in the splenic and gastric veins had an important bearing upon the origin of splenic apoplexy. The author named fifty-five animals in which he had discovered valves in the abdominal veins. These included two of the Carnaria, one Marsupial, fourteen Pachyderms, sixteen Antelopes, eight Deer, and fourteen other ruminants, including the Alpaca (*Auchenia*) and Guanaco (*C. llama*).

On the Size of the Blood-corpuscle in relation to the Size of the Animal, its Swiftness and Powers of Endurance. By EDWARDS CRISP, *M.D.*

The object of the author of this paper was to show that the opinion generally entertained that the largest animals in the same family had always the largest blood-disks was often erroneous. Among the *Quadrumana* there were many exceptions to this supposed law, as also in the *Cheiroptera*. In the *Carnaria*, a natural family, the common Cat (*F. domestica*) had as large a corpuscle as that of the Lion (*F. leo*). In the rodents, the little Harvest-mouse (*M. messorius*) had as large a corpuscle as that of the common Rat (*M. decumanus*); and it was remarkable that the animals with the largest blood-corpuscles might be called aberrant, as the Elephant (*E. indicus*), Capybara (*H. capybara*), and Great Ant-eater (*M. jubata*). Among birds, as in the ducks and geese, there were many exceptions to this rule; and the reptiles and fishes were more prolific in examples. As regards the small size of the blood-corpuscle in relation to higher amount of organization, swiftness, and powers of endurance of the animals, the blood-disks of the Chimpanzee, Orang, many of the smaller monkeys, race-horse, cart-horse, greyhound, pug-dog, hare, rabbit, goat, otter, fox, sheep, hog, rapacious birds, sharks, and others were adduced to disprove this theory. These inferences were exemplified by a diagram of the blood-corpuscle of 180 different species of animals, drawn to scale.

On the Temperature of the Sexes. By JOHN DAVY, *M.D., F.R.S. L. & E.*

Mr. Lewes, in his excellent work on the scientific writings of Aristotle, when commenting on the dictum of that philosopher, that man has more warmth than woman, expresses a contrary opinion as established by modern investigations.

The author, from his own observations, supports the statement of Aristotle, having, in a large number of instances, in which comparative trials were made with much care, found the temperature of woman a little lower than that of man.

A priori, he thinks this might be expected, inasmuch as it is an established fact that man, on an average, consumes more oxygen in respiration than woman. And his observations on the temperature of other animals, so far as they extend, have been confirmatory. As a special example, he compares the temperature of the male and female of the common fowl. Under similar circumstances he has found that of the former a little higher than that of the latter, the maximum of the one having reached 108°·5, the maximum of the other 108°.

Some Observations on the Horse-chestnut (Æsculus hippocastaneum). *By* JOHN DAVY, *M.D., F.R.S. L. & E.*

In this paper the author gives an account of some experiments made by him on the nut, the leaves, and the bark of this tree. The nut he found composed chiefly of starch, cellulose, and casein, with a little oil and mucilage. In the shell of the nut, in the leaves, and in the bark he detected tannin and colouring-matter.

He concludes with pointing out some of the uses of the several parts, how the nut is a nourishing food, especially for sheep, as proved by experience in Switzerland, and is likely to be so for pigs, which show no aversion to it; and further, how the leaves and shell of the nut and the bark are applicable to dyeing and tanning and the making of ink. The colour they impart is a good brown or yellow; and when fixed by alum as a mordant, it bears washing in the instance of cotton and silk. In France another use is made of the nut: crushed by grinding to the state of a fine powder and mixed with water, it forms an emulsion, which is employed in the manufacture of silk, woollen, and linen fabrics; and the refuse, it is represented, mixed with an equal portion of pollard, proves a nutritive food for poultry. It has been used also in Paris mixed with flour in the making of bread.

On Cell Theories. *By* J. T. Dickson.

The author adverted to the recent progress in the synthesis of organic materials, and remarked that some physiologists had endeavoured to show that it was as easy to form cells out of unorganized matter as to make organic substances; but, from the absence of the life-element, he compared such manufactures merely to models.

On the Use of Milk and Scotch Barley as an Article of Diet. *By* George Frean.

The author suggested that a larger supply of milk might be obtained. It is not generally known that the Government have a convict establishment at Dartmoor, in Devonshire. The convicts have been employed in reclaiming waste lands, and, after various experiments, are allowed to keep cattle. They have at this time one of the best herds of cows and calves in the county, in number 184, producing upwards of 100 lbs. of butter per week, of delicious taste and quality, and this, too, on a comparatively small acreage of land, the peat land yielding nutrition in abundance. This is a sample and experiment on perhaps the worst and most unfavourable corner of 80,000 acres of land. An unstinted supply of milk to the children of the labouring population would lead to the use of Scotch barley, rice, oatmeal, &c. An excellent beverage may be obtained with Scotch barley and skimmed milk at small cost.

On the Vocal Organ of the Corixa, *an Aquatic Insect.* *By* R. Garner, *F.L.S.*

This insect, when confined in a vessel of water, is remarkable in producing a continuous sound, distinct from any produced by striking the sides of the vessel. The legs are elevated simultaneously with the noise, and friction might be produced upon the edge of the elytra, or by means of a projection or process at the base of the first pair of legs; there is also a little sac, which is probably accessory to the sound, situated at the base of the under-wings on each side, containing a little club-like body of a shape similar to the poisers of a fly or tipula.

On the Various Forms assumed by the Glottis. *By* George Duncan Gibb, *M.A., M.D., LL.D., F.G.S.*

The author stated that it had been an accepted notion that, for the most part, the glottis assumed a triangular form; and this view was taught almost to the present hour. This led him to go into the question of what were the various forms assumed by the glottis, and in what manner did they arise. In stating this problem, he briefly considered the relation that subsisted between the true vocal cords and the thyro-arytenoid muscles; and he then made some observations upon, and briefly described the arrangement of, the muscular fibres, especially as lately made out by M. Battaille, which he said had much to do in regulating the form of the glottis. He adopted that author's division of the muscle into three bundles, and approved of the name of triceps laryngea, which he had given to it; he also confirmed the accuracy of Battaille's researches. He then entered upon a description of the manner of action of the various fibres, and its influence in giving a form to the glottis. This varied from an isosceles, equilateral, or right-angled triangle, to a lozenge or barrel, circular, oblong, lanceolate, elliptic, pyriform, or arched and linear form. The commonest of these was an isosceles triangle; and a rare form was a right-angled triangle, which he had never met with unless in women, when the larynx is shallow from before backwards. A parallel or oblong glottis he explained, and showed how it occurred; he had seen it several times, but necessarily narrow, because the vocal cords, under such circumstances, could not be separated more than one or two lines at their point of origin. A more remarkable form than any of these was the reversal of the triangle, the glottis, during the utterance of continuous falsetto sounds, assuming the shape of a narrow Y, then a narrow V, and then a narrow oblong, before the termination of the experiment. The cause of this, with an illustration, was given. A pear or bulbous shape, like the new form of wine-decanter, and an arched form, composed of the narrow segment of a circle, were other forms noticed. He concluded with some observations on the form of the glottis seen in the chest and falsetto registers, and the parts in action*.

Note on the Action of the Bromides of Lithium, Zinc, and Lead. By GEORGE DUNCAN GIBB, *M.A., M.D., LL.D., F.G.S.*

The bromide of lithium was prepared with the view of treating gout and rheumatism of the throat and neck. In small doses it acts as a tonic, gentle stimulant, and sometimes as a diuretic, and may be combined with other agents with advantage. The bromide of zinc was found to relieve impaired nervous power; whilst the bromide of lead was proposed as a soothing and cool local agent in certain inflamed states of the mucous membrane.

On the Functions of the Liver. By JOHN GOODMAN, *M.D., L.R.C.P.L.*

The functions of this organ are, by the most recent works on physiology, declared to be of two principal kinds, viz. excrementitious and digestive. It is represented as a *filter*, which purifies by excretion the venous blood. This is not, however, the main function of this organ, but only the result of a more highly important process. As the great INLET *to the systemic circulation for the dissolved and soluble aliment and venous blood, its chief office is the* CHEMICAL CORRECTION of these fluids previous to their admission into the general mass of blood. This it effects as a highly organized gland by the power of the VITAL FORCE, which it exercises in common with the stomach, lungs, kidneys, &c. By this power it seizes the acids, acrid, noxious, and oxygenous substances absorbed from the aliment by the vena porta, decomposes them, and compels them to combine with the FREE SODA (liberated from the hydrochloric acid employed in digestion), the ALKALIES of the aliment and the excess of CARBON and HYDROGEN arriving in the venous blood of the vena porta; and to form new compounds, some of which are secreted in the various products termed bile, while others thus purified and rendered more or less innocuous are admitted into the systemic circulation, part to be eliminated in the lungs in the form of carbonic acid and water, and other portions transmitted for the purposes of nutrition.

Proofs.—The facts of the non-appearance in the circulation of the blood of acids, bile, and other acrid principles previously existing in the aliment,—the loss of oxygen from starch or sugar, when transformed into fat by this organ,—the alkaline character of the chyle,—the absence of bile in the excreta of Asiatic cholera, and in the acid and fœtid evacuations of chronic diarrhœa,—the presence of acid in the blood, &c., in gout and rheumatism, in all which diseases the liver is always defective in its action, form just and reasonable proofs of these highly important functions of the liver.

On the Hour of Death in Acute and Chronic Disease. By ALFRED HAVILAND.

The author had collected over 5000 cases of death, with the hour of death and other circumstances recorded, which he had tabulated and exhibited on a large chart. He showed, in 1000 cases of death in children under five years of age, that the periods of the greatest mortality took place during the hours between one and eight A.M.; that an extraordinary depression took place in the succeeding hours. Between nine and twelve P.M. the rate of mortality was at its minimum. He then compared these statistics with 2891 deaths from all causes, and the chart showed how remarkably the wave-lines of death coincided with those above. He then compared these diagrams with deaths from consumption, which, although they showed a general resemblance to the wave-line, yet between the hours of four to eight A.M. there was a depression, when compared with the first four hours' period. He urged his professional brethren to assist him in his investigations by forwarding to him data for further investigation of this interesting subject. He contended that the tables on the chart proved the extraordinary mortality in the early hours of the morning, when the powers of life were at their lowest ebb, and,

* For a more detailed account of these researches, see 'The Lancet' for October 15th, 1864.

strange to say, when the patient was least cared for. He urged the necessity of feeding and supporting the patients at their weakest hour, so as to tide them over a critical period.

On the Relative and Special Applications of Fat and Sugar as Respiratory Food. By Dr. Thomas Hayden.

On the Occurrence of Indigo in Purulent Discharges. By Dr. W. Bird Herapath, *F.R.S.*

This paper was on the occurrence of indigo in purulent discharges, in which, after alluding to observations made by him to the members of the Medical Association on two instances which had occurred in his practice, in which he had found indigo in the urine of individuals suffering from renal disease, he said that since that period they had been instructed by Heller, Schunck, Virchow, and others that urine, even in the healthy state, contained a substance from which an indigo-blue pigment might be obtained in traces or excessively small quantities; and Kletzinsky had shown them that the urine of the horse and the cow contained a comparatively large quantity of that pigment-forming substance. It was remarkable, however, that indigo very rarely appeared to be eliminated directly from the body in its markedly blue colour. On the contrary, it was thrown off rather in the colourless form, or as a light yellow substance, which, upon treatment with acids, split up into three other substances, two pigments, named uroglancine or indigo blue, urrhodine or indigo red; whilst a saccharine substance was also separated in a notable quantity, —thus proving that indican or uroxanthine is a glucoside. The colouring produced by fermentation, oxidation, &c., was alluded to, and the author remarked that in the indigo plant it would be recollected the colouring-material did not exist ready formed, but that it required a peculiar process of fermentation and oxidation, to be carried on in the expressed juices of the plant during a considerable period, in order to obtain that valuable blue in any quantity. The occurrence of the vegetable product, indigo, in the fluids eliminated from the human body had been considered an instance of the deterioration of the animal elements, as remarkable as the presence of grape sugar in the blood, &c., of diabetic patients; but it was now known that there were numerous proximate principles which, though usually obtained from the vegetable kingdom, were common to both the animal and vegetable worlds. Pathologists and physiological chemists were tolerably well agreed that the source of the indigo-forming substance in the animal economy might probably be due to destruction of some of the proteine compounds, and more especially hæmatosin, the well-known colouring-matter of the blood-globules; for they invariably found that the blue pigment predominated in those diseases in which great destruction of blood-pigment occurred, as in phthisis, Bright's disease, scarlatina, and such like diseases. Dr. Herapath cited a case in which pus or the liquor puris had been shown to contain blue pigment, and which he believed was the first instance recorded of that character. The subject of the case was a coachman, and had been under the author's care for phlegmonous erysipelas of the leg, which occasioned extensive vesication, and ultimately sloughing of the integuments, from which wounds large quantities of serum and pus exuded. The spirit lotions employed in the treatment became rapidly blue in colour, and all the bed-clothes were similarly stained blue on exposure to the air. Some of the blue-coloured spirituous solution, set aside in a corked bottle, became shortly discoloured; but on again exposing to air, its blue colour returned from the influence of oxygen on an oxidizable material. Other agents, as chlorine, chlorinated lime, destroyed the blue colour, as they would have done in preparations of indigo. The blue-coloured material was separated on a filter, dissolved in a solution of potassa, when deoxidized by sugar, and again separated from impurities by filtering, from which fluid the indigo was deposited by renewed exposure to atmospheric oxygen; some of this pigment, further purified by washing and drying, gave blue-coloured hexagonal prisms on being cautiously sublimed by following Dr. Guy's directions, and when examined in the microscope had all the appearances of sublimed indigo, which the action of other chemical tests confirmed. The source of this pigment was evidently the purulent secretions of the inflamed leg, which, by getting mixed with the spirit lotions, stained the clothes employed, the serum or liquor puris having previously contained it in a colourless form.

[This case will be found more fully reported in the 'Medical Times and Gazette,' September 24th, 1865.]

On the Physiological Effects of the Vacuum Apparatus. By Dr. T. Junod.

The author exhibited his exhausting boot in an improved form, and read a brief notice of the physiological effects produced by its application. He related an extreme case, in which, the blood having been drawn into a lower limb by the boot, partial insensibility of the upper limbs followed.

On the Lentil as an Article of Food, and its Use from the Earliest Historical Time. By C. G. Monteith.

The author thinks the lentil, as an article of diet, deserving of more consideration than it has of late received.

On the Action of the Nervous Tissue concerned in Perception. By W. E. C. Nourse, *F.R.C.S., Fellow of the Royal Medical and Chirurgical Society, and President of the Brighton and Sussex Natural History Society.*

Some approach towards understanding the action of the nervous tissue, concerned in perception, may be gained by enumerating and scrutinizing the structural and functional conditions essential to that action. The structural conditions are shown in the well-known microscopical anatomy of the parts. The nervous tissue is liberally supplied with blood, especially its central and peripheral expansions. This supply of blood is intimately connected with the exercise of the nervous functions, even with those called mental, since they are heightened by increased circulation, enfeebled by diminished circulation, altered by changes in the blood, and made to cease when circulation stops. Of the functional conditions attending the action of the nervous tissue, the circulation of the blood is the most important. The blood stands in relation with the nervous tissue, 1st, as to its *mechanical* conditions, which are alterations in its entire quantity, changes in the quantity circulating in each part, its mutable relations to the calibre of the blood-vessels, and variations in the rate and force of circulation; 2nd, as to its *chemical* conditions, the addition to it of some vapour or drug, alcohol, opium, chloroform, and the like, or differences in the amount of its contained salts or water; 3rd, as to its *chemico-vital* conditions, more or less carbonization or oxygenation, more or less fibrine, albumen, or blood-corpuscles, more or less recent chyle, or changes from malassimilation or from actual disease. Under each of these different states the perceptive power is found to vary in strength, in acuteness, and in correctness, and is often held in abeyance or stopped. It can nevertheless maintain its action under many unfavourable circumstances. These considerations, though not explaining in what the nervous action consists, bring us nearer to it, and show that the function of perception is intimately connected with the healthy and active blood-nutrition of the nervous tissue and with its waste and repair.

On the Functions of the Cerebellum. By W. T. S. Prideaux.

On the Inhalation of Oxygen Gas. By Dr. B. W. Richardson.

The paper was supplementary to one read at the Oxford meeting. The author said his experiments on the inhalation of oxygen had led him to an almost precise knowledge of the conditions under which oxygen would most freely combine with blood. It had been stated, in nearly every modern work on physiology, that oxygen inhaled in the pure form is a narcotic poison. These statements are based on the researches of Mr. Broughton, in which the late Sir Benjamin Brodie took part. The observations of Mr. Broughton, in so far as the recital of the phenomena observed by him were concerned, were strictly correct; but the inferences that had been drawn from them were nearly altogether incorrect, and were, at the best, so narrow as to be comparatively valueless. In fact, Mr. Broughton had seen but one form of oxygen inhalation. The author next stated that the influence of oxygen by inhalation was modified—(1) by dilution of the oxygen, (2) by dilution of the blood, (3) by the activity of the oxygen, (4) by the presence or absence in the blood of bodies which stop combination. On the point of dilution of oxygen, Dr. Richardson stated that a certain measure of dilution was required, not because the body consumed too quickly in pure oxygen, but because neutral oxygen would not combine with the carbon of the blood unless it were distributed. In atmospheric air the dilution is just sufficient to sustain healthy combination; at 60° F. the quantity of oxygen may be increased in amount to three parts of the gas to two of nitrogen, and may be absorbed. Beyond this, the combining power is reduced, and oxygen is not absorbed. Hence animals die in the gas as it approaches the pure state; they die not by a narcotic process, but by a process of negation. On the point of dilution of the blood, the author said that blood possessing a specific gravity of 1055 seemed to have most steady power in absorbing oxygen as it existed in common air; by changing the quantity of water in the blood, until the blood is brought to a specific gravity of 1060, the absorption of oxygen can be raised to a maximum; but when the specific gravity is more than 1060, the absorption declines. Below 1055 the absorption steadily declines in proportion to the reduction. In respect to the activity of the oxygen, the most differing results are obtained, according to the activity. If the oxygen be made fresh from chlorate of potassa, even in the pure form it sustains life, and the activity of the functions is increased; if electric sparks are passed through the gas, or if the gas be heated to 100°, the same is the fact. On the other hand, if the gas is exposed to ammonia, to decomposing animal matter, or even to living animals over and over again, it loses its activity, and no longer combines with the blood. Alcohol, chloroform, opium, and certain alkaline products formed in the blood in diseases prevent the absorption of oxygen, and death not uncommonly takes place from this cause. Great increase of water does the same. After this description, Dr. Richardson added that the question had often been put, whether the inhalation of oxygen could be usefully applied in the treatment of disease. Priestly, Beddoes, Hill, and many of those who lived when oxygen was first discovered, had formed the most sanguine expectations on this point; they saw before them an elixir, if not *the* elixir vitæ. Chaptal, in speaking of the effects of oxygen in consumption, said of it, "It raises hope, but, alas! it merely spreads flowers to the tomb." Since then various opinions of the extremest kind have been expressed, the differences having arisen from the entire want of order that has been associated with the inquiry. One man has used pure oxygen, the other diluted; the one active, the other negative oxygen. The one has given the gas to anæmic people, whose blood is surcharged with water; the other to diabetic or choleraic persons, whose blood is of high specific gravity; the one has given it heated, the other at the temperature of the day. If even a stick of phosphorus were exposed to oxygen under such varying conditions, the phenomena obtained would be as variable as those that have been registered in physic regarding oxygen as a remedy. The difficulties of arriving at uniform results have been almost insurmountable from another cause—that of obtaining oxygen in a ready form for inhalation. Fortunately, this difficulty was now removed. The discovery by Mr. Robbins of a mode of evolving oxygen, by acting on peroxide of barium and bichromate of potassa with dilute sulphuric acid, had given the author the opportunity of inventing a little apparatus for inhaling oxygen, which could be carried anywhere and used at a moment's notice. In conclusion, Dr. Richardson remarked that his object in bringing forward this short communication was to invite medical men to a method of research which promised much, and which now might be carried on with certainty of result and uniformity of experience.

On the Physiological Effects of Tobacco. *By* Dr. B. W. Richardson.

The author began by saying that, without being a devotee to tobacco, he had for many years past smoked. He did not come before the Section biassed in any degree, as his remarks would prove; he came simply as a man of science, who had tried to comprehend the facts of the whole question, and he should put these facts ward clearly, fairly, and free from technicalities.

Products of the Combustion of Tobacco.—Some recent researches on this subject had led the author to the fact, that these products are much more complex than had been supposed. He described an apparatus which was, in fact, an automaton smoker, by which he had been enabled to have various kinds of tobacco and cigars smoked by means of a bellows, the smoke which, in the case of a man, would enter the mouth, being all caught and subjected to analysis. The results of these inquiries had led him to the determination of the following bodies as products of the combustion of tobacco:—(1) water; (2) free carbon; (3) ammonia; (4) carbonic acid; (5) an alkaloidal principle, called nicotine; (6) an empyreumatic substance; (7) a resinous bitter extract.

Physical Properties of the Component Parts.—The water is in the form of vapour. The carbon is in the form of minute particles, suspended in the water-vapour, and giving to the eddies of smoke their blue colour. The ammonia is in the form of gas combined with carbonic acid. The carbonic-acid gas is partly free and partly in combination with ammonia. The nicotine is a non-volatile body, an alkaloid which remains in the pipe. The empyreumatic substance is a volatile body, having an ammoniacal nature, but the exact composition of which is as yet unknown; it is this that gives to the smoke its peculiar odour; it adheres very powerfully to woollen materials, and in the concentrated form is so obnoxious as almost to be intolerable. The bitter extract is a resinous substance, of dark colour, and of intensely bitter taste; it is, probably, a compound body, having an alkaloid as its base; it is not volatile, and only leaves the pipe by being carried along the stem in the fluid form.

Variations in different kinds of Tobacco.—The greatest variations exist in various kinds of tobacco. Simple tobacco that has not undergone fermentation yields very little free carbon, much ammonia, much carbonic acid, little water, none or the smallest possible trace of nicotine, a very small quantity of empyreumatic vapour, and an equally small quantity of bitter extract. Latakia tobacco yields these same products only. Bristol bird's-eye yields large quantities of ammonia and very little nicotine. Turkish yields much ammonia. Shag tobacco yields all the products in abundance; and the same may be said of pure Havanna cigars. Cavendish varies considerably: some specimens, which are quickly dried, are nearly as simple as Latakia; other specimens, which are moist, yield all the products in great abundance. Pigtail yields every product most abundantly. The little Swiss cigars yield enormous quantities of ammonia, and Manillas yield very little.

Physiological Effects of the compounds named above.—The water-vapour is innocuous. The carbon settles on the mucous membrane and irritates the throat. The carbonic acid is a narcotic, if it be received into the lungs. The ammonia causes dryness and biting of the mucous membrane of the throat, and increases the flow of saliva; absorbed into the blood, it renders the fluid too thin, causing irregularity of the blood-corpuscles; it also causes, when absorbed in large quantities, suppression of the biliary secretion and yellowness of skin; it quickens and then reduces the action of the heart, and, in young smokers, it produces nausea. The empyreumatic substance seems to be almost negative in its effects, but it gives to the tobacco-smoke its peculiar taste, and it is this substance that makes the breath of confirmed smokers so unpleasant. Nicotine is scarcely ever imbibed by the cleanly smoker; it affects those only who smoke cigars by holding the cigar in the mouth, and those who smoke dirty pipes saturated with oily matter: its effects when absorbed are very injurious; it causes palpitation, tremor, and irregular action of the heart, tremor and unsteadiness of the muscles generally, and great prostration; it does not, however, produce nausea or vomiting. The bitter extract is the cause of vomiting and nausea when it is absorbed; both it and the nicotine are always received into the mouth in solution, and produce their effects either by direct absorption from the mouth or by being imperceptibly swallowed and taken into the stomach.

Mode of Smoking.—The greatest difference arises from the manner of smoking. Those who use clean long pipes of clay feel only the effects of the gaseous bodies and the free carbon. Wooden pipes and pipes with glass stems are injurious. Cigars, smoked to the end, are the most injurious of all. To be safe, a cigar ought to be cast aside as soon as it is half smoked; and every cigar ought to be smoked from a porous tube. Cigars, indeed, are more injurious than any form of pipe; and the best pipe is unquestionably what is commonly called a "churchwarden" or "long clay." After the clay pipe, the meerschaum is next in wholesomeness. A pipe with a meerschaum bowl, an amber mouth-piece, and a clay stem easily removable or changeable for a halfpenny, would be the beau-ideal of a healthy pipe. All attempts to construct pipes so as to condense the oil have failed. To be effective they must be very large and inconvenient. It is of no slight importance, if a man must smoke, for him to be careful of the manner in which it is done. A man may, by practice, become habituated to a short foul pipe; but he never fails to suffer from his success in the end, nor, unless the habit of actual stupefaction be acquired, is any pleasurable advantage derived. What may be called the soothing influence of tobacco is as well brought about by a clean porous pipe, or well-made cigarette, as by any more violent and dangerous system, while the harm that is inflicted is of an evanescent character.

What is the Best Method of Estimating the Nutritive Values of Foods and Dietaries? *By* Dr. EDWARD SMITH, *F.R.S.*

There are four methods in use for the estimation of the nutritive value of foods: (1) the weight of the food; (2) the nitrogenous and carboniferous elements in food; (3) the nitrogenous food, carbon and hydrogen (reckoned as carbon), in food; (4) the nitrogen and carbon in food.

Dr. Smith concluded by putting the question, How shall we estimate the food which is necessary to the system?—by that which any given class of persons is known to obtain, or by that which a scientific inquiry into the excretions, conjoined with a knowledge of the state of the health, would supply? He said:—The former is open to the fallacy that the persons in question may be over-fed or under-fed, since their measure of the food is, within limits, that of the means to acquire it; and yet it offers these positive facts, that those persons do live on the dietary in question, and, under its influence, have a certain duration of life and a certain yearly amount of sickness—values which can be duly estimated when compared with those of other sections, or of the whole community. Assuming that the class in question stood high in these evidences of health as compared with other classes, our confidence would be high also; but it would not thence follow but that another dietary might yet further tend to improve health and prolong life. The best class in this and other communities may not have reached the *ultima Thule* of health and longevity. But, with all its defects, it is most desirable that this information should be within our reach, and that Government should be induced to institute such inquiries upon a large scale. Science is under obligations to our own Government for having taken some steps in this direction; but it remains to urge them to advance still further. So far as I know, no other nation has seriously entered on the inquiry. The latter method is conclusive when the investigation refers to the effects of different foods; for by it, it may be demonstrated what proportion of each enters the circulation, and in what degree it influences the vital transformations; but when the aim is to ascertain the degree of sufficiency of a whole dietary, it is too limited in its scope, since it must be made upon one or a very few individuals, and could be regarded as undoubted in the conditions only in which it is made; and it assumes that which recent inquiries disprove—that there is not great diversity in the amount of food which large masses of the people obtain—that the differences lie within not wide limits.

On Obliteration of the Sutures in One Class of Ancient British Skulls. *By* Dr. J. THURNAM.

The skulls from the Long Barrows of the stone period gave indications of *synostosis* as a race-character; and in connexion with this fact, it was worthy of notice that the great longitudinal sutures close earlier in the inferior than in superior races, and that their early obliteration was an African peculiarity. A comparison of a number of skulls showed that the elongated form was often coincident with the early obliteration of the sagittal suture; but the two things did not usually stand in the relation to each other of cause and effect. This was only the case when the obliteration of the sutures, which was congenital, or at least had occurred in the earliest period of life. This constitutes true *synostosis*, which, when affecting the parietals, produces the abnormal long and narrow skull known as *scaphocephalus*. Facts were adduced which appeared to prove that the dolichocephalous Britons, in common with other dolichocephalous peoples, were much more liable to synostosis of the parietals than the brachycephalous races; and that when it occurred it resulted in an exaggeration of the elongate form natural to the race.

The author referred to the finding in a long barrow in Wiltshire, from which fourteen skeletons had been taken, of a very much elongated scaphocephalic skull, which was marked by the perfect obliteration of the sagittal suture, while the coronal and all the lateral sutures were open. It was that of a young man, and evidently not a case of premature senile obliteration. After speaking of the result of discoveries in Gloucestershire and in other parts of England, Dr. Thurnam gave a description of an elongate ancient British skull, found at Charlcomb, near Bath, the transverse depression of which had been thought to be caused by the wearing of a particular description of head-dress.

In reply to an inquiry, Dr. Thurnam said his observations did not bear out the impression that the most ancient race of this country was of the same type with the brachycephalous one often supposed to have been once spread over the whole of Northern Europe. The theory was not well sustained, inasmuch as our oldest skulls were very long and narrow, whereas in Lapland and Finmark they were the reverse.

On a Supplementary System of Nutrient Arteries for the Lungs. *By* William Turner, *M.B., F.R.S.E.*

In this paper the author described the arterial plexus situated on the side of the pericardium beneath the mediastinal pleura. It was formed by the junction of a number of slender, elongated, thread-like arteries, derived from the pericardiac, mediastinal, and phrenic branches of the internal mammary artery, with each other and with numerous fine branches derived from the trunks of the intercostal arteries. The plexus so formed consisted of a wide and irregular meshwork, and served to constitute, in the antero-posterior direction, an inosculating medium between the arteries of the anterior and posterior thoracic walls, whilst inferiorly it inosculated with the arteries of the diaphragm. From it also a number of slender thread-like arteries passed to the lung, some in front of its root, others behind, and others between the layers of the ligamentum latum pulmonis. Through the agency of this subpleural mediastinal plexus, an arterial communication is thus established between the vessels of the lung and the arteries which supply the wall of the chest with blood.

The paper is printed *in extenso* in the 'British and Foreign Medico-Chirurgical Review,' January 1865.

On Cranial Deformities—Trigonocephalus. *By* William Turner, *M.B., F.R.S.E.*

In this paper a peculiar form of head was described, in which the frontal eminences were completely absent, and, in consequence, the forehead above the eyebrows and orbits was flattened or even concave. In the middle line, however, the forehead projected forwards and formed a sort of beak, narrow below at the root of the nose, but swelling out laterally at the line of the hair. From above, the head looked broadly ovate, or even somewhat triangular, the apex being at the forehead, the rounded base at the occiput. The peculiar shape of the head was noticed, in the case described, at the time of birth; the child, now between five and six years old, was well-grown and intelligent. The head evidently corresponded to the form termed *Trigonocephalus* by Professor Welcker, of Halle. The author argued that the production of this form of head was due to a fusion of the two centres of ossification of the frontal bone, and consequent premature obliteration of the frontal suture.

The paper is printed *in extenso* in the 'Natural History Review,' January 1865.

GEOGRAPHY AND ETHNOLOGY.

Address of the President, Sir RODERICK I. MURCHISON, *K.C.B., D.C.L., LL.D., F.R.S., V.P.G.S., Director-General of the Geological Survey, and President of the Royal Geographical Society.*

INTIMATELY bound up as I have been with the British Association since it was founded, in 1831, let me first assure you that I am proud to have been the person who, at our last meeting at Newcastle, had the honour of moving the resolution that we should this year assemble in Bath, a city with which I have long been connected by many dear ties. Twenty-eight years have elapsed since we were gathered together at the neighbouring city of Bristol; and now we return, to make this attractive place the scientific centre of the south-western districts of England, under the general Presidency of my eminent Geological colleague Sir Charles Lyell.

Our Section of Geography and Ethnology had no existence when we last met in this part of England; but ever since its formation thirteen years ago, as proposed by myself, it has been very popular. I may, indeed, assume with confidence that it will remain so, as long as England continues to be distinguished in sending out to distant lands so many enterprising travellers and explorers. From the days of Edward the Sixth, when an expedition sailed, under the eyes of that young king, to discover a north-eastern passage to the mighty empire of China, then called Cathay, and downwards, through the voyages of the illustrious Raleigh, and others of the reign of Elizabeth, to our own times, the same spirit has animated the adventurers of this nation.

Having already in this summer taken a view of the last year's progress of geography, in an Address to the Royal Geographical Society, I will on this occasion chiefly direct your attention to some points of general interest, which have marked the advancement of our science during the last forty years.

To begin with one of the great glories of this century, let us call to mind how little was known of the Arctic regions when Parry made his first explorations, and how, after being followed by many a gallant voyager, the culminating Arctic honour devolved upon a single English woman, who, devoting her fortune to the search after her noble-minded husband, engaged the services of that successful navigator, M'Clintock, and determined the cheering fact that, in perishing, Franklin was the first to make the long-sought north-west passage.

The delineation of all the Arctic discoveries upon the map of the world, with the memorable exception of the American voyage of Kane, as sent forth by Grinnell of New York, is, indeed, exclusively due to British energy, and is a trophy well worthy of the country which accomplished so much in its earlier career of enterprise in the little vessels of a Drake, a Frobisher, and a Hudson.

To pass to the vast region of our antipodes, or the furthest from our homes, let us remember how small was the portion of Australia known a quarter of a century ago, in comparison with that which our countrymen now occupy. The great interior was then almost a *terra incognita,* the larger part having been pronounced to be an useless desert. Recently, however, it has been successfully traversed by Stuart, M'Kinlay, Burke, Wills, and Landsborough, and is known to contain so much fertile land, that sheep are found to thrive well in tracts which were considered to be mere saline wastes. The discovery of a vast abundance of gold has doubtless been one great cause of the rapid strides latterly made in Australia, particularly in raising the rich auriferous colony of Victoria to a degree of commercial prosperity which, for its rapid growth, is unequalled in our history. But even in the colony of South Australia, where the precious metal has not been found, though it is rich in copper-mines, we have seen the spirit of adventure, in search of new pasture-lands, lead to vast geographical discoveries, in making which M'Douall Stuart traversed the continent, and planted the British ensign on its northern shores. Again, if we look at the promising and fertile new colony of Queensland, on the north-eastern coast, we see an important question of climate all but decided, in a direction contrary to the opinion of most men a few years back. For we now know that broad tracts of intertropical land of a certain altitude, sufficiently removed from a warm ocean, and well clothed with vegetation, will permanently support large flocks of sheep, even as far as S. latitude 18°.

Whilst the coasts and extensive parts of the interior of this new British continent have been occupied, there still remained one grand desideratum, which scientific research could alone supply. The most direct route to our important colonies of New South Wales and Queensland, particularly that portion lying between these and the Indian Seas, was to a great extent sealed to our commercial marine, owing to the dangerous navigation through Torres Straits, which occasioned the very frequent loss of vessels on the numerous coral-reefs fringing the eastern seaboard of Australia. Thanks to the persevering skill, under a thousand difficulties, of British naval surveyors, the dangers have at last been so clearly defined and laid down on charts that a broad and deep channel, ensuring safe and regular navigation, has been made available to all navigators.

If we carry our view to the south of Australia, it is no longer the north of New Zealand, with its capital, Auckland—now, unhappily, the seat of a bloody war—which most interests geographers*. Apart from the material prosperity of the Middle Island, and the discovery of much gold near its southern end and in the Scotch colony of Otago, the grandest scenes of nature have, by the researches of Hector, M'Kerrow, and Haast, been opened out to us in the gorgeous forests which fringe the gigantic glaciers, and in the deep fiords, or bays, of its western coasts.

Glancing northward, from Australia to our Asiatic possessions, we have before us that great Indian Archipelago, the chief characters and details of which were first made known to us by my gifted friend and associate at this Meeting, Mr. John Crawfurd. In later years this most interesting archipelago has been visited by Mr. A. R. Wallace, one of those skilful travellers whom it is my special business, and, indeed, my great pride, to extol. Disdaining the search after the precious metals, and all the lures of traffic, this excellent naturalist has examined all the natural-history productions of those islands, from the mighty Borneo to the small isles bordering the Polynesian Sea and Australia.

Just such another disinterested and truth-loving explorer of distant realms is Mr. H. W. Bates, now acting as one of our Secretaries; who, having gone out on the same scientific venture with Wallace, in a previous voyage to South America, remained, during eleven years, collecting those materials which have enabled him to lay before his countrymen that instructive and pleasing book 'The Naturalist on the Amazons.'

As I have thus wandered to South America, let me remind you of the fact that our senior Secretary, Mr. Clements Markham, has not only travelled over the mountainous regions of Peru, but has turned those travels to a great national purpose. He has, in fact, with the aid of Mr. Spruce, been the collector of those Cinchona-plants, or Jesuit's bark, which afford the best quinine, and, transplanting them to suitable sites in India, has laid the ground for saving, not only a needless expenditure, but also the lives of many a colonist and soldier.

This consideration has brought us to British India, of which an accurate trigonometrical survey has been carried up to the highest summits of the Himalaya Mountains, and over the grand glacial regions which extend from Western Thibet to Nepaul. In preceding years the interest of the public had been attracted to the surveys of the Himalaya Mountains; and their extreme height having been estimated to be upwards of 30,000 feet, we thus learnt that the northern frontier of British rule in India exceeded in altitude the loftiest peaks of the Andes by about the whole height of the highest mountain in Britain.

It had been supposed that some depressions in the ocean would be found to balance in depth the extremest heights of land, and this anticipation has been exceeded; for soundings in the South Atlantic, between America and Africa, have shown depths of more than 40,000 feet. If these measurements be reliable—for there is some reason to doubt them—the depth beneath the surface of the sea, at

* Dr. Hochstetter, one of the scientific men of Austria, in the voyage of the 'Novara,' who has already written very ably upon the physical geography and geology of New Zealand, is about to produce a still larger work thereon, which will, I hope, be translated into English.

certain points, far exceeds the heights of the loftiest mountains above it. Another and still more startling result of modern research is the fact that, in dredging the bottom of the North Atlantic Sea, living starfish were brought up from a depth of a mile and a half, and were alive, even preserving their colour, when examined on the spot by Dr. Wallich.

If we turn for a moment from the advances in geographical research made by our own countrymen, we must admit that, of all foreign countries, Russia has of late years been most eminent in this respect. The Geographical Society of St. Petersburg wields not only the power and influence of the Imperial Government of Russia, but receives also large grants of public money, which have enabled it to carry on simultaneous researches in the steppes near the Caspian and in the Caucasus, and also to describe the grand natural features of Central Asia, the boundaries of the Chinese Empire, and the whole river-system of the mighty Amur with its numerous affluents. In this way serious geographical errors have been corrected and new features laid down (by positive observations) on maps; whilst the natural history of the animals and plants, as well as of the human inhabitants of large regions, of which little was previously known, has been fully developed. These data are accompanied by ethnological and statistical descriptions of the inhabitants of Eastern Siberia, of the great island of Sakhalin, of Mongolia, and the new territory of the Russians on the right bank of the Ussuri River, with its coast-line extending southwards almost to Japan. Of the latter region, indeed, we had, until very recently, only the most imperfect knowledge.

Returning to the labours of our own countrymen, I might expatiate for a long time on their discoveries in other distant lands. Even in the vast ancient empire of China, so civilized in many respects, it is but of late years that its grandest river, the Yangtsze-Kiang, was opened out to British commerce, through the energy of the Earl of Elgin and Captain Sherard Osborne; whilst the upper part of this mighty stream has since been followed to 1800 miles above its mouth, and admirably laid down on a detailed map by Blakiston.

Then, again, we hope to welcome here that indefatigable explorer of various distant lands, our Medallist, Sir Robert Schomburgk, on his arrival from Siam, where he has been British Consul-General for several years, and of which peculiar kingdom he is thoroughly well qualified to give you a most interesting account.

Omitting almost entirely to notice what foreign geographers and ethnologists have accomplished, I have touched thus briefly upon some of the researches of our countrymen, because I address a Section of the British Association; but I must not occupy too much of your time by retrospective views when we ought to be gathering fresh fruits.

There is, however, one subject for your consideration, on which I must say a few words. Whether judging from the great advances which have been mentioned, or from what you may have heard or read elsewhere, you must not for a moment imagine that so great have been the discoveries, that our vocation as explorers of new lands is likely to come to an end. On this point men of high intellectual attainments, who do not carefully consult maps, are apt to be deceived; and I will therefore indicate a few of the grand geographical problems which remain to be solved.

At the last anniversary festival of the Royal Geographical Society, the Right Honourable W. Gladstone, after congratulating geographers on their successful progress, thus addressed them:—"There is nothing to do now but to congratulate you on your proud position, and to express a confident hope that you will go on as you have done. The only apprehension which I think the most sensitive of your friends can entertain, is one connected with the approaching exhaustion of that scene to which, at present at least, your labours are confined—I mean the limited surface of the globe itself. Alexander, in his day, thought he might reach a point in his career when he would desire to have new worlds to conquer. You, too, gentlemen, seem likely, at some time or other, to reach that point."

Now, whatever meaning my eloquent friend may have attached to the words "some time or other," let me assure you, Ladies and Gentlemen, that that time is indeed very remote, as you will admit when I simply lay before you a few facts respecting certain distant regions. You will then see how very long a time must elapse before we and our posterity can hope to clear away the ignorance respecting a large portion of the earth which now prevails.

Looking first at the most recent maps of Africa, see what enormous lacunæ have to be filled in, and what vast portions of it the foot of the white man has never trodden. True it is that large tracts north of the equator have been described by Germans and French, as well as by English expeditions, particularly that in which Barth was so distinguished.

With the exception, however, of Abyssinia and the snowy mountain Kilimandjoro, explored by Von der Decken and the late Richard Thornton, few of these tracts have been laid down on detailed maps. In the central equatorial region, but for the example set by the three gallant officers of our Indian armies, Burton, Speke, and Grant, and encouraged and supported, I rejoice to say, by the Royal Geographical Society, those countries would have remained as unknown as they have been throughout all history, from the days of Ptolemy to our own. But if thus a chief water-basin of the White Nile has been boldly outlined, how much does there remain to be done in order to test the value of the anticipations of Dr. Beke—still more, to complete a general sketch even of the geography of equatorial Africa! Is it not essential that the Victoria Nyanza of Speke, a body of water as large as Scotland, which has only been touched at a few points on its southern, western, and northern shores, should have all its shores and affluents examined? And do not the Mountains of the Moon of the same explorer invite a survey? Have we not yet to find out the source of the great Zaire or Congo, and trace that river to its mouth? And who has yet reached the sources of the mighty Niger? Again, when we cast an eye down the map southwards, are we not still in ignorance of the drainage and form of a prodigious extent of country between the Tanganyika Lake of Burton and Speke, and the Zambesi and Shiré of Livingstone? Are we not at this moment most anxious to determine, by positive observation, whether there exists a great series of lakes and rivers proceeding, as Cooley has suggested, from Tanganyika on the north to Lake Nyassa on the south? and has not Livingstone's very last effort been directed to this point?

If Central Africa is ever to advance in civilization, and its inhabitants are to be brought into commercial relations with Europe, one of the best chances of our accomplishing it will, in my opinion, consist in rendering the great White Nile a highway of intercourse and traffic. And if the present ruler of Egypt shall bring about this most desirable end, by putting a stop to the lawless slave-trade, carried on beyond his frontiers under the guise of dealing in ivory, and by establishing marts of commerce on the banks of the great river, Africa will owe more to him than to any ruler since the days of the Roman Emperors, who, though they tried, never succeeded in opening out the regions around the headwaters of the Nile.

In touching upon this subject, I have to congratulate you on the news which has arrived, that that chivalrous explorer, Mr. Samuel Baker, is successfully examining the central equatorial regions, from which, I trust, he will bring us the solution of some of the problems already adverted to, and will determine the real source of the waters which supply the Luta N'zige of Speke and Grant.

I have also to announce that Baron von der Decken has proceeded on his bold adventure to explore the interior of Africa from the east coast, by ascending the Juba, or one of the adjacent rivers, with two river-steamers constructed at his own cost.

In making these allusions to African discovery, most heartily do I congratulate geographers on the safe return of my excellent and disinterested friend Livingstone. Already, after his first two great traverses, from east to west and from west to east, across South Africa, this undaunted missionary had won for himself imperishable renown. But now, after a second expatriation which has lasted upwards of six years (his previous journeys occupying sixteen years), during which he has been labouring conjointly to improve the condition of the natives and to extend geographical knowledge, he comes home with a firm resolution to adhere to his noble calling for the benefit of the natives, and to return to that country in which the black man must bless his name!

The return also of Captain Burton, from the Congo and Fernando Po, ensures for us some fresh and pregnant communications respecting Western Africa; and when we know that Francis Galton, though much occupied with the duties of a General Secretary, will always take part in our discussions, and that Barth* is likely to be present, it is probable that we shall have a concourse of travellers capable of illustrating the geography and ethnology of Africa, such as was never assembled at any former meeting.

If we turn to America, we find that an adventurous gentleman of Chili, Señor Don Guillermo Cox, has described a new route across the Andes, which, by almost bringing together the waters flowing into the Atlantic and Pacific, is likely to open out commerce between fertile regions on the west and Buenos Ayres on the Atlantic. Aware of our almost entire ignorance of the interior of Patagonia, the same bold traveller purposes to make a journey throughout this enormous unknown region down to the Straits of Magellan.

In mentioning these straits, I am bound to remind you how, in former years, that eminent nautical surveyor Admiral FitzRoy, when accompanied by the great naturalist Charles Darwin, threw a flood of light upon the configuration and structure of the coasts of South America and the Falkland Islands. Now, although in this short and popular Address I cannot do justice to all the advances which have been made in meteorology, it gratifies me to direct your attention to the recent important labours in that science of the same gallant officer. For, by well-digested comparisons between the state of the barometer and the direction and force of the winds, Admiral FitzRoy has proved to the nation what useful interpreters in his hands are these natural phenomena. By his forecasts of approaching storms and the prompt use of the electric telegraph, he has saved many a ship and the lives of numbers of our seamen.

If we range from the south to the north of America, numerous indeed are the tracts which call for examination; and even at this meeting I hope to see new features pointed out to us in that northern prolongation of the Rocky Mountains, which separates the sources of the Saskatchewan on the east from those of the Thomson and Fraser rivers of British Columbia on the west. This knowledge, acquired, under great privations, by young Viscount Milton and his friend Dr. Cheadle, comes to us here in addition to what had been gathered together by Palliser, Hector, and Blakiston, as published in a Parliamentary Blue Book, and has fortunately arrived in time to improve a highly valuable map of British North America, which, derived from original documents, is now about to be issued to the public by that sound practical geographer, John Arrowsmith, who, in virtue of the great services he has rendered to geographical science, most worthily obtained a gold medal of the Royal Geographical Society.

Let me next remind you that we are yet entirely in the dark as to the true geography of the interior of Arabia. It is indeed only within the last few months that, travelling in the guise of a physician, the spirited and eloquent Palgrave has been the first intelligent person to traverse that country to the Persian Gulf. Can any one who recently heard this traveller narrate his adventures before the Geographical Society ever forget the deep impression he made upon the crowded audience when he told us his wondrous Arabian Nights' tale? In a word, we must confess that modern geographers are infinitely less acquainted with Arabia than the ancients and their great geographer Ptolemy.

Again, in Asia—though Russia has very recently, as I have said, done much in the north, and the English in the far south-east of that quarter of the globe—the very last communication to the Royal Geographical Society, proceeding from the zealous Hungarian M. Vámbéry, who travelled disguised as a Dervish, or holy Mohammedan beggar, has brought vividly to our minds a consciousness of the little we know of the vast countries once ruled over by Genghis Khan and Timur? In truth, the passage to the ancient capital Samarkand across those regions has of late years become infinitely more difficult than in the days of Marco Polo. Then (1390), and even in 1405†, when an embassy from Henry the Third of Spain to the great Emir Timur reached Samarkand, the wide-spread influence of Genghis Khan still subsisted. From that distant day there is no record of any European

* Dr. Barth was unexpectedly prevented from coming to England.

† See 'Narrative of the Embassy of Clavijo,' translated and edited by Clements R. Markham. Volume of the Hakluyt Society, 1859.

having visited Samarkand until the year 1841, when the Emir of Bokhara requested the Emperor Nicholas to send scientific men from Russia to search for gold. This Imperial expedition, which visited Samarkand as well as Bokhara, was purely scientific, and consisted of two officers of the School of Mines, Butenieff and Boguslowski; a very able young naturalist, Lehmann, since dead; an interpreter; and that eminent geographer Khanikoff, who, at the Meeting of this Association held at Oxford in 1860, gave us such an interesting account of other parts of Central Asia*.

On the whole, however, as M. Vámbéry will tell us, those regions are so occupied by savage warring Turcomans and other Tartars, that the solitary traveller is more decidedly shut out from them than he is from Arabia, China, Africa, and other countries, in which so many great problems also remain to be solved.

No region certainly calls more for the examination of geographers than Asia, the cradle of the human race; and, albeit the Russians, independently of their researches in Bokhara and Samarkand, have made notable explorations from Siberia into Mongolia, and southwards to the borders of China and Japan, Sir Henry Rawlinson will, I hope, explain to you what extensive regions there are which require to be explored and defined between Nineveh and Babylon, the countries of his memorable exploits, and the British empire of the East. There, even at this day, no one has followed the grand river Burhampooter from Hindostan into China, though the project has often been agitated, and will, I trust, soon be accomplished.

Again, are there not other vast tracts in the New World which no scientific traveller or explorer has yet visited? Cannot our Secretaries, to whom I have already alluded, point to many a district, nay, to whole regions, which call for examination? Ask Mr. Clements Markham how much there remains for the geographer to do along the great Cordillera of the west? Then let Mr. Bates speak to you, as I trust he will at this meeting, of the enormous countries watered by the affluents of the mighty Amazons, which still call for fresh researches.

Without further dwelling, as I might, upon numberless new fields for exploration, I hope that I have now satisfied you that the apprehension of geographers having already done so much that they will soon have little or no work to perform, is quite imaginary; for you may rely upon it, that the most ardent and adventurous men, whether geographers, ethnologists, or naturalists, will find stout employment for many a long year.

If I were to extend my observations to those boundless branches of our subject comprehended under the term Physical Geography, which only come into play after the discoveries of new lands have been made, this Address would necessarily be swollen to undue dimensions. In fact, physical geography embraces the consideration of the last of the long series of geological changes, as well as of all natural operations in the historic period, and the geographical distribution of man, animals, and plants. Nay, more; in the hands of so skilful an exponent as Maury, it involves continual researches into the condition and relations of the ocean and the

* M. Khanikoff's account of this expedition was translated into English by Baron de Bode, under the title of 'Bokhara; its Amir and its People,' 1845. Shortly after this expedition left Orenburg I was myself in that city and on the Kirghis steppes, and saw what a continuous trade and intercourse took place, as of old, between Russia and Bokhara. It is much to be regretted that the English public are so little acquainted with such facts as are mentioned by the Russian explorers. For example, and independently of science, M. Lehmann has left an account of the very friendly relations which existed between the Russian officers and our unfortunate countrymen Stoddart and Conolly, who, shortly after the departure of the Russian Mission, were barbarously murdered by order of the Khan of Bokhara. M. Khanikoff has, indeed, himself assured me that he tried in vain to induce our officers, who had had disputes with the Emir, to leave the country with the Russian Mission, being convinced that they ran great risk by remaining in the power of a lawless fanatic. I am indebted to a Russian gentleman, M. Hippius, whose notice will be communicated to this meeting, for recalling my attention to these facts. For an account of the mineral structure of the region, see 'Annales des Mines de Russie,' 1842, Nos. 10 and 11; and for the natural history and geology, as well as the buildings of Samarkand, see the interesting journal of M. Lehmann in the 17th volume of the Beiträge of Von Baer and Von Helmersen. My valued friend General von Helmersen doubts if Marco Polo ever was at Samarkand!

atmosphere, as well as of the earth, which must prove to be of ceaseless interest*. Viewed in this broad sense, geography is, indeed, of surpassing importance, and the field for the range of our noble science becomes really unlimited†.

Let us therefore hope that at this meeting we may gather together a few shreds of that augmenting knowledge of foreign parts which the wandering habits of our countrymen have led them to acquire, respecting the outlines and structure of various countries, their inhabitants and natural products, and thus justify my anticipation, that the Bath Meeting will be second to no one which has preceded it in the interest of the Geographical and Ethnological communications which will be laid before us.

In conclusion, I have a just pride in quoting the animating and truthful words which Mr. Gladstone recently addressed to geographers, inasmuch as they cannot be too widely known, and will, I am sure, be warmly applauded by this Assembly:—"It is the love of adventure," said the eloquent statesman, "it is the boldness in facing danger, it is the strong self-reliance, it is the ready presence of mind, it is all that constitutes that powerful individuality which lies at the root of the whole greatness of this country, and which likewise has lain at the root of the greatness and the performances of geographers. The very same causes which have made you distinguished as a Geographical Society, are those which have made England distinguished among the nations of the world."

On the Province of Azerbaijan.
By KEITH E. ABBOTT, *Consul-General at Teheran.*

Notes on the Maories of New Zealand, with Suggestions for their Pacification and Preservation. By Col. SIR JAMES EDWARD ALEXANDER, *K.C.L.S.*

The author specified the causes which led to the New Zealand wars of 1860 and 1863, in the former of which he commanded a regiment. He believed that a great wrong had been done to the Maories, whom he described as a generous and improving people, suffering under the prejudices and selfishness of *the lower class* of English settlers. The plan he suggested for their pacification and preservation was forming them into agricultural colonies, teaching them husbandry, and encouraging them in trade.

On the Ethnology of Cambodia. By DR. A. BASTIAN, *of Bremen.*

The author remarked that, the more the extent of the splendid stone monuments which spread over Cambodia, Laos, and the adjoining provinces of Cochin-China becomes known and investigated, the more urgently will rise the demand on scientific research to solve the problem of their construction. As the chronicles of Cambodia are quite modern, and as on the early annals of the Siamese no reliance can be placed, one naturally looks for information to another neighbouring state—Tonquin, which, thanks to its Chinese civilization, presents something like Chinese regularity and order in its records. Till now, however, the study of Tonquinese history has been bare of any valuable results. In the eastern part of the province of Bindinh was discovered, some years ago, amidst the jungle, a large town in ruins, consisting of fifty towers, which were ornamented with figures of men and animals, and surrounded with a square wall of white stone. A Chinese traveller, who visited Cambodia in the year 1295, speaks of fifty-four towers in the capital, each containing the statue of a deity, with a serpent in its hand (as it is seen in Java), to ward off those passing. The ruins of Nakhon Vat were likewise accidentally discovered by the Cambodians in the year 1570, after having lain buried in the jungle for many centuries; and, in travelling over the frontiers between Birmah and Siam, the author had many spots in that desolate region

* See the new small work, 'Physical Geography,' by M. F. Maury, LL.D. Longman, London.

† In my last Address to the Royal Geographical Society, I explained how all the various affiliations of geography, in this extended sense, are combined in the operations of the Imperial Geographical Society of St. Petersburg.

pointed out to him where traces of former cities were overgrown and hidden by the dense vegetation.

On the Delta of the Amazons. *By* H. W. Bates, *Assist.-Sec. R.G.S.*

The area which geographically constitutes the Delta of the Amazons forms an irregular triangle, measuring about 180 miles each way. Contrary to what might be expected in the mouth of a great river lying on the equator, the country in and around it has a pleasant and salubrious climate. The islands and neighbouring mainland are not formed wholly of fluvial deposit: this is the case only with a portion of the area, 120 miles distant from the sea, the remaining portion, or that lying nearest the sea, having a rocky base and a sandy soil, the product of the disintegration of the rocks. The author concluded that this alluvial portion of the area was the true delta, and that at no very distant period the seaward portion of the present delta formed a series of islands lying off the mouth of the river. These islands he proved to be of great antiquity by an analysis of their fauna, which shows (in the groups examined) a large proportion of endemic species. The strong affinity of the fauna of the south side of the delta with that of Guiana also tended to show that the two regions could not have been formerly separated by a gulf 180 miles wide, impassable by these species. Had this been the case, the southern margins would more naturally have been peopled from Brazil further south, there being no known barrier to hinder the migration of species from this direction. All the facts furnished by the physical geography and the fauna pointed to the result, that an ancient tract of land or chain of islands bridged over the space between Guiana and what are now the southern borders of the delta.

An Account of the Human Bones found in Tumuli situated on the Cotteswold Hills. *By* Dr. H. Bird.

The barrows and tumuli on the Cotteswold Hills vary in their size, structure, and contents. They are of two kinds—round tumuli and long barrows. The round tumuli are roughly constructed, and a kist is generally placed near the centre. The kist may contain the bones of one or many human bodies of different ages and both sexes, and flint-flakes and black rude pottery. The long tumuli or barrows are constructed in a superior manner. The bones found in the round tumuli indicate a peculiar race. They are tall, stout, square-built, and athletic, varying in height from five feet six inches to above six feet. They had long oval heads with large bases, wide and expanded behind, narrow, low, and contracted in front. The human remains discovered in the long barrows differ from those of the round tumuli, and are often mixed. Most of the higher-developed skulls, found in the vaults of the long tumuli, were broken across the vertex; and Dr. Thurnam has suggested that such broken skulls found at Rodmorton tumulus may have been broken before death, being the remains of murdered prisoners, or of persons slain for sacrificial purposes. Dr. Bird described some of a large collection of bones which he had taken from the tumuli, expressing an opinion, from the difference in configuration of some of the skulls, and some slight difference in the thigh bones, that some were the remains of an inferior race—the aborigines of the country—and others of a superior race that had made incursions into them from other lands. He contended, too, that the flints which he had found were identical in character with those recently discovered abroad, and which were held as proofs of an earlier history than that current among us.

Advance of Colonization in North-Eastern Australia. *By* Sir George Bowen, *M.A.*

On the Present State of Dahome. *By* Captain Burton.

In the year 1863–64, the author twice visited Dahome; and he was now induced to thus make known the results of his observations of Dahome life in the belief that his experience would rectify many popular mistakes. The extent of the land of Dahome had been exaggerated, and was but about 4000 square miles, with a population of about 150,000. The Customs of the Dahomans are divided into Grand and Yearly. The Grand Custom takes place only after the death of a king. The last Grand Customs were performed, in November 1860, by Gelele, the present sovereign, to honour the name of his sire Gezo. Reports from the Wesleyan missionaries show that very little change has taken place as regards the number of victims during two-thirds of a century. The Yearly Customs were first heard of by Europe in the days of Agaja the Conqueror (1708–27). They form continuations of the Grand Customs, and they periodically supply the departed monarch with fresh attendants in the shadowy world. The number of victims at the Annual Customs has been greatly swollen by report. During the author's second visit to Agbome forty men were put to death, an equal number of women presumably being sent to the next world; but if so, the execution took place within the palace. The men were all criminals and war-captives; no innocent Dahoman is ever killed on these occasions, and the king judges in person those accused of capital offences. He is so particular about the lives of his subjects, that, throughout the empire, coroners' inquests must follow every death and certify that it has not been violent. The time of execution is during the hours of darkness; and of these Zan Nyanyana, or "Bad Nights," there were two—January 1 and January 5, 1864. The public stay within doors under pain of death, and the king personally superintends the executions. Some are clubbed ("*ammazzati*"); others are beheaded by the Mingan, or premier. After death the bodies are exposed in the Uhunjro market-place for a few days. The men, attired as during life, in shirts and nightcaps, are seated in pairs upon Gold Coast stools, supported by a double-storied scaffold, about 40 feet high, of rough beams, two perpendiculars and as many connecting horizontals. Between these patibula are galleries of thin posts, about 30 feet tall, with single or double victims, hanging head downwards; cords, passed in several coils round the ankles and above the knees, attach them to the cross bar of the fatal tree. These tokens of the king's piety are allowed to remain exposed for several days, after which they are thrown into the city ditch. It is not, however, at the Customs that the great loss of life takes place. Whatever action, however trivial, is performed by the king, it must dutifully be reported to his sire in the shadowy realm. A victim, almost always a war-captive, is chosen; the message is delivered to him, an intoxicating draught of rum following it, and he is despatched to Hades in the best of humour. Captain Burton continued:—"I heard of only one case where the victim objected to lose his life. Even those who were prepared for the Customs (which I witnessed) sat looking at the various ceremonies, beating time to the music, and eyeing all my movements. At my request the king pardoned about half of them, but no man thanked me. There are two ethnological peculiarities in Dahome which require notice—the corporeal duality of the king, and the precedence of women over men. The monarch is double—two kings in one. Gelele, for instance, rules the city, and Addo-kpon governs the bush—that is to say, the country and farmer folk. The latter has his palace, about six miles from the capital, his high officers, male and female, his wives and eunuchs. Moreover criminals and victims are set apart for him at the Customs. With regard to the position of women, it must be remembered that the king has two courts, masculine and feminine. The former never enter the women's palace; the latter never quit it except on public occasions. The high officers of both courts correspond in name and dignity: there are, for instance, the female "Min-gan" and the male "Min-gan," the she-Meu and the he-Meu, and the woman officer is called the "No," or, mother of the man. Strangers also find maternal parents. There is, for instance, an English "mother," who expects presents from her *protégés*. Some resident merchants have two "mothers," one given by the late, the other by the present king. Royalty itself is not exempt; there are "mothers" for all the deceased rulers. The origin of this exceptional organization is, I believe, the masculine *physique* of the women, enabling them to compete with the men in bodily strength, nerve, and endurance. The custom is of old date in Yoruba; and our histories depict the "Mino" ("our mothers"—vulgarly called amazons), before the birth of the late King Gezo, who used to boast that he had organized a female army. He ordered every Dahoman to present his daughter, of whom the most promising are chosen, and trained to arms. Gelele, the actual ruler, causes every girl to be brought to him before marriage, and retains her at his pleasure in the palace. Of Gelele's so-called amazons about two-thirds are said to be maidens—a peculiar body in Africa. The remaining third have been married. That an element of desperation might not be wanting, women liable to death are "dashed" to the king, and are duly enlisted. The fighting women are not *de facto* married to the king; but it may take place at his discretion. The first person that made the present ruler a father was one of his colonels. The amazons affect male attire, especially when in uniform. There is nothing savage or terrible in their appearance. When young, they are compelled to dance and to take violent exercise, which renders them somewhat lean; and, as they advance in years, they grow in weight. The soldieresses are not divided into regiments. There are, however, three distinct bodies, as in the male army. The Fanti company takes the centre, and represents the body-guard. The king generally pays "distinguished strangers" the compliment of placing them in command. I had this honour, but was not thereby entitled even to inspect my corps. The Fanti women bind round their hair, which requires scanty confinement, narrow white fillets, with two rude crocodiles of blue cloth sewn on the band. The other two divisions are the wings, right and left. The three corps consist of five arms, under their several officers—namely, 1. The Agbarya, or blunderbuss-women, who may be considered the grenadiers. They are the biggest and strongest of the force, and each is accompanied by an attendant carrying ammunition. With these rank the carbineers, the bayoneteers, and a company armed with heavy weapons, and called "Gan' u' nlan," or "Sure to kill." 2. The Elephant-hunters, who are held to be the bravest of these women; twenty have been known to bring down, at one volley, with their rude appliances, seven animals out of a herd. 3. The Nyekplo-hen-to, or women armed with the huge razors, of which an illustration lately appeared in the English papers. 4. The infantry, or line women, forming the staple of the forces; from them, as in France, the *élite* is drawn. They are armed with Tower muskets, and are well supplied with ammunition. But they "manœuvre with precisely the precision of a flock of sheep," and they are too light to stand a charge of the poorest European troops. Personally they are lean, without much muscle; they are hard dancers, indefatigable singers, and, though affecting a military and swaggering gait, they are rather mild and unassuming in general appearance. 5. The Go-hen-to, or archeresses, who, in the late king's time, were young girls, the parade corps, the pride of the army, and the pink of dancers. Armed with a peculiar bow, a quiver full of light cane-shafts, and a small knife lashed with a lanyard to the wrist, they were distinguished by scanty attire, by a tunic extending to the knee, and by an ivory bracelet on the left arm. Their weapon has sunken in public esteem. Under Gezo's son they are never seen on parade, and, when in the field, they are used as scouts and porters. They also carry the wounded to the rear. The total number of amazons was 1685. Gelele, the present king, has never been able to bring more than 10,000 troops into the field. His "most illustrious viragos" are now a mere handful. King Gezo lost the flower of his force, in March 1851, under the walls of Abeokuta, and the loss was never made good. Gelele has lately followed the example of his sire. On Tuesday, March 15, 1864, the present king carried out his favourite project, his daily thought and nightly dream—an attack upon Abeokuta, where his father had left fame and honour. The attempt was contemptible in the extreme, and the consequence to Dahome a loss of about 1000 slain and about 2000 captured. Thus Dahome yearly loses *prestige*. She is weakened by a traditional policy, by a continual shedding of blood, and by the arbitrary measures of her king, who has resolved to grind the foes of his subjects for ten years, of which six have elapsed. She is demoralized by an export slave-trade, by frequent failings in law, and by close connexion with Europeans. As was remarked a dozen years ago by Commander Forbes, Dahome now contains no Dahomans. The gallant old race of which our historians speak has been killed out; its place has been taken by a mongrel breed of captives. Except the royal blood, which may number 2000 souls, all are of an impure race, and are *bonâ fide* slaves to the king. Under these circumstances, it is pleasing to remark the gradual but sure advance of El Islam, the perfect cure of the disorders which rule the land. Amongst eight hammock-bearers I found two Moslems."

On the River Congo. By Captain Burton.

This paper contained the particulars of the author's ascent to the Yellala, or Great Rapids of the Congo. He remarked that Africa boasted four first-rate rivers, all rising within the zone of nearly constant rain. These were the Nile, the Niger, the Zambesi, and the Congo. The latter was the least-known. Navigators have contented themselves hitherto with noticing its prodigious outfall; and since the fatal expedition of Captain Tuckey, travellers have not ventured to explore it. On July 29th, 1863, Captain Smith, of H.M. ship 'Torch,' gave Captain Burton a passage southwards from Fernando Po, where he had been suffering, like all other white men there, with some severity. As the improvement of his health was but slow, he resolved upon proceeding towards the highlands of the Upper Congo, which tradition represented to be a sanatorium. After adventures and observations, Captain Burton reached the Great Rapids. In conclusion, Captain Burton observed that, above those rapids the grand river forks. There is a north-eastern branch, which has been represented as flowing from a lake. The information he obtained at the rapids left him no doubt of the fact. In the previous year, when he visited the source of the river Gaboon, he was informed by the Fans, that after eighteen days' travel towards the east they came upon a water flowing to the right or southward. This must be the north-eastern fork of the Congo. He hoped that the survey of his distinguished friend Paul du Chaillu would set the question at rest. The south-eastern branch of the Congo, Captain Burton firmly believes, is the Coango and the Cassai which Dr. Livingstone crossed near the head.

On the Islands of Kalatoa and Puloweh. By John Cameron.

On the Iberian Population of Asia Minor anterior to the Greeks. By Hyde Clarke, *of Smyrna.*

The names of places in a country are philological and therefore ethnological records, and it is on these that the present investigation is founded. The most marked result is that there is no affinity in the ancient names of Asia Minor with those of Armenia, although there is an old tradition that the Lydians were descendants of the Armenians. On comparing the names in Lydia, Caria, Mysia, and generally in Western Asia Minor with European topographical terms, affinities are found with Greece, Italy, and Spain. These affinities are with the archaic and new Greek element in Greece, with the archaic and new Latin element in Italy, and with the Iberian element in Spain. The result is, as William von Humboldt had predicted, the existence of an Iberian population in Asia Minor. Some of the details are as follows. *Arna* is a local form which is well marked, and it is copious in Greece and Italy. *Asta, Astyra,* or *Astura* is a recognizable Iberian form. It signifies a rock. Thus we have *Astyra* in Mysia and Troas, *Astura* in Latium, *Astura* in Spain, *Asta* in Liguria and Spain. It occurs also in Asia Minor, both as a prefix and as a termination. The form *Blaundus* of Phrygia is found in the *Blanda* of Lucania and Spain, and in other shapes. *Bura,* a termination in Asia Minor, is a marked Iberian type. It is perhaps *berri* (Basque), a town. *Cora* appears to be the same as *Cara.* It perhaps means a peak or promontory; in Basque *gora* is high. *Ilia, Ilion,* or *Ilium* is a remarkable form; in Iberian it signifies a city, town, or place. *Manda, Menda,* or *Munda* most probably signifies a hill or mount, for which *Mendia* is a word in Basque. *Peda* or *Bada* must be a word for a mountain, as in *Idubeda* and *Orospeda,* mountains in Spain. *Petarra,* the French-Basque for mountains, is found in *Patara* of Lycia and Cappadocia. *Perga,* or *Barga* is widely distributed; it is applied to a mountain fortress or acropolis. With regard to words beginning with the letter R, it is worthy of remark that they are very rare in Asia Minor, and that such words are also very rare in modern Basque. *Sardea,* Basque for a fort, is found in *Sardene,* a mountain of Mysia, in *Sardes,* which has an acropolis, and in *Sardemissus,* a mountain of Pamphylia. *Tama, Tema,* or *Dyma* is a particle extensively applied to mountains and hill-forts. It is a noticeable circumstance, that in Troas we find *Ilium, Pergamus, Pedæum, Astyra, Scamander,* and *Ida,*—all Iberian names. According to the author's views, the "Iliad" records the final struggle between the Iberian and the Indo-European races for supremacy in Asia Minor.

On the Western Shores of the Dead Sea. By the Rev. G. Clowes, *B.A.*

The journey was performed in 1863 in company with four friends, under the guidance of Abu Dahûk, sheikh of the Jahâlin tribe of Arabs. The party reached the shores of the Dead Sea through the Wady-ez-Zuweirah. Whilst crossing the broad plain which here stretches towards the lake, dead trees were observed standing in the water at some distance from the shore. Mr. Poole, in October 1855, remarked the same thing; it is therefore more than probable that a permanent rise in the level of the sea has taken place of late years. To the north of the Wady-ez-Zuweirah, the party noticed the existence of three distinct parallel beaches, the highest lying at least fifty feet above the level of the sea, which removed all doubt that the Dead Sea was once much higher than at the present time, and therefore the old idea of the Cities of the Plain being submerged is untenable. At a place half a mile south of Ain Jidy, the author, whilst bathing and trying the buoyancy of the water, found that he was being carried by a strong current in a northerly direction. He suggested that this may either have been an eddy caused by the influx of the Jordan, or a movement produced by a spring in the bed of the lake. The analysis of a bottle of water collected at this point countenances the latter idea, for he had fortunately the means of comparing it with that of a portion collected two days previously from the north of the lake:—

	Collected April 9th, half mile S. of Ain Jiddy.	Collected April 7th, from north shore.
Specific gravity	1·1674	1·1812
Percentage of salts	20·54	21·585
Boiling-point	106°·5 Cent.	108° Cent.

These analyses showed that the water collected at Ain Jidy was less dense and contained a smaller percentage of salts than that obtained two days previously at the north. These facts appeared most interesting in connexion with the question whether the supply of water from the known sources is sufficient to counterbalance the enormous evaporation constantly going on.

Account of an Expedition across the Rocky Mountains into British Columbia, by the Yellow-Head or Leather Pass. By Viscount Milton *and* Dr. Cheadle.

This journey was undertaken with a view to discover the shortest route between the Red River settlement and the gold district of Cariboo, in British Columbia. The pass by which the party crossed the Rocky Mountains had been formerly used by the *voyageurs* of the Hudson Bay Company; but it had been long abandoned. The route followed, after descending from this pass, namely, by the Thompson River, had never before been attempted, owing to the dense growth of primitive forest and the dangerous navigation of the streams. The enterprise was successfully accomplished by Lord Milton and his companion, though not without the loss of nearly all their baggage and provisions and several narrow escapes of life. Enough was seen to convince them that this was the best line for the construction of a road from Canada, *viâ* Red River, into British Columbia, as it was the most direct one practicable, and was far removed from the United States frontier. A great portion of the country to the east of the mountains was noticed to have been completely changed in character by the agency of the beaver, which formerly existed here in enormous numbers. The shallow valleys were formerly traversed by rivers and chains of lakes, which, dammed up along their course at numerous points, by the work of these animals, have become a series of marshes in various stages of consolidation. So complete has this change been, that hardly a stream is found for a distance of 200 miles, with the exception of the large rivers. The animals have thus destroyed, by their own labours, the waters necessary to their existence. In the Thompson and Frazer River valleys, the travellers noticed a series of raised terraces on a grand scale. They were traced for 100 miles along the Thompson, and for about 200 miles along the Frazer River, forming three tiers on each side of the valley, each tier being of the same height as the corresponding one on the opposite side. The lowest terrace was of great width, and presented a perfectly level surface, raised some 30 or 40 feet above the river-bank. The second was seldom more than 200 or 300 yards wide, and stood at about 50 or 60 feet above the lower one. The third lay at a height of 400 or 500 feet above the river, on the face of the inaccessible bluffs. They were all perfectly uniform, and free from the rocks and boulders which encumber the present bed of the river, being composed of sand, gravel, and shale, the detritus of the neighbouring mountains. The explanation of these phenomena is to be sought in the barrier of the lofty Cascade chain of mountains, through which the Frazer has pierced a way lower down the valley. At a former period, the valleys of the Frazer and the Thompson seem to have been occupied by a succession of lakes, the Cascade range then forming a barrier which dammed up this great volume of water; the highest tier of terraces would mark the level at which it then stood. Some geological convulsion caused a rent in the mountain barrier, allowing the waters to escape partially, so as to form a chain of lakes at the level of the middle terraces; and subsequently, after long periods of repose, two other similar disturbances successively deepened the cleft, and drained the waters first to the height of the lowest terrace, and finally to their present level. In the course of the paper, the country east of the Rocky Mountains was highly extolled as a promising region for settlement, especially by an agricultural population.

On the Sources of the Supply of Tin for the Bronze Tools and Weapons of Antiquity. By JOHN CRAWFURD, *F.R.S.*

Tin, as is well known, is found only in a very few parts of the world, and the only localities producing it which have reference to the question under consideration are England, the Malayan peninsula, and Northern China. The ore is easily reduced, and in early times was found in drift or alluvium. The tin-formations of the Malayan countries are the most extensive in the world. These three sources are the only principal ones from which the nations of ancient Europe could have derived this metal. Tin would be supplied in the same manner as silk and spices, with the difference of being imported from the West as well as the East. Merchants dealing in the metal would convey it as far as it fetched a profit, until western and eastern tin met at a central point, which may have been Egypt. All the nations west of it would be supplied with British, and all those east of it with Malayan or Chinese tin. British tin would be conveyed by land to the Channel, then, crossing it, reach France, and through France find its way to Italy, Greece, and Egypt. The author totally disbelieved, with Sir Cornewall Lewis, in the voyages of the Phœnicians to the Scilly Islands, through which they are imagined to have supplied the Eastern world with Cornish tin. The voyage from the entrance of the Mediterranean would be 1000 miles in a straight line over a stormy ocean—a voyage very unlikely to be performed by ancient mariners, who, we know, even in the Mediterranean, only crept along the coasts, hauling their craft ashore in foul weather. Besides, the Scilly Islands, the supposed Cassiterides, afford no evidence of having ever produced tin. There is, in fact, no evidence that either the Greeks or the Phœnicians ever passed the Straits of Gibraltar.

On the Supposed Infecundity of Human Hybrids or Crosses. By JOHN CRAWFURD, *F.R.S.*

The object of this paper is the refutation of a theory which has lately obtained countenance in France and America, the purport of which is that the cross offspring of different races of man is essentially sterile, and must without intermixture of the pure blood of one or other of the parents, in due time die out. In refutation of this extravagant hypothesis, the author refers to the dense populations of France and England, the most mixed nations of Europe, and the millions of Mulattos and Mestizos which have come into existence since the discovery of the New World. Even where the two races were perfectly equal, he shows that no sterility was the result, and for this purpose quotes the case of the mutineers of the 'Bounty,' in which nine English mariners intermarrying with the same number of Tahitian women, had in the course of seventy years, or little more than two generations, amounted to 268, or been multiplied near fifteenfold.

On the Early Migration of Man. *By* John Crawfurd, *F.R.S.*

The object of the writer of this paper is to show that the migrations of man in his early and rude state were impossible, from his own weakness or want of means, and the obstacles of physical geography opposed to his progress; and he quotes in proof of his opinion some of the best-authenticated cases of early migrations, in all of which man had made a large progress in civilization.

On the supposed Stone, Bronze, and Iron Ages of Society. *By* John Crawfurd, *F.R.S.*

The object of the writer is to show, contrary to the general belief of archæologists, that in most cases iron was used before bronze, or that an iron age in general preceded a bronze one. With this view, he quotes a number of examples, chiefly drawn from the practice of Oriental nations.

On the Yostedal Brae, a large Glacier-system in Southern Norway. *By* Charles M. Doughty.

This glacier-system lies between the sixty-first and sixty-second parallels of north latitude. The height of the snow-line in this region is undetermined; but it probably varies from 4000 to 5400 feet. Observations were made upon four of the greater glacial outlets which descend into the valley Yostedal and its branches, and the approximate daily motion of a transverse line determined by help of a theodolite lent by the Royal Geographical Society. The phenomena commonly described as characteristic of glaciers by writers on the Swiss Alps were observed upon one or other or all of these. They vary in length from about seven to about ten English miles, and in breadth from about half a mile to one mile. Three of them are much rifted, and are inclined, near their lower extremities, at an angle of from 12° to 16°. Of these the daily motions of the centre were found to lie between twelve and fifteen inches. In the fourth case, the lower part of the ice-stream being remarkably consolidated, with a slope of 7° when measured, and nearly free from crevasses, the diurnal motion at (near) the centre was four inches. These glacial outlets have all considerably diminished in modern times, and are still diminishing. They descend to within from 1000 feet to 1700 feet of the sea-level. Their names are Nigaardsbrae, Faabergstolsbrae, Lodalsbrae, and Trangidalsbrae. They are noticed in Professor James Forbes's work, 'Norway and its Glaciers.' Bohr, a Norwegian gentleman, published many years ago an account of a short visit to this neighbourhood, and more lately M. Durocher has described and compared them with the glaciers of the Alps. A work upon the "Fölge Fond," another of South Norway's glacial systems, is about to be published by the University of Christiania. The motions of glacial outlets in general appear to depend, next to climate, upon their thicknesses. The writer believes the character and constitution of the great icy expansions, one of which is noticed here, to be the subject most deserving of attention in the glacial systems of southern Norway. He believes that they accurately resemble, on the small scale, the glacial coverings of Greenland and the Polar lands.

On a recent Earthquake at St. Helena. *By* Sir C. Elliot.

On the Fixity of the Types of Man. *By the* Rev. T. Farrar.

As far as we can go back, the races of man, under all zones, appear to have maintained an unalterable fixity. On the oldest Egyptian monuments we find Jews, Arabs, Negroes, Egyptians, Assyrians, and Europeans depicted with a fidelity as to colour and feature hardly to be surpassed by a modern artist. It might be objected that this fixity was due to the surrounding conditions having remained unaltered.

But a glance at the map shows this objection to be invalid; for the eastern region of Asia, from 70° N. lat. to the equator, offers every variety of temperature, yet is peopled by a single type, the Mongolian. By the side of the fair Circassian we find brown Calmucks: short, dark Lapps live side by side with tall, fair Finns. The colour of the American Indian depends very little on geographical position. In short, colour is distributed over the globe in *patches, not in zones.* Europeans transplanted from the temperate to the torrid zone do not, even in the course of generations, undergo any considerable modification of type. This may be seen in the Dutch, who have lived in South Africa for 300 years, and in the descendants of the Spaniards and Portuguese in South America; also in the negroes transplanted to America. Independently of this, we find races widely differing from each other, but dwelling side by side, who, so far as we know, have, from time immemorial, been affected by the same climate: such is the case with the Bosjesmen and the Kaffirs, the Fuegians and the Patagonians, the Parsees and the Hindoos. This fixity of type applies to habits as well as to corporeal features. The life of the Ishmaelite of to-day might be described in the identical terms applied to his first ancestor; and the Mongol has the same habits as in the days of Æschylus and Herodotus, or, perhaps, thousands of years before. It may be objected that a period of a few centuries is little or nothing in ethnological matters. It is, at any rate, everything to those who, without miraculous interference, of which nothing is recorded, have not more than that period between the Deluge and the date of the oldest Egyptian monument in which to account for the appearance of, for instance, the full-grown, well-marked Nigritian type. It remains for every one who is convinced of these facts to draw from them such inferences as appear to him most truthful and logical.

On the Poisoned Arrows of Savage Man.

By Professor HARLEY, *M.D., F.R.S., University College, London.*

A large collection of the missile weapons of savage man shows various gradations in the inventive faculty of races. First, there is the simple pointed stick, fixed in the end of the reed shaft of the arrow, as seen in the weapons of the Solomon Islanders. Experience having taught savages the inefficiency of this kind of arrow, we next see notches cut in the stick; and this is again improved on by fixing iron barbs in the arrow-head to retain it in the wound. A great improvement on all these is found in the arrows of the nations of Eastern Africa, which have an iron head to the shaft, as well as barbs below it. The next great step in advance is the invention of a poison wherewith to anoint the point of the missile, so as to insure speedy death to the wounded animal. Poisoned arrows are found amongst the natives of the Malay archipelago, Northern India, Africa, and South America; but many weapons sent, by travellers and others, to the author as poisoned have turned out, on examination, not to be so, but to have been merely smeared with paint for ornament or conservation. The desideratum in an effective poisoned missile is so to contrive it as to enable it to remain in the wound sufficiently long to make the action of the poison certain. An iron or even a smooth wooden point or blade does not answer this end. The savages of the banks of the Zambesi, in Africa, therefore show considerable ingenuity in winding a cotton thread round the arrow-head, and smearing this with the fatal juice. But the Indians of the northern parts of South America have gone beyond this, and have invented the most ingenious weapon yet known amongst uncivilized nations. It is a reed with a sharp point fixed in a hole at the end. The arrow-head pierces the animal; the concussion shakes off the shaft. An Indian on going to the chase takes a quiver full of these points—they are, in fact, his shot; the point alone remains in the wound of the animal he shoots, and its death is thereby rendered almost certain. Moreover, if by some mischance his booty escapes him, the Indian does not lose the arrow, which takes him some time to manufacture, and of which he can only carry with him a limited supply. The author has carefully analyzed and experimented on all the arrow-poisons which he had been able to obtain, and the result was that there were only two distinct kinds of the physiological action of the poison used by savage races; one is typified by the *Woorara* of the northern parts of South America, and the other by the poison of Borneo, known in the latter country as the *Antiar*. The action of these two groups of poisons is diametrically opposite. The *Woorara* affects the muscular system, destroying its action before it affects the heart; whilst the Borneo poison paralyzes the heart first, leaving the muscular system active for some short time after. The author then discussed the subject of the existence of nearly identical weapons (such as the blow-gun, through which short poisoned arrows are propelled by the breath) amongst tribes of savages widely separated from each other—the natives of Borneo, the tribes of the Himalayan mountains, and the Indians of the northern parts of South America. He said there were three modes of accounting for this coincidence:—1. They may have been invented by primitive men before the various races became segregated; 2, the distant tribes may have communicated with each other since their separation; 3, or the invention may have been independent, analogous conditions having given rise to the same ideas. The balance of probability, he thought, inclined towards the second of these explanations.

On Russian Trade with Bokhara. *By* M. Alexander Hippius.

The trade between Russia and the Central Asiatic nations is not large, and consists chiefly of cattle exchanged by the Russians with the Kirgeeses for corn. There is certainly no matter for English jealousy. Everybody who contributes to avoid such jealousies further contributes to effect the working hand-in-hand of the English and Russians, and deserves great merit in advancing geographical knowledge and calming the ferocious barbarism in Khiva, Bokhara, Kokan, &c. Their influence on the sea-like Kirgees-steppes is quite as baneful as the piratical states were formerly to the Mediterranean Sea. Sir Henry Rawlinson said that M. Vámbéry might fairly claim the honour of having been the first European who had visited and described Samarkand for 450 years. The author claimed that honour for his countrymen, the Russians. The Khan of Bokhara, being desirous to explore certain parts of his kingdom in search of gold, asked the Russian Government to send him some officers of mines for that purpose, in consequence of which a party were sent. MM. Butteneff and Bogoslowski have published, in the Russian official 'Mining Journal' of 1842, Nos. 10 and 11, several articles concerning the mineralogical riches, mining, money, &c., in Bokhara, and the meteorological observations made during their journey.

On the Ethnology of the Iranian Race. *By* M. Nicolas de Khanikof.

Starting with the Aryan theory of the original identity of the Hindus and Iranians or Persians, the writer proceeded to answer the question, Where was the cradle of the Iranian family? by an investigation into some of their most ancient traditions, beginning with an analysis of the Vendidad and the poems of Firdusi. The conclusion was that they were probably originally scattered to the north, west, south, and east of the fertile valleys situated between the Hindoo Koosh, the Cordilleras of Poughman and Koohi Baba, and of the well-watered plains of Herat, Seistan, and Kirman. The results of a careful examination of craniological types amongst the nations of these parts of Asia partly confirmed this conclusion. The Persian blood, however, has been much improved by crossing, during more than 2000 years, with various populations, but especially with Semites and Turanians.

A Narrative of her Journeys in the South Slavonic countries of Austria and Turkey in Europe. *By* Miss Muir Mackenzie.

A remarkable Storm and Beach Wave at St. Shotts, Newfoundland. *By* Kenneth Maclea.

Travelling Notes on China, Mongolia, and Siberia, 1863. *By* Alexander Michie.

The writer left Pekin in August 1863, to proceed overland to Russia. The tribes who are scattered all over the desert and the mountainous country to the north, from the Chinese wall to the Siberian frontier, are the descendants of the

Huns, and maintain to this day the habits of the ancient Scythians. Utilizing the few resources at their command, and their wants being few and simple, they are nearly independent of the entire world. Their government is despotic and patriarchal. They pay tribute to their chiefs, who are all subject to the Emperor of China; but, practically, the Mongols enjoy every liberty. M. Michie described Siberia at some length, and, speaking of its inhabitants, says the Slavonic population are the descendants of exiles, but not necessarily convicts. In the days of serfdom in Russia a proprietor had the privilege of sending a serf into exile without assigning a higher reason than his own will. Hence many persons of good character have been exiled from sheer caprice on the part of their masters. It was also remarked that many exiles rise to eminence.

On the Atmosphere, showing that there is a difference in its Vital Constituents North and South of the Equator. By SAMUEL MOSSMAN.

Latest News from Mr. S. Baker, *the Traveller in Central Africa. By* JOHN PETHERICK.

This was an extract from a recent letter of Mr. Petherick, dated Khartûm, May 23rd, 1864. A number of men belonging to Kurschid Aga, a trader of the Upper Nile, had returned to Khartûm from Gondokoro, and had informed Mr. Petherick that they had accompanied Mr. Baker as far as Kamrasi's palace, near Lake Victoria Nyanza, where they had formed a trading depôt, and had left some of their party in charge thereof. Mr. Baker had been well received by the chief Kamrasi, who having supplied him with an escort, had left that place to explore a lake to the westward. The men informed me that, anxious to return to their boats for the purpose of supplying the new station with sufficient requirements for the prosecution of trade during the rainy season, they did not wait for Mr. Baker, therefore as they left no boats at Gondokoro, that gentleman will have no chance of returning by the Nile until the termination of the next year's trading campaign, which terminates at that place in the months of May or June 1865. In answer to strict inquiries, Mr. Baker was stated to have been in good health, but to have lost his cattle.

On the Ethnic Relations of the Egyptian Race. By REG. STUART POOLE.

The author commenced by stating that his object was to inquire what light the ancient Egyptian monuments threw upon the single or more than single origin of the Egyptian race, and thus to call in the aid of archæology in the examination of one of the most interesting problems of ethnology. He brought forward no evidence as to which the general body of Egyptologists were not agreed.

Race.—The simplest division into which the races of man could be reduced was black, white, and intermediate. Of the black race, one of the varieties of the lowest type was the African negro; of the white race, one of the varieties of the highest type the Shemite Arab. These varieties the author selected because the Egyptian monuments show us that, for the last 3000 years, they have been the two most typical neighbours of the Egyptians. The ancient Egyptians constituted a variety of what has been called the Ethiopian race, but might be better called the Lower Nilotic. The modern Egyptians constitute a somewhat different variety. The ancient Egyptians, as known to us from monuments ranging from 4000 to 2000 years ago, were acknowledged by all ethnologists to hold an intermediate place between the Negroes and the Arabs. The physical characteristics of the Egyptians were then minutely described, their intermediate place shown, and the difference of the modern from the ancient Egyptians, in the further departure from the Negro and approach to the Arab, proved. The cause of this difference was well known to be the great influx of Arabs into Egypt, especially since the Muslim conquest. But, notwithstanding this change, which was less than we should expect, the Negro type still asserted itself in the Egyptians, and a period of 4000 years gave us no parallax. In race they seemed to present the traits of a double ancestry.

Religion.—The heathen religions might be thus classified:—High nature-worship; low nature-worship, and use of charms (or Fetishism); and magic (or Shamanism). Shemite idolatry was high nature-worship; Iranian, the same or of the same origin; Nigritian, low nature-worship; Tatar, magic. The ancient Egyptian religion had never been explained as a system. It was self-contradictory, as in the case of animal-worship, for which no reason could be assigned. A critical examination would show that the Egyptian religion consisted of two elements, high and low nature-worship Shemite and Nigritian, which was further proved by the actual Shemite or Nigritian characteristics of these two portions.

Art.—Art was often connected with race. But, as pure Shemites and Negroes had no art, the Egyptians could not have been of either stock alone. The gradual increase in size and importance of the monuments and engineering works in the earliest period might be explained by the existence of a serf-race of Nigritians gradually destroyed or absorbed by the Shemites.

Language.—Languages might be classed, according to seeming development, as monosyllabic, agglutinate, and amalgamate; according to relations, as the Semitic family, the Iranian family, and the so-called Turanian family. The last is not proved to be a family, and its different groups are connected by similarities that do not establish cognation. The author proposed the term "Barbaric" for this class, not family. The monosyllabic and agglutinate languages are barbaric; the amalgamate, Semitic and Iranian. The Egyptian language had a barbaric monosyllabic vocabulary and an amalgamate Semitic grammar. This, it was maintained, could only be explained on the supposition of a double origin of the Egyptians. These opinions were stated in the 'Genesis of the Earth and of Man,' and were adopted by the author of this paper as affording a solution of the great difficulties of his special study of Egyptology.

On the Principles of Ethnology. *By* T. S. Prideaux.

On the Scythians. *By the* Duc de Rousillon.

A Journey to Xiengmai and Moulmein. *By* Sir Robert Schomburgk.

On some Rude Tribes supposed to be the Aborigines of Southern India. *By* Dr. Shortt.

On the Meenas, a Wild Tribe of Central India. *By* Lieut.-Col. Showers, *F.R.G.S.*

The ethnological description of the tribe was prefaced by some observations on aborigines generally, and introducing the different modes in which contact with the dominant race had been found to modify their character and condition; and taking it as a test of the character of the rule of the dominant races respectively, the author referred to several examples of the successful reclaiming of wild tribes in India by the enrolment of them into military and police corps, as affording a vantage ground of comparison, in favour of the government of the late rulers of India, against that of any other government. The detailed account of the particular tribe described represents a remarkable race, which, having retreated centuries ago to a strong hilly tract at the quadruple boundary of four independent native states, had maintained itself in a state of lawless independence, by taking advantage of the jealousies of the different states concerned, and subsisting by plundering as a profession. Emboldened at length by long impunity, the tribe seems to have had the audacity to make a series of inroads into the neighbouring British district, attacking even walled towns, and carrying off the plunder and some of the inhabitants to their fastnesses. These outrages are stated as the cause of our author having to take the Meenas in hand; and in referring to the present tranquillity of that once immemorially disturbed district, and the changed behaviour of the tribe, by the operation of the measures adopted on that occasion, it is satisfactory to learn that all was effected without a shot being fired, affording as it does a pleasing contrast to the deplorable contests with savage tribes going on at the present day in other parts of the world. An armed demonstration sufficed to introduce the administrative measures which have been attended with such happy results.

On the Physical Geography of the Peruvian Coast Valleys of Chira and Piura, and the adjacent Deserts. By RICHARD SPRUCE, *F.R.G.S.*

This was a description of the soil and climate of those districts of northern Peru in which the different Peruvian varieties of the species of cotton-tree, named *Gossypium barbadense,* are so successfully cultivated. The memoir will be published by the Indian Government for distribution amongst the planters in India, where these varieties of the cotton-plant were introduced by Mr. Clements Markham. The districts described are remarkable for the absence of rain, the only humid and fertile districts being the valleys of the numerous short streams which flow from the Andes to the Pacific. Seasons of heavy rain, nevertheless, occurred at long intervals, in some cases of seventeen years.

On the River Purús. By RICHARD SPRUCE.

This river communicates with the Amazon by one principal mouth, and at four narrow channels (called *furos*). When the author was at the Barra do Rio Negro, in 1851, a man of colour, named Serafim Salgado, arrived there from the Purús, where he had spent some six months trading with the Purupurú (or Spotted) Indians, who inhabit the lower part of the river, and from whom it takes its name; and also with the Catauixís, whose settlements extend upwards to a distance of two months' journey from the mouth. This Serafim Salgado was afterwards officially commissioned to explore the river. It is clear, from Serafim's report, that the plain through which the Purús flows has a scarcely perceptible declivity, for he nowhere encountered cataracts or even rapids. Indeed, the head of navigation of the Purús must needs be on a lower level than that of the Beni and Mamoré; and yet on a tributary of the latter (the Chaparé) Gibbon found that water boiled at 209° 5′, indicating an elevation above the sea of only 465 feet. This goes far to show that Humboldt may be correct in his supposition of a strip of low land extending from the Amazon valley, between the Andes on the one hand and the mountains of Brazil on the other, all through the provinces of Mojos and Chiquitos, to the basin of the River Plate. The Purús will at some future day become one of the great highways between the Andes and the Amazon.

Account of his Journey across Australia. By M'DOUALL STUART.

Notes on Kurdistan. By J. G. TAYLOR, *H.M. Consul at Diabekir.*

On the Physical and Political Geography of the Jordan Valley and Eastern Palestine. By the REV. H. B. TRISTRAM, *F.L.S.*

The author communicated the chief results of his recent natural-history exploration of Palestine. No signs of volcanic eruption were found in the neighbourhood of the Dead Sea and the Jordan Valley, and the statements of De Saulcy on these points were shown to be wholly erroneous. The depression of the Dead Sea was coincident with the synclinal line of the great system of inclined limestone strata of the region. The district of Moab was spoken of in most laudatory terms, as regards its climate and fertility; indeed, the southern portion of the Jordan valley formed a tract of country entirely different as to its vegetation and animal life from the rest of Palestine. Its fauna and flora yielded many new species, and showed Indian and African types; the total results could not, however, at present be given, as the flora was still being worked out by Mr. Lowne, the botanist to the Expedition.

On the Turcoman Tribes of Central Asia. By M. VAMBERY.

A Visit to Samarcand. By M. VAMBERY.

Journey along the West Coast of Middle Island, New Zealand. By ALBERT WALKER.

On the Progress of Civilization in Northern Celebes. *By* Alfred R. Wallace, *F.R.G.S.*

The northern peninsula of Celebes is the only part of that island which is of volcanic structure. A considerable portion of it is elevated 2500 feet above the sea, forming the beautiful plateau of Tondano, in the centre of which is a lake about twenty miles in circumference. Scattered about this plateau are volcanic peaks and ridges 6000 or 7000 feet high. A fertile soil clothes even the mountain slopes of all this region, and, assisted by the abundant equatorial rains and a mild and uniform temperature, supports a vegetation of great luxuriance and beauty. The Dutch have now had possession of this country for nearly 200 years, having taken it from the Portuguese in 1677. The inhabitants, more particularly on the centre plateau, differ from those of the rest of the Celebes. They often approach to the fair complexion of the European, while they retain the straight black hair and general physiognomy of the Malay races. In character they are gentle and submissive, industrious and easily educated. Up to a very recent period they were complete savages, and were almost always at war with each other. They built their huts upon lofty posts to guard against attacks, and decorated them with the heads of their slain enemies. Their clothing was strips of bark, and their religion was a degrading demon-worship. From this state of barbarism they have been raised to comparative civilization in a short time by the Dutch Government. The country is now becoming a garden worthy of its sweet native name, "Minahassa." The villages are almost all like model villages, and the cottages like those one sees upon the stage. The streets are bordered with trimmed turf, and fenced with hedges of roses in perpetual bloom. Near every village are the most beautifully cultivated and productive coffee-plantations, while rice-fields and fruit and vegetable grounds supply abundance of food to the inhabitants. In every village there is a school-house, and in the larger ones a church also. The people are all neatly dressed, and the native chiefs and schoolmasters would pass muster among respectable people in England. On arriving at one of these chiefs' houses, in a principal village, the writer was received by a gentleman in a suit of black; boys nicely dressed and with smooth-combed hair brought water and napkins for him to wash, and he was furnished with a dinner comprising every European comfort, finger-glasses, clean napkins, claret, and beer, along with a variety of well-cooked native dishes. The house was handsome and lofty; the chairs and tables were of fine native woods, and, though made by self-taught natives, were of superior workmanship to any but the very best we get at home; and as he sat in the verandah taking coffee his eye was gratified by the sight of beautiful flowers, which, in this delightful climate, are perpetually renewed. This great change is the result of the introduction of the coffee-plant under Government superintendence, and of the labours of Dutch Protestant missionaries. The native chiefs were induced to further the views of the Government by the promise of a per-centage on the coffee-produce of their district, and the whole system is carried out by them, under the advice and support of the inspectors and Dutch residents. Each family in a village works in the plantations; an account is kept of the number of days' labour each gives, and when the produce is sent to the government warehouses, and paid for at the fixed price agreed upon on the formation of the plantations, the amount is divided proportionately among the inhabitants. The chief and the other head men of the village decide upon how many days a week it is necessary to work at different times of the year, and the villagers are called to labour at fixed hours by beat of gong. This community of labour is a common feature among people in the first stages of civilization, and rarely is any other pressure than public opinion required to insure regularity. Habits of industry have thus been fostered, and a considerable sum of money is realized annually by each family. Under the advice and example of the missionaries and government inspectors, the people build neat houses and adopt European clothing and habits. Their children go to school; the Malay language spreads rapidly, and is superseding the numerous native dialects; and general morality has undergone a vast improvement. No one who sees these people, and inquires as to their former condition, can avoid the conclusion that they are both morally and physically far superior to what they were. But it is said this change has been brought about by "monopoly" and "despotism," and therefore cannot be right.

The author believed, however, that the relation of a civilized to an uncivilized race over whom it rules is exactly analogous to that of parent to child, or of adults to infants, and that a certain amount of despotic rule and guidance is as essential in the one case as it is in the other. The only question is as to the manner in which the "paternal despotism" shall be carried out; and he thinks that the system of upholding and regulating the power of the native chiefs, whom the people are already accustomed to obey, of introducing systematic cultivation under government superintendence, and favouring the exertions of missionaries and native teachers, is a far better plan than throwing open a country to the competition of a low class of European traders and cultivators, which inevitably leads to the degradation of the natives, and a conflict of interests, inducing mutual animosity between the two races. The system of the Dutch, as carried out here and in Java, he considers as most excellent, and especially valuable as a step in the education of an uncivilized race; and he cannot but contrast it with the deplorable results of the free competition of antagonistic races in New Zealand, which can only end in the extermination of a people which it seems probable would, under more favourable conditions, have been capable of improvement and civilization.

On the Increasing Desiccation of Inner Southern Africa. *By* JAMES FOX WILSON.

A very noticeable fact has of late years attracted the attention of residents in South Africa—namely, the gradual drying up of large tracts of country in the Trans-Gariep region. The Calabari Desert is gaining in extent, gradually swallowing up large portions of habitable country on its borders. Springs of water have diminished in their flow, and pools, such as that at Serotli, described by Livingstone, are now either dry or rapidly becoming so. A long list of springs and pools now gradually drying up was given by the author of the paper. The great change, however, had commenced, if we may trust native traditions, long before the advent of Europeans, which are corroborated by the existence of an immense number of stumps and roots of acaciæ in tracts where now not a single living tree is to be seen. In seeking to account for this, it was necessary to dismiss from the mind all idea of cosmical changes or earthquakes, of which no trace is visible in Southern Africa. The causes lie in the physical characteristics of the country and in the customs of the inhabitants. The region drained by the Orange river is naturally arid, from the interposition of the Quathlamba mountains between it and the Indian Ocean, whence the chief rain-clouds are derived. The prevailing winds are from the north-east. The clouds, heavily laden with vapour from the Indian Ocean, are driven over Caffraria, watering those lands luxuriantly; but when the moisture-bearing nimbi arrive at the summits of the mountain range which divides Caffraria from the interior country, they are not only deprived already of part of their moisture, but they meet with the rarefied air of the central plains, and consequently rise higher and evaporate into thinner vapour. There are few spots, however, which are wholly destitute of vegetation, and large trees are frequent. There is no district which does not maintain its flocks of wild animals; but the diminution of even one or two inches of rain in the year is most severely felt. The author came to the conclusion, after a careful inquiry into the geological formations of the region and the sources of springs, that much water must lie, throughout wide tracts, deep below the surface of the soil, and that the boring of artesian wells would yield a permanent supply for irrigation. But as a remedy for the growing evil, he laid particular stress on legislative enactments to check the reckless felling of timber and burning of pastures, which has been long practised both by the natives and the European colonists.

The Hairy Men of Jesso. *By* W. MARTIN WOOD.

ECONOMIC SCIENCE AND STATISTICS.

Address by William Farr, *M.D., D.C.L., F.R.S., the President of the Section.*

Gentlemen,—I am deeply sensible of the honour which has been conferred upon me by placing me in this Chair.

In opening your proceedings, I propose to bring rapidly under your notice the state of the science which you have met in this Section to promote as Members of the British Association.

Mathematics is the great abstract science which fosters all the rest; and physics, mechanics, chemistry, mineralogy, geology, geography, ethnology, embrace the phenomena of the heavens, the earth, and the three kingdoms of nature. They occupy other Sections.

Man himself is the special study of physiology and of ethnology in two of those Sections; but there they inquire into the functions and parts of the body, or the condition of our race as the foremost of the animal kingdom; while geography describes nations, as it describes mountains and rivers, because they are on the earth's surface.

We have to do with men in States, and in political communities. Statistics is essentially a science of the relations of numbers of men, and its laws are founded on the observation of mankind as they exist in nations now and in past times; but, building on facts that can be measured and expressed in numbers, it is only in civilized communities, and in recent times, that it finds adequate materials. The domain of the past we almost abandon to the geologists or the historians: and we leave the uncivilized world in the possession of our enterprising neighbours the ethnologists; while we yet hope one day to enter this field, and indeed have already made, under established Governments, some conquests among the races in India, in Russia, and in South America.

Man in society possesses property, and all his possessions fall within our province, for they form an intrinsic part of the State. We have to study, besides the political relations of men to each other, their riches in land, in horses, sheep, and the cattle on a thousand hills, in grain and crops, in precious metals, in minerals, and in merchandise.

Here are found the grounds of two grand divisions of statistics; the first falling under the head of *Population,* and the second under the head of *Property,* which is the subject also of economic science.

Under Population are discussed the races, sexes, ages, marriages, births, deaths, causes of death, the ranks, professions and tenures of each people in a State: from their earnings the value of their life-work is deduced; certain acts are also investigated, such as baptisms, attendances at schools or at churches, votes at elections, crimes, punishments, diseases, and civil actions. Civil and military statistics constitute a capital chapter of this division.

The statistics of Property are divisible into two chapters: the first treats of the fixed property, including land, mines, forests, manufactories, houses, roads, canals, and rivers; its basis is a map on a scale large enough to exhibit the quantities of every parcel of land and the area of every dwelling-house: the holdings of land, its burthens, and transfers, naturally fall under this head.

Under the second head falls the moveable property, including live stock, ships, machines, goods, merchandise, and vendible products of all kinds.

The annual produce of the two classes of property, its transport, its sales, its prices, and its relation to the stock, form the subject of the three sections of agricultural statistics, industrial statistics, and commercial statistics.

The public revenue and expenditure, the financial operations of the public exchequer, of the banks, and of the great companies, offer an extensive field, and are in the domain of financial statistics.

There are other minor divisions, but the object I aim at is to survey rapidly the field of our labours, which, although it is concerned in the facts of public interest to statesmen and political inquirers, and includes the fundamental part of politics, yet does not embrace all the doctrines of that kindred science, which, I may add, has been luminously expounded by Sir George Lewis in the treatise on the

'Methods of Observation and Reasoning in Politics;' his greatest work—and to politics what Whewell's book is to the physical sciences—replete with the latest results of European learning, and a solid, hitherto unsurpassed, contribution to political science.

Sir George Lewis was a Fellow of the Statistical Society, and himself a labourer in early life in the field of practical statistics. He was well versed, too, in its philosophy, yet his genius did not lie in the direction of the physical sciences or of the mathematics, which are the soul of statistics; but, standing on the border land, and on an eminence surveying all the territories, his calm judgment is impartial and commands attention. Noticing the imperfections in the early records of facts and numbers, Sir George Lewis observes,—

"The importance of accurate statistical information as the basis of historical description, as well as of political reasoning, both speculative and practical, cannot be too much insisted on. The attention of modern Governments has been directed to the subject, and it has been understood that a constant registration of social and political facts ought to be kept up, without any immediate practical object; like the observations of the heavenly bodies, temperature, weather, tides, and other natural phenomena, made by the physical philosopher. Facts, unimportant in themselves, become important as units comprised in a complete enumeration; and results are thus obtained, to which mere conjecture, or the loose and vague impressions derived from a partial observation, could not have led. This process is now carried on, with more or less completeness, by all civilized Governments, and the collection of statistical information, not merely for practical but for scientific purposes, is recognized as a legitimate object of public policy. There are now statistical departments in all the principal states of Europe"*.

Here is another element of classification, for the materials of science exist in each State, so in our archives are the statistics of England, Sweden, France, Spain, Italy, Germany, Russia, the United States of America, and some other countries, at least in outline. M. Quételet, one of the founders of this Section of the British Association, is now engaged on a work, of which proofs are on the table, exhibiting the comparative statistics of the population of Europe, on a plan nearly uniform. He submits it to your inspection, and had a great desire to be present, but is kept away by circumstances over which he has no control. I feel sure that I have your authority to reciprocate the good wishes of this veteran of science. The work had its origin at the International Statistical Congress, which was convened in 1860 by Her Majesty's Government, in London, and was presided over by the late Prince Consort; whose sagacity, we may believe, did not fail him when he proclaimed that the statists of his day were laying "the foundation of an edifice, necessarily slow of construction, and requiring, for generations to come, laborious and persevering exertion, intended as it is for the promotion of human happiness, by leading to the discovery of those eternal laws upon which that universal happiness is dependent." These last words of the good Prince may well cheer us on the way.

You will see at once that the observation of the scientific facts with which we are concerned in so many States of the world, has already supplied the materials for sure induction, and placed statistics among those applied sciences which reveal laws, and arm man with power over man and over nature.

In proportion as Governments are organized and intelligent, they cultivate statistics; and it is gratifying to observe that nearly all the States of Europe sent official delegates to the Statistical Congress which met last year at Berlin, under the auspices of the Government of Prussia, and under the able presidency of Dr. Engel.

Spain, which had fallen in arrear, had been put upon her mettle, and in 1857, and again in 1861, took a census, of which many interesting results have just been published: the population was 15,658,531, some millions more than she formerly had credit for, and entitling her, when her finances are upon a sound footing, again to a place among the Powers of Europe.

The Kingdom of Italy was no sooner constituted than its statistics were deve-

* Vol. i. p. 137.

loped. A census was taken, and we find a population of 22 millions (21,893,171)* in this constitutional State. Over, Rome, Venice, Lombardy, Mantua, Trieste, the Tyrol, Ticino, Savoy, Corsica, Malta, and the Kingdom of Italy, a population of 27 millions speaking Italian is diffused. The births, deaths, and marriages are registered, and the principal statistical elements are under observation and inquiry in the Kingdom of Italy, which will henceforward have a voice of weight in the affairs of Europe, and in science. The statistics of Italy are ably displayed in the Statistical Annuary, for 1864, of Correnti and Maestri, who have had a large share in the organization of the statistics of the new kingdom.

Russia, until lately, did little for statistical science; and the Emperor Nicholas refused to send a Russian to the first Congress in Brussels, on the alleged ground that his empire had nothing to learn from the science of Europe. Things have since greatly changed, and the Russian Government now fully recognizes the claims not only of her own people, but of science and of Europe, to a faithful account of the population and resources of that empire. M. von Buschen and Mr. Wilson were sent over by the Imperial Government to observe our proceedings in the last census; and M. Troinski, who was here recently, informed me that measures were under consideration for taking as accurate a census of Russia as circumstances will allow. The births, deaths, and marriages will also be registered more accurately. We may thus expect a great accession of information from Russian statists, respecting an empire emancipating millions of serfs, and passing through changes which the older States of Europe traversed in what may be called pre-statistic times. Popular books contain many statements of numbers which are put forth as statistics, but are purely conjectural, or are based upon loose estimates. Among the latter numbers is the alleged population of Russia, which is set down in the Gotha Almanack at 74,139,394 souls, neither more nor less—exclusive of the population of Russian America, which belonged to a company whose privileges expired at the end of 1863. How far this is wrong it is difficult to say; there have been partial censuses, but the population of the empire has never been enumerated.

So it is in our Indian Empire, the population of which is cited as 135,571,351. The populations of the North-West Provinces, and of the Madras Presidency, have been counted, but the other numbers are "guesses," for we have not everywhere adopted the "practice of counting." The population is as likely to be several millions more in India as to be millions less, for the maxim of Dr. Johnson is not invariably true, that "when numbers are guessed they are always magnified." It is said that the population of Rome was once estimated by the weight of cobwebs within its precincts; and that Xerxes ascertained the numbers of his host by measuring the ground upon which they stood. How the guesses are made in India we do not precisely know, but it is probable that the population of many of the provinces has been estimated from their area. The enlightened and really beneficent Government of India, which collects £43,000,000 of revenue from the population annually, will no doubt ere long contrive to perform the really arduous task, at least once for that part of Southern Asia, which Russia is about to perform in the North for the barbarous tribes of Siberia, and thus extend the boundaries of official knowledge, enumerate Her Majesty's subjects, and make India by its census an integral part of the empire.

The British Colonies deserve great praise for their statistics. The last census of Canada is elaborate; and Mr. Archer, Mr. Rolleston, and their colleagues in Australia, have placed the statistics of those colonies upon such a footing that we shall be able to trace with extraordinary minuteness the development of the empire in the southern hemisphere.

Of China several State censuses are cited, but I confess that I have less faith in the official returns of 367,632,907 "mouths"† (the Chinese for *souls*) in China proper, than I have in those of India; in fact, we should be glad to hand the num-

* Estimated for 1st January 1863; by the census of 1st January 1862, the population was 21,776,953; increase 116,218.

† See paper by R. M. Martin, in "Addenda to Report on Sanitary State of the Army in India," 8vo edit., p. 559. A recent return makes the population of the whole empire 415,000,000 (Gotha Almanack, 1864).

bers over to the geographers, recommending them, when they give the populations of countries, even in their elementary books, to cite the figures with discrimination. A due appreciation of the value of published facts is an element in all the sciences.

Statistics is prosecuted to some extent in every State; and in countries where observation is difficult, intelligence scarce, and facts fugitive, figures appear to be so essential that they are invented. I should regret to apply this remark to the census of the Sandwich Islands, which in 1861 had a population of 67,084 natives and 2716 foreigners, and is declining, according to the census of King Kaméhaméha IV. and of his Anglo-Saxon Queen Emma, *née* Miss Rooker. Indeed I would rather adduce the insular census to prove that statistics are journeying round the world, and that the statistics of small States are often interesting, and illustrate general laws.

It is evident that the statistics of Bath, for instance, which has 52,528 inhabitants, are at least as instructive as the statistics of Hesse Homburgh, which has a population of only 26,817; while those of the 444,873 people of Somerset, the county in which we meet, are not a whit less interesting than those of any of twenty-four small kingdoms and principalities in Germany, which fill the pages of that useful publication the Gotha Almanack.

Wherever there is local Government we look for local statistics, as they afford means of information which enlightened municipal councillors can always turn to account. We may well believe that, as Adam Smith boasted he had converted some of the merchants of Glasgow to his doctrines before he had promulgated them to the world, his spirit lingers among their descendants, for the statistics of that city have long held an honourable place on our rolls. The statistics of Glasgow are (as indeed are those of any city) of universal interest, when they are collected and discussed by such a statist as the late Dr. Strang, a truthful observer, a thoughtful writer, and an excellent man. In the name of our Section I venture to say that we shall be very glad if the Mayors (with the prosperity of Glasgow before them) and all the town councils in England, Bath leading, will at once appoint competent officers to elaborate their statistics.

As well as Governments and municipal bodies, England has always at work in the field of science richly gifted independent men, like Buckle and Darwin, who devote their lives to science, either as observers or reasoners; and as an example of what an individual can do, I will cite Dr. Heysham, who twice enumerated from house to house the population of Carlisle, abstracted the ages of the dead from the burial registers, and published the results in a judicious form. The volume Mr. Milne (as he informed me) found by chance on a book-stall; whereupon he opened a correspondence with Dr. Heysham, constructed the Carlisle Life Table, and deduced a general law of mortality which served through many years as the basis for thousands of transactions, and for the valuation of millions of property. The names of the two men, the statistical observer and the statistical reasoner, will remain for ever engraved upon our annals.

It is evident that statistics may be investigated in every English parish; and I know no fairer field than local statistics offer to a liberal and ingenuous mind. Some subjects can be more impartially investigated by private gentlemen than by men in office; and a specimen is a paper by Mr. Norman, which is a model of style and statistical logic, proving the fact, which at first appeared paradoxical, that, large as the taxation is, the people of England pay less in proportion to their means, and get more work for their money than the people of any other country*. Again, the remarkable work before you of M. Guerry, on the comparative crime of England and France, embodies the labours of the life of one of the most ingenious private statists in Europe†.

The Statistical Society of London has done so much, by its papers and its Journal, in the eyes of Europe for science, that a similar Society has recently been founded in Paris, and publishes an excellent Journal, to which M. Legoyt and others con-

* On the Pressure of Taxation in this and other Countries. By George Warde Norman, Esq.

† Statistique Morale de l'Angleterre comparée avec la Statisque Morale de la France. Par M. A. M. Guerry, Correspondant de l'Institut, &c. 1864.

tribute, the necessary complement to the well-known 'Journal des Économistes.' The Dublin and the Manchester Societies remind us by their useful labours of the utility of Statistical Societies in our great cities.

I admit that the country has a right to look to the Government for the census, for registration returns, for commercial statistics, for agricultural statistics, for industrial statistics, and for financial statistics, as the collection, analysis, and promulgation of facts of universal interest is one of the Queen's most useful prerogatives. Formerly little or nothing of the kind was done; but by referring to the annual reports which emanate now from the public offices, you will see that this great duty is kept in view. The reports of the War Office and the Admiralty, those of the Board of Trade, of the Customs, the Inland Revenue, the Post Office, and of the Registrars-General of England, Scotland, and Ireland, of the Poor Law Board, and of the Emigration Commissioners, of the Privy Council Officer of Health, of the Education, Factory, and Mine Inspectors; the judicial statistics, criminal and civil, the Consuls' Reports which the Foreign Office now publishes, show that the Civil Service is everywhere anxious to do its duty. And I shall perhaps be pardoned for reminding you that men in the Civil Service are among the great names of our science, from Petty, King, and Davenant, to Deacon Hume, Porter, McCulloch, John Mill, and, to cite no more contemporaries, Adam Smith himself. The Civil Service of the present day is quite in a position to sustain the statistical reputation of England in the face of Europe. What it wants is a better coordination of its work; which might, as was recommended by the Congress, be accomplished by a board at which the principal offices should be represented.

We venture in this Section to call the attention of Mr. Milner Gibson to the organization of a central authority "to direct," in the words of the late Prince Consort, "all the great statistical operations." Such a body has been recently created in many of the States of Europe.

Another matter this Association may very properly urge on the same minister. We ought, from agricultural statistics, to know approximately in October the produce of the harvest in Europe as well as in America, and the state of the live stock to supply the markets. The season has been extraordinary; what have been its effects upon the crops? Unfortunately the Government has nothing to tell us. English agricultural statistics are a complete blank. Yet no one seriously doubts the utility of this question of the supply of food, to town and country, to rich and poor, to farmers and merchants; it will enter largely into the commercial combinations of the next twelve months, and is one of the elements affecting the circulation.

The Registrar-General of Ireland procures the returns for that division of the United Kingdom; and the produce of the last harvest of Australia is known: it is in some parts, if my memory serves, half the average crop; an unpleasant result, which may influence the gold supply, but will partially be mitigated by timely provisions to meet a loss the extent of which is already known.

Mr. Hunt has just published a return of the mines of every kind, and of the mineral produce of the kingdom. It is alike creditable to him, to Sir Roderick Murchison, and to the mining proprietors, who voluntarily supplied the information. Some of them are not far from us, and will perhaps communicate the results to the Section.

I now come to our tools and our methods. Foremost in importance is the question of statistical units. The Legislature has just passed a measure authorizing the use of the metric weights and measures in England; and the report of a Committee of the Association on the subject will be presented to the Association by Mr. Heywood. In the first stage of statistics we count; but this no longer suffices, and we have to weigh or measure.

Upon the choice of units of weights and measures our progress in no slighlt degree depends. Now, one weight will not serve all purposes. Coal, for instance, cannot be sold by the ounce, it is sold by the ton; sugar by the hundredweight; tea by the pound; gold by the ounce; while opium is administered in grains. If the hundredweight consisted of one hundred pounds, the ton of ten hundreds, the ounce of the tenth of a pound, and all the units required in every trade were so related to each other that we could say tens, hundreds, thousands, and so on, as we do in common numeration, all the compound rules which fill our books of arithmetic and puzzle children would be got rid of. So with regard to measures and money—let all the units increase by tens, and all goes "merry as a marriage bell." One set of rules will apply to the weights, measures, and moneys of all trades and of all nations which use the Arabic figures. With regard to money, we cannot do better than adhere to the sovereign for statistical purposes: it is of gold, which is becoming everywhere the standard of value, is the largest unit in use, and is admirably suited to measure large values. The florin, and new farthings or mils, of which 100 would make a florin, 1000 = £1, are all the moneys of account required. The penny will be 4 farthings, the shilling 50, and no change in the coinage is required. The Chancellor of the Exchequer will, let us hope, inaugurate this reform, which would be an immense boon to all classes that have anything to do with bills, accounts, and statistics.

We might decimalize our old weights and measures, but the several ranks of units would not fit well into each other; the change would give a great deal of trouble, and there is no chance that other nations would adopt it, for this simple reason, that the first nations have had for years the admirable metrical system in use. Our merchants deal with these nations largely, and if we adopt the metre, Russia, America, and our colonies will adopt it. If England wills it, the whole civilized world will have one system of weights, measures, and money, as it has one system of decimal arithmetic. This system annihilates those ugly pages of Colenso, the compound rules; so through it, in the words of the highest authority, Professor Barlow, "a child may learn everything necessary for entering into the common concerns of the world in a month as well and better than in a year under our complicated system"*.

A Metric Act will be an emancipation act for children, and will give them time for higher studies in mathematics. The compound rules of arithmetic, English orthography, and Latin verses, are the tasks for which the school-boy is oftenest punished; and they are the opprobrium of the age. Unlike the truths of science, they can only be flogged into the brains of English boys. Statists should at once make the pound sterling and the metric weights and measures their units.

In the English market gold and silver are sold by the ounce; coffee, tea, tobacco, spices, indigo, silk, cotton, and leather by the pound; meat by the stone; sugar, butter, rice, by the hundredweight; coal, iron, copper, tin, lead, palm oil, logwood, hemp, flax, by the ton; wool by the pack. For statistical purposes it is convenient to take one unit, the metric ton=a cubic metre of water, and nearly equal to the English ton, to express the imports and exports, and the quantities of all articles sold by weight. This would facilitate comparison. The quantities sold by volume, such as wheat, fish, oil, wine, and spirits, might also be expressed by one unit—the metric tun, the bulk of water weighing a metric ton. The qualities and prices of some articles, such as wheat and spirits, are regulated by the weight of equal bulks, or by the specific gravity, which is easily expressed as it is the weight of a metric *tun* of the stuff, when a metric *ton* is taken for unity. Cloth, linen, calico, and silk, are sold by linear units, which are exceedingly objectionable, and should be converted into square units for statistical purposes.

In mechanics a unit of this kind is used; a pound weight raised a foot is called a unit of work, and 33,000 such units of work in a minute, form the further unit —Watt's *horse-power*. The unit of work may be called a double unit, inasmuch as it involves two elements—weight (*pound*) and space (*foot*), while the horse-power takes in time (*minute*), and is a treble unit. The French use a similar element thus compounded: the horse-power is 75 *kilograms* raised a *metre* in a *second*. Remark that two of the elements of this unit are intangible. Chemistry furnishes examples of compound units in its binary and ternary atoms. In statistics, double and triple units are in use; thus when I say the rate of mortality in a regiment is 2 per cent. per annum, I employ the double unit, a year of life. The years of life are found by multiplying the time in years into the mean numbers living. The strength of a regiment is 1000, and the average deaths are 20 in a year, 5 in a quarter, so the mortality is as above stated; but if the men die at the rate of 20 in a quarter, you have 20 deaths to 250 years of life, and the mortality is 8 per cent.

* Mathematical Dictionary.

These compound units are the sources of frequent fallacies; thus if the population is compared with the deaths in a quarter, a week, a day, or any short interval of time, the apparent mortality is reduced to any extent. In reckoning interest and profit-rates, £1 under investment a year is the double unit; if the dividend on £100 is £2 half-yearly, the rate of profit is £4 a year.

The rate of profit is found by dividing (1) the profits by (2) the capital multiplied into (3) the *time*.

Inattention to this principle is the source of some of the common fallacies on the income-tax. Thus if two persons are taxed equitably on their property, they are taxed in proportion to its amount and to the time it is under the protection of the State: if A pays £1 on £1000 in a year, B is not fairly treated if he is made to pay £1 every three months. The sophist assures B that he pays at the same rate as A, keeping out of view the fact that the taxable unit is compounded of value and time. Income is an indication, but not a measure, of property, yet if A has a sum under investment in one way, he may have to pay at the rate of 6*d*., while B with the same amount of property may now have to pay 10, 20, 30 sixpences as his quota of the year's taxation. A life income of £1000 a year on men of 20 and upwards, at 5 per cent., is on an average worth £11,712; while at the same interest, the same income in perpetuity is worth £20,000. The owners of two properties taxed upon the same unit of value, pay £11·712 and £20·000 as their quota of the year's tax; under an income-tax the same premium is exacted from properties of totally different values.

The first step in every statistical inquiry is to determine the value of the units to be employed, be they single, double, or multiple. Thus if you find that the mines of a country yield 5000 tons of copper ore, while the mines of another yield 10,000, these are only preliminary units; the final statistical unit is the ton of copper. So of all the minerals the ton of metal is the final unit. The heating power of coal is the element of value, and as it can be measured, it should supply the final unit.

In the statistics of products it is necessary to take time and space into the final units of value; thus coal at the pit's mouth is worth say 5*s*. a ton, and at this price 40,000,000 tons are worth £10,000,000; but the consumer pays 10*s*., 20*s*., 30*s*., 40*s*. a ton for this coal, and its cost in consumption may be £40,000,000. This comprises the profit of the coal merchant, the interest of capital, the coal dues, and the cost of transport, which varies with the supply of horses, roads, canals, railways. Our exports and imports differ in value in the home and foreign market. The value of products should be determined at every stage; thus we should follow wheat from the market till it becomes (1) flour and (2) bread, and take care that in all these cases the units are so like in all their aspects as to admit of comparison. It does not follow that two countries which have the same numbers of cattle are equally rich in that kind of stock; the herds of cattle may differ in size, in age, in their amounts of produce of milk, butter, and meat—in the quality of all their products. Horses differ still more in excellence. In Smithfield sheep are not bought by the head, but by the stone; the offal is sunk, and the price varies from 6*d*. to 8*d*. per pound in inferior and prime sheep. The butcher gets at, and the statist uses, the pound of saleable meat as the final unit. All the elements which the statist wants here are taken into account in the *value* of stock and of its produce; with this he gets comparable units in every climate. Again, take land: land-measures vary. Statists gain a step by employing as their unit a hectar, or a square of 100 metres to the side; it is a large acre, of which our present acre is four tenths. The United Kingdom contains (31,367,507) thirty-one million hectars of land, rather more than a hectar to each person. This is the proportion of land to people in a populous country; and the hectar is a convenient unit of area. England has 15, Scotland 8, and Ireland 8 million hectars of land; the population being 20 millions in England, 3 millions in Scotland, and 6 in Ireland. The proportions in ten are—England 7, Ireland 2, Scotland 1; on areas related as 2, 1 and 1. Ireland has still twice the population of Scotland. Italy has 26, Prussia 29, Spain 51, France 54, Austria 64 million hectars.

We come to States of a very different magnitude; the United States of America hold 440, Turkey 474, Russia in Europe 544 million hectars. Including the whole of their subject territories, the United States possess 730, England has 1145, and Russia 2133 million hectars. We do not accept this unit in statistics as the final unit of land. Land is rich, poor, or waste—cultivated or uncultivated; and a hectar in the centre of London, in the vale of Gloucestershire, on the banks of the Lena in Siberia, in Melbourne, and in the middle of Australia, is a very different thing. All the chief elements that we need are summed up in the mean *value of a hectar*; and in the usual divisions of hectars into arable, meadow, pasture, forest, water, waste. The value of the land of the United States certainly exceeds that of the Russian Empire; in the absence of agricultural statistics, we do not know the value of our land, but the value of the fixed property of the Isles of England exceeds the value of the fixed property in either the Russian or American dominions*. The *value of a hectar* is the final land unit.

As all the mechanical forces are expressible in units of weight, so the values of land, of all property, of all products, are expressible in units of gold; and we may either measure those values, and express them in tons, or in any pieces of equal weight of that metal. We take the sovereign for the statistical unit of value, because it is in use—for the same reason as engineers take horse-power as the unit of work.

What are we to say to the human unit? Here also distinctions have to be drawn. As hectars differ, so does the average man of different states. Besides the divisions incidental to sex and age, the work of different races of men varies in quantity; a navvy, a Siberian peasant, a Hindoo, a Negro, a Chinaman, an Esquimaux, do very different quantities of work in the year.

The mechanical force of a country is the sum of the working forces of its population, with its steam-engines, horses, winds, waters, which can all be measured by the engineer's unit of work. Adam Smith proposed to employ a unit of labour as the unit of value. The wages of men express the value of their labour in gold, and from the mean value of these earnings at different ages of life, the economic value of a man is calculated by taking the interest of money and the contingencies of his life into account. At the age of 25, the present value of the future earnings of an English agricultural labourer, after deducting the cost of necessary maintenance, is £246†. The value of the mean worktime of artisans, artists, and professional men, varies indefinitely; and as it is evident that the human units differ, so the difference can be appreciated by the value of their works. Nations differ in their intellect as well as in their moral faculties; and the expression of these forces of the soul, whether we look at scientific achievements or vulgar errors, at virtues or crimes, is one of the difficult problems in statistics. It is by the correct appreciation of units, of the things signified by figures, that the statist is distinguished from the empiric who throws heaps of tables in our faces, and asserts that he can prove anything by figures.

After observation, discrimination of units, and expression of their numbers in figures, come the exposition of facts in tables or diagrams, and the determination of their relations by mathematical analysis. Logarithms facilitate the calculation of ratios; and the calculus of probabilities enables the statist from the past to predict the future within determinable limits of error. Prediction is a function of this, as it is of all the sciences. The exposition of doctrines, and the use of them in argument, to induce men to follow a course of action, is an important part of statistics; and as it is connected with politics, has been carried to a high pitch of excellence in England. Several of the pieces of Burke, some extant speeches of Pitt, and in recent times the speeches of Huskisson, of Peel, and of the Chancellor of the Exchequer, as well as articles in the newspapers and reviews of the higher class, offer examples of this order of eloquence.

Statistics admit of many practical applications, and this naturally commends the study to the minds of Englishmen. I will mention an example. In the first place, as we have had a minister, we have had statistics of trade, and from the time of Davenant until the present day, when the Statistical Department is pre-

* The true value of real estates and personal property in the States was estimated at the census of 1860 to be £3,232,000,000, taking $5 to £1.

† Statistical Journal, vol. xvi. p. 43.

sided over by Mr. Fonblanque, the statistics of trade have formed the basis of a large field of economical reasoning. They guided Huskisson, Peel, Graham, and Gladstone in legislation, by showing the exact effects of rates of duty on the revenue, and on the property of the country. Yes, the statistics of Deacon Hume, of Porter, of Tooke, of Newmarch, of Wilson, of M'Culloch, and of our blue books, have accelerated the march of free trade, and banished Protection from the shores of England. Statistics, pursuing her through the world, are demonstrating her disastrous influences in every land. Figures show, year after year, that every country which isolates itself from mankind by prohibition, no matter what may be the natural riches of its soil and climate, withers under the influences of protective tariffs. The people out of the open air of competition grow idle and weak. The imports of 1861 (in England) were of the value of 217 millions sterling, and the exports of 160 millions, including 35 millions of foreign and colonial merchandise; the revenue was £70,600,000, and exceeded the expenditure. What do the statistics of Austria show us? Why in 1861–62 her total imports were 22 millions sterling, her exports 34 millions; her revenue 40 millions, her expenditure 51 millions; and as a consequence her debt is accumulating in geometric progression; her credit is low, and her paper is depreciated. This magnificent empire, of 36 millions of the finest races of Europe, with minerals in the Carpathians, Bohemia, and the Alps, with 64 million hectars of land stretching over the rich plains on the Upper Elbe and the Danube, is thus crippled by a good Emperor and a patriotic Chamber, on the speculation that certain manufactures will prosper ultimately in Austria if they are nursed and encouraged at the expense of the nation for some indefinite time.

France has been drawn towards free trade by statistics; her exports are 123 millions sterling in value; and by the development of her resources, she does not yet falter under an annual expenditure of 83 millions sterling.

Spain, which has broken the chains of the Inquisition, is still in the fetters of protection, that is, still makes her people pay dear for goods to satisfy their wants; her imports are of the value of only 15 millions sterling, her revenue is only 20 millions, and she is unable to pay her debts, so that she is without the legitimate credit which a nation containing many men of the nicest honour can justly claim.

The United States' statistics offer the saddest illustration of the effects of levying protective duties; their imports (1860–61) were 67 millions sterling; their revenue was 10 millions in 1861–62, exclusive of loans, and their expenditure, it is said, was 114 millions; and higher rates of import duties on the class of articles manufactured in New England will necessarily reduce the amount of revenue. The present war was kindled by combustible materials, of which protective duties form no insignificant item.

The statistical argument in favour of free trade is accumulating: it gains fresh force in every table, and will in the end lead all nations to exchange their products freely.

Another thing statistics does; it enables Governments to count the cost of war, and to weigh its results against its expenses.

There can be no doubt that statistics, by disclosing the laws of life and reproduction, tends to improve the health and moral condition of the people, to point out the causes of disease, and to prove so plainly the utility of sanitary measures, that the people become willing to pay the expenses. In England the Registrar-General has, during twenty-seven years, shown how much the public health is deteriorated by destructive causes; so in our towns they are in the course of removal; the Registrar-General of Scotland and Dr. Stark have lately done the same there, and in the present year the Registrar-General of Ireland and Dr. Burke, following Sir William Wilde, have entered the field. Our army has been invigorated by statistics; and the Commission over which Lord Herbert first, and after his death, Lord Stanley so ably presided, has proposed to endow India with the sanitary institutions of England. Under the eminent man who now governs India, the English race, which has hitherto languished in that paradise, will, we may hope, taste the fruits of the tree of life, and perpetuate itself in the tropics among the natives who also descend from the original Aryan stock.

Statistics, it must be confessed, has done little for mankind yet, in comparison with its vast powers. Innumerable social problems are still unsolved, and politics, which Alembert justly pronounced, in the 'Cyclopædia,' "perhaps the most difficult of all the sciences," is every day making fresh demands on statistics. Take the Balance of Power. How are political powers to be measured, and how is the statesman to construct his parallelogram of forces? In past times France, the Emperor, and England were the principal powers; and the problem had then the complications of the three bodies in mechanics, but England, France, and Austria have now Prussia and Russia by their sides, to say nothing of Turkey; Spain is rising again, and the Italian sword is asserting its place; the two States of America disjoined, are two of the great powers of the world, with which Europe will have to reckon. Italy was comminuted into small States; it is now one power. And latterly Germany—still in two great masses, and a multitude of fragments, which have been as dust in the balance—coalescing, has planted herself on the neck of the Baltic in the face of Russia and Sweden, England and France looking on. Here is a mass of 72,000,000 men, with its due proportion of needle-rifles, and a navy, not yet formidable. It has nearly, but not quite, twice the population of France (37,386,313) with her rectified frontier; against which Denmark, with only 2,605,024 people, or, excluding German Holsteiners, two millions dared gallantly to defend her frontiers; but which the Emperor of the French did not deem it prudent to encounter for the sake of an old ally of France in the company of England, with the coveted Rhine—that German river—before his armies.

This population of the German States is split up (our statistics show) into 36 million Austrians, 18 million Prussians, and 18 million Germans comminuted in cities and principalities—but scarcely powers. And if it has France on the west flank it has Russia, with what may be taken at 66 million people, on the eastern frontier, not very distant from Berlin and Vienna. Germany has also unfriendly races within its limits—Poles, Hungarians, and Italians who divide Austria from the sea. Between Germany and Russia lies Poland, in pieces and ashes, but still exhaling her indestructible soul in one flame to heaven. The fine Scandinavian race has fallen back behind the Baltic, before the masses of Russia and Germany, and stands at bay, looking towards England. In the south is looming, we are reminded, the possible coalition of the Latin races in face of the descendants of those Germans who broke the power of the Roman empire. Over the Atlantic, 8 millions were added to the population of the United States in ten years; and at the same rate of increase, the people on the ample territories will amount to 42 millions in six years', to 56 millions in sixteen years' time. Our colonies are increasing at as fast a rate, and repose secure in peace under the sceptre of the Queen. How are all these bodies to be balanced? How is the power of each State to be measured?

The first step in the solution of the problem of equilibrium is naturally the determination of the population, and of the value of the wealth or credit which nerves the sinews of war. When this is done for each State, the unit to get at is the precise worth of the fighting man and officer; the numbers of such units in service and in reserve; the arms, fortresses, and ships. It was enough not long ago to count the ships of the line, frigates, and other vessels; for when the naval historian had told, in addition to the number of ships and men, the number of guns at Aboukir or Trafalgar, his readers were satisfied. The unit of naval force is now by no means so simple; it is compounded of the velocity of the ship and its resisting power—as well as of the weight, velocity, and destructive force of its shot and shells. Strategic position, administration, fertility of military genius, are all elements of power to be taken into account. What minister knows at this hour the military force in war of his own State with any degree of accuracy? or can weigh the force of other States in his balance? What means has he of judging of the number of possible adverse or favourable combinations? As the number of States increases, the possible combinations increase more rapidly. Thus take England, France, or Austria, and there are only three possible combinations of two against one; throw in Russia and Prussia, and the possible combinations are ten of three powers against two, and five of four powers against one; and one, two, or three may be neutral while the rest are at war. England, France, Prussia, Austria, Russia, Italy, Spain, Turkey, the Federals, and Confederates, constitute ten States of 293 millions; that is 29·3 millions to each on an average; and ten combinations can be formed of nine against one, 210 of four against six; in all 511 war combinations. Then if we introduce the element of neutrality, the combinations are still further multiplied; and there remains the separate probability of each alliance. After all the resources of statistics are exhausted, enough is left to task the intellect of the most sagacious minister. We are beyond the age of Government by instinct; and the political questions of the day in England demand new light from science. In the decision of the course to pursue in all the questions of the balance of power—of peace and war—the country has the wisdom of experienced ministers like Lord Palmerston and Lord Derby to rely upon; but the Queen's Ministers know the difficulties of the problem, and will appreciate the value of the facts which they require from statistics—and which the Houses of Parliament require—to aid them in deciding questions of international policy. In steering the vessel of the State over the ocean our captains cannot now entirely rely upon their stars; they must consult their "Nautical Almanack."

Besides the problem of equilibrium, there remain others of equal difficulty. Aristotle, Comte, and other thoughtful theorists, looked with favour on the organization of mankind in small States. But while small States often exhibit great intellectual activity, and in Judea, Greece, Italy, Switzerland, Holland, Frankfort, Weimar, Würtemberg, and elsewhere, have nurtured men of transcendent genius, they exist now by sufferance; they exert little direct influence on the political affairs of mankind. Property is less secure in these dominions than it is in large States; and their defence is more difficult, and in proportion much more expensive. Thus, to say nothing of smaller States, Bavaria, to keep the same army in the field as Prussia, must draw four times as deeply on the resources of her people. Sweet are the charms of small Courts and local Government; yet the people of small States are, as in Italy, yielding by degrees to the soft compulsion of powerful neighbours; and the great continental powers, as their population increases, evince a passion for the sea, to which the small States upon the coasts may not for ever offer an effectual barrier. Still a valiant nation in hearty cohesion, feeble in aggression, cannot be subjugated by a nation of four or perhaps ten times its magnitude; as was seen in the cases of Greece and Persia, of Prussia under Frederick—who with 5 millions of people fought 100 millions—in Austria and Switzerland, Spain and the Netherlands, England and America. The population of England was about 10,530,000, and that of the whites in the States 2,614,000, holding half a million slaves, in the war when the colonists resisted brave British armies, until the intervention of France and other European powers closed the unavailing contest.

In spoiling Poland three great powers participated; and Hungary in the war of 1848 was only recovered by Austria with the aid of Russia. Each of the great powers of Europe has fought—and is able to defend its existence for a time against —Europe in coalition, so long as the hearts of the people are loyal.

The solution of the problem—can 19 Free States conquer 15 Slave States, can 19 millions of people subjugate 8 millions of freemen holding 4 million slaves?—might have prevented a desolating war. And statistics supplies but one solution.

The census was taken in the United States in 1790, eleven years before the first English census; and the last report by Mr. Kennedy is one of the fullest of which statistics can boast. From this it appears that the 697,897 slaves of 1790 had multiplied so rapidly, that they amounted to 3,953,760 in 1860; and this increase proves that the physical condition of the slaves and their health are, as the Southerners tell us, good in a warm climate. They cannot possibly, in the aggregate, like the blacks in Cuba, be worked to death by the masters of English blood, and their conduct during the war confirms this inference. The present Southerners did not, as Sir George Lewis remarks of the Greeks, invent slavery; they inherited it under their laws, and are in the same uneasy situation as masters would be here, who had paid their servants wages for life in advance. With the growth of population, the equitable abolition of slavery in America, like the abolition of serfdom in Europe, is only a question of time, to be worked out in peace as the prosperity of the South increases; yet the institution of slavery is so much at variance with the principles of liberty and of the American constitution, that its speedy extinction is a sacred aspiration in the North, and is shared in England. The passionate war, which has a tragic interest, has shown that though the British race has undergone changes, such as Sir Charles Lyell pointed out, it has lost none of its valour, none of its endurance and none of its military genius in America since the days of Washington. It is rather exposed to the reproach Hume addressed to England, of fighting on uselessly in stubborn anger, when the object of the war is attained, or is unattainable, than to that of imitating the new fashion set by the Emperor of the French in the Crimea and Lombardy.

As the war proclaims the power of two nations, Kennedy's ample statistics fill us with astonishment at their achievments in all the arts of life; and if Frederick in Prussia, and Peter in Russia, are justly, for founding two great powers, called Great, that title cannot be withheld from the nations sprung from the men whom England sent over the waves of the Atlantic.

In Bath Abbey, I am reminded, lie quietly the ashes of Malthus, one of the fathers of statistics, and one of the founders of this Section of the Association at Cambridge. In his celebrated work he deduced from all the information then extant respecting the populations of the earth, the well-known law that population increases in geometrical progression. The first philosophic naturalist of his age assures us that this law rules in every species of plant and animal; and that he derived from Malthus the conception of the struggle for existence, which, with the tendency to variations of form and natural selection always operating in favour of the best, through the millions of ages which our President unrolled before us last night, wrought those miracles of organization which we now regard with wonder and awe.

Malthus did not, however, sufficiently advert to one great characteristic of man, which distinguishes him from all his fellow creatures. The lion and the eagle prey upon the fawn and the lamb, but do not breed them; and even the busy bee only gathers honey from flowers existing. Man, by his industry, creates flowers, fruit, grain, and all products; his science places the forces of nature in his hands; his powers of transport give him the use of the lands of all climates; and hence subsistence has increased during the present century in a more rapid geometrical progression than the numbers of the people in England. Hence her numerous cities, her full ports and her cultivated fields; hence the States of America, hence Canada and its sister provinces, hence the colony of the Cape, Australasia, and our Indian Empire. If, like the power of Imperial Rome, whose ruined temples lie under our feet in the streets of Bath, England should ever decline and pass away, she will not have existed in vain; she will leave eternal traces of her life in the life of mankind; and our dry fossil figures, read by the Macaulay of a later age, will reveal the works in America, in Australia, and India of a great nation. But hitherto no signs of decay are visible; our population is to-day in its youth; it has proportionably more young men in it than any other people in Europe; who in no respect, take them in the ranks of the Volunteers or in the Sections of the British Association, need fear a comparison with their contemporaries. The English race—the greatest of the nationalities—amidst all the coalescing nations, yields all the signs of being able to hold her own for ages to come. Yes—

"Thou shalt be the mighty one yet!
Thine the liberty, thine the glory, thine the deeds to be celebrated,
Thine the myriad-rolling ocean, light and shadow illimitable,
Thine the lands of lasting summer, many blossoming Paradises,
Thine the North, thine the South, and thine the battle-thunder of God"*.

Let us, gentlemen, work hard in that humble field allotted to us; and by doing our duty endeavour to make the statistics of our day worthy of the country in which we live. Above all, let us never forget at our meetings how much we are indebted to the men no more among us, who have made us heirs of their labours, and to whom we are bound by natural piety. Among those names this year to be especially remembered is that of Sir Alexander Tulloch, K.C.B. He was a Fellow of the Statistical Society, to whose 'Journal' he contributed valuable papers; with Henry Marshall and Dr. Balfour he laboured successfully in army statistics; he organized the pensioners; his ability in administration induced the Government

* Tennyson.

to send him with Sir John M'Neil to the Crimea, where he rendered essential service to his country, helped to save the army, and afterwards endured a persecution which he merited only by honesty and endured with brave constancy. M. Villermé in France is a great name gone; we may place it after that of M. Quételet. His contributious to statistics are clear, truthful, and practical. Like the Earl of Shaftesbury, he strove to do good to workmen by judicious regulations. In Germany Dr. Casper, a most amiable and excellent physician, has left works which are often cited in England. Let us strive, gentlemen, to continue the labours which these men began, and to imitate their virtuous love of statistical truth.

On the Rates of Mortality and Marriage amongst Europeans in India.
By SAMUEL BROWN, *F.R.S.*

After some introductory remarks, supported by very suggestive and encouraging, because low, ratios of mortality among Europeans in India, the author stated that, in reference to the mortality amongst civilians in India, the general conclusions at which he had arrived from a large mass of original observations which he had laid before the Section, are:—1. That a considerable diminution has taken place of late years in the mortality at the middle ages (twenty to thirty-five), and at all ages if we compare it with the earlier observations of the present century; 2. that a very marked distinction may be observed in favour of married life; 3. that, as compared with Farr's English healthy life-table, the difference varies from $\frac{1}{2}$ to 1 per cent. between the ages twenty and fifty-five, after which it fluctuates, but is generally rather higher than the English rate. Other statistics are also given with regard to marriage. This subject may be fully illustrated by some facts which have been collected recently in a paper read before the Statistical Society, and published in the 'Statistical Journal,' by Mr. P. M. Tait. The Eurasians, as the name indicates, are a mixed race, the descendants of Europeans (originally, to a great extent, Portuguese) and Asiatic parents. Latterly the British is the predominant European element; but the name appears applied indiscriminately to the children of other colonists—Jews, Syrians, Christian Arabs, Armenians, Persians, Danes at Serampore, Chinese, and Americans. They are looked upon with some prejudice by the natives, being described as having the vices of the natives and Europeans without the probity of the latter. But they are much employed in the superior government offices; and some Indian officers who have employed them bear witness to their quickness at computation, intelligence, probity, and unquestionable loyalty. They form a large proportion of the members of the Uncovenanted Service Pension Fund. Out of 945 who entered in twenty-four years, ending 20th April 1857, there were 693 of this class, or 73 per cent., 246 Europeans, or 26 per cent., and the remaining 8, or 1 per cent., were not described. Hitherto the mortality of Eurasians has been thought to be greater than that of Europeans, and some assurance companies decline them at European rates of premium; but at ages under forty it seems that about 13·5 Eurasians die per 1000, and 17·6 civilians. It is probable, however, that, with the recent improvement in European life in India, the difference would be found scarcely perceptible. In the recent and very elaborate 'Report of the Commissioners appointed to inquire into the Sanitary State of the Army in India,' in which Dr. Farr took so conspicuous a part, the fullest evidence was taken upon every subject that affects the health or mortality of the Indian army, the causes of the excess of the death-rate amongst Europeans as compared with natives, and the remedies suggested for its almost entire disappearance.

On the Progress of Postal Banks (Post-Office Savings-Banks).
By W. CHETWYND.

Between September 1861 and Midsummer 1864, 3000 of these banks had been established in the United Kingdom; and the amount standing in the names of the depositors up to that time, with accumulations of interest, amounted to upwards of four millions.

Statistics relative to the Bristol Coal-Field. By Handel Cossham.

The whole basin within the limits of the mountain limestone ridge, extending from Wickwar on the north to the Mendip Hills on the south, contains about 150 square miles, two-thirds of which lie on the south, or Somersetshire side of Bristol; but, being so largely covered up by overlying strata of lias, new red sandstone, and even the oolitic limestone, it has been much less worked, and is not so well understood as many of our other coal-fields. The author thinks that energy and enterprise will develope and utilize the vast mineral resources of this district much more largely in the future. The northern portion of the Bristol coal-field around Kingswood Hill has probably been worked for 300 or 400 years; and in the district of Moorwood and Vobster, adjoining the Mendip Hills, there are evidences of very ancient and extensive mining operations. The area of this coal-field is thus stated:—

						Tons to work.
Above the Pennant	there are	4 seams,	area	5 sq. miles	....	30,000,000
In the Pennant	„	3	„	8 „	....	10,000,000
Kingswood series	„	15	„	25 „	....	600,000,000
Ashton „	„	3	„	15 „	....	100,000,000
		25				740,000,000

It is more difficult to estimate the quantity to be worked on the Somersetshire side: 1,000,000,000 tons is within the mark. This gives 1700 years as the probable duration of the Bristol coal-field at the present rate of production. The total quantity of coal now raised annually is about 1,000,000 tons—namely, 550,000 tons on the northern side, and 450,000 tons on the Somersetshire side. This forms about one-eightieth part of the total quantity raised in the United Kingdom. There is no doubt that the Bristol coal-field is capable of affording a much greater yield than it now produces, provided more capital and skill are brought to bear upon its development.

On Military Statistics of certain Armies, especially those of the United States. By E. B. Elliott, *of Washington.*

The author called attention, first, to the rates of sickness experienced by the Danish forces during the late conflict in Schleswig-Holstein; secondly, to the rates of sickness, mortality, and other casualties experienced by the United States Volunteers during the first fifteen months of the existing civil war; and, thirdly, to certain physiological characteristics of the United States Volunteers, and the laws which govern the distribution of certain measurements. According to official data kindly furnished by the distinguished chief of the medical bureau, the following rates of sickness, in hospitals and quarters, obtained at the different dates specified:—February 27th, 10·20 to 1000 numerical strength; March 20th, 9·75; April 23rd, 14·20; May 28th, 11·90; June 25th, 8·50; July 30th, 8·85. These rates average about ten and one-half per cent. of the mean numerical strength of the army. The sickness rate was lowest just previous to the taking of Alsen (June 29th), and highest on the 23rd of April, a few days subsequent to the taking of Duppel, by the allies (13th April). The increase in April, attending the taking of Duppel, was due both to wounds received in action and to the greater prevalence of the zymotic class of diseases. The average rate was nearly identical with the sickness rate of the United States' forces during the nine earlier months of the existing civil war (10·4 per cent.), and less than the rate for the subsequent six months (16·9 per cent.). The mortality of the United States' volunteers during the fifteen months, July 1861, to August 1862, inclusive, as deduced from careful and elaborate examination of the official monthly returns of strength and casualties of regiments, conducted under the auspices of the Sanitary Commission, was at the annual rate of somewhat over seven (7·2) in every 100 men—of which two (2·0) were from killed in action, and five (5·2) from diseases and accidents. The rate of mortality of officers from disease, as in other wars, has been *less* than that of the men, but from wounds received in action much greater. The mortality from wounds, both of officers and men, has in general been considerably less than that from disease, although the mortality of officers in the latter part of the period the reverse has been the case, their mortality from wounds having somewhat exceeded that from disease. The rate of mortality in the existing war (7·2 per cent. per annum), for the period under consideration, although much greater than that of civilians of the military age, both in Europe and America, and greater than that of the army of the United States in time of peace, has been less than that of the United States' forces during the war against Mexico, and very considerably less than that of the British forces on the Spanish Peninsula (in 1811–14) and in the Crimea (1854–56); the average annual rate in the Spanish Peninsula having been 16½ per cent., and in the Crimea about 23 per cent., the last-mentioned rate only embracing those dying in hospitals, and not including deaths on the field of battle. This smaller rate of mortality, as compared with those of the other protracted wars mentioned, is believed to be due, in no small degree, not merely to the early organization, by the people, of systematic methods of inquiry into the condition of the soldier, and of timely relief to the suffering—prompted by the noble examples and wise teachings of the Herberts and Nightingales, and other practical philanthropists of Europe—but also in part to the omnipresent representatives of the press of the country, continually informing as to the condition and the wants of the different corps and subdivisions of the army. The casualties from all causes have been at the rate of 28 per cent. per annum of the strength, to wit, seven from deaths, twelve discharged from service, mainly for disability, six deserted, and three missing in action. The number discharged for disability is much larger than it would have been had greater care been taken by the surgeons in conducting the medical examinations of recruits presenting themselves for acceptance. In the early part of the war, the greatest laxity prevailed in this regard, and thousands have been discharged from the service for hernia and other disabling infirmities, under which they were labouring at the time of enlistment. Of ten thousand (9835) recruits from the North Eastern States of Vermont, Massachusetts, Rhode Island, and Connecticut, about 30 per cent.; and of sixteen thousand (16,404) from the North Western States of Indiana, Michigan Lower, and Minnesota, 12½ per cent., represented themselves as of foreign birth. The paper also gave the average ages, heights, circumference of chests, weight, and other characteristics of the American soldier, illustrated by comparisons with British, French, and Prussian data; and accompanied with tables showing the distribution, both observed and calculated, of the soldiers with respect to such characteristics, together with an analytical statement of the mathematical laws which govern the distribution.

Life Tables, by the Swedish Calculating Machine (with Photographs of the Machine by A. Claudet). *By* William Farr, *M.D., D.C.L., F.R.S.*

On the Causes which Produce the Present High Rate of Discount. By Prof. Henry Fawcett.

The author considered, first, whether the high rate which at present exists was likely to remain permanent, and, secondly, whether the high rate was an evil in itself, and whether it wanted any special kind of remedy to remove it. Some City men were expressing their abhorrence of the Bank Charter Act—that to this Act was to be attributed the present state of things—that money was getting too dear, and there was no knowing what would be the result if the Act were not repealed. He contended that the Bank Charter Act had nothing to do with causing this high rate of discount, and that Her Majesty's Government would be guilty of great vacillation and weakness if they listened to the cry which had been got up against the Bank Act by interested speculators, and repeal a statute that ought to be adhered to with the utmost firmness. So long as they had prudent men governors of the Bank of England, as at present, they would have nothing to fear; because, whether compelled to do so or not, they would always keep in the coffers of the Bank sufficient bullion with which to meet the demands that might be made upon them. The Act ought not to be suspended. It should either be repealed once and for all or rigidly adhered to, even if the rate of discount advanced far beyond its present amount. A high rate of interest could not fairly be attributed to a high rate of discount. Just as with all other commodities, the price of money varied with the supply and demand; and there could be no doubt that the present high rate was produced by an activity of speculation which had caused a great demand for capital, and by the heavy exports of specie to the East. There was no cause for alarm if the demand for borrowing still continued. The remedy could only be the rise of price to such a point as would check those who wished to borrow, and gradually, as the rate rose, money would be attracted from foreign countries to England, and in time we should obtain all that we required. There was every reason to expect that a much higher rate of interest was likely to prevail for some years to come than had prevailed for years past; because the export of capital was likely to increase rather than decrease, owing to the establishment of so many banks of late in all parts of the world.

Notes on a Cotton-Chart, showing the Effect on Cotton of the Civil War in America. By Colonel C. W. Grant, *R.E., late Bombay Engineers.*

The cotton-chart exhibited at the Section showed, by diagrams of ascending and descending lines of red, blue, and black, the quantity of cotton imported respectively from India and America, and the total imports from its earliest introduction to the present time; the fluctuations in the prices were shown by thin red and blue lines, and at the sides of the chart were the actual number of bales and prices corresponding to these lines, with the years and dates below; the proportionate quantity of cotton received from all parts was also shown by circular areas of different colours; the cost of cultivation in India and America of slave- and free-grown cotton, &c.

The following Table will best show the chief results elicited in the chart:—

Date.	Total quantity of cotton imported, in bales of 400 lbs.	Cotton imported from America, in bales of 400 lbs.	Cotton imported from India, in bales of 400 lbs.	Average price of American cotton.	Average price of Indian cotton.	Total value of cotton imported.
	Bags.	Bags.	Bales.	Per bag.	Per lb.	£
1747	7	7		£3 11*s.* 5*d.*		25
1784	164 bales and 71 bags.	71	164	£3 11*s.* 5*d.*	24*d.*	6,805
	Bales.	Bales.		Per lb.		
1800	260,515	72,730	20,400	26*d.*	14*d.*	5,601,073
1820	571,651	302,395	57,725	11½*d.*	8½*d.*	7,583,632
1840	1,599,500	1,257,500	216,400	6½*d.*	4½*d.*	15,140,000
1860	3,477,346	2,490,527	506,406	6½*d.*	4½*d.*	35,756,589
1861	3,142,461	1,829,227	794,574	9*d.*	6¾*d.*	38,653,395
1862	1,309,925	43,810	965,483	18¼*d.*	12¼*d.*	31,093,045
1863	1,673,958	57,090?	1,080,000	24¼*d.*	19½*d.*	56,277,943
1864	2,241,932	242,552?	1,310,480	27½*d.*	*20¼*d.*	73,974,335

There is some discrepancy in the quantity of cotton from America, as the greater portion is blockade-run cotton from the Bahamas. The Indian bales are reduced to 400 lbs. per bale to admit of a comparison with the American.

The following remarkable facts connected with the cotton-trade, and the effect upon it of the civil war in America, were elicited:—

The imports of cotton into England rose from 7 bags, valued at £25, in 1747 to 3,477,346 bales of 400 lbs., of the value of £36,000,000, in 1860, or in little more than a century; the supply of cotton from America fell from 2,490,527 bales in 1860 to 43,860 bales in 1862, the total supply falling from 3,477,346 bales in 1860 to 1,309,925 in 1862, the year of the cotton famine; the price of cotton rose from 6½*d.* per lb. for American and 4½*d.* per lb. for Surat in 1860 to 27½*d.* per lb. for American and Egyptian and 20¼*d.* per lb. for Dhollera or Surat in 1864; in August 1864 the

* The reaction has commenced; on May 15, 1865, Dhollera cotton was selling in Bombay at 9*d.* per lb., including freight.

prices were $29\frac{3}{4}d.$ per lb. for Egyptian and $23\frac{1}{2}d.$ per lb. for Dhollera, or nearly *five times* the prices in 1860. In 1860 we paid about £36,000,000 for cotton; in 1864 nearly £74,000,000, or more than double, and more than the total revenue of Great Britain, namely, £70,000,000, for *one* article of import alone. In 1862 nearly 400,000 operatives were thrown out of employ by the stoppage of the cotton-mills, and the pauperism amounted to 240 in the 1000, who were supported by voluntary subscriptions chiefly; now the pauperism is 63 in the 1000.

Yet notwithstanding this vast drain of money, this want of employment for tens of thousands, the country flourished. The revenue in 1863–64 was £70,000,000. The exports, which in 1860 (the most flourishing commercial year on record) amounted to £135,000,000, and fell to £125,000,000 in 1861 and to £127,000,000 in 1862, ROSE to £146,000,000 in 1863 and to £160,000,000 in 1864, or £25,000,000 more than in 1860. And that private wealth kept pace with that of the country may be gleaned from the asserted fact that in 1864 the amount invested in new companies was no less than £192,000,000 of which £22,000,000 was paid up.

So much for England and the manner in which she has weathered the storm: now see the effect on India and some other countries. In 1860 we paid for Indian cotton only £3,500,000; in 1864 nearly £37,000,000; and in 1863 £36,000,000; or including 1865 nearly £100,000,000 in three years, of which a very large proportion was paid in hard cash. In 1860 we paid £1,500,000 for cotton from Egypt, and in 1864 we paid her £14,000,000. In 1864 we also paid about £10,000,000 for cotton to the Brazils, China, and Japan. So true is it, "that it is an ill wind that blows nobody good."

Statement of the Mortality of the City of Bath. By R. T. GORE.

The author, after a few preliminary remarks, epitomized the sanitary statistics of the city and its vicinity thus:—

General Summary of Mortality.—The total population of the city, according to the last census, and including the workhouse and hospitals, may be taken at 52,500, and the total deaths as follows:—Lansdown, 341; Walcot, 280; Abbey, 298; Lyncombe and Widcombe, 214; Bathwick, 91. Total, 1224. To these must be added, for deaths of persons belonging to city parishes, in the workhouse, 59; in United Hospital, 67. Total deaths, 1350. Population as above, 52,500; deaths, 1350. Ratio to population, 25·714; ranging from, Bathwick, 17·28 to, in Abbey district, 27·09. Of the total deaths, the numbers, at certain ages, are as follows:—under 10 years, 41·63; from 60 to 100, 28·82; intermediate ages, 29·25.

Mortality of Country Districts of the Bath Union, year ending June 30, 1864.—Population, 15,808; deaths, 331; ratio, 20·93. Under 10 years, 47·9; from 60 to 100, 30·03; intermediate ages, 22. It should be added, as a general remark applying to all districts both in town and country, that, during the year in question, there was a prevalent epidemic of scarlatina, with a heavy rate of mortality. Thus, in the Twerton district, of 166 deaths, 51 were from scarlatina, and of these 29 in the quarter ending March 31, 1864. In the Batheaston district, of 128 deaths, 16 were from scarlatina. In Lansdown district, of 341 deaths, 62 were from the same cause, and of these 62 were in young persons from infancy to 22 years of age.

On Crime in England and France.
By M. GUERRY, *of the Institute of France.*

Some remarks on the French Calculating Machine.
By Major-General HANNYNGTON.

Statistics of Live Stock. By R. HERBERT.

On the Recommendations of the Public School Commissioners for the Distribution of School Time. By JAMES HEYWOOD, *M.A., F.R.S., F.G.S., F.S.A.*

The Royal Commissioners appointed to inquire into English public school education, proposed in their report the following scheme for the distribution of the school or class lessons in a week, as furnishing a comparative scale of the number of hours to be devoted to the respective subjects of instruction, and the time to be given out of school for preparation.

School Lessons (at One Hour each).	Hours in a Week.
I. Classics, with History and Divinity	11
II. Arithmetic and Mathematics	3
III. French or German	2
IV. Natural Science	2
V. Music or Drawing	2
	20

Hours of Preparation.	Hours in a Week.
Classical composition	5
Classics, &c.	10
French or German	2
Natural Science	2
	19
Hours of school lessons	20
Hours	39

Dr. Faraday, in his evidence before the Public Schools' Commission (1862), mentions his opinion that one-fifth certainly of the time which an individual devotes to study, ought to be devoted to the attainment of natural knowledge.

"The first thing to do," remarks the learned Professor, "is to give scientific teaching an assured and honoured place in education.

"The study of natural science is so glorious a school for the mind that, with the laws impressed on all created things by the Creator, and the wonderful unanimity and stability of matter, and the forces of matter, there cannot be a better school for the education of the mind."

With such obvious advantages arising from the study of natural science, an inquiry may be made why the great public schools of this country do not encourage a larger amount of class or school lessons in natural philosophy, as well as in other modern subjects of instruction.

The Royal Commissioners remark in their report, that in the public schools there is especial deficiency in arithmetic and French; and they observe that the path of promotion, and the subjects in which the time and thoughts of the boys are employed, are mainly classical; the traditions of the most ancient public schools are classical; the chief honours and distinctions of those seminaries are classical; and the head master and, where the tutorial system exists, the tutors are men distinguished chiefly as classical scholars.

To improve the existing system, a school council is suggested by the Royal Commissioners, consisting of the assistant masters, or a selected number of them, representing the whole body; and, in the latter case, the classical and the mathematical masters, and the teachers of modern languages and natural sciences respectively, are recommended to be duly represented on the council. The head master is proposed to preside, if present, and matters concerning the teaching or discipline of the school are intended to be considered by the council.

In University College School, London, the head master is requested by the governing body of that institution to call together the assistant masters at least once in every term, to consult with them as to the management and arrangement of the classes; and the views of parents may be communicated to the head master regarding such subjects as Greek, mathematics, natural philosophy, chemistry, and German.

School lessons at University College School are distributed in a week from Monday morning to Saturday afternoon in the following manner:—

Latin occupies 9 hours in each week in every class; but neither Greek nor Latin verse compositions form any part of the system of lessons at the school.

French has 6 hours a week assigned to it in each of the three junior classes, and 3 hours a week in each of the three senior classes.

German occupies $2\frac{1}{4}$ hours in a week in the senior classes; and Greek has $4\frac{1}{2}$ hours a week in the classical subdivisions of those classes, its place being taken in the other subdivisions of the upper classes by more modern subjects, such as writing, arithmetic, geography, English, history, mathematics, natural philosophy, and social science.

Drawing and practical chemistry are extras.

The following arrangement of the classical subdivision of the fourth class has been made in the lessons for a week:—

Greek $4\frac{1}{2}$ hours, Latin 9; French 3; German $2\frac{1}{4}$; history $1\frac{1}{2}$; mathematics 6 arithmetic 3. Total $29\frac{1}{4}$ hours.

The time of the more modern subdivision would be thus arranged in the fourth class:—

Latin 9 hours; French 3; German $2\frac{1}{4}$; English $1\frac{1}{2}$; history $1\frac{1}{2}$; geography $1\frac{1}{2}$ mathematics 6; arithmetic 3; writing $1\frac{1}{2}$. Total $29\frac{1}{4}$ hours.

On the Locality of the various Religious Bodies in Ireland.
By the Rev. Dr. Hume.

On the British Home and Colonial Empire in its Mutual Relations.
By Lieutenant-Colonel Kennedy.

The object of this paper was to combat the notion that the colonies are useless appendages to the British empire. It pointed out the advantages which the colonies derive from the mother country, by the protection afforded to their commerce on the high seas by means of the strongest navy in the world, which costs them nothing. It proves the benefits which the mother country derives from her colonies, exclusive of British India, by their high consumption of British manufactures (£3 6*s*. 10*d*. per head of population) as compared with the consumption of the rest of the world who are not under the British flag—2*s*. 4*d*. per head, which is in the ratio of 28 to 1.

On the Economical Administration of the Navy. By Prof. Leone Levi.

The naval expenditure constituted 30 per cent. of the total amount of the supply services voted by the House of Commons, and, in the forces of the country, the navy held the first rank. It was shown that, in the time of war, the average cost per man, a hundred years ago, was £68 per man; whereas, in the Russian war, it was £270 per man. In times of peace, the cost, a hundred years ago, was £105 per man; whereas, at present, it was £150 per man. But a great change had taken place in the state of the navy—first, in the size of ships, and, second, in the introduction of steam.

Statistics on the Number and Occupations of Foreigners in England.
By Prof. Levi.

According to the last census there were 80,090 foreigners in England and Wales, being at the rate of 0·0·41 to every 100 natives. That, however, was considerably less than the number of foreigners in France or the United States. In France, in 1861, there were 506,381 foreigners in a population of 37,386,313; and, in the United States, in 1860, there were 4,136,175 foreigners out of a population of 27,489,461. Of the 80,090 foreigners in England and Wales 73,000 were Europeans, 9500 Armenians, 500 Africans, and 500 between Asiatics and natives of other countries. Of the 73,000 Europeans 30,900 were Germans, 13,000 were French, 5500 were from Holland, 4500 from Italy, 5000 from Norway and Sweden, 5000 from Russia and Poland, 2000 from Spain and Portugal, 2000 from Belgium, and 2500 from Denmark, and about 1000 from Greece and Turkey. Fully one half of the foreigners in England and Wales are located in London. Of the total number of foreigners in this country, 57,000 are males and 27,000 females; and, of the 73,000 Europeans, 13,000 were under twenty years of age.

Sanitary Statistics of Salisbury. By A. B. Middleton.

On Brief Writing. By I. Pitman.

The consonant signs employed in all shorthand alphabets are the right line | and the two opposite curves ( ) which, when placed in the four possible distinct positions, perpendicular, horizontal, sloping to the right, and sloping to the left, make twelve distinct signs. As these are not sufficient to supply one for every consonant, recourse is then had to some appendage to the straight line, as a hook or a circle. The experiment of at once doubling the number of straight lines and curves by writing them light and heavy was first made in Phonography; and, as the principle was employed in this system, it proved in practice a remarkable success.

Consonant sounds are divisible into two classes, which may generally be designated as breath letters and voice letters. It was found that in English the breath letters exceed in number the voice letters in the proportion of five to two. The breath letters are *k*, *p*, *t*, *sh* (called *ish* as a letter, heard in wis*h*), *s*, *th* (called *ith* as a letter, heard in brea*th*), *f*; and the voice letters are *g*, *d*, *b*, *zh* (named as a letter *zhe*, heard in measure), *z*, *th* (called *the*, as a letter, heard in brea*the*), *v*. These make up two-thirds of the consonants in our language. There are also three nasals, *m*, *n*, *ng* (named *ing* as a letter, heard in si*ng*); 2 liquids, *l*, *r*; 2 consonants formed from vowels, *w* (*oo*), *y* (*ee*); and the aspirate, *h*. Of pure vowels we have six long, *ah*, *eh*, *ee*, *aw*, *oh*, *oo*; and six short, *a*, *e*, *i*, *o*, *u* (in b*u*t, son), *ŏŏ*; called, as letters, *at*, *et*, *it*, *ot*, *ut*, *ŏŏt*. These 22 consonants and 12 vowels form the alphabet of simple sounds for the English language. It is convenient and even necessary to have signs for the two frequent double consonants *ch* (called *chay* as a letter, heard in *ch*oose, stret*ch*) and *j* (in *j*uice, e*dg*e); and for the double vowels *ī*, *oi*, *ou*, *ū*. *Ch* is composed of the simple letters *t*, *sh*; and *j* of *d*, *zh*. The diphthong *ī* is composed of an obscure vowel rapidly pronounced (which may be represented by *e* or *a*), followed by short *ee*, thus *ei* or *ai*; *oi* is *aw* long, followed by short *ee*; *ou* is an obscure vowel rapidly pronounced (which may be represented by *o* or *a*) followed by short *oo*, thus *ou* or *au*; and *ū* is *ee*, *oo*, the *ee* being pronounced as *y*. There are, therefore, in the shorthand alphabet 12 vowels, 4 diphthongs, and 24 consonants; total, 40 letters.

The principles on which the right lines and curves in various positions are assigned as the representatives of the consonants are these:—Light strokes represent breath letters, and heavy strokes represent voice letters. By placing the six signs | **|** (**(**) **)** in four positions, we obtain 24 characters serviceable for letters, which is the number we require. But in arranging the signs and sounds it is evident that some accommodations must be made as to heavy and light strokes; for six of the consonants, *m*, *n*, *ng*, *y*, *w*, *h*, do not pair as breath letters and voice letters, as do the others. It is a most fortunate circumstance that we can harmoniously arrange 22 out of these 24 signs, so as to preserve a relation between the sound and the sign.

There are two *kinds* of classes of letters, 1st, gutturals, palatals, dentals, and labials; so called from the seats of articulation where they are produced; and 2nd, mutes or explodents, in which the sound is completely *stopped in* till it is exploded, as *p*; nasals, in which the sound issues through the nose, as *m*; liquids, or melting letters, as *l*, having the capacity of uniting with other letters, and producing diphthongal consonants; semivowels, or half vowels, *y*, *w*; and aspirate or breathing, *h*;—these various classes being so called from the quality of the sound, or the place of its exit. Now it is evident that but one of these two kinds of classification—organic and qualitative—can be regarded in assigning signs to sounds; for a given stroke can no more be written in two positions at the same time, than a thing can be in two places at the same time. In laying the foundation of Phonography I carried out an exhaustive series of experiments to ascertain which kind of strokes, straight or curved, and what positions, would best suit the different classes of letters; and I found that the best alphabet resulted from giving the straight lines to the explodents *k*, *t*, *ch*, *p*, and the curves to all the other classes; placing guttural and nasal letters in the horizontal position, dentals in the upright position, labials sloping to the left, and palatals sloping to the right. Following out this arrangement, every letter is in the same position as all the other letters of the same class, except *h* and the downward *r*; and twenty-seven years' experience has given every assurance that can be desired that on this ground Phonography is unassailable; or, as an eminent American phonographer, Stephen Pearl Andrews, expressed it, "The fundamental principles of the art—the alphabet of the system—cannot be shaken till a new geometry is discovered." For an exhibition of the phonetic shorthand alphabet, the reader is referred to Mr. Pitman's publications.

On the Quantity and Value of Foreign Grain imported into the United Kingdom since the Repeal of the Corn Laws. By FREDERICK PURDY, *F.S.S., Principal of the Statistical Department, Poor-Law Board.*

The author observed that the benefits which the country had already derived from free trade were beyond the most sanguine anticipations of those who had successfully striven to destroy the protective tariff of England. The Custom House returns disclose figures which, to those who are not very familiar with statistical and economic research, look like fabulous amounts. For example, in the four years ended with 1844 (these were the last years of the celebrated and mischievous "sliding scale") 1,791,000 quarters was the average yearly quantity of wheat imported; the price of British wheat being, in those years, 64*s.* 4*d.*, 57*s.* 3*d.*, 50*s.* 1*d.*, and 51*s.* 3*d.*, taking the prices chronologically. But, in the four years ended with 1863, the average imports were 6,970,000 quarters, at prices ranging between 44*s.* 9*d.* and 55*s.* 5*d.* The imports in quantity were, in the last four years, nearly *fourfold* what we obtained in 1841–44; at the same time the price was much lower. Under "grain" the author classed wheat, wheaten flour and meal, barley, oats, rye, maize, peas and beans, &c.; and it was shown, with regard to the value of these commodities, that the whole of the imports during the decade ended with 1863 amounted to £250,202,000. Nearly all this vast quantity of grain and flour which this money-value represents has been consumed in this kingdom, about £3,000,000 worth only having been exported in the ten years. The annual average home consumption of foreign corn, flour, and meal for 1852–63 was 11,865,000 quarters, valued at £25,000,000 very nearly. Three periods of four years each were then taken to show the imports according to population.

	Average annual quantity per head.
1842–45	0·8 of a bushel.
1852–55	2·3 bushels.
1860–63	4·4 bushels.

So that the quantity taken with reference to the population was precisely *five and a half times* greater in 1860–63 than it was eighteen years before. It was further shown that, as regards the different parts of the United Kingdom, they appeared to participate equally in the imports of grain properly so called; but that, of flour and meal, Ireland received a much smaller quantity than either England or Scotland—*e. g.*, the following were shown to be the proportions in each division in 1861:—

	Bushels of grain per head.	lbs. of flour and meal per head.
England and Wales	3·9	28·6
Scotland	3·9	29·3
Ireland	3·9	3·6

The year of maximum imports was 1862, when 18,441,000 quarters of grain, meal, and flour of all sorts were received into the ports of the United Kingdom, valued at £37,772,000. Mr. Macculloch had computed that, for human food and for the inferior animals, this country required 49,000,000 quarters of grain, flour, and meal annually. This estimate was framed five or six years ago. Very recently, Mr. Caird has computed the quantity of wheat required for the consumption of Great Britain at 18,700,000 quarters.

From the appendix to the paper the following figures have been abstracted, to show the countries to which we were, at the latest date, indebted for our grain imports:—

Quantities of Grain, of every Description of Grain, and of Flour and Meal, imported into the United Kingdom in 1863. Total quantity, 25,955,939 quarters. Whereof were from—

	qrs.		qrs.
1. United States	3,807,035	7. Denmark	1,076,000
2. Turkey (Moldavia, &c.) .	1,887,700	8. British North America..	920,000
3. Prussia	1,751,012	9. Sweden	886,723
4. Russia................	1,737,388	10. Hanse Towns..........	379,584
5. France	1,099,714	11. Other parts of Germany	208,320
6. Egypt.................	1,079,311		

Statistics of Crime and Criminals in England. By T. W. Saunders, *Recorder of Bath.*

The speaker called attention to the importance of the subject and the very great amount of popular error entertained with reference to it—so great, indeed, that the belief was well established that, as regards crime and criminals, this country is in a deplorable condition. He observed that to the abandonment of the practice of transporting our worst offenders to the colonies, and the substitution of penal servitude at home, this supposed evil is universally attributed. He stated that the facts he had to bring under consideration would, he believed, expose this error and show that, with reference to crime and criminals, the country was never in a more satisfactory condition than at the present time. He then referred to the state of crime in the sixteenth, seventeenth, and eighteenth centuries, as showing its great prevalence, and contrasted the security of life and property in the present day with the dangers which beset them in former times. He drew attention to the establishment in 1856 of a uniform system of police throughout the whole country, and to the fact that at the end of 1853 the first penal-servitude Act came into operation, the effects, however, of which were not felt until the year 1859; and he dwelt upon the importance of the statistics as now furnished by the police authorities to the government, and that these returns continually proved the general decrease of crime and of the criminal classes. These returns, he said, showed that the *criminal classes at large*, comprising *known thieves and depredators, receivers of stolen goods, prostitutes, suspected persons, and vagrants and tramps* numbered as follows in the years as under:—

1858..............................	134,922
1859..............................	135,766
1860..............................	131,024
1861..............................	123,049
1862..............................	127,051
1863..............................	126,139

showing a decrease in five years of 8783; and that if *vagrants* and *tramps* were excluded, who were often honest people, and the number of whom is greatly affected by merely temporary causes, such as the cotton famine, the numbers would be as follows:—

1858..............................	112,363
1859..............................	112,413
1860	108,760
1861	99,048
1862	102,635
1863	92,957

showing a decrease in five years of 19,406, and this, too, whilst in the same time no less than 12,281 persons had been released in this country from penal servitude. He proceeded to show that hand in hand with this diminution there had been a decrease in the number of *houses of bad character*—those the resorts of thieves and prostitutes, the decrease since 1859 being no less than 3566, or nearly 14 per cent.! The actual diminution of crime, he remarked, had kept pace with the diminution of the criminal classes; and after calling attention to the fact that the police kept a register of all crimes committed, whether or not any persons were apprehended for them, he stated that the numbers of indictable offences committed in each year since and inclusive of 1858 are as follows:—

1858	57,868
1859	52,018
1860	50,405
1861	50,809
1862	53,225
1863	52,211

showing that in the last year, as compared with the year 1858 (only five years since), there had been a decline in indictable crimes committed to the extent of 5657, or 11 per cent. He said that from these returns it would appear that the year 1860 was the lowest as regards actual crimes committed, and that the year 1861 came next, the increase being, however, *less than one per cent.*, and that this increase was *apparent* rather than *real*, as the population itself increases at the rate of *one and a quarter* per cent. per annum. That with reference to the increase in the year 1862, such increase was to be accounted for by certain exceptional causes. 1st, The deplorable effects of the civil war in America were first felt in Lancashire in that year, causing an excess of crime in that county over the preceding year of 1149. 2nd, In that year the new Criminal Law Consolidation Acts came into operation; and as these statutes enacted from twenty to thirty new indictable offences, these assisted to swell the excess of the year. 3. There was an excess in *attempts to commit suicide* of 407, the number in 1860 being 174, and in 1862, 581; but as an *attempt to commit suicide,* though an indictable offence, is not considered by the public as a crime, crimes in the sense in which they are properly understood being those offences which are committed by one man against another, and not against himself, and as there was no actual increase in suicides themselves, leading to the well-founded ground that the apparent increase arose more from police intervention than any actual increase itself, it would be right to exclude this increase from the computation. Taking, therefore, the increase of crime in 1862 over 1861 to be 2820, and deducting the increase in Lancashire, and the excess of attempts to commit suicide (saying nothing of the new indictable offences), the excess of the year will appear to be 1264, which is a number exactly corresponding with the rate of increase of the population.

He proceeded to show that in the last year (1863) there was a decrease with reference to 1862 of 1014 crimes, though still an increase upon 1860 (the lowest year upon record); but that in this year, as in 1862, the same exceptionable and temporary causes were in operation. Thus there was still an excess of crime in Lancashire, though much reduced; but that the excess in *attempts to commit suicide* had increased from 174 in 1860 to 686 in 1863; that deducting, therefore, the excess in Lancashire and the excess in *attempts to commit suicide,* there would be an excess of crimes in 1863 over 1860 of only 1080; but that if the increase in crime had only kept pace with the increase of population, the increase should have been 1890. So that comparing 1863 with 1860 (the lowest year on record for crime), there is a relative decrease, and this, notwithstanding that during the last five years more than 12,000 convicts of the worst class had been set at liberty.

He observed that the fact that there is no real increase in crime in this country reflects very great credit upon our systems of police and penal punishment; for that had there been even a considerable increase no surprise would have been justified, since it could hardly have been supposed that those classes of criminals who formerly, when their term of transportation expired, became the pest and terror of our colonies would, merely by being kept in this country, become orderly and well-conducted members of society. It was certainly true, he observed, that during the last few years there had been some increase in crimes of violence against persons and property, though even in this respect the country is better off than it was six years ago.

He called attention to a common but fallacious way of viewing the question of the increase of crime, by taking, as a proof of such increase, the increased number of persons apprehended and committed for trial; and he explained that, as only a percentage of criminals are apprehended for the crimes they commit, the increased committals may be due alone to the superior vigilance of the police; and he stated that whilst in 1860 the apprehensions for crimes committed was 49 per cent., it gradually increased to 58 per cent. in 1863, thus showing an increase of 9 per cent. in the apprehensions in three years in respect of the same number of crimes. He also observed that the percentage of *commitments for trial* upon apprehensions had also increased from 65 per cent. in 1860 to 69 per cent. in 1863—facts which show that a great increase of criminals for trial is quite consistant with there being no actual increase in crimes committed.

Two facts, he remarked, testified to the efficient working of our present system of punishments: 1st, the decreasing number of recommitments, these being 40 per cent. upon the total commitments in the year 1859, and progressively declining to 37½ per cent. in 1863: 2nd, the great number of persons who had been subjected to penal servitude who were living honest lives; for that in February in the last year the Government directed the police authorities throughout the country to make a return as to the modes of life of the persons then at large, either upon tickets-of-leave or upon the termination of sentences of penal servitude, and it was ascertained that there were 4379 such persons, and that of these 2025 were living the lives of honest well-conducted men (being in fact nearly one-half), the remainder being either doubtful or bad characters. He referred, also, to the very gratifying fact of a substantial decrease of crime amongst the juvenile population, the decline in the number of commitments of prisoners under sixteen years of age being one-third in seven years, the numbers in 1856 being 13,981, and in 1863 only 8459.

He observed that we could never hope by merely penal discipline entirely to reclaim criminals from crime, or prevent innocent persons from embracing it; that as long as poverty and ignorance exist, so long will there be destitution and its offspring, crime; that in this age, when science is doing so much through machinery to supersede mere manual labour, and when skilled labour is almost the only kind of labour that is in requisition, the uneducated man is daily becoming more and more embarrassed in his efforts to obtain a livelihood; that to the uneducated man the lowest and commonest kinds of labour are alone open, and when from any cause these fail he has no other resource, and want and destitution are his lot. That this is so is proved by our criminal returns, which show that crimes are annually becoming more and more confined to the ignorant; that in the year 1856 the *untaught, untrained, and unskilled to work* comprised 53 per cent. of all those who were committed for trial; whilst in the year 1863 this percentage had increased to 63½, or more than 10 per cent. in seven years! That the more clearly to show that crime is being confined to the ignorant, the returns should be looked at as exhibiting the degrees of education amongst the criminals; and that, going back to the year 1856, it would be found that 33 per cent. of our criminals could *neither read nor write*, whilst in the year 1863 this class had increased to 35 per cent.; that in 1856 the numbers who could merely *read, or read and write imperfectly*, were 53 per cent. upon the whole, whilst in 1863 they were 60 per cent. But that looking to the *educated* proportion of our criminals, the numbers who, in 1856, could *read and write well* were only 5½ per cent., whilst in 1863 even this small percentage had declined to 3½, the most striking fact being that of criminals possessing *superior instruction* the percentage in 1856 was only 0·3, which in 1863 had further declined to 0·2.

He concluded as follows:—"Such facts as those conclusively show the tendency of crime to confine itself to the untrained and ignorant, and to leave the educated almost wholly free from its association. Crime and ignorance clearly go hand in hand; and although it by no means follows that an untaught man will become a criminal, instruction would appear to afford a guarantee against its possessor becoming such. The statistics I have now brought under your attention establish, I think, these propositions:—that notwithstanding we now keep nearly all our criminals in this country instead of transporting a large proportion of them to our colonies, the criminal classes have greatly declined in numbers, whilst crime itself is at as low an ebb as at any period of our history; that our detective and penal machinery works well, and that crime is more and more becoming the associate of only the untaught and ignorant. If I am correct in the facts I have stated and the conclusions I have drawn from them, our duty and policy alike point out, that whilst we should not neglect by penal discipline to endeavour to reform the criminal, and by the terror of his example work healthily upon the minds of those whose misfortune it may be to be brought within criminal influences, we should, by a judicious system of education, redouble our efforts to place the humbler classes in such a position as will enable them to escape or successfully resist all temptations to the commission of crime."

On the "Truck System" in some Parts of the West of England.
By Edward Spender.

In the West of England, especially in Devon, Somerset, Gloucestershire, and Herefordshire, the practice prevails of paying a proportion of the wages of the agricultural labourer in cider. This proportion varies from 20 to 50 per cent. on the whole. The latter large figure is attained in Herefordshire during harvest time, when a mower or a reaper will earn 9*s.* a week in money and drink nine gallons of cider a week, cider at the time being worth 1*s.* a gallon. In Devonshire there does not seem to be the same excess, but the system prevails more or less. The question then arises, How far is it desirable as regards the health, and the morals of the labourer? What is cider? Is it food or poison?—Or both, or neither? Professor Voelcker has analyzed an imperial pint of cider drawn by agricultural labourers in Somersetshire, and he finds the following results:—

	Cider contains parts	Bread contains parts
Water	94·21	36
Flesh-forming matters	·02	8
Heat-producing ,,	5·57	56
General matters	·20	—
	100·00	100·00

Hence a man would require to drink nearly 8½ gallons of cider in order to take into the system the same amount of carbon or heat-producing constituents as is contained in a pound of wheaten bread; and in order to obtain the same amount of nitrogen, or flesh-forming constituent, he would have to swallow 32 gallons of cider. Compared with meat the difference is of course far greater. Cider can therefore scarcely be called food. It would be going too far to call it poison when it is pure; but the cider drank by the lower classes is rarely pure. Experiments have shown that, whether the cider be pure or not, a farm labourer will work better on coffee or cocoa than on cider.

On politico-economical grounds, the "cider-truck" cannot be too strongly condemned. It is even more unscientific than the truck-system which prevailed in the manufacturing and mining districts, and which was forbidden by the Act 1 & 2 Wm. IV., cap. 37. Under that system the employer did not sell his own produce at a certain fixed sum not to be altered according to the changes in the money value of that produce. Under the "cider-truck" the farmer gives a fixed quantity of cider regardless of the rise and fall in the value of cider caused by the scarcity or abundance of the apple crop. The result is, that just as the farmer is receiving the least return, he is making the greatest outlay. When a poor apple crop reduces his profits, he is paying the highest wages; while when, on the contrary, the apples are abundant, and he could afford to pay his labourers highly, he is really paying them less than usual. Supposing the cider to be genuine, the farmer in a bad year may be paying wages at the rate of 18*s.* per week, while in a good year he will be paying at the rate of 12*s.*; this fact alone is a strong inducement for the farmer to adulterate the favourite beverage. He cannot afford to give good cider in bad times, and having once formed the habit of adulterating, he cannot lay it aside when there is no need to resort to it.

Another strong objection is that while the ordinary truck allows a man a choice in the articles he takes, the cider truck does not, but compels him to take an enormous quantity of an article which he can scarcely afford to have at all. A person of the upper classes who spent a fifth of his income, still more one-half, on his cellar would run the risk of an inquiry into his sanity by the Lunacy Commissioners. Yet not only is nothing said against the extravagance of the labourer, but he is actually forced to commit it. It has been urged in behalf of the system, that it prevents the labourer from resorting to the drink-shop. It is of small advantage to the labourer to be drenched, *nolens volens*, by his master instead of at his own option by the publican. As a matter of fact, cider-shops abound in the cider counties, and are frequented by agricultural labourers, who resort thither for companionship, and, as a matter of course, drink "for the good of the house."

The great difficulty in remedying this evil lies in the opposition to a remedy on the part of those who suffer for want of it. It is one of the worst features of the cider truck that it enforces selfishness. A young newly married labourer will take home his earnings to his wife, and would prefer that the whole of them should be paid in money. The elder labourer approves of the "cider truck," and would oppose any alteration of it. Thus in proportion as there is a greater need of thrift does thriftlessness increase; just as the labourer becomes the father of a family, and there are more mouths to feed, does he take home less money to feed them with. Both parties are wedded to the system, and reform is thereby rendered very difficult. Some influential agriculturists in Somersetshire have substituted money for cider, and have found that, when fairly carried out, the change has been approved by the labourer. An agreement may be difficult at the onset, but, when once made, it will be permanent, whereas the present disputes about quality and quantity are perennial. The extension of the Truck Act to the agricultural districts is therefore much to be desired, and seems to be the only efficient remedy for the manifold evils of the "cider-truck."

The Sanitary Statistics of Clifton.
By J. A. Symonds, *M.D., F.R.S.E., &c., &c.*

This paper proved the importance of adding verbal explanations to statistical figures. The Registrar-General's report had given 24 in 1000 as the death-rate of Clifton, calculated from the deaths in the quarter ending June 1864. This statement would be very injurious to the reputation of Clifton as a watering-place, unless it were explained that its name is given to a large Poor-law district, to the population of which Clifton proper contributes little more than one-fifth. The several subdistricts of Clifton Union were described in detail as to their sanitary characteristics, and as to their respective death-rates, calculated from the annual returns of death in the five years from 1859 to 1864. The average for Clifton proper is 17 in 1000; and if a quarterly return be a fair basis of calculation, it would be found that in some quarters the death-rate amounted to only 15 in 1000. On comparing the death-rates of the several subdistricts of Clifton Union, the author showed the influence of urban and rural agencies. The highest death-rates denote the combination of poverty and crowding. He compared the death-rates of several localities in England, and ascertained that the average for a crowded town was 24 in 1000, for a rural district 15, and for a mixed district 21. Clifton Union is a mixed district. One of its subdistricts, three miles distant from Clifton proper, gives 24 in 1000; for it belongs really to one of the most miserable quarters on the outskirts of Bristol. A purely rural subdistrict, Westbury, gives 15 in 1000, and Clifton proper 17 in 1000. But the average of the whole union is 21. Many details as to the subdistricts were related. The paper concluded with the expression of a strong wish that the classification of numerical returns representing the elements of the social life of our people should not be compelled to follow Poor-law lines and limitations, which, however suitable to Poor-law purposes, may cause figures to express something very different from what would be their meaning were the facts which they number grouped in accordance with scientific requirements, rather than with the convenience of a special branch of national administration. Then the numerical death-rate of a crowded city would express the mortality in that city, including items that are now transferred to a rural district, or appended to a healthy watering-place. The numerical death-rate of a village would mean the mortality of that village, unswollen by the deaths in a city poor-house; and the numerical death-rate of a watering-place would express the mortality in that watering-place simply, neither complicated with the mortality of distant rural retreats nor burthened with that of the sickly suburbs of a crowded city.

On the Comparative Rates of Mortality in Paris and London. *By* William Tite, *M.P., F.R.S.*

After noticing the imperfect manner in which the registers of the mortality of Paris were kept, in consequence of the superficial mode in which the examination into the causes of death were made by the agents charged with the duty of ascertaining them, Mr. Tite took occasion to praise the returns that were issued by the care of the English Registrar-General. The imperfect character of the Paris returns, and their only appearing at the period of two years *after* the events they recorded, in fact, rendered anything like a rigorous comparison between the mortality of the two cities almost impossible. "I wish it to be distinctly understood," said Mr. Tite, "that in giving what seemed to me to be the results of the London and Paris rates of mortality, I do not pretend to give them with all the accuracy that ought to prevail in such important documents. For the Paris rates, in my judgment, can only be regarded as close approximations."

Mr. Tite then proceeded to notice the various causes which, in his opinion, ought to render residence in Paris more favourable to human life than that in London. He dwelt upon the superior quality of the soil, the kinds of food that are consumed, the class of materials that are used in house-building, the climate, &c., all of which are superior in Paris to those which are to be met with in London. Yet, with all these advantages, the mortality of Paris is greater than that of London; for we find, from the "Statistique Générale de la France" and in the weekly returns issued by the Registrar-General, that the mortality of the two cities may be represented by the following figures:—

Year.	Paris. Rate per cent.	London. Rate per cent.
In 1853	2·95	2·44
" 1854	3·51	2·94
" 1855	2·99	2·43
" 1856	2·43	2·21
" 1857	2·73	2·24
" 1858	2·73	2·39
" 1859	2·86	2·27
" 1860	2·53	2·25
" 1861	2·57	2·32
" 1862	2·49	2·36
	10 | 27·79	10 | 23·85
Average of 10 years	2·78	2·39

It is, moreover, to be observed that the increased mortality of Paris is accompanied by a diminished proportion of births to deaths in that city compared with London; and that, therefore, this statement cannot be assumed to give a correct view of the mortality prevailing there. Thus, if the years 1860, 1861, and 1862 be taken as giving the average return (and those years are expressly selected as being the most favourable), we find that the proportion of births to deaths in the two cities was—

Year.	Paris. Births.	Paris. Deaths.	London. Births.	London. Deaths.
1860	51,056	41,261	92,825	61,617
1861	53,570	43,664	96,389	63,001
1862	52,312	42,185	97,418	66,950

upon a gross population that was estimated at 1,696,141 in Paris, and 2,859,778 in London. This would give a larger number of children born in London than in Paris; and every one knows that the rate at which children die is greater than in the subsequent periods of life. The comparison is therefore the more unfair to London: there were more children born there; consequently there were more deaths among that class of the population.

It was shown that the same tendency existed in the one city as in the other to resort to the curative means afforded by the hospitals; but Mr. Tite called attention to the fact, that the children of the Parisians were habitually sent away from home, and thus tended to diminish the rate of mortality in the city; whilst the children of Londoners were kept at home to live or to die, as the case might be. The deaths that were registered in the Paris hospitals were, however, more than those which took place in the hospitals of London, not only comparatively, but positively; and attention was called to the fact that, out of the total number of births in the year 1862, as many as 6522 out of 52,312 took place in the public hospitals of Paris. The effect of the greater facilities that were thus given to the indulgence of the passions, by the assistance that was offered to the confinement of women in that city, was also alluded to; and the increased mortality that was created was made the subject of some remark.

Mr. Tite thought that much of the increased mortality that he showed to prevail in Paris over London was to be attributed to the overcrowding that was observable in the former city; to the bad hygienic conditions of the houses, as far as regarded their ventilation, the removal of the refuse, and the water-supply; and to the bad laying-out of the town generally. It appeared that in Paris as many as 35·17 persons lived under the same roof, whereas in London the average number was only 7·72; and everything that was going on in the former city tended to increase the proportion of the inhabitants to the house-room. As to the hygienic conditions of the houses, Mr. Tite observed that it was by no means rare to find that the houses in the best quarters of Paris were erected with a front building towards the street of 14 mètres high, which was only separated from a back building by a court-yard of 6 mètres wide, and the air of the inhabitants of the latter was forced to be renewed in this well. The habits of the best classes were, moreover, such as to render this inconvenience from the want of ventilation more injurious; and "the villainous smells" that could be distinctly perceived in all parts of the city were attributed to the deficient notions that prevailed in this respect, and to the deficient manner in which the service of the town was performed in respect to the removal of the house-refuse. The streets of Paris were also very badly planned; and though much had been done to improve the state of things thus pointed out of late, yet much remained to be done before Paris could compare with London in this respect. The streets in the former city were crooked, narrow, and confined, and the circulation of air in them was very much impeded. Mr. Tite thought that, in fact, the number of people that crowded together under the same roof, and the bad state of the houses themselves, were the main causes of the increased rate of mortality observable in Paris.

The state of the sewerage and the water-supply of Paris were also said to be very deficient. Thus, it was calculated that there were above 700 kilomètres of streets in Paris, but there was not half that length of streets sewered; and in Paris the sewers had very different functions to perform than they had in London, as they were designed to carry off from the former city only the rain-water and some portion of the liquid sewage, whereas, in the latter, they conveyed away from the householder all the house-refuse and the rain-water indiscriminately. There had been executed a well-devised scheme for discharging the sewage on the northern side of the Seine, which conducted the waters to the neighbourhood of Asnières; but this did not deal with the sewerage of the islands, nor did it relieve the river from the impurities that it received from the sewerage of the south side, which, in fact, was poured into the Seine just above the intake of the water-works of Chaillot. The error that the French engineers had committed in designing their system of sewers was in limiting them to the functions of drains, instead of making them serve both as drains and sewers. As to the water-works in Paris, their insufficiency was proved by the fact that there were only about 25,000 subscribers out of 50,000 householders; and by the fact that the water was, in the majority of cases, only delivered on the level of the ground floor. The peculiar tenure of the French houses, indeed, opposed the introduction of the water to the various flats, or stories, that are let out to distinct and separate families. The supply of water in Paris was at present undergoing a radical change, but it was still very much behind the system that prevailed in London.

But, with all the causes that give rise to the increased mortality of Paris over

London, it is not the less certain that of late the proportion of the excess had tended to decrease, in consequence of the works that had been executed for the better organization of the sewerage, the water-supply, the street-ventilation, and the reform of the house-system under the orders of the Emperor. The inquiry into the rates of mortality has, however, thus far led to ascertaining the fact that the mortality of London is less that that of Paris by nearly 4 in 1000, if the average be taken over a period of ten years; it is less by nearly 13 in 10,000, if attention is solely confined to the rate of mortality which prevailed in the year 1862.

After stating that he had followed, in the statistics given in the paper thus read, the "Statistique Générale de la France" and the "Annuaire du Bureau des Longitudes" for all that had reference to the mortality of Paris, and the returns of the Registrar-General for that of London, Mr. Tite concluded by adopting the statement that had been made upon the subject by M. Legoyt. That gentleman, Mr. Tite said, stated that, "firstly, Paris had more marriages, and of legitimate children less than London; secondly, that in spite of this lesser fecundity, and the well-known fact that a great number of the children born in Paris died in the country, Paris had a rate of mortality that was much greater than that of London; thirdly, that there was a greater proportion of male deaths in London than in Paris; fourthly, that the proportion of births to deaths was greater in London than Paris." It must have cost the national vanity of M. Legoyt a great deal to make these admissions, and they may very fairly be taken as representing the facts of the case.

On the Land-Transfer of Australia as applicable to Ireland. *By* Colonel Torrens.

The author, after some preliminary remarks, proceeded as follows:—"We will now consider the different methods prescribed for conducting the future transfers and other dealings with land, through the instrumentality of 'Registration of Title'; without again accumulating the complexities and doubts of retrospective title from which they have been cleared by the procedure just described under the Australian method, which is that adopted in the Bill of the Irish Association, the Record Book is the pivot upon which the whole mechanism turns. It is compiled by binding together the duplicates of all conveyances and declarations of titles issued by the Estates Court representing the freehold, each of which constitutes a distinct folium, consisting of two or more pages set apart for recording together the memorials of all future dealings, whether with the freehold or any lesser estate or interest in the land represented by the conveyance or declaration of title, until a change of ownership of the freehold is registered. When this occurs, the existing declaration of title or conveyance is cancelled, the exising folium of the record closed, a fresh declaration of title issued to the new proprietor, and a new folium opened in the Record Book, upon which are carried forward the memorials of all lesser estates and charges affecting the land, and continuing current at the time of recording the ownership of the freehold. Printed forms of contract, with full instructions for the guidance of parties dealing, are to be supplied at the lands'-titles office and law-stationers' shops. These instruments must be filled in duplicate. All covenants essential to the existence, use, and enjoyment of estates and interests which are the subject of the contract are declared to be implied in these instruments; and, when recorded, they are endorsed with the folium of the record constituted by the declaration of title of the land, where the memorials of them will be found entered in the order in which they are recorded. They are then numbered in consecutive series; one original of each is handed to the party whose title is evinced thereby, the other is filed in the lands'-titles office. Under this method accumulation of instruments with voluminous indexes, the fatal objection to other systems, is avoided. The retrospective character of title is effectually got rid of, as each separate estate of interest in each parcel of land is represented, so long as it exists, by one instrument only; and, as each instrument necessarily discloses the nature of the property held by the proprietor, with all that a party dealing can require to know, search is unnecessary, except to ascertain the non-existence of caveats—and even that is accomplished without reference to any index, as each instrument indicates the folium where the history of the title is recorded. Transfers, leases, mortgages, and other charges, as provisions for families, as also entails and settlements, are conducted with security, facility, and economy, without curtailment of the freedom which landed proprietors enjoy in the disposition of their estates under the present system. The only difference is that we pursue a direct straightforward procedure to the accomplishment of what is required instead of a circuitous, intricate, and artificial procedure."

Statistics of Crime in Australia. *By* W. Westgarth (*of Australia*).

Crime in Australia, as compared with England, is much greater, owing to the effects of transportation upon the colony. The favourable condition, however, of South Australia, New Zealand, and particularly Queen's Town, leads them to hope that the entire group would, but for that cause, have compared favourably with the mother country. In Victoria the cost of police and prisoners for 1860 amounted to 15*s.* per head of the population, that for England and Wales being only 2*s.* $1\frac{1}{2}$*d.* In New South Wales the yearly average of the five years 1858–62 gives 1 criminal in 433; and, in Victoria, for 1859-61, the still worse result of 1 in 375. The colonies present considerable diversities with regard to crime, which are to be attributed chiefly to the transportation system. There was no feature of these colonies more satisfactory than their progressive social improvement, as instanced by the yearly diminution of crime there.

Registration of Births and Deaths in Ireland. *By* J. Wilson.

In accordance with the provisions of the Act of last year, the 163 poor-law unions and 718 dispensary districts have been adopted as areas for the registration of births and deaths. During the first quarter there were registered 30,330 births, affording an annual ratio of 1 in 48 of the inhabitants; the number of deaths was 28,540, being equal to an annual mortality of 1 in 51 of the population. The annual birth-rate varied in the provinces as follows:—In Leinster it was 1 in 49; in Munster, 1 in 41; in Ulster, 1 in 52; and in Connaught, 1 in 54. The death-rate was, in Leinster, 1 in 46; in Munster, 1 in 51; in Ulster, 1 in 50; and in Connaught, 1 in 65. The return shows that, during the three months ended 30th June last, the births registered amounted to 38,701, affording an annual ratio of 1 in 37, which was an increase of 8371 on the number of the previous quarter; the deaths amounted to 24,448, being equal to an annual ratio of 1 in 59, and was a decrease of 4092 when compared with the previous quarter. The annual birth-rate during that quarter varied in the provinces thus:—In Leinster it was 1 in 38; in Munster, 1 in 34; in Ulster, 1 in 38; and in Connaught, 1 in 41. The death-rate was as follows:—In Leinster, 1 in 55; in Munster, 1 in 60; in Ulster, 1 in 57; and in Connaught, 1 in 77.

Sanitary Statistics of Cheltenham. *By* Dr. Edward Wilson, *M.A.*

After a description of the geology, mineral springs, and climate of Cheltenham, the author stated that in 1852 the Local Improvement act was passed, empowering the Commissioners to purchase then existing sewers, and to extend the system wherever needed, requiring moreover that tanks should be constructed communicating with mains into which the whole of the sewerage of the town was to be conducted.

Under these powers the rights of the Sewer's Company passed into the hands of the Commissioners in 1857, and large additions have been made to the sewers in the denser parts of the town; but the greater portion of the three large estates of Bays Hill, Lansdowne, and Pittville, occupied by the better classes of houses, is still practically beyond the supervision of the local authorities, being dependent on private sources for sewerage; and though the sewers on these estates are assumed by the Commissioners to be adequate to the requirements of the people, it is obvious that where there is no power of inspection except on presentment of nuisance there can be no adequate official knowledge. Whilst, therefore, all credit is due to the Commissioners for what has been done, it would be unwise to ignore the conclusion that the present system of divided responsibility affords no adequate guarantee for the efficient drainage of the whole town, and that an act of Parliament rendering the purchase of private sewers not only permissive but compulsory on the Commissioners would remove an existing anomaly, and be to the eventual benefit of the town at large. In the tanks to which the sewerage is now conducted the solids are separated and mixed with town ashes to form manure, while the liquid portions are passed, after very partial deodorization, into the streams, which are rendered excessively foul by the subsequent decomposition of the filth.

The streams within the town are thus kept comparatively pure, but the mills on the Chelt render its streams intermittent, and interfere with the scour in its channel.

The water supply is derived in part from the sandbed on which the town is built, in part from the rainfall of the hills. That from the sandbed is usually preferred for drinking purposes, but it is extremely hard, containing 36 to 80 grs. per gallon. That from the hills contains 11 to 12 grs. per gallon.

The first act for bringing hill water to the town was obtained by the water company in 1824. In 1849 the amount supplied was 72½ gals. per house daily; at the present time all information is denied by the company, but it is hoped that their energetic measures, combined with the anxiety of the Town's Commissioners on the subject, may result in an additional supply of wholesome water, sufficient not only for household purposes, but for public washhouses and baths, which are justly considered at the present day as among the most essential of sanitary requirements.

The population of Cheltenham in 1861 was 36,693—males being to females as 100 to 138—the proportion for England and Wales being 100 to 105. The growth of the town is still double the natural increase due to excess of births over deaths; and greater than that of the inland watering places generally, in the ratio of 13·24 to 7·28 per cent. The social conditions of Cheltenham are peculiar, and affect in a remarkable manner the census returns for certain periods of life. The tables produced showed the large accession to the population during the school period, between the ages of 10 and 20; whilst the absence of any large manufacturing or commercial industries in the town, and the consequent departure of the boys on leaving school, will account in part for the enormous preponderance of females (190 to 100 males) between the ages of 20 or 30: other causes doubtless contribute to this result, but that they are acting chiefly among the higher classes is evident from the fact that in St. Peter's ecclesiastical district, which is occupied by the very poor, the males in 1861 were actually in excess of the females. During the later periods of life numbers flock to the town in search of health and the social advantages for which it has acquired a reputation; and it is no easy task to balance accurately the effects of these two sources of addition to the population from without—one tending materially to decrease, the other to augment the liability to disease and death. The proximity of great wealth to great poverty is nowhere so marked as in a watering place, and Cheltenham is no exception to the rule. The absence of any large manufacturing industry, and the dependence of the poorer classes on the capricious expenditure of their richer neighbours, cannot fail to cause fluctuations in the labour market most injurious to the independence and self-reliance of the working classes. In Cheltenham this is strongly felt, and the large extent of pauperism existing may in part be due to this cause. The great wealth and peculiar nature of the occupations in Cheltenham is seen from the fact, that whilst the houses

			in England and Wales, per cent.	in Cheltenham, per cent.
	under	£5	18	3
Above £5 and	"	£10	34	33
" £10	"	£50	44	47
" £50	"	£100	3	11
" £100 and upwards			1	6

Average rental England and Wales . . £15 5*s*.
" Cheltenham . . . £25 7*s*.

As compared with Clifton, the numbers of the following classes, in every 10,000 living, were in 1861

	Cheltenham.	Clifton.
Domestic servants (male)	83	27
" " (female)	416	341
Coachmen or grooms (domestic)	19	14
Milliners and dressmakers	210	153
Tailors	69	30
Hairdressers	8	3
Druggists	12	7
Engaged about horses	100	54
Masons, cabinet makers, &c	315	242

On turning from these evidences of wealth and luxury, it seems strange to find the amount per head spent on the poor of the Cheltenham Union increasing, and persistently in excess of the average for the kingdom at large. One reason has been already suggested; others might probably be found in the enormous charities of the place and the lapse of the Mendicity Society, which formed one of the most effectual checks on mendicancy and imposture. The mean number of paupers per cent. for the year ending Lady Day was:—

	1856.	1859.	1862.	1863.	1864.
Cheltenham	5·5	5·6	5·9	6·2	6·3
England and Wales	4·8	4·4	4·5		

and the expenditure for the last four years has shown a steady increase; thus in the year ending Lady Day:—

	1859.	1860.	1861.	1862.	1863.	1864.
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Cheltenham	6 0	6 $2\frac{3}{4}$	6 $4\frac{1}{2}$	6 $8\frac{1}{4}$	6 $11\frac{1}{2}$	7 $0\frac{1}{4}$
England	5 $8\frac{1}{4}$	5 6	5 9	6 0		

The increase in pauperism bears no proportion to the increase of the population, and it is probably, to a great extent, independent of this cause. The various medical charities, including the General Hospital and Dispensary, the Coburg Institution, the Ophthalmic Infirmary, and Union Workhouse, were treated of at some length, and the need of some special provision in connexion with the Hospital for the treatment of infectious cases was strongly urged. These cases are now treated from the out-patient department at their own miserable homes, devoid most frequently of the commonest necessaries of life, and likely to become *foci* for the spread of disease and death. The various church charities were also passed in review, so far as information concerning them could be obtained; and amongst these a school for instruction in household duties, instituted by the Rector, was regarded as the germ of a better and more organized system for the relief of the sick poor in the town. By the two-fold workings of this institution the girls are, on the one hand, educated in household duties and trained to thrift and tidiness; whilst, on the other, the produce of the kitchen, which represents the alms of the congregation, is distributed to the sick and aged poor through district visitors appointed for the purpose. Means were suggested for extending the system to other church districts, and so organizing the whole as to direct the streams of charity more exclusively to the sick and disabled, and it was expected that the period of convalescence might thus be materially shortened to working men, and the continual drain upon the ratepayers, from this source at least, be perceptibly diminished. Several tables were drawn up to show the prevalent diseases and most frequent causes of death in the district; a few extracts only can be given. It must first be premised, however, that Cheltenham, in the Registrar General's Returns, and the Cheltenham of ordinary conversation are two entirely different quantities. The former being the town or borough, with a population of 39,693, in 1861, on an area of 3,740 acres, plus the twelve surrounding parishes of Swindon, Prestbury, Charlton Kings, Leckhampton, Cubberly, Cowley, Whitcombe, Badgworth, Shurdington, Up Hatherly, and Staverton, containing together in 1861 a population of 10,099, on an area of 21,136 acres. The returns therefore obtained from the whole district cannot be held to represent the state of one portion to the exclusion of the rest without the corrections afforded by an appeal to local records. It is strange, then, that difficulties and serious expense should be made to attend any such inquiry, and that in the absence of any reliable information on the part of the Registrar-General, and on the part of the local authorities in our large towns, as to the sanitary condition of those towns, no effort should be made to facilitate the examination of the documents which can alone, under the present system, give the most essential information. The death-rate in the parish of Cheltenham varies in a most remarkable manner, from as high as 22·2 to the low figure of 15·6; the average for ten years being 19·29, which, if the deaths in the General Hospital and Union Workhouse be excluded, gives a result very slightly in excess of the standard northern districts as determined by Dr. Greenhow. In 1840–41–42 the death-rate for the district was 23 in the 1000, a figure which has not been reached since the improved drainage has been carried out in the town. Cheltenham has always enjoyed a remarkable immunity from zymotic disease. Deaths from small-pox, scarlatina, measles, typhus, diarrhœa, dysentery, and cholera are much below the average for the kingdom, and these are the diseases which are now usually held as tests of the sanitary condition of a town. There are still deaths from small-pox, however, in sufficient numbers to make it a formidable foe, and to convict a people of culpable neglect. For though the deaths from this disease during the ten years 1850–1861 were in Cheltenham district only 92 in 10,000 living under five years of age, whilst in England and Wales there were 103, it must not be forgotten that in 44 registration districts there were no deaths from this cause under five years, and that in 279 districts the deaths were under 50. Of the deaths from all causes in the Cheltenham district, no less than one-fifth occur in children under one year of age, and nearly one-third in children who have just completed their fifth year. This mortality would seem to be due, in part, to ignorance and neglect on the part of the mothers; but that it also depends on inherited weakness, poverty, and malnutrition appears plain from the excessive number of deaths at early ages due to tabes mesenterica and brain-disease, including hydrocephalus. In diseases of the respiratory organs, including phthisis, the Cheltenham district shows a favourable comparison with the averages for the whole kingdom—for Gloucester and for Clifton—a result which could scarcely be expected when the number of invalids frequenting the town is taken into consideration. Rheumatism is prevalent in the district, especially in villages round the town lying on the undrained clay, and its effects are visible in the excessive number of deaths from diseases of the heart and dropsy. Diseases of the brain, including hydrocephalus, are also prevalent between the ages of 35 and 55—a curious circumstance, and not admitting of ready explanation in the general absence of occupations calculated to lay special stress on the nervous centres. The condition of the town then is, on the whole, satisfactory, and on a consideration of its physical and social advantages, there is no *primâ facie* reason why it should have a death-rate higher than the healthiest town in the kingdom. The improvements already accomplished should be but an earnest of the efforts to follow. There can be no stagnation—to stand still is to go backwards. No effort should be spared as long as there is a single preventable death in the community. We might then venture to dream of the sanitary Utopia of the Registrar-General, and to expect "that the tide of health-seekers may again be turned to our shores, and our justly celebrated watering places may hold out sanitary inducements such as shall attract even the foreigner to our shores."

MECHANICAL SCIENCE.

Address by John Hawkshaw, *F.R.S., F.G.S., President of the Section.*

The President opened the proceedings of the Section by reading a brief Address, as follows:—In rude ages men were willing to depend on brute force, or to eke out that force by implements of the simplest kind. As they advanced in knowledge and civilization they sought for other and more complex contrivances, which were better calculated to add to their powers. Thus originated mechanics, and mechanical contrivances therefore multiply with the increase of the intelligence of mankind. Consequently at no former period of the world's history have the subjects to which this Section is devoted assumed such magnitude and importance as they now do. And those who devote themselves to these subjects may rest assured that they labour in a field which is practically without limits, and in a soil that can suffer neither from exhaustion nor over-cultivation. They who have lived through the last thirty years have witnessed triumphs of ingenuity far surpassing those of the past, but which, in like manner, may be surpassed by the future. I am proud to belong to this Section, and deem it an honour to be called upon to preside over its sittings on this occasion. The papers read here treat of subjects which, from their nature, cannot be amongst the most popular, but they are second to none in utility. One of the objects of the British Association is to encourage and stimulate scientific pursuits; and stimulus is sometimes wanted even to the working qualities of Englishmen. We must take care not to fall behind other countries. We cannot forget that for some years we have had to go to Prussia for the steel tiers of our locomotive engines, and that lately we have had occasion to seek locomotive boiler-plates in France. It is plain we cannot rest in our wonted superiority, and slacken and grow idle. Even in Russia it is now proposed to put up works for the manufacture of steel with machinery, which is intended to surpass our own. We shall not, however, unless we become supine, suffer from the advancement and improvement of other countries, and the British Association is large enough in its sympathies to take pleasure in the advancement of science and art in every part of the globe.

On the Power required to overcome the Vis Inertiæ of Railway Trains, with a Description of a Machine to propel Trains between Stations at frequent Intervals without Locomotives. By PETER W. BARLOW, *C.E., F.R.S., F.G.S.*

The attention of the author was first directed to this subject on the opening of the North Kent Railway, in 1850, when the locomotive engineer reported that a much larger consumption of coke ensued than on the main line of the South-eastern Railway with similar trains. Upon investigation of the cause of this difference, by experiments on the atmospheric railway and on locomotive trains, it became apparent that the increase arose from the power required to overcome the *vis inertiæ* of trains, more frequently occurring from the greater number of stations. The remedy then applied by his advice was locomotives of more tractive power, thus, however, adding to the weight of the engine and to destruction of the permanent way. The tractive power has been gradually increased with increased traffic to such an extent that in some instances the author recently observed that a speed of twenty miles is now frequently reached before the last carriage leaves the platform—a speed which would carry the train above half a mile by its own momentum or *vis viva*; and it then occurred to him that if by a local tractive power, applied during the length of the platform, a velocity of thirty-four or thirty-five miles could be given, railways having frequent stations could be worked by stationary power, at a small comparative cost, and the evils of locomotives (particularly in underground railways) could be avoided. The author explained, by experiments, that the economy of stationary power arose not only from its usual economy over locomotives, but that, by the law of accelerating forces, a train that would be propelled at a given velocity for a given distance would be propelled at a much greater velocity by four times the power applied one-fourth of the distance. The propelling power suggested to be employed is that on Mr. Armstrong's hydraulic principle; and the author estimates that a tractive force of 8 tons (equal to that of three locomotives) applied for 300 feet at a station will propel a train of 60 tons for one mile at greater velocity than if one locomotive worked the whole distance. It was also explained that such mode of applying stationary power would not interfere with the use of locomotives for special purposes; and that although such propellers as the author advocated were especially adapted to lines having frequent trains, yet they would be very valuable on railways generally, particularly at stations at the foot of inclines, where at present much time is frequently lost in getting heavy trains into motion.

On Improvements in the Defence of Ships of War. *By* Admiral Sir E. Belcher.

The author proposes to construct the ship on the customary plan of close iron ribs, but filling up the interstices between the iron with condensed teak. Constructing a vessel with 36 inches' depth of rib, at the vulnerable portions to which shot can reach, which will probably involve 12 vertical feet of her side, say 8 feet below water and 4 feet above, we should then have a vessel of stronger framework than any now built, building, or contemplated. In lieu of teak the author suggested paper or millboard as very efficacious, having been witness at Algiers, in 1816, to a case in which a ream of foolscap paper, end on, resisted a 68-pound shot. It is of the first importance to provide such a tonnage as shall, in the case of ships of the 'Warrior' class, be capable of floating the contemplated armament, independent of the forward and after compartments. The first object will be the fortification of the sides, or contour of the oval form of battery up to the lines of rolling, by such a disposition of iron framing as may effectually withstand the heaviest missile discharged from the heaviest gun afloat with impunity.

On the New Elevator Gun. *By* Edward Charlesworth.

On Steam Boilers. *By* Zerah Colburn.

The paper pointed out the causes of failure and bursting, and showed the value of cast iron as a material for the purpose, and that small cast-iron spheres do not retain the solid matter deposited from the water. Small water-tubes and small water-spaces in ordinary boilers always choke with deposit when the feed-water contains lime; but cast-iron boiler *spheres,* although they may be temporarily coated internally with scale, are found to part with this whenever they are emptied of water. This fact is the most striking discovery that has been made in boiler engineering. It removes the fatal defect of small subdivided water-spaces, which can now be employed with the certainty of their remaining constantly clear of deposit. Cast-iron boilers on this principle, invented by Mr. Harrison of Philadelphia, are now working in several of the midland and northern counties. Mr. Harrison employs any required number of cast-iron hollow spheres, eight inches in external diameter and three-eighths of an inch thick, communicating with each other through open necks and held together by through tie-bolts. A number of these spheres are arranged in the form of a rectangular slab, which is so set as to secure a complete circulation of the water, and several of these slabs, set side by side and connected together, form the boiler; about two-thirds of the whole number of spheres being filled with water, while the remainder serve as steam-room. The bursting strength of these spheres corresponds to a pressure of upwards of 1500 lbs. per square inch, as verified by repeated experiment—between six and seven times greater than that of the ordinary Lancashire boilers of large size. The self-acting scaling action, which has been found to be the same in all cases where the boiler has been worked, has been explained by conjecture. It deserves the careful investigation of the chemist and mechanical philosopher, with whom the author prefers to leave the subject.

On the Torpedoes used by the Confederate States in the Destruction of some of the Federal Ships of War, and the Mode of attaching them to the Rams. *By* Captain Doty, *Confederate States' Navy. Communicated by* Admiral Sir E. Belcher.

The torpedo consists of a shell filled with explosive material, whether gunpowder or gun-cotton, and is carried under the surface of the water at the end of a bar attached to the stem of the ram or other vessel, projecting some ten or twelve feet. The bar has a slight sliding motion, by means of which the end of the bar within the vessel, as soon as the torpedo strikes the enemy's ship, acts on a simple mechanical arrangement, bringing the wires connected with the torpedo into circuit with a galvanic battery, and causing the explosion of the shell. Some small wooden steamers, with such an engine of war attached, attacked the Federal frigates 'New Ironsides' and 'Minnesota,' and so much damaged them by the explosion as to render them unfit for further effective service till docked for repairs. It was also employed in like manner against the new sloop-of-war 'Housatonic,' attached to the Federal blockading squadron off Charleston, which ship filled and went down in eight minutes after the explosion of the torpedo under her counter. It is unhesitatingly asserted by competent judges that a vessel properly constructed for the use and application of the torpedo battery, and possessing superiority of speed, would prove a formidable antagonist against a number of frigates armed with the heaviest metal; for it would, by advancing end on, present the least surface to their fire, and always under the most acute angles. An especial advantage which it possesses is that it may be worked at all times—for instance, in a rough sea, when ordinary guns could not be used—while it may be employed with certain success, under cover of darkness, against an enemy's fleet, destroying, disabling, or driving them away from the coast altogether. Great economy, simplicity, and safety are, further, among the valuable and important qualities claimed for this submarine battery. Neither the battery itself nor the men working it are in the least exposed, the apparatus being situated much below the line of flotation. Admiral Belcher proceeded to point out the superiority of such an engine of warfare over rams. A ram with a velocity of ten knots overhauls and touches the stern of the vessel she chases which is going at the rate of nine and a half knots; a half-knot velocity would not injure her opponent, although it might impair her steerage, and bring her broadside to operate on her, in all probability at such close quarters, to her detriment. But a ram fitted with the means of projecting a simple shell under the counter, or into contact with the screw, would inevitably destroy, or at least so derange, rudder and screw that her great work of executing the ram manœuvre at right angles to her antagonist would no longer be matter of doubt, and surrender would, under such difficulty, doubtless result. The French and other foreign governments have approved of the plans of Captain Doty. Our own government ordered the examination of them by a scientific committee, and it has expressed approbation in an official communication.

On Suggested Improvements in Doors. *By* G. Fawcus.

Many serious accidents happen to children by their hands and feet getting into the openings at the backs of doors. Other persons sometimes are hurt by the shutting of the doors of railway-carriages. It is now proposed to remove the possibility of this kind of accident by a different plan of hanging the doors, the back of the door being made semicircular and to revolve in a groove of the same curvature, presenting no opening in whatever position the door may be.

Improvements in Scaling- and other Ladders. *By* George Fawcus.

On Improvements in Screw Propellers. *By* George Bell Galloway.

On Lifeboats for Ships and Steamers. *By* George Bell Galloway.

On Instruments for the Measurement of Gas. *By* George Glover.

Description of a Parallel Gauge. *By* G. Hartmann.

On the Practical Progress of Naval Architecture in Ocean and River Steamers, with Suggestions for Improvements in the Steerage of the Great Eastern and large and small Ironclads, Rams, and Gunboats, similar to the Assam Nautilus, by the use of Balanced Rudders in Bow and Stern. *By* Captain A. Henderson.

On Chain-cable and Anchor Testing. *By* R. A. Peacock, *C.E.*

1. To adjust the weights of the hydrostatic press, the author recommends an instrument like a pair of pincers, 10 inches long from the pivot to the ends of the long legs, and 1 inch from the pivot to the shorter ends; and, grasping the diameter of the indicator valve with the shorter ends, its amount will be read off, magnified tenfold, at the long ends with a scale and vernier, and there need be no error exceeding $\frac{1}{1000}$th of an inch. Allowance should also be made for the friction of the ram in the cylinder. Or, otherwise, provide a suitably strong coiled steel spring with frame, nearly like a Salter's letter-balance, and graduate it up to 5 tons with actual tons of pig iron, then, on laying it on the platform in connexion with the press, it will be known when the press is exerting a force of 1, 2, 3, &c. tons respectively, and the weights can be adjusted accordingly. Great weights will be multiples of small ones.

2. Nine different sizes of stud-link cables were tested at Woolwich, and 15·9 tons per square inch was their average strength. But the average strength of ordinary English iron is 25 tons; so there is a loss of more than one-third of the strength by making it into cables, which it is desirable to recover if possible. And since there is tension on the exterior half and compression on the interior half of the link, he proposes to heat the cables to cherry red before testing, which would enable the particles to adjust themselves according to their respective tendencies and take off the strain. And perhaps an advantage would be gained by cooling them in oil. This annealing would probably make iron, of the same size, materials, and make, homogeneous; so that the degree of permanent elongation with the Admiralty strain could be taken as a test of strength.

3. He objects to the hammer test, because no two men will strike blows of the same force, and consequently no one can know the amount of that force. If any blows are to be applied, he proposes to have a number of weights, each one as heavy as a fathom of a different size of cable, and to let the proper one drop upon its cable from one and the same height.

4. He proposes to break one or more samples of each cable, and to state the breaking force, or forces, on the certificates.

5. An anchor is condemned when the testing strain causes a permanent deflexion of the arm of $\frac{5}{8}$ inch by one set of rules and $\frac{3}{4}$ inch by another set, without any reference to the length of the arm. He proposes instead to condemn all anchors of which the permanent deflexion exceeds a certain fixed amount per foot in length of the arm.

6. Too much permanent set being justly considered fatal to the character of a wrought-iron anchor, too much permanent set ought also to be fatal to the character of a wrought-iron cable.

On the Construction of Shot-proof Targets. *By* T. Symes Prideaux.

According to the author's views, an armour-protected structure should consist of two essentially distinct parts, a yielding face and a supporting back—the first, a series of detached targets so fixed as to be capable of receding a certain distance upon the impact of the projectile; the second, an inner self-supporting structure, continuous throughout, and strong enough to sustain the weight and strain of the detached targets suspended from it, and also to resist their pressure or support their impact when receding before the blow of a projectile.

On some of the Strains of Ships.
By Professor W. J. Macquorn Rankine, *C.E., LL.D., F.R.S.*

In previous scientific investigations respecting the strains which ships have to bear it has been usual to suppose the ship balanced on a point of rock, or supported at the ends on two rocks. The strains which would thus be produced are far more severe than any which have to be borne by a ship afloat. The author computes the most severe straining actions which can take place in a ship afloat, viz. when she is supported amidships on a wave-crest and dry at the ends; and he finds that the bending action cannot exceed that due to the weight of the ship, with a leverage of 0·5 of her length, and that the racking action cannot exceed ·16 of her weight. Applying those results to two remarkably good examples of ships of 2680 tons displacement, one of iron and the other of wood, described by Mr. John Vernon in a paper read at the Institution of Mechanical Engineers in 1863, he finds the following values of the greatest stress of different kinds exerted on the materials of the ship:—

In the iron ship, tension	....	3·92	tons per square inch.
„ „ thrust	....	2·35	„ „
„ „ racking stress	....	1·44	„ „

It follows that, in the iron ship, the factor of safety against bending is between five and six, agreeing exactly with the best practice of engineers, and that there is a great surplus of strength against racking:—

In the wooden ship, tension	....	0·371	tons per square inch.
„ „ thrust	.. ..	0·239	„ „

Here the factors of safety are between ten and fifteen, which also agrees with good practice in carpentry. As for the racking action, the iron diagonal braces required by Lloyd's Rules would be sufficient to bear one-fifth of it only, leaving the rest to be borne by the friction and adhesion at the seams of the planking.

On Units of Measure.
By W. J. Macquorn Rankine, *C.E., LL.D., F.R.S.*

Professor Rankine, one of the Committee, dissented from that part of the Report which recommended the abandonment of the British units of measure, and read a paper, in which he arrived at the conclusion that while the advantages of decimal multiplication and division as applied to units of measure are incontestable, the question between different units, such as the mètre and the inch, is one of convenience, in which the interests of science and of trade cannot be separated; and that inasmuch as the British inch and multiples of the inch are already established by law and custom and used for practical purposes, in regions inhabited by one-fourth of mankind, their use ought not to be abandoned in scientific writings.

On Submarine Telegraphy. By Captain Selwyn, *R.N.*

The paper commences by pointing out possible or probable causes of the failure and loss which have hitherto been lamentably prominent features in these great enterprises. The author considers that there is not the slightest reason to doubt that gutta-percha, properly laid at the bottom of the sea, in whatever depth, is a perfect and reliable insulator of electricity, reasoning from the fact that many of the shallow-water cables have been down from eight to twelve years. The prior failures are ascribed to faulty mechanical construction of the cable and faulty mechanical arrangements for its deposition on the bed of the ocean. The life of the cable, that which must not be injured in any case, is the copper wire that conveys the electricity. A stretching of this, even to the extent of one in a hundred (which, be it recollected, means perhaps one mile in a hundred), cannot for an instant be admitted. Yet this wire is placed in the centre of a comparatively soft and absolutely weak core, and surrounded with spirals of iron or steel by way of giving strength. The axiom of mechanics which is here transgressed is this:—In any structure composed of spirals in combination with straight lines, any strain must first be borne by the straight lines. It was stated that the best insulator is the compound of Mr. John Macintosh, one-half cheaper than either gutta-percha or india-rubber, and much superior to either gum, both in goodness of insulation and lowness of inductive capacity. With regard to the route which it is advisable to pursue: recent discoveries of shoal water, 80 furlongs half way, lat. 43° 30′ N., long. 38° 50′ W., in the direct great-circle tract between this country and the island of Bermuda make it certain that means may be found of dividing any future cable into comparatively short sections. Captain Selwyn is of opinion that a species of vulcanized rubber coating will be found the best and cheapest protecting material. Captain Selwyn's plan for paying out the cable consists in the employment of one or more cylindrical drums, built of sheet iron or wood, as strongly put together as these materials now are in ships, with no more liability to leakage, but with the remarkable difference that here you have a ship or floating structure which is hermetically sealed against the influx of water from any other cause. On these drums or floating cylinders the whole cable to be laid is coiled; and, owing to the great capacity or cubical contents of any cylindrical body, as much cable can be well and safely carried in this way for £5000 as would cost, if in a ship, £30,000, or six times as much, without the safety. The cable which is now to be carried by the Great Eastern could be well carried on two cylinders costing less than £8000 each.

On a Machine for Testing Girders. By J. L. Stothert *and* Robert Pitt.

The machine (which was exhibited in action to the Members of the Section) consists of a compound steelyard lever of the first order, from the extremity of which is suspended a pan to contain weights, the lesser lever being furnished with a graduated index and a sliding weight, as in a weighing machine; the beam under proof represents the fulcrum, and the resistance is obtained by pivoting the short end of the larger lever on a centre attached to a mass of stone buried in the ground or to a screw pile; the ends of the beam rest upon two moveable standards or jacks, and are made to rise and fall either by screws or by a hydraulic press; the object of this arrangement (which is the principal point of novelty in the machine) being to preserve the centres of the steelyards in a level line, however great the deflection of the beam. The deflection is measured on a straight edge, supported on standards fixed to the ends of the beam, and rising and falling with it, and by means of a rod screwed to the upper flanch of the centre of the beam, and working a light lever indicator moving against a quadrant scale, the deflection and set can be distinctly read off to the $\frac{1}{100}$th of an inch. The pressure caused by the weight of the steelyards alone is previously ascertained by actual weighing, and becomes a constant quantity to be added to the indicated load. The advantages of the arrangement consist in, 1st, perfect safety to the operator; 2nd, great accuracy in defining the weight applied, and in determining the deflection and set; 3rd, extreme facility of the whole operation, enabling girders to be proved at a cost of about one shilling per ton of girder; 4th, moderate cost of the apparatus.

On Microscopical Photographs of various Kinds of Iron and Steel.
By H. C. Sorby, *F.R.S., F.G.S.*

The author first briefly explained how sections of iron and steel may be prepared for the microscope so as to exhibit their structure to a perfection that leaves little or nothing to be desired. He then exhibited a series of microscopical photographs, taken under his directions by Mr. Charles Hoole, illustrating the various stages in the manufacture of iron and steel, and described the structures which they present. They show various mixtures of iron, of two or three well-defined compounds of iron and carbon, of graphite, and of slag; and these, being present in different proportions, and arranged in various manners, give rise to a large number of varieties of iron and steel, differing by well-marked and very striking peculiarities of structure.

On the Working of Underground Railways by Hydraulic Power.
By Mr. Symons.

At the last Meeting of the Association Messrs. Hawthorne brought forward a plan of working railways by fixed steam-engines in connexion with endless wires working round a series of wheels placed between the lines of rail. It was suggested as especially adapted for underground railways, where it would be desirable to dispense with locomotives. It will be obvious, however, that a very considerable drawback to its adoption is the great loss of power by friction. The author of this paper suggests that water-power may be substituted with advantage for the continuous wire; and he proposes, in fact, to use an endless wire of water instead of one of iron wire. A great saving of power would result from the fact that, by this plan, only the traction-wheels actually in contact with the train would be in motion. Drawings were exhibited to show the working of the plan.

Experiments on the Elasticity of Iron. By James Williams.

In the engineers' workshop, where straight bars of metal are used for the purpose of testing the work under process of manufacture, it is necessary to keep at least three bars or surfaces of each kind for the purpose of testing each other; for it has long been known that a straight edge, got up with all the care and accuracy possible, true to-day will be bent to-morrow; indeed the very handling of it while in use is quite sufficient to distort it to such a degree that the workman frequently has to put it by awhile until it comes to the natural temperature of the room he works in, the partial heat of the hands alone being sufficient to render it useless for its object. In getting up straight edges and flat surfaces, if two only are used to test each other, it is all but a certainty that one will be hollow and the other rounding; but by using three we are enabled to discover this defect. The author showed the flexibility of iron and steel by experiments.

On Plated Ships and their Armament. By Captain Wheatley, *R.N.*

On Revolving Sails. By Captain Wheatley, *R.N.*

On Improvements in the Defence of Ships of War. By Captain Wheatley.

The author thinks that in future the mode of attacking an iron ship will be to imitate the practice of a breaching battery on shore, where all the guns are directed to a particular spot in the wall to be breached, and to take the ship's water-line as a horizontal line, and the line of any prominent mark, as a mast or funnel, for a perpendicular, and to order all the guns to be directed on the one spot where these two lines meet. He also proposes that screens of oiled south-wester canvas, having a piece of heavy wire-rope at the bottom, should be let down immediately the shot has struck, a bag of wood-shavings and a mattress forced into the gap, covered by a plank and shored up from the inner side of the wing. This will only stop the main rush of the water; a great deal will still flow through the irregular crevices. These he proposes to stop by plastering the canvas to the side with hydraulic cement, which is said to become fixed under water in a quarter of an hour.

List of Papers of which Abstracts have not been received.

On the Spectrum of Polarized Light. By A. Waugh.

Description of a cheap form of Automatic Regulator for the Electric Light. By Samuel Highley, *F.G.S.*

On the Geognostic relations of the Auriferous Quartz of Nova Scotia. By Henry C. Salmon, *F.G.S.*

On the Formation of the Jordan Valley and the Dead Sea. By the Rev. H. B. Tristram, *M.A., F.L.S.*

On the Geology of Palestine. By the Rev. H. B. Tristram, *M.A., F.L.S.*

On the Ornithology of Palestine, and the peculiarities of the Jordan Valley. By the Rev. H. B. Tristram, *M.A., F.L.S.*

Notice of a New Entromostracon, *from Exmouth. By* Thomas Wright, *M.D.*

On South African Swifts and Swallows. By Frederick R. Surtees.

On the Development of Cysticercus. *By* D. W. Brittain.

On the Dietary of the Agricultural Poor. By the Rev. J. Slatter.

On the Combination of Food in the Meals of the Labouring Classes. By Edward Smith, *M.D., F.R.S.*

Nutritive Elements in the Dietary of the Labouring Classes. By Edward Smith, *M.D., F.R.S.*

On the Growth of Desert in Morocco. By Dr. Thomas Hodgkin.

On the Comoro Islands. By Capt. Algernon de Horsey, *R.N.*

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[*An asterisk* (*) *signifies that no abstract of the communication is given.*]

LIST OF PLATES.

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Together with the Transactions of the Sections, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE FIFTH MEETING, at Dublin, 1835, *Published at* 13s. 6d.

CONTENTS:—Rev. W. Whewell, on the Recent Progress and Present Condition of the Mathematical Theories of Electricity, Magnetism, and Heat; — A. Quetelet, Aperçu de l'Etat actuel des Sciences Mathématiques chez les Belges;—Capt. E. Sabine, on the Phenomena of Terrestrial Magnetism.

Together with the Transactions of the Sections, Prof. Sir W. Hamilton's Address, and Recommendations of the Association and its Committees.

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CONTENTS:—Prof. Daubeny, on the Present State of our Knowledge with respect to Mineral and Thermal Waters;—Major E. Sabine, on the Direction and Intensity of the Terrestrial Magnetic Force in Scotland;—J. Richardson, on North American Zoology;—Rev. J. Challis, on the Mathematical Theory of Fluids;—J. T. Mackay, a Comparative View of the more remarkable Plants which characterize the neighbourhood of Dublin and Edinburgh, and the South-west of Scotland, &c.;—J. T. Mackay, Comparative Geographical Notices of the more remarkable Plants which characterize Scotland and Ireland;—Report of the London Sub-Committee of the Medical Section on the Motions and Sounds of the Heart;—Second Report of the Dublin Sub-Committee on the Motions and Sounds of the Heart;—Report of the Dublin Committee on the Pathology of the Brain and Nervous System;—J. W. Lubbock, Account of the Recent Discussions of Observations of the Tides;—Rev. B. Powell, on determining the Refractive Indices for the Standard Rays of the Solar Spectrum in various media;—Dr. Hodgkin, on the Communication between the Arteries and Absorbents;—Prof. Phillips, Report of Experiments on Subterranean Temperature;—Prof. Hamilton, on the Validity of a Method recently proposed by G. B. Jerrard, for Transforming and Resolving Equations of Elevated Degrees.

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CONTENTS:—Major E. Sabine, on the Variations of the Magnetic Intensity observed at different points of the Earth's Surface;—Rev. W. Taylor, on the various modes of Printing for the Use of the Blind;—J. W Lubbock, on the Discussions of Observations of the Tides;—Prof. T. Thomson, on the Difference between the Composition of Cast Iron produced by the Cold and Hot Blast;—Rev T. R. Robinson, on the Determination of the Constant of Nutation by the Greenwich Observations;—R. W. Fox, Experiments on the Electricity of Metallic Veins, and the Temperature of Mines;—Provisional Report of the Committee of the Medical Section of the British Association, appointed to investigate the Composition of Secretions, and the Organs producing them;—Dr. G. O. Rees, Report from the Committee for inquiring into the Analysis of the Glands, &c. of the Human Body;—Second Report of the London Sub-Committee of the British Association Medical Section, on the Motions and Sounds of the Heart;—Prof. Johnston, on the Present State of our Knowledge in regard to Dimorphous Bodies;—Lt.-Col. Sykes, on the Statistics of the Four Collectorates of Dukhun, under the British Government;—E. Hodgkinson, on the relative Strength and other Mechanical Properties of Iron obtained from the Hot and Cold Blast;—W. Fairbairn, on the Strength and other Properties of Iron obtained from the Hot and Cold Blast;—Sir J. Robison, and J. S. Russell, Report of the Committee on Waves;—Note by Major Sabine, being an Appendix to his Report on the Variations of the Magnetic Intensity observed at different Points of the Earth's Surface:—J. Yates, on the Growth of Plants under Glass, and without any free communication with the outward Air, on the Plan of Mr. N. J. Ward, of London.

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Together with the Transactions of the Sections, Rev. W. Vernon Harcourt's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TENTH MEETING, at Glasgow, 1840, *Published at* 15*s.*

CONTENTS:—Rev. B. Powell, Report on the recent Progress of discovery relative to Radiant Heat, supplementary to a former Report on the same subject inserted in the first volume of the Reports of the British Association for the Advancement of Science;—J. D. Forbes, Supplementary Report on Meteorology;—W. S. Harris, Report on Prof. Whewell's Anemometer, now in operation at Plymouth;—Report on "The Motion and Sounds of the Heart," by the London Committee of the British Association, for 1839-40;—Prof. Schönbein, an Account of Researches in Electro-Chemistry;—R. Mallet, Second Report upon the Action of Air and Water, whether fresh or salt, clear or foul, and at various temperatures, upon Cast Iron, Wrought Iron and Steel;—R. W. Fox, Report on some Observations on Subterranean Temperature;—A. F. Osler, Report on the Observations recorded during the years 1837, 1838, 1839, and 1840, by the Self-registering Anemometer erected at the Philosophical Institution, Birmingham;—Sir D. Brewster, Report respecting the two Series of Hourly Meteorological Observations kept at Inverness and Kingussie, from Nov. 1st, 1838 to Nov. 1st, 1839;—W. Thompson, Report on the Fauna of Ireland: Div. *Vertebrata*;—C. J. B. Williams, M.D., Report of Experiments on the Physiology of the Lungs and Air-Tubes;—Rev. J. S. Henslow, Report of the Committee on the Preservation of Animal and Vegetable Substances.

Together with the Transactions of the Sections, Mr. Murchison and Major E. Sabine's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE ELEVENTH MEETING, at Plymouth, 1841, *Published at* 13*s.* 6*d.*

CONTENTS:—Rev. P. Kelland, on the Present state of our Theoretical and Experimental Knowledge of the Laws of Conduction of Heat;—G. L. Roupell, M.D., Report on Poisons;—T. G. Bunt, Report on Discussions of Bristol Tides, under the direction of the Rev. W. Whewell;—D. Ross, Report on the Discussions of Leith Tide Observations, under the direction of the Rev. W. Whewell;—W. S. Harris, upon the working of Whewell's Anemometer at Plymouth during the past year;—Report of a Committee appointed for the purpose of superintending the scientific cooperation of the British Association in the System of Simultaneous Observations in Terrestrial Magnetism and Meteorology;—Reports of Committees appointed to provide Meteorological Instruments for the use of M. Agassiz and Mr. M'Cord;—Report of a Committee to superintend the reduction of Meteorological Observations;—Report of a Committee for revising the Nomenclature of the Stars;—Report of a Committee for obtaining Instruments and Registers to record Shocks and Earthquakes in Scotland and Ireland;—Report of a Committee on the Preservation of Vegetative Powers in Seeds;—Dr. Hodgkin, on Inquiries into the Races of Man;—Report of the Committee appointed to report how far the Desiderata in our knowledge of the Condition of the Upper Strata of the Atmosphere may be supplied by means of Ascents in Balloons or otherwise, to ascertain the probable expense of such Experiments, and to draw up Directions for Observers in such circumstances;—R. Owen, Report on British Fossil Reptiles;—Reports on the Determination of the Mean Value of Railway Constants;—D. Lardner, LL.D., Second and concluding Report on the Determination of the Mean Value of Railway Constants;—E. Woods, Report on Railway Constants;—Report of a Committee on the Construction of a Constant Indicator for Steam-Engines.

Together with the Transactions of the Sections, Prof. Whewell's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWELFTH MEETING, at Manchester, 1842, *Published at* 10*s*. 6*d*.

CONTENTS:—Report of the Committee appointed to conduct the cooperation of the British Association in the System of Simultaneous Magnetical and Meteorological Observations;—J. Richardson, M.D., Report on the present State of the Ichthyology of New Zealand;—W. S. Harris, Report on the Progress of Meteorological Observations at Plymouth;—Second Report of a Committee appointed to make Experiments on the Growth and Vitality of Seeds;—C. Vignoles, Report of the Committee on Railway Sections;—Report of the Committee for the Preservation of Animal and Vegetable Substances;—Lyon Playfair, M.D., Abstract of Prof. Liebig's Report on Organic Chemistry applied to Physiology and Pathology;—R. Owen, Report on the British Fossil Mammalia, Part I.;—R. Hunt, Researches on the Influence of Light on the Germination of Seeds and the Growth of Plants;—L. Agassiz, Report on the Fossil Fishes of the Devonian System or Old Red Sandstone;—W. Fairbairn, Appendix to a Report on the Strength and other Properties of Cast Iron obtained from the Hot and Cold Blast;—D. Milne, Report of the Committee for Registering Shocks of Earthquakes in Great Britain;—Report of a Committee on the construction of a Constant Indicator for Steam-Engines, and for the determination of the Velocity of the Piston of the Self-acting Engine at different periods of the Stroke;—J. S. Russell, Report of a Committee on the Form of Ships;—Report of a Committee appointed "to consider of the Rules by which the Nomenclature of Zoology may be established on a uniform and permanent basis;"—Report of a Committee on the Vital Statistics of large Towns in Scotland;—Provisional Reports, and Notices of Progress in special Researches entrusted to Committees and Individuals.

Together with the Transactions of the Sections, Lord Francis Egerton's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE THIRTEENTH MEETING, at Cork, 1843, *Published at* 12*s*.

CONTENTS:—Robert Mallet, Third Report upon the Action of Air and Water, whether fresh or salt, clear or foul, and at Various Temperatures, upon Cast Iron, Wrought Iron, and Steel;—Report of the Committee appointed to conduct the cooperation of the British Association in the System of Simultaneous Magnetical and Meteorological Observations;—Sir J. F. W. Herschel, Bart., Report of the Committee appointed for the Reduction of Meteorological Observations;—Report of the Committee appointed for Experiments on Steam-Engines;—Report of the Committee appointed to continue their Experiments on the Vitality of Seeds;—J. S. Russell, Report of a Series of Observations on the Tides of the Frith of Forth and the East Coast of Scotland;—J. S. Russell, Notice of a Report of the Committee on the Form of Ships;—J. Blake, Report on the Physiological Action of Medicines;—Report of the Committee on Zoological Nomenclature;—Report of the Committee for Registering the Shocks of Earthquakes, and making such Meteorological Observations as may appear to them desirable;—Report of the Committee for conducting Experiments with Captive Balloons;—Prof. Wheatstone, Appendix to the Report;—Report of the Committee for the Translation and Publication of Foreign Scientific Memoirs;—C. W. Peach, on the Habits of the Marine Testacea;—E. Forbes, Report on the Mollusca and Radiata of the Ægean Sea, and on their distribution, considered as bearing on Geology;—L. Agassiz, Synoptical Table of British Fossil Fishes, arranged in the order of the Geological Formations;—R. Owen, Report on the British Fossil Mammalia, Part II.;—E. W. Binney, Report on the excavation made at the junction of the Lower New Red Sandstone with the Coal Measures at Collyhurst;—W.

Thompson, Report on the Fauna of Ireland: Div. *Invertebrata*;—Provisional Reports, and Notices of Progress in Special Researches entrusted to Committees and Individuals.

Together with the Transactions of the Sections, Earl of Rosse's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE FOURTEENTH MEETING, at York, 1844, *Published at* £1.

CONTENTS:—W. B. Carpenter, on the Microscopic Structure of Shells;—J. Alder and A. Hancock, Report on the British Nudibranchiate Mollusca;—R. Hunt, Researches on the Influence of Light on the Germination of Seeds and the Growth of Plants;—Report of a Committee appointed by the British Association in 1840, for revising the Nomenclature of the Stars;—Lt.-Col. Sabine, on the Meteorology of Toronto in Canada;—J. Blackwall, Report on some recent researches into the Structure, Functions, and Œconomy of the *Araneidea* made in Great Britain;—Earl of Rosse, on the Construction of large Reflecting Telescopes;—Rev. W. V. Harcourt, Report on a Gas-furnace for Experiments on Vitrifaction and other Applications of High Heat in the Laboratory;—Report of the Committee for Registering Earthquake Shocks in Scotland;—Report of a Committee for Experiments on Steam-Engines;—Report of the Committee to investigate the Varieties of the Human Race;—Fourth Report of a Committee appointed to continue their Experiments on the Vitality of Seeds;—W. Fairbairn, on the Consumption of Fuel and the Prevention of Smoke;—F. Ronalds, Report concerning the Observatory of the British Association at Kew;—Sixth Report of the Committee appointed to conduct the Cooperation of the British Association in the System of Simultaneous Magnetical and Meteorological Observations;—Prof. Forchhammer on the influence of Fucoidal Plants upon the Formations of the Earth, on Metamorphism in general, and particularly the Metamorphosis of the Scandinavian Alum Slate;—H. E. Strickland, Report on the recent Progress and Present State of Ornithology;—T. Oldham, Report of Committee appointed to conduct Observations on Subterranean Temperature in Ireland;—Prof. Owen, Report on the Extinct Mammals of Australia, with descriptions of certain Fossils indicative of the former existence in that continent of large Marsupial Representatives of the Order Pachydermata;—W. S. Harris, Report on the working of Whewell and Osler's Anemometers at Plymouth, for the years 1841, 1842, 1843;—W. R. Birt, Report on Atmospheric Waves;—L. Agassiz, Rapport sur les Poissons Fossiles de l'Argile de Londres, with translation;—J. S. Russell, Report on Waves;—Provisional Reports, and Notices of Progress in Special Researches entrusted to Committees and Individuals.

Together with the Transactions of the Sections, Dean of Ely's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE FIFTEENTH MEETING, at Cambridge, 1845, *Published at* 12*s*.

CONTENTS:—Seventh Report of a Committee appointed to conduct the Cooperation of the British Association in the System of Simultaneous Magnetical and Meteorological Observations;—Lt.-Col. Sabine, on some points in the Meteorology of Bombay;—J. Blake, Report on the Physiological Actions of Medicines;—Dr. Von Boguslawski, on the Comet of 1843;—R. Hunt, Report on the Actinograph;—Prof. Schönbein, on Ozone;—Prof. Erman, on the Influence of Friction upon Thermo-Electricity;—Baron Senftenberg, on the Self-Registering Meteorological Instruments employed in the Observatory at Senftenberg;—W. R. Birt, Second Report on Atmospheric Waves;—G. R. Porter, on the Progress and Present Extent of Savings' Banks in the United Kingdom;—Prof. Bunsen and Dr. Playfair, Report on the Gases evolved from Iron Furnaces, with reference to the Theory of Smelting of Iron;—Dr. Richardson, Report on the Ichthyology of the Seas of China and Japan;—Report of the Committee on the Registration of Periodical Phenomena of Animals and Vegetables;—Fifth Report of the Committee on the Vitality of Seeds;—Appendix, &c.

Together with the Transactions of the Sections, Sir J. F. W. Herschel's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE SIXTEENTH MEETING, at Southampton, 1846, *Published at* 15*s*.

CONTENTS:—G. G. Stokes, Report on Recent Researches in Hydrodynamics;—Sixth Report of the Committee on the Vitality of Seeds;—Dr. Schunck on the Colouring Matters of Madder;—J. Blake, on the Physiological Action of Medicines;—R. Hunt, Report on the Actinograph;—R. Hunt, Notices on the Influence of Light on the Growth of Plants;—R. L. Ellis, on the Recent Progress of Analysis;—Prof. Forchhammer, on Comparative Analytical

Researches on Sea Water;—A. Erman, on the Calculation of the Gaussian Constants for 1829;—G. R. Porter, on the Progress, present Amount, and probable future Condition of the Iron Manufacture in Great Britain;—W. R. Birt, Third Report on Atmospheric Waves;—Prof. Owen, Report on the Archetype and Homologies of the Vertebrate Skeleton;—J. Phillips, on Anemometry;—J. Percy, M.D., Report on the Crystalline Flags;—Addenda to Mr. Birt's Report on Atmospheric Waves.

Together with the Transactions of the Sections, Sir R. I. Murchison's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE SEVENTEENTH MEETING, at Oxford, 1847, *Published at* 18*s*.

Contents:—Prof. Langberg, on the Specific Gravity of Sulphuric Acid at different degrees of dilution, and on the relation which exists between the Development of Heat and the coincident contraction of Volume in Sulphuric Acid when mixed with Water;—R. Hunt, Researches on the Influence of the Solar Rays on the Growth of Plants;—R. Mallet, on the Facts of Earthquake Phenomena;—Prof. Nilsson, on the Primitive Inhabitants of Scandinavia;—W. Hopkins, Report on the Geological Theories of Elevation and Earthquakes;—Dr. W. B. Carpenter, Report on the Microscopic Structure of Shells;—Rev. W. Whewell and Sir James C. Ross, Report upon the Recommendation of an Expedition for the purpose of completing our knowledge of the Tides;—Dr. Schunck, on Colouring Matters;—Seventh Report of the Committee on the Vitality of Seeds;—J. Glynn, on the Turbine or Horizontal Water-Wheel of France and Germany;—Dr. R. G. Latham, on the present state and recent progress of Ethnographical Philology;—Dr. J. C. Prichard, on the various methods of Research which contribute to the Advancement of Ethnology, and of the relations of that Science to other branches of Knowledge;—Dr. C. C. J. Bunsen, on the results of the recent Egyptian researches in reference to Asiatic and African Ethnology, and the Classification of Languages;—Dr. C. Meyer, on the Importance of the Study of the Celtic Language as exhibited by the Modern Celtic Dialects still extant;—Dr. Max Müller, on the Relation of the Bengali to the Arian and Aboriginal Languages of India;—W. R. Birt, Fourth Report on Atmospheric Waves;—Prof. W. H. Dove, Temperature Tables, with Introductory Remarks by Lieut.-Col. E. Sabine;—A. Erman and H. Petersen, Third Report on the Calculation of the Gaussian Constants for 1829.

Together with the Transactions of the Sections, Sir Robert Harry Inglis's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE EIGHTEENTH MEETING, at Swansea, 1848, *Published at* 9*s*.

Contents:—Rev. Prof. Powell, A Catalogue of Observations of Luminous Meteors;—J. Glynn on Water-pressure Engines;—R. A. Smith, on the Air and Water of Towns;—Eighth Report of Committee on the Growth and Vitality of Seeds;—W. R. Birt, Fifth Report on Atmospheric Waves;—E. Schunck, on Colouring Matters;—J. P. Budd, on the advantageous use made of the gaseous escape from the Blast Furnaces at the Ystalyfera Iron Works;—R. Hunt, Report of progress in the investigation of the Action of Carbonic Acid on the Growth of Plants allied to those of the Coal Formations;—Prof. H. W. Dove, Supplement to the Temperature Tables printed in the Report of the British Association for 1847;—Remarks by Prof. Dove on his recently constructed Maps of the Monthly Isothermal Lines of the Globe, and on some of the principal Conclusions in regard to Climatology deducible from them; with an introductory Notice by Lt.-Col. E. Sabine;—Dr. Daubeny, on the progress of the investigation on the Influence of Carbonic Acid on the Growth of Ferns;—J. Phillips, Notice of further progress in Anemometrical Researches;—Mr. Mallet's Letter to the Assistant-General Secretary;—A. Erman, Second Report on the Gaussian Constants;—Report of a Committee relative to the expediency of recommending the continuance of the Toronto Magnetical and Meteorological Observatory until December 1850.

Together with the Transactions of the Sections, the Marquis of Northampton's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE NINETEENTH MEETING, at Birmingham, 1849, *Published at* 10*s*.

Contents:—Rev. Prof. Powell, A Catalogue of Observations of Luminous Meteors;—Earl of Rosse, Notice of Nebulæ lately observed in the Six-feet Reflector;—Prof. Daubeny, on the Influence of Carbonic Acid Gas on the health of Plants, especially of those allied to the Fossil Remains found in the Coal Formation;—Dr. Andrews, Report on the Heat of Combination;—Report of the Committee on the Registration of the Periodic Phenomena of Plants and

Animals;—Ninth Report of Committee on Experiments on the Growth and Vitality of Seeds;—F. Ronalds, Report concerning the Observatory of the British Association at Kew, from Aug. 9, 1848 to Sept. 12, 1849;—R. Mallet, Report on the Experimental Inquiry on Railway Bar Corrosion;—W. R. Birt, Report on the Discussion of the Electrical Observations at Kew.

Together with the Transactions of the Sections, the Rev. T. R. Robinson's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWENTIETH MEETING, at Edinburgh, 1850, *Published at* 15*s*.

CONTENTS:—R. Mallet, First Report on the Facts of Earthquake Phenomena;—Rev. Prof. Powell, on Observations of Luminous Meteors;—Dr. T. Williams, on the Structure and History of the British Annelida;—T. C. Hunt, Results of Meteorological Observations taken at St. Michael's from the 1st of January, 1840 to the 31st of December, 1849;—R. Hunt, on the present State of our Knowledge of the Chemical Action of the Solar Radiations;—Tenth Report of Committee on Experiments on the Growth and Vitality of Seeds;—Major-Gen. Briggs, Report on the Aboriginal Tribes of India;—F. Ronalds, Report concerning the Observatory of the British Association at Kew;—E. Forbes, Report on the Investigation of British Marine Zoology by means of the Dredge;—R. MacAndrew, Notes on the Distribution and Range in depth of Mollusca and other Marine Animals, observed on the coasts of Spain, Portugal, Barbary, Malta, and Southern Italy in 1849;—Prof. Allman, on the Present State of our Knowledge of the Freshwater Polyzoa;—Registration of the Periodical Phenomena of Plants and Animals;—Suggestions to Astronomers for the Observation of the Total Eclipse of the Sun on July 28, 1851.

Together with the Transactions of the Sections, Sir David Brewster's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWENTY-FIRST MEETING, at Ipswich, 1851, *Published at* 16*s*. 6*d*.

CONTENTS:—Rev. Prof. Powell, on Observations of Luminous Meteors;—Eleventh Report of Committee on Experiments on the Growth and Vitality of Seeds;—Dr. J. Drew, on the Climate of Southampton;—Dr. R. A. Smith, on the Air and Water of Towns: Action of Porous Strata, Water and Organic Matter;—Report of the Committee appointed to consider the probable Effects in an Œconomical and Physical Point of View of the Destruction of Tropical Forests;—A. Henfrey, on the Reproduction and supposed Existence of Sexual Organs in the Higher Cryptogamous Plants;—Dr. Daubeny, on the Nomenclature of Organic Compounds;—Rev. Dr. Donaldson, on two unsolved Problems in Indo-German Philology;—Dr. T. Williams, Report on the British Annelida;—R. Mallet, Second Report on the Facts of Earthquake Phenomena;—Letter from Prof. Henry to Col. Sabine, on the System of Meteorological Observations proposed to be established in the United States;—Col. Sabine, Report on the Kew Magnetographs;—J. Welsh, Report on the Performance of his three Magnetographs during the Experimental Trial at the Kew Observatory;—F. Ronalds, Report concerning the Observatory of the British Association at Kew, from September 12, 1850 to July 31, 1851;—Ordnance Survey of Scotland.

Together with the Transactions of the Sections, Prof. Airy's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWENTY-SECOND MEETING, at Belfast, 1852, *Published at* 15*s*.

CONTENTS:—R. Mallet, Third Report on the Facts of Earthquake Phenomena;—Twelfth Report of Committee on Experiments on the Growth and Vitality of Seeds;—Rev. Prof. Powell, Report on Observations of Luminous Meteors, 1851–52;—Dr. Gladstone, on the Influence of the Solar Radiations on the Vital Powers of Plants;—A Manual of Ethnological Inquiry;—Col. Sykes, Mean Temperature of the Day, and Monthly Fall of Rain at 127 Stations under the Bengal Presidency;—Prof. J. D. Forbes, on Experiments on the Laws of the Conduction of Heat;—R. Hunt, on the Chemical Action of the Solar Radiations;—Dr. Hodges, on the Composition and Œconomy of the Flax Plant;—W. Thompson, on the Freshwater Fishes of Ulster;—W. Thompson, Supplementary Report on the Fauna of Ireland;—W. Wills, on the Meteorology of Birmingham;—J. Thomson, on the Vortex-Water-Wheel;—J. B. Lawes and Dr. Gilbert, on the Composition of Foods in relation to Respiration and the Feeding of Animals.

Together with the Transactions of the Sections, Colonel Sabine's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS of the TWENTY-THIRD MEETING, at Hull, 1853, *Published at* 10*s*. 6*d*.

Contents:—Rev. Prof. Powell, Report on Observations of Luminous Meteors, 1852–53;—James Oldham, on the Physical Features of the Humber;—James Oldham, on the Rise, Progress, and Present Position of Steam Navigation in Hull;—William Fairbairn, Experimental Researches to determine the Strength of Locomotive Boilers, and the causes which lead to Explosion;—J. J. Sylvester, Provisional Report on the Theory of Determinants;—Professor Hodges, M.D., Report on the Gases evolved in Steeping Flax, and on the Composition and Œconomy of the Flax Plant;—Thirteenth Report of Committee on Experiments on the Growth and Vitality of Seeds;—Robert Hunt, on the Chemical Action of the Solar Radiations;—John P. Bell, M.D., Observations on the Character and Measurements of Degradation of the Yorkshire Coast; First Report of Committee on the Physical Character of the Moon's Surface, as compared with that of the Earth;—R. Mallet, Provisional Report on Earthquake Wave-Transits; and on Seismometrical Instruments;—William Fairbairn, on the Mechanical Properties of Metals as derived from repeated Meltings, exhibiting the maximum point of strength and the causes of deterioration;—Robert Mallet, Third Report on the Facts of Earthquake Phenomena (continued).

Together with the Transactions of the Sections, Mr. Hopkins's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS of the TWENTY-FOURTH MEETING, at Liverpool, 1854, *Published at* 18*s*.

Contents:—R. Mallet, Third Report on the Facts of Earthquake Phenomena (continued);—Major-General Chesney, on the Construction and General Use of Efficient Life-Boats;—Rev. Prof. Powell, Third Report on the present State of our Knowledge of Radiant Heat;—Colonel Sabine, on some of the results obtained at the British Colonial Magnetic Observatories;—Colonel Portlock, Report of the Committee on Earthquakes, with their proceedings respecting Seismometers;—Dr. Gladstone, on the influence of the Solar Radiations on the Vital Powers of Plants, Part 2;—Rev. Prof. Powell, Report on Observations of Luminous Meteors, 1853–54;—Second Report of the Committee on the Physical Character of the Moon's Surface;—W. G. Armstrong, on the Application of Water-Pressure Machinery;—J. B. Lawes and Dr. Gilbert, on the Equivalency of Starch and Sugar in Food;—Archibald Smith, on the Deviations of the Compass in Wooden and Iron Ships;—Fourteenth Report of Committee on Experiments on the Growth and Vitality of Seeds.

Together with the Transactions of the Sections, the Earl of Harrowby's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS of the TWENTY-FIFTH MEETING, at Glasgow, 1855, *Published at* 15*s*.

Contents:—T. Dobson, Report on the Relation between Explosions in Coal-Mines and Revolving Storms;—Dr. Gladstone, on the Influence of the Solar Radiations on the Vital Powers of Plants growing under different Atmospheric Conditions, Part 3;—C. Spence Bate, on the British Edriophthalma;—J. F. Bateman, on the present state of our knowledge on the Supply of Water to Towns;—Fifteenth Report of Committee on Experiments on the Growth and Vitality of Seeds;—Rev. Prof. Powell, Report on Observations of Luminous Meteors, 1854–55;—Report of Committee appointed to inquire into the best means of ascertaining those properties of Metals and effects of various modes of treating them which are of importance to the durability and efficiency of Artillery;—Rev. Prof. Henslow, Report on Typical Objects in Natural History;—A. Follett Osler, Account of the Self-Registering Anemometer and Rain-Gauge at the Liverpool Observatory;—Provisional Reports.

Together with the Transactions of the Sections, the Duke of Argyll's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS of the TWENTY-SIXTH MEETING, at Cheltenham, 1856, *Published at* 18*s*.

Contents:—Report from the Committee appointed to investigate and report upon the effects produced upon the Channels of the Mersey by the alterations which within the last fifty years have been made in its Banks;—J. Thomson, Interim Report on progress in Researches on the Measurement of Water by Weir Boards;—Dredging Report, Frith of Clyde, 1856;—Rev. B. Powell, Report on Observations of Luminous Meteors, 1855–1856;—Prof. Bunsen and Dr. H. E. Roscoe, Photochemical Researches;—Rev. James Booth, on the Trigonometry of the Parabola, and the Geometrical Origin of Logarithms;—R. MacAndrew, Report on the Marine Testaceous Mollusca of the North-east Atlantic and Neighbouring Seas, and the physical conditions affecting their development;—P. P. Carpenter, Report on the present state of our knowledge with regard to the Mollusca of the West Coast of North America;—T. C. Eyton, Abstract of First Report on the Oyster Beds and Oysters of the British Shores;—Prof. Phillips, Report on Cleavage and Foliation in Rocks, and on the Theoretical Explanations of these Phenomena: Part I.;—Dr. T. Wright on the Stratigraphical Distribution of the Oolitic Echinodermata;—W. Fairbairn, on the Tensile Strength of Wrought Iron at various Temperatures;—C. Atherton, on Mercantile Steam Transport Economy;—J. S. Bowerbank, on the Vital Powers of the Spongiadæ;—Report of a Committee upon the Experiments conducted at Stormontfield, near Perth, for the artificial propagation of Salmon;—Provisional Report on the Measurement of Ships for Tonnage;—On Typical Forms of Minerals, Plants and Animals for Museums;—J. Thomson, Interim Report on Progress in Researches on the Measurement of Water by Weir Boards;—R. Mallet, on Observations with the Seismometer;—A. Cayley, on the Progress of Theoretical Dynamics;—Report of a Committee appointed to consider the formation of a Catalogue of Philosophical Memoirs.

Together with the Transactions of the Sections, Dr. Daubeny's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWENTY-SEVENTH MEETING, at Dublin, 1857, *Published at* 15*s.*

CONTENTS:—A. Cayley, Report on the Recent Progress of Theoretical Dynamics;—Sixteenth and final Report of Committee on Experiments on the Growth and Vitality of Seeds;—James Oldham, C.E., continuation of Report on Steam Navigation at Hull;—Report of a Committee on the Defects of the present methods of Measuring and Registering the Tonnage of Shipping, as also of Marine Engine-Power, and to frame more perfect rules, in order that a correct and uniform principle may be adopted to estimate the Actual Carrying Capabilities and Working-Power of Steam Ships;—Robert Were Fox, Report on the Temperature of some Deep Mines in Cornwall;—Dr. G. Plarr, De quelques Transformations de la Somme $\Sigma_0^{t}{}^{-\alpha} \frac{a^{t|+1}\beta^{t|+1}\delta^{t|+1}}{1^{t|+1}\gamma^{t|+1}\epsilon^{t|+1}}$, α étant entier négatif, et de quelques cas dans lesquels cette somme est exprimable par une combinaison de factorielles, la notation $a^{t|+1}$ désignant le produit des t facteurs $a\,(a+1)\,(a+2)$ &c....$(a+t-1)$;—G Dickie, M.D., Report on the Marine Zoology of Strangford Lough, County Down, and corresponding part of the Irish Channel;—Charles Atherton, Suggestions for Statistical Inquiry into the extent to which Mercantile Steam Transport Economy is affected by the Constructive Type of Shipping, as respects the Proportions of Length, Breadth, and Depth;—J. S. Bowerbank, Further Report on the Vitality of the Spongiadæ;—John P. Hodges, M.D., on Flax;—Major-General Sabine, Report of the Committee on the Magnetic Survey of Great Britain;—Rev. Baden Powell, Report on Observations of Luminous Meteors, 1856–57;—C. Vignoles, C.E., on the Adaptation of Suspension Bridges to sustain the passage of Railway Trains;—Professor W. A. Miller, M.D., on Electro-Chemistry;—John Simpson, R.N., Results of Thermometrical Observations made at the 'Plover's' Wintering-place, Point Barrow, latitude 71° 21′ N., long. 156° 17′ W., in 1852–54;—Charles James Hargrave, LL.D., on the Algebraic Couple; and on the Equivalents of Indeterminate Expressions;—Thomas Grubb, Report on the Improvement of Telescope and Equatorial Mountings;—Professor James Buckman, Report on the Experimental Plots in the Botanical Garden of the Royal Agricultural College at Cirencester;—William Fairbairn on the Resistance of Tubes to Collapse;—George C. Hyndman, Report of the Proceedings of the Belfast Dredging Committee;—Peter W. Barlow, on the Mechanical Effect of combining Girders and Suspension Chains, and a Comparison of the Weight of Metal in Ordinary and Suspension Girders, to produce equal deflections with a given load;—J. Park Harrison, M.A., Evidences of Lunar Influence on Temperature;—Report on the Animal and Vegetable Products imported into Liverpool from the year 1851 to 1855 (inclusive);—Andrew Henderson, Report on the Statistics of Life-boats and Fishing-boats on the Coasts of the United Kingdom.

Together with the Transactions of the Sections, Rev. H. Lloyd's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWENTY-EIGHTH MEETING, at Leeds, September 1858, *Published at* 20*s.*

CONTENTS:—R. Mallet, Fourth Report upon the Facts and Theory of Earthquake Phenomena;—Rev. Prof. Powell, Report on Observations of Luminous Meteors, 1857–58;—R. H. Meade, on some Points in the Anatomy of the Araneidea or true Spiders, especially on the internal structure of their Spinning Organs;—W. Fairbairn, Report of the Committee on the Patent Laws;—S. Eddy, on the Lead Mining Districts of Yorkshire;—W. Fairbairn, on the Collapse of Glass Globes and Cylinders;—Dr. E. Perceval Wright and Prof. J. Reay Greene, Report on the Marine Fauna of the South and West Coasts of Ireland;—Prof. J. Thomson, on Experiments on the Measurement of Water by Triangular Notches in Weir Boards;—Major-General Sabine, Report of the Committee on the Magnetic Survey of Great Britain;—Michael Connal and William Keddie, Report on Animal, Vegetable, and Mineral Substances imported from Foreign Countries into the Clyde (including the Ports of Glasgow, Greenock, and Port Glasgow) in the years 1853, 1854, 1855, 1856, and 1857;—Report of the Committee on Shipping Statistics;—Rev. H. Lloyd, D.D., Notice of the Instruments employed in the Magnetic Survey of Ireland, with some of the Results;—Prof. J. R. Kinahan, Report of Dublin Dredging Committee, appointed 1857-58;—Prof. J. R. Kinahan, Report on Crustacea of Dublin District;—Andrew Henderson, on River Steamers, their Form, Construction, and Fittings, with reference to the necessity for improving the present means of Shallow-Water Navigation on the Rivers of British India;—George C. Hyndman, Report of the Belfast Dredging Committee;—Appendix to Mr. Vignoles' paper "On the Adaptation of Suspension Bridges to sustain the passage of Railway Trains;"—Report of the Joint Committee of the Royal Society and the British Association, for procuring a continuance of the Magnetic and Meteorological Observatories;—R. Beckley, Description of a Self recording Anemometer.

Together with the Transactions of the Sections, Prof. Owen's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWENTY-NINTH MEETING, at Aberdeen, September 1859, *Published at* 15*s.*

Contents:—George C. Foster, Preliminary Report on the Recent Progress and Present State of Organic Chemistry;—Professor Buckman, Report on the Growth of Plants in the Garden of the Royal Agricultural College, Cirencester;—Dr. A. Voelcker, Report on Field Experiments and Laboratory Researches on the Constituents of Manures essential to cultivated Crops;—A. Thomson, Esq. of Banchory, Report on the Aberdeen Industrial Feeding Schools;—On the Upper Silurians of Lesmahago, Lanarkshire;—Alphonse Gages, Report on the Results obtained by the Mechanico-Chemical Examination of Rocks and Minerals;—William Fairbairn, Experiments to determine the Efficiency of Continuous and Self-acting Breaks for Railway Trains;—Professor J. R. Kinahan, Report of Dublin Bay Dredging Committee for 1858–59;—Rev. Baden Powell, Report on Observations of Luminous Meteors for 1858–59;—Professor Owen, Report on a Series of Skulls of various Tribes of Mankind inhabiting Nepal, collected, and presented to the British Museum, by Bryan H. Hodgson, Esq., late Resident in Nepal, &c. &c.;—Messrs. Maskelyne, Hadow, Hardwich, and Llewelyn, Report on the Present State of our Knowledge regarding the Photographic Image;—G. C. Hyndman, Report of the Belfast Dredging Committee for 1859;—James Oldham, Continuation of Report of the Progress of Steam Navigation at Hull;—Charles Atherton, Mercantile Steam Transport Economy as affected by the Consumption of Coals;—Warren de la Rue, Report on the present state of Celestial Photography in England;—Professor Owen, on the Orders of Fossil and Recent Reptilia, and their Distribution in Time;—Balfour Stewart, on some Results of the Magnetic Survey of Scotland in the years 1857 and 1858, undertaken, at the request of the British Association, by the late John Welsh, Esq., F.R.S.;—W. Fairbairn, The Patent Laws: Report of Committee on the Patent Laws;—J. Park Harrison, Lunar Influence on the Temperature of the Air;—Balfour Stewart, an Account of the Construction of the Self-recording Magnetographs at present in operation at the Kew Observatory of the British Association;—Prof. H. J. Stephen Smith, Report on the Theory of Numbers, Part I.;—Report of the Committee on Steamship performance;—Report of the Proceedings of the Balloon Committee of the British Association appointed at the Meeting at Leeds;—Prof. William K. Sullivan, Preliminary Report on the Solubility of Salts at Temperatures above 100° Cent., and on the Mutual Action of Salts in Solution.

Together with the Transactions of the Sections, Prince Albert's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE THIRTIETH MEETING, at Oxford, June and July 1860, *Published at* 15*s.*

Contents:—James Glaisher, Report on Observations of Luminous Meteors, 1859–60;—J. R. Kinahan, Report of Dublin Bay Dredging Committee;—Rev. J. Anderson, Report on the Excavations in Dura Den;—Professor Buckman, Report on the Experimental Plots in the Botanical Garden of the Royal Agricultural College, Cirencester;—Rev. R. Walker, Report of the Committee on Balloon Ascents;—Prof. W. Thomson, Report of Committee appointed to prepare a Self-recording Atmospheric Electrometer for Kew, and Portable Apparatus for observing Atmospheric Electricity;—William Fairbairn, Experiments to determine the Effect of Vibratory Action and long-continued Changes of Load upon Wrought-iron Girders;—R. P. Greg, Catalogue of Meteorites and Fireballs, from A.D. 2 to A.D. 1860;—Prof. H. J. S. Smith, Report on the Theory of Numbers, Part II.;—Vice-Admiral Moorsom, on the Performance of Steam-vessels, the Functions of the Screw, and the Relations of its Diameter and Pitch to the Form of the Vessel;—Rev. W. V. Harcourt, Report on the Effects of long-continued Heat, illustrative of Geological Phenomena;—Second Report of the Committee on Steamship Performance;—Interim Report on the Gauging of Water by Triangular Notches;—List of the British Marine Invertebrate Fauna.

Together with the Transactions of the Sections, Lord Wrottesley's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE THIRTY-FIRST MEETING, at Manchester, September 1861, *Published at* £1.

CONTENTS:—James Glaisher, Report on Observations of Luminous Meteors;—Dr. E. Smith, Report on the Action of Prison Diet and Discipline on the Bodily Functions of Prisoners, Part I.;—Charles Atherton, on Freight as affected by Differences in the Dynamic Properties of Steamships;—Warren De la Rue, Report on the Progress of Celestial Photography since the Aberdeen Meeting;—B. Stewart, on the Theory of Exchanges, and its recent extension;—Drs. E. Schunck, R. Angus Smith, and H. E. Roscoe, on the Recent Progress and Present Condition of Manufacturing Chemistry in the South Lancashire District;—Dr. J. Hunt, on Ethno-Climatology; or, the Acclimatization of Man;—Prof. J. Thomson, on Experiments on the Gauging of Water by Triangular Notches;—Dr. A. Voelcker, Report on Field Experiments and Laboratory Researches on the Constituents of Manures essential to cultivated Crops:—Prof. H. Hennessy, Provisional Report on the Present State of our Knowledge respecting the Transmission of Sound-signals during Fogs at Sea;—Dr. P. L. Sclater and F. von Hochstetter, Report on the Present State of our Knowledge of the Birds of the Genus *Apteryx* living in New Zealand;—J. G. Jeffreys, Report of the Results of Deep-sea Dredging in Zetland, with a Notice of several Species of Mollusca new to Science or to the British Isles;—Prof. J. Phillips, Contributions to a Report on the Physical Aspect of the Moon;—W. R. Birt, Contribution to a Report on the Physical Aspect of the Moon;—Dr. Collingwood and Mr. Byerley, Preliminary Report of the Dredging Committe of the Mersey and Dee;—Third Report of the Committee on Steamship Performance;—J. G. Jeffreys, Preliminary Report on the Best Mode of preventing the Ravages of *Teredo* and other Animals in our Ships and Harbours;—R. Mallet, Report on the Experiments made at Holyhead to ascertain the Transit-Velocity of Waves, analogous to Earthquake Waves, through the local Rock Formations;—T. Dobson, on the Explosions in British Coal-Mines during the year 1859;—J. Oldham, Continuation of Report on Steam Navigation at Hull;—Professor G. Dickie, Brief Summary of a Report on the Flora of the North of Ireland;—Professor Owen, on the Psychical and Physical Characters of the Mincopies, or Natives of the Andaman Islands, and on the Relations thereby indicated to other Races of Mankind;—Colonel Sykes, Report of the Balloon Committee;—Major-General Sabine, Report on the Repetition of the Magnetic Survey of England;—Interim Report of the Committee for Dredging on the North and East Coasts of Scotland;—W. Fairbairn, on the Resistance of Iron Plates to Statical Pressure and the Force of Impact by Projectiles at High Velocities;—W. Fairbairn, Continuation of Report to determine the effect of Vibratory Action and long-continued Changes of Load upon Wrought-Iron Girders;—Report of the Committee on the Law of Patents;—Prof. H. J. S. Smith, Report on the Theory of Numbers, Part III.

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PROCEEDINGS OF THE THIRTY-SECOND MEETING, at Cambridge, October 1862, *Published at* £1.

CONTENTS:—James Glaisher, Report on Observations of Luminous Meteors, 1861–62;—G. B. Airy, on the Strains in the Interior of Beams;—Archibald Smith and F. J. Evans, Report on the three Reports of the Liverpool Compass Committee;—Report on Tidal Observations on the Humber;—T. Aston, on Rifled Guns and Projectiles adapted for Attacking

Armour-plate Defences;—Extracts, relating to the Observatory at Kew, from a Report presented to the Portuguese Government, by Dr. J. A. de Souza;—H. T. Mennell, Report on the Dredging of the Northumberland Coast and Dogger Bank;—Dr. Cuthbert Collingwood, Report upon the best means of advancing Science through the agency of the Mercantile Marine;—Messrs. Williamson, Wheatstone, Thomson, Miller, Matthiessen, and Jenkin, Provisional Report on Standards of Electrical Resistance;—Preliminary Report of the Committee for investigating the Chemical and Mineralogical Composition of the Granites of Donegal;—Prof. H. Hennessy, on the Vertical Movements of the Atmosphere considered in connexion with Storms and Changes of Weather;—Report of Committee on the application of Gauss's General Theory of Terrestrial Magnetism to the Magnetic Variations;—Fleeming Jenkin, on Thermo-electric Currents in Circuits of one Metal;—W. Fairbairn, on the Mechanical Properties of Iron Projectiles at High Velocities;—A. Cayley, Report on the Progress of the Solution of certain Special Problems of Dynamics;—Prof. G. G. Stokes, Report on Double Refraction;—Fourth Report of the Committee on Steamship Performance;—G. J. Symons, on the Fall of Rain in the British Isles in 1860 and 1861;—J. Ball, on Thermometric Observations in the Alps;—J. G. Jeffreys, Report of the Committee for Dredging on the N. and E. Coasts of Scotland;—Report of the Committee on Technical and Scientific Evidence in Courts of Law;—James Glaisher, Account of Eight Balloon Ascents in 1862;—Prof. H. J. S. Smith, Report on the Theory of Numbers, Part IV.

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PROCEEDINGS OF THE THIRTY-THIRD MEETING, at Newcastle-upon-Tyne, August and September 1863, *Published at £1 5s.*

CONTENTS:—Report of the Committee on the Application of Gun-cotton to Warlike Purposes;—A. Matthiessen, Report on the Chemical Nature of Alloys;—Report of the Committee on the Chemical and Mineralogical Constitution of the Granites of Donegal, and of the Rocks associated with them;—J. G. Jeffreys, Report of the Committee appointed for Exploring the Coasts of Shetland by means of the Dredge;—G. D. Gibb, Report on the Physiological Effects of the Bromide of Ammonium;—C. K. Aken, on the Transmutation of Spectral Rays, Part I.:—Dr. Robinson, Report of the Committee on Fog Signals;—Report of the Committee on Standards of Electrical Resistance;—E. Smith, Abstract of Report by the Indian Government on the Foods used by the Free and Jail Populations in India;—A. Gages, Synthetical Researches on the Formation of Minerals, &c.;—R. Mallett, Preliminary Report on the Experimental Determination of the Temperatures of Volcanic Foci, and of the Temperature, State of Saturation, and Velocity of the issuing Gases and Vapours;—Report of the Committee on Observations of Luminous Meteors;—Fifth Report of the Committee on Steamship Performance; G. J. Allman, Report on the Present State of our Knowledge of the Reproductive System in the Hydroida;—J. Glaisher, Account of Five Balloon Ascents made in 1863;—P. P. Carpenter, Supplementary Report on the Present State of our Knowledge with regard to the Mollusca of the West Coast of North America;—Professor Airy, Report on Steam-boiler Explosions;—C. W. Siemens, Observations on the Electrical Resistance and Electrification of some Insulating Materials under Pressures up to 300 Atmospheres;—C. M. Palmer, on the Construction of Iron Ships and the Progress of Iron Shipbuilding on the Tyne, Wear, and Tees;—Messrs. Richardson, Stevenson, and Clapham, on the Chemical Manufactures of the Northern Districts;—Messrs. Sopwith and Richardson, on the Local Manufacture of Lead, Copper, Zinc, Antimony, &c.;—Messrs. Daglish and Forster, on the Magnesian Limestone of Durham;—J. L. Bell, on the Manufacture of Iron in connexion with the Northumberland and Durham Coal-field;—T. Spencer, on the Manufacture of Steel in the Northern District;—H. J. S. Smith, Report on the Theory of Numbers, Part V.

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1845. ‡Ainslie, Rev. G., D.D., Master of Pembroke College. Pembroke Lodge, Cambridge.

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1841. *Ainsworth, Thomas. The Flosh, Egremont, Cumberland.
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1861. *Alcock, Ralph. 47 Nelson-street, Oxford-street, Manchester.
1862. §Alcock, Sir Rutherford. The Athenæum Club, Pall Mall, London.
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1853. *Ayrton, W. S., F.S.A. Allerton-hill, Leeds.

Babbage, B. H. 1 Dorset-street, Manchester-square, London.
*Babbage, Charles, M.A., F.R.S. L. & E., Hon. M.R.I.A., F.R.A.S. 1 Dorset-street, Manchester-square, London.
*Babington, Charles Cardale, M.A., F.R.S., F.L.S., F.G.S., Professor of Botany in the University of Cambridge. (*Local Treasurer.*) St. John's College, Cambridge.
Bache, Rev. Samuel. 44 Frederick-street, Edgbaston, near Birmingham.
1845. ‡Back, Rear-Admiral Sir George, D.C.L., F.R.S., F.R.G.S. 109 Gloucester-place, Portman-square.
Backhouse, Edmund. Darlington.
1863. ‡Backhouse, J. W. Sunderland.
Backhouse, Thomas James. Sunderland.
1851. ‡Bacon, George. Tavern-street, Ipswich.
**Baddeley, Captain Frederick H., R.E.*
1864. *Bailey, C. D. 7 Camden-crescent, Bath.
Bagot, Thomas N. Ballymoe, Co. Galway.
Bailey, Samuel. Sheffield.
1855. ‡Bailey, William. Horseley Fields Chemical Works, Wolverhampton.
1857. §Baily, William Hellier, F.L.S., F.G.S., Acting Palæontologist to the Geological Survey of Ireland. 51 Stephen's Green, Dublin.
*Bain, Richard. Gwennap, near Truro.
Bainbridge, Joseph. (Messrs. Morris and Prevost, Gresham House, London.)
*Bainbridge, Robert Walton. Middleton House, near Barnard Castle, Durham.
*Baines, Edward. Headingley Lodge, Leeds.
1858. ‡Baines, Frederick. Burley, near Leeds.
1858. *Baines, Samuel. Victoria Mills, Brighouse, Yorkshire.
1858. ‡Baines, T. Blackburn. 'Mercury' Office, Leeds.
1851. ‡Baird, A. W., M.D. Lower Brook-street, Ipswich.
1846. ‡*Baker, Rev. Franklin.*
1858. *Baker, Henry Granville. Bellevue, Horsforth, near Leeds.
1861. *Baker, John. Dodge-hill, Stockport.
1861. *Baker, John. (R. Brooks & Co., St. Peter's Chambers, Cornhill, London.)
1847. ‡Baker, Thomas B. Lloyd. Hardwick-court, Gloucester.
1849. *Baker, William. 63 Gloucester-place, Hyde Park, London.
1863. §Baker, William. 6 Tuptonville, Sheffield.
1845. ‡Bakewell, Frederick. 6 Haverstock-terrace, Hampstead.
1860. §Balding, James, M.R.C.S. Barkway, Royston, Herts.
Baldwin, Rev. John, M.A. Dalton, near Ulverston, Lancashire.
1851. *Baldwin, The Hon. Robert, H.M. Attorney-General. Spadina, Co. York, Upper Canada.
*Balfour, John Hutton, M.D., M.A., F.R.S. L. & E., F.L.S., Professor of Medicine and Botany in the University of Edinburgh. 27 Inverleith-row, Edinburgh.
*Ball, John, M.R.I.A., F.L.S. Oxford and Cambridge Club, Pall Mall, London.
1863. §Ball, Thomas. Bramcote, Nottingham.
*Ball, William. Rydall, Ambleside, Westmoreland.
1852. ‡Bangor, Viscount. Castleward, Co. Down, Ireland.
1856. ‡Banks, Richard William. Kington, Herefordshire.
1846. ‡Banks, Rev. S. H., LL.D. Dullingham, Newmarket.
Bannerman, Alexander.

Year of Election.

1861. ‡Bannerman, James Alexander. Limefield House, Higher Broughton, near Manchester.
1853. ‡*Bannister, Anthony.*
1861. *Barbour, George. Bolesworth Castle, Tattenhall, Chester.
1859. ‡Barbour, George F. Bouskeid, Edinburgh.
*Barbour, Robert. Portland-street, Manchester.
1855. ‡Barclay, Andrew. Kilmarnock, Scotland.
Barclay, Charles, F.S.A., M.R.A.S. Bury-hill, Dorking.
Barclay, James. Catrine, Ayrshire.
1852. *Barclay, J. Gurney. Walthamstow, Essex.
1860. *Barclay, Robert. Leyton, Essex.
1863. ‡Barford, J. Gale. Wellington College, Berks.
1860. *Barker, Rev. Arthur Alcock, B.D., Rector of East Bridgeford, Nottinghamshire.
Barker, James.
1857. ‡Barker, John, M.D., Curator of the Royal College of Surgeons of Ireland. Dublin.
1846. ‡Barlow, Rev. John, M.A., F.R.S., F.L.S., F.G.S. 5 Berkeley-street, London.
Barlow, Lieut.-Col. Maurice (14th Regt. of Foot). 5 Great George-street, Dublin.
Barlow, Peter. 5 Great George-street, Dublin.
1857. ‡Barlow, Peter William, F.R.S., F.G.S. 26 Great George-street, Westminster, London.
1861. *Barnard, Major R. Cary. Cambridge House, Bays-hill, Cheltenham.
1864. *Barneby, John H. Brockhampton Park, Worcester.
Barnes, Rev. Joseph Watkins, M.A., F.C.P.S. Kendal, Westmoreland.
*Barnes, Thomas, M.D., F.R.S.E. Carlisle.
Barnes, Thomas Addison.
*Barnett, Richard, M.R.C.S. Park-crescent, Oxford.
1859. ‡Barr, Lieut.-Colonel, Bombay Army. (Messrs. Forbes, Forbes & Co., 9 King William-street, London.)
1861. *Barr, W. R. Norris Bank, Heaton Norris, Stockport.
1860. ‡Barrett, T. B. Welshpool.
1852. §Barrington, Edward. Fassaroe Bray, Ireland.
1852. ‡Barrington, Richard S. Trafalgar-terrace, Monkstown, Co. Dublin.
1858. ‡Barry, Rev. A. Spencer-place, Leeds.
1862. *Barry, Charles. Lapswood, Sydenham-hill, Kent.
Barstow, Thomas. Garrow-hill, near York.
1858. *Bartholomew, Charles. Broxholme, Doncaster.
1855. ‡Bartholomew, Hugh. New Gas-works, Glasgow.
1858. *Bartholomew, William Hamond. 5 Grove-terrace, Leeds.
1851. ‡Bartlet, A. H. Lower Brook-street, Ipswich.
1857. ‡Barton, Folloit W. Clonelly, Co. Fermanagh.
1852. ‡Barton, James. Newry, near Belfast.
*Barton, John. Bank of Ireland, Dublin.
1864. §Bartrum, John S. 41 Gay-street, Bath.
1858. *Barwick, John Marshall. Albion-street, Leeds.
*Bashforth, Rev. Francis, B.D. Minting, near Horncastle, Lincolnshire.
1861. ‡Bass, John H., F.G.S. 2 Picton Villas, Camden-road, London.
1850. ‡Bastard, Thomas H. Charleton, Blandford.
1848. ‡Bate, C. Spence, F.R.S., F.L.S. 8 Mulgrave-place, Plymouth.
Bateman, James, M.A., F.R.S., F.L.S., F.H.S. Knypersley Hall, near Congleton, Staffordshire.
*Bateman, John Frederic, C.E., F.R.S., F.G.S. 16 Great George-street, Westminster, London.
*Bateman, Joseph, LL.D., F.R.A.S., J.P. Walthamstow, London.

Year of Election.

1864. §Bates, Henry Walter, Assist.-Sec. R.G.S. 15 Whitehall-place, London.
Bateson, John Glynn. Liverpool.
1852. ‡Bateson, Sir Robert, Bart. Belvoir Park, Belfast.
1863. *Bathurst, Rev. W. H. Lydney Park, Gloucestershire.
1863. §Bauerman, H. 22 Acre-lane, Brixton, London.
1861. ‡Baxendell, Joseph, F.R.A.S. 108 Stock-street, Manchester.
1858. ‡*Baxter, Robert.*
*Bayldon, John. Horbury, near Wakefield.
1851. *Bayley, George. 2 Cowper's-court, Cornhill, London.
1854. ‡Baylis, C. O., M.D. 51 Hamilton-square, Birkenhead.
1855. ‡Bayly, Capt., R.E. 205 St. Vincent-street, Glasgow.
Bayly, John. 1 Brunswick-terrace, Plymouth.
Bazley, Thomas Sebastian, B.A. Agden Hall, Lymm, Warrington.
Beal, Captain. Toronto, Upper Canada.
1860. *Beale, Lionel S., M.B., F.R.S., Professor of Physiology and of General and Morbid Anatomy in King's College, London. 61 Grosvenor-street, London.
Beale, Samuel.
Beamish, Francis B. Cork.
*Beamish, Richard, F.R.S. (*Local Treasurer.*) 2 Suffolk-square, Cheltenham.
Bean, R. H.
1861. §Bean, William. Alfreton, Derbyshire.
*Beatson, William. Rotherham.
1857. ‡*Beattie, Joseph.*
1855. **Beaufort, William Morris, F.R.G.S. India.*
1861. *Beaumont, Rev. Thomas George. Chelmondiston Rectory, Ipswich.
1859. *Beck, Joseph, F.R.A.S. 31 Cornhill, London.
1864. §Beck, Richard. Lister Works, Holloway, London.
1851. §Becker, Ernest, Ph.D. Buckingham Palace, London.
1864. §Becker, L. E. Altham, Accrington.
1858. *Beckett, William. Kirkstall Grange, Leeds.
1860. ‡Beckles, Samuel H., F.R.S., F.G.S. 9 Grand Parade, St. Leonard's-on-Sea.
1846. ‡Beddome, J., M.D. Romsey, Hants.
1854. ‡*Bedford, James, Ph.D.*
1858. ‡*Bedford, James.*
1850. ‡Begbie, James, M.D. 21 Alva-street, Edinburgh.
1846. §Beke, Charles T., Ph.D., F.S.A., F.R.G.S. Bekesbourne House, near Canterbury, Kent.
1847. *Belcher, Rear-Admiral Sir Edward, R.N., F.R.A.S., F.R.G.S. Union Club, Trafalgar-square, London.
1847. ‡Belcher, William. Abingdon.
1850. ‡Bell, Charles, M.D. 3 St. Colme-street, Edinburgh.
Bell, Frederick John. Woodlands, near Maldon, Essex.
1859. ‡Bell, George. Windsor-buildings, Dumbarton.
1860. ‡Bell, Rev. George Charles, M.A. Worcester College, Oxford.
1855. ‡Bell, Capt. Henry. Chalfont Lodge, Cheltenham.
1862. *Bell, Isaac Lowthian. The Hall, Washington, Co. Durham.
1853. ‡Bell, John Pearson, M.D. Waverley House, Hull.
*Bell, Matthew P. 245 St. Vincent-street, Glasgow.
1859. ‡Bell, Robert, jun. 3 Airlie-place, Dundee.
1864. §Bell, R. Queen's College, Kingston, Canada.
1855. ‡Bell, the late Sheriff. Glasgow.
Bell, Thomas, F.R.S., F.L.S., F.G.S., Professor of Zoology, King's College, London. The Wakes, Selborne, near Alton, Hants.
1863. *Bell, Thomas. Usworth House, Gateshead, Durham.

Year of Election.

Bellhouse, Edward Taylor. Eagle Foundry, Manchester.
1854. ‡Bellhouse, William Dawson. 1 Park-street, Leeds.
Bellingham, Sir Alan. Castle Bellingham, Ireland.
1864. *Bendyshe, T. 88 Cambridge-street, Pimlico, London.
1848. ‡Benham, E. 18 Essex-street, Strand, London.
Benkhausen, George.
1850. ‡Bennett, J. Hughes, M.D., F.R.S.E., Professor of Institutes of Medicine in the University of Edinburgh. 1 Glenfinlas-street, Edinburgh.
1852. *Bennoch, Francis. The Knoll, Blackheath, Kent.
1857. ‡Benson, Charles. 11 Fitzwilliam-square West, Dublin.
Benson, Robert, jun. Fairfield, Manchester.
1848. ‡Benson, Starling, F.G.S. Gloucester-place, Swansea.
1863. ‡Benson, William. Fourstones, Newcastle-on-Tyne.
1848. ‡Bentham, George, F.R.S., Pres. L.S. 91 Victoria-street, Westminster, London.
Bentley, John. 9 Portland-place, London.
1845. ‡Bentley, J. Flowers. Stamford, Lincolnshire.
1863. §Bentley, Robert, F.L.S., Professor of Botany in King's College. 55 Clifton-road, St. John's-wood, London.
1863. §Berkley, C. Marley Hill, Gateshead, Durham.
Bermingham, Thomas.
1848. ‡Berrington, Arthur V. D. Woodlands Castle, near Swansea.
*Berryman, William Richard. 6 Tamar-terrace, Stoke, Devonport.
1862. ‡Besant, William Henry, M.A. St. John's College, Cambridge.
1858. ‡Best, William. Leydon-terrace, Leeds.
1859. ‡Beveridge, Robert, M.B. 20 Union-street, Aberdeen.
1863. ‡Bewick, Thomas John. Allenheads, Carlisle.
1857. ‡Bewley, Charles. Cope-street, Dublin.
*Bickerdike, Rev. John, M.A. St. Mary's Parsonage, Leeds.
Bickersteth, Robert. Rodney-street, Liverpool.
1849. ‡*Bidwell, Henry.*
1863. ‡Bigger, Benjamin. Gateshead, Durham.
1864. §Biggs, R. 17 Charles-street, Bath.
1855. ‡Billings, Robert William. 4 St. Mary's-road, Canonbury, London.
Bilton, Rev. William, M.A., F.G.S. University Club, Suffolk-street, London; and Chislehurst, Kent.
Bingham, Rev. William, M.A.
Binney, Edward William, F.R.S., F.G.S. 40 Cross-street, Manchester.
*Binyon, Thomas. Henwick Grove, Worcester.
Birchall, Edwin. Oakfield Villas, Birkenhead.
Birchall, Henry.
1847. ‡Bird, Rev. Charles Smith, Vicar of Gainsborough.
1854. ‡Bird, William Smith. Dingle Priory, near Liverpool.
Birkenshaw, John Cass.
1862. §Birkin, Richard. Apsley Hall, Nottingham.
*Birks, Rev. Thomas Rawson. Kelshall Rectory, Royston.
*Birley, Richard. Seedley, Pendleton, Manchester.
1861. ‡Birley, Thomas Thornely. Highfield, Heaton Mersey.
*Birt, W. Radcliff, F.R.A.S. 42 Sewardstone-road West, Victoria Park, London.
1854. ‡*Bishop, Rev. Francis.*
Black, James, M.D., F.G.S., F.R.S.E. 2 George-square, Edinburgh.
1863. ‡Black, William. South Shields.
Blackburn, Bewicke. Clapham Common, London.
Blackburne, Right Hon. Francis. 34 Merrion-square South, Dublin.
Blackburne, Rev. John, M.A. Yarmouth, Isle of Wight.
Blackburne, Rev. John, jun., M.A. Rectory, Horton, near Chippenham.

Year of
Election.

1859. ‡Blackie, John Stewart, Professor of Greek. Edinburgh.
1855. *Blackie, W. G., Ph.D., F.R.G.S. 36 Frederick-street, Glasgow.
*Blackwall, John, F.L.S. Hendre House, near Llanrwst, Denbighshire.
*Blackwell, Thomas Evans, F.G.S. Montreal.
1863. ‡Bladen, Charles. Jarrow Iron Company, Newcastle-on-Tyne.
1859. ‡Blaikie, Sir Thomas. Kingseat, Aberdeen.
1863. §Blake, C. C. Anthropological Society, 4 St. Martin's-place, London.
1849. *Blake, Henry Wollaston, M.A., F.R.S. 8 Devonshire-place, Portland-place, London.
1846. ‡Blake, James, M.B. Pall Mall, London.
1846. *Blake, William. South Petherton, Ilminster.
1860. ‡Blakely, Capt. A. T. 34 Montpellier-square, Knightsbridge, London.
1845. ‡Blakesley, Rev. J. W., B.D. Ware Vicarage, Hertfordshire.
1861. §Blakiston, Matthew. 9 Euston-street, Dublin.
*Blakiston, Peyton, M.D., F.R.S. St. Leonard's-on-Sea.
Blanchard, Lieut.-Col.
*Bland, Rev. Miles, D.D., F.R.S., F.S.A., F.R.A.S. 5 Royal-crescent, Ramsgate.
Blanshard, William. Redcar.
Blood, William B.
Blore, Edward, F.S.A. 4 Manchester-square, London.
1853. ‡Blundell, Henry J. P. Brunswick House, Beverley-road, Hull.
Blundell, R. H.
1859. ‡Blunt, Sir Charles, Bart. Heathfield Park, Sussex.
Blunt, Henry. Shrewsbury.
1859. ‡Blunt, Capt. Richard. Bretlands, Chertsey, Surrey.
Blyth, B. Hall. 135 George-street, Edinburgh.
1850. ‡Blyth, John, M.D., Professor of Chemistry in Queen's College, Cork.
1858. *Blythe, William. Holland Bank, Church, near Accrington.
Boase, C. W. Dundee.
1845. ‡Bodmer, Rodolphe. Newport, Monmouthshire.
1864. §Bogg, J. Louth, Lincolnshire.
Bogle, James.
1859. *Bohn, Henry G., F.R.G.S. York-street, Covent Garden, London.
*Boileau, Sir John Peter, Bart., F.R.S. 20 Upper Brook-street, London; and Ketteringham Hall, Norfolk.
1859. ‡Bolster, Rev. Prebendary John A. Cork.
Bolton, R. L. Gambier-terrace, Liverpool.
1849. ‡Bolton, Thomas. Kinver, near Stourbridge.
1863. §Bond, Francis T., M.D. Hartley Institution, Southampton.
Bond, Henry John Hayes, M.D. Cambridge.
*Bond, Walter M. The Argory, Moy, Ireland.
Bonomi, Ignatius. 36 Blandford-square, London.
Bonomi, Joseph. Soane's Museum, 15 Lincoln's-Inn-fields, London.
1861. §Booth, James. Yorkshire-street, Rochdale.
1835. ‡Booth, Rev. James, LL.D., F.R.S., F.R.A.S. The Vicarage, Stone, near Aylesbury.
1861. *Booth, John. Monton, near Manchester.
1861. *Booth, Councillor William. Dawson-street, Manchester.
Boothman, Thomas.
1861. *Borchardt, Dr. Louis. Bloomsbury, Oxford-road, Manchester.
1849. ‡Boreham, William W., F.R.A.S. Haverhill, Suffolk.
1863. ‡Borries, Theodore. Lovaine-crescent, Newcastle-on-Tyne.
*Bossey, Francis, M.D. 4 Broadwater-road, Worthing.
Bosworth, Rev. Joseph, LL.D., F.R.S., F.S.A., M.R.I.A., Professor of Anglo-Saxon in the University of Oxford. Oxford.
1859. ‡Bothwell, George B. 9 Bon Accord-square, Aberdeen.

Year of Election.

1858. ‡Botterill, John. Burley, near Leeds.
Bottomley, William. Forbreda, Belfast.
1850. ‡Bouch, Thomas, C.E. 1 South Hanover-street, Edinburgh.
Boult, E. S.
Bourne, Lieut.-Col. J. D. Heathfield, Liverpool.
1858. ‡Bousfield, Charles. Roundhay, near Leeds.
1846. *Bowerbank, James Scott, LL.D., F.R.S., F.R.A.S. 3 Highbury-grove, London.
1856. *Bowlby, Miss F. E. 27 Lansdown-crescent, Cheltenham.
1863. ‡Bowman, R. Benson. Newcastle-on-Tyne.
Bowman, William, F.R.S. 5 Clifford-street, London.
1863. ‡Bowron, James. Stockton-on-Tees.
1863. ‡Boyd, E. F. Moor House, Durham.
Boyle, Alexander, M.R.I.A. 35 College Green, Dublin.
Brabant, R. H., M.D. Bath.
Bracebridge, Charles Holt, F.R.G.S. The Hall, Atherstone, Warwickshire.
1849. ‡Bracey, Charles. Birmingham.
1864. §Bradbury, Thomas. Longroyde, Brighouse.
Bradshaw, Rev. John.
1861. *Bradshaw, William. Mosley-street, Manchester.
*Brady, Antonio. Maryland Point, Essex.
1857. *Brady, Cheyne, M.R.I.A. Willow Bank, De Vesci-terrace, Kingstown, Co. Dublin.
Brady, Daniel F., M.D. 14 North Frederick-street, Dublin.
1863. §Brady, George S. 22 Fawcett-street, Sunderland.
1862. §Brady, Henry Bowman, F.L.S., F.C.S. 40 Mosley-street, Newcastle-on-Tyne.
1858. ‡Brae, Andrew Edmund. 29 Park-square, Leeds.
1864. §Braham, P. 6 George-street, Bath.
Braid, James.
*Brakenridge, John. Wakefield.
Brancker, Rev. Thomas, M.A. Limington, Somerset.
1850. ‡Brand, William, F.R.S.E. 5 Northumberland-street, Edinburgh.
1861. *Brandreth, Henry. Eton.
Brandreth, John Moss. Preston.
1852. ‡Brazier, James S. Marischal College and University of Aberdeen.
1857. ‡Brazill, Thomas. 12 Holles-street, Dublin.
1859. ‡Brebner, Alexander C. Audit Office, Somerset House, London.
1859. *Brebner, James. 20 Albyn-place, Aberdeen.
1854. ‡*Bretherton, Frederick.*
1860. ‡Brett, G. Salford.
1854. *Brett, John Watkins. 2 Hanover-square, London.
1854. ‡*Brewin, Robert.*
‡Brewster, Sir David, K.H., LL.D., D.C.L., F.R.S. L. & E., Hon. M.R.I.A., F.G.S., F.R.A.S., Vice-Chancellor of the University of Edinburgh. Edinburgh.
1859. ‡Brewster, Rev. Henry. Manse of Farnell.
*Briggs, General John, F.R.S., M.R.A.S., F.G.S. 2 Tenterden-street, London.
1863. *Bright, Sir Charles Tilston, C.E., F.R.G.S., F.R.A.S. 12 Upper Hyde Park-gardens, and 1 Victoria-street, Westminster, London.
Bright, John, M.P. Rochdale, Lancashire.
1863. §Brivit, Henri. Washington Chemical Works, Washington, Durham.
Broadbent, Thomas. Marsden-square, Manchester.
1848. ‡Brock, Rev. G. B. Mount Pleasant, Swansea.
1859. ‡Brodhurst, Bernard Edwin. 20 Grosvenor-street, Grosvenor-square, London.

Year of Election.

1847. ‡Brodie, Sir Benjamin C., Bart., M.A., F.R.S., Professor of Chemistry in the University of Oxford. Cowley House, Oxford.
1834. ‡Brodie, Rev. James. Monimail, Fifeshire.
Brogden, John.
1853. ‡Bromby, J. H., M.A. The Charter House, Hull.
Bromilow, Henry G.
Brook, William. Meltham, York.
*Brooke, Charles, M.A., F.R.S. 16 Fitzroy-square, London.
1855. ‡Brooke, Edward. Marsden House, Stockport, Cheshire.
1864. *Brooke, Rev. J. T. Bannerdown House, Batheaston, Bath.
1855. ‡Brooke, Peter William. Marsden House, Stockport, Cheshire.
1863. §Brooks, J. C. Wallsend.
*Brooks, Samuel. King-street, Manchester.
1846. *Brooks, Thomas (Messrs. Butterworth and Brooks). Manchester.
Brooks, William. Ordfall-hill, East Retford, Nottinghamshire.
1847. §Broome, C. E. Elmhurst, Batheaston, near Bath.
1863. *Brough, Lionel H., F.G.S., one of Her Majesty's Inspectors of Coal-Mines. Clifton, Bristol.
*Broun, John Allan, F.R.S., Astronomer to His Highness the Rajah of Travancore.
Brown, Alexander, M.A.
1863. ‡Brown, Alexander Crum, F.R.S.E. Arthur Lodge, Dalkeith-road, Edinburgh.
Brown, Charles Edward. Cambridge.
1855. ‡Brown, Colin. 3 Mansfield-place, Glasgow.
1863. *Brown, Rev. Dixon. Howick Rectory, Alnwick.
1858. ‡Brown, Alderman Henry. Bradford.
Brown, Hugh. Broadstone, Ayrshire.
1859. ‡Brown, Rev. J. C., LL.D., Lecturer on Botany in King's College, Aberdeen. 156 Crown-street, Aberdeen.
Brown, James.
1850. ‡*Brown, James L.*
1858. ‡Brown, John. Barnsley.
1863. §Brown, John H. 40 East Parade, Newcastle-on-Tyne.
1863. ‡Brown, Ralph. Lambton's Bank, Newcastle-on-Tyne.
1856. *Brown, Samuel, F.S.S. The Elms, Larkhall Rise, Clapham, London.
1850. ‡*Brown, Samuel, M.D.*
*Brown, Thomas. Hardwick House, Chepstow.
*Brown, William. 3 Maitland Park Villas, Haverstock-hill, London.
1855. ‡Brown, William. 179 Bath-street, Glasgow.
1850. ‡Brown, William, F.R.S.E. 25 Dublin-street, Edinburgh.
1863. ‡Browne, B. Chapman. Tynemouth.
1854. ‡*Browne, Henry, M.D.*
1862. *Browne, Robert Clayton, B.A. Browne's Hill, Carlow, Ireland.
Browne, William. Richmond-hill, near Liverpool.
1855. §Brownlee, James. 173 St. George's-road, Glasgow.
Brownlie, Archibald. Glasgow.
1853. ‡Brownlow, William B. Villa-place, Hull.
*Bruce, Alexander John. Kilmarnock.
1852. ‡Bruce, Rev. William. Belfast.
1851. ‡Bruff, P. Handford Lodge, Ipswich.
1863. *Brunel, H. M. Duke-street, Westminster, London.
1863. ‡Brunel, J. Duke-street, Westminster, London.
1859. ‡*Bryant, Arthur C.*
1858. ‡*Bryant, Wilberforce.*
1861. §Bryce, James. 76 Oldham-street, Manchester.
Bryce, James, M.A., LL.D., F.G.S. High School, Glasgow.
Bryce, Rev. R. J., LL.D., Principal of Belfast Academy. Belfast.

Year of Election.

1850. ‡Bryson, Alexander, F.R.S.E. Hawkhill, Edinburgh.
1859. ‡Bryson, William Gillespie. Cullen, Aberdeen.
Buchanan, Andrew, M.D., Regius Professor of the Institutes of Medicine in the University of Glasgow. Glasgow.
Buchanan, Archibald. Catrine, Ayrshire.
Buchanan, D. C. Poulton cum Seacombe, Cheshire.
1850. ‡Buchanan, George. 14 Duke-street, Edinburgh.
Buchanan, James, R.E.
*Buck, George Watson. Ramsay, Isle of Man.
1864. §Buckle, Rev. George, M.A. Twerton Vicarage, Bath.
1846. ‡Buckley, Colonel. New Hall, Salisbury.
1847. ‡Buckley, Rev. W. E., M.A. Middleton Cheney, Banbury.
1848. *Buckman, James, F.L.S., F.G.S., Professor of Natural History in the Royal Agricultural College, Cirencester. Bradford Abbas, Sherbourne, Dorsetshire.
1851. *Buckton, G. Bowdler, F.R.S. 7 Kensington Gardens-square, London.
1848. ‡Budd, Edward. Hafod Works, Swansea.
1848. *Budd, James Palmer. Ystalyfera Iron Works, Swansea.
1851. ‡Bullen, George. Carr-street, Ipswich.
*Buller, Sir Antony. Pound, near Tavistock, Devon.
1845. ‡Bunbury, Sir Charles James Fox, Bart., F.R.S., F.L.S., F.G.S., F.R.G.S. Barton Hall, Bury St. Edmunds.
1845. ‡Bunbury, Edward H., F.G.S. 15 Jermyn-street, London.
Bunch, Rev. Robert James, B.D., F.C.P.S. Emanuel Rectory, Loughborough.
1863. §Bunning, T. Wood. 6 Grey-street, Newcastle-on-Tyne.
Bunt, Thomas G. Nugent-place, Bristol.
1854. ‡Burckhardt, Otte. Bank Chambers, Liverpool.
Burd, John.
**Burd, John, jun.*
1863. *Burgess, John. Rastrick, Yorkshire.
Burgoyne, General Sir John F., Bart., G.C.B., D.C.L., F.R.S., Inspector General of Fortifications. 8 Gloucester-gardens, London.
1857. ‡Burk, J. Lardner, LL.D. 2 North Great George-street, Dublin.
Burn, William.
1859. ‡Burnett, Newell. Belmont-street, Aberdeen.
1860. ‡Burrows, Montague, M.A., Commander R.N. Oxford.
1857. ‡Busby, John. 9 Trafalgar-terrace, Monkstown, Ireland.
1864. §Bush, W. 7 Circus, Bath.
Bushell, Christopher. Royal Assurance-buildings, Liverpool.
1855. *Busk, George, F.R.S., Sec. L.S., F.G.S., Examiner in Comparative Anatomy in the University of London. 15 Harley-street, Cavendish-square, London.
1857. ‡Butcher, Rev. S., D.D. 13 Fitzwilliam-square West, Dublin.
Butler, Spitsburg.
1857. ‡*Butt, Isaac.*
Butterfield, Rev. Charles Dales. West Retford Rectory, West Retford.
1845. ‡Butterfield, J. M. 45 Mount, York.
1861. *Butterworth, John. 58 Mosley-street, Manchester.
1855. *Buttery, Alexander W. Monkland Iron and Steel Company, Cardarroch, near Airdrie.
1845. ‡*Button, Charles.*
Buxton, Edward North.
1854. ‡Byerley, Isaac. Seacombe, Liverpool.
Byng, William. Orwell Works House, Ipswich.
1852. ‡Byrne, Rev. Jas. Ergenagh Rectory, Omagh, Armagh.

Year of Election.

Cabbell, Benjamin Bond, M.A., F.R.S., F.S.A., F.R.G.S. 1 Brick-court, Temple; and 52 Portland-place, London.
Cabbell, George.
1854. ‡Cadell, William. Monteith.
1858. §Cail, John. Stokesley, Yorkshire.
1863. §Cail, Richard. The Fell, Gateshead.
1854. ‡Caine, Nathaniel. Dutton-street, Liverpool.
1858. *Caine, Rev. William, M.A. Greenheys, Manchester.
1854. ‡*Caine, William Sproston.*
1863. ‡Caird, Edward. Finnart, Dumbartonshire.
1861. *Caird, James Key. Finnart on Loch Long, by Gare Loch Head, Dumbartonshire.
1855. *Caird, James T. Greenock.
1857. ‡Cairnes, Prof. Queen's College, Galway.
1845. ‡Calder, Rev. William. Fairfield Parsonage, Liverpool.
Caldwell, Robert. 9 Bachelor's-walk, Dublin.
1857. ‡Callan, Rev. N. J., Professor of Natural Philosophy in Maynooth College.
Callender, W. R. Victoria Park, Rusholme, near Manchester.
1853. ‡Calver, E. K., R.N. 21 Norfolk-street, Sunderland.
1857. ‡Cameron, Charles A., M.D. 17 Ely-place, Dublin.
Cameron, John. Glasgow.
1845. ‡*Campbell, Colin.*
1859. ‡Campbell, Rev. C. P., Principal of King's College, Aberdeen. Aberdeen.
1857. *Campbell, Dugald, F.C.S. 7 Quality-court, Chancery-lane, London.
1855. ‡Campbell, Dugald, M.D. 186 Sauchiehall-street, Glasgow.
Campbell, Sir Hugh P. H., Bart. 10 Hill-street, Berkeley-square, London; and Marchmont House, near Dunse, Berwickshire.
Campbell, James.
*Campbell, Sir James. Glasgow.
Campbell, Rev. James, D.D. Forkhill, Dundalk, Ireland.
1855. ‡*Campbell, John.*
Campbell, John Archibald, F.R.S.E. Albyn-place, Edinburgh.
1852. ‡Campbell, William. Donegal-square West, Belfast.
1859. ‡Campbell, William. Dunmore, Argyllshire.
1862. *Campion, Rev. William. Queen's College, Cambridge.
1853. ‡Camps, William, M.D., F.R.G.S. 40 Park-street, Grosvenor-square, London.
Cape, Rev. Joseph, M.A., F.C.P.S. Birdbrook Rectory, Halstead, Essex.
*Carew, William Henry Pole. Antony House, near Devonport.
1861. ‡Carlton, James. Mosley-street, Manchester.
Carmichael, H. 18 Hume-street, Dublin.
Carmichael, James.
Carmichael, John T. C. Messrs. Todd & Co., Cork.
*Carpenter, Philip Pearsall, B.A., Ph.D. Cairo-street, Warrington.
1854. ‡Carpenter, Rev. R. Lant, B.A. Halifax.
1845. ‡Carpenter, William B., M.D., F.R.S., F.L.S., F.G.S., Registrar of the University of London. 8 Queen's-road West, Regent's Park, London.
Carpmael, William. 4 Old-square, Lincoln's Inn, London.
1856. ‡Carr, John. Queen's Circus, Cheltenham.
Carr, Ralph. 34 Bedford-place, Russell-square, London.
1849. ‡Carr, William. Gomersal, Leeds.
*Carr, William, M.D., F.R.C.S. Lee Grove, Blackheath, Kent.
1855. ‡Carrick, John. Hill-street, Garnet-hill, Glasgow.

Year of Election.

1861. *Carrick, Thomas. 37 Princess-street, Manchester.
1861. *Carson, Rev. Joseph, D.D., Fellow of Trinity College, Dublin, M.R.I.A. 18 Fitzwilliam-place, Dublin.
1857. ‡Carte, Alexander, M.D. Royal Dublin Society, Dublin.
1845. ‡Carter, G. B. Lord-street, Liverpool.
1845. ‡*Carter, James.*
1855. ‡Carter, Richard, C.E. Long Carr, Barnsley, Yorkshire.
*Cartmell, Rev. James, D.D., F.G.S., Master of Christ's College, Cambridge.
Cartmell, Joseph, M.D. Carlisle.
Cartwright, Rev. R. B. Stoke Rectory, Grantham.
1862. §Carulla, Facundo, F.A.S.L. Care of Messrs. Daglish and Co., 8 Harrington-street, Liverpool.
*Cassels, Rev. Andrew, M.A. Batley Vicarage, near Leeds.
Castle, Charles. Clifton, Bristol.
Castle, Robert. Cleeve Court, Bristol.
1853. ‡Cator, John B., Commander R.N. 1 Adelaide-street, Hull.
1855. ‡*Catterill, Rev. Henry.*
1859. ‡Catto, Robert. 44 King-street, Aberdeen.
Caw, John Y.
1849. ‡Cawley, Charles Edward. The Heath, Kirsall, Manchester.
1860. §Cayley, Arthur, F.R.S., V.P.R.A.S., Sadlerian Professor of Mathematics in the University of Cambridge. Cambridge.
Cayley, Digby. Brompton, near Scarborough.
Cayley, Edward Stillingfleet, M.P. 19 Harley-street, London; and Wydale, Malton, Yorkshire.
1858. *Chadwick, Charles, M.D. 35 Park-square, Leeds.
1860. §Chadwick, David. 64 Cross-street, Manchester.
Chadwick, Edwin, C.B. Richmond, Surrey.
Chadwick, Elias, M.A. Pudleston-court, near Leominster.
Chadwick, John. Broadlands, Rochdale.
1859. ‡Chadwick, Robert. Highbank, Manchester.
1861. ‡Chadwick, Thomas. Wilmslow Grange, Cheshire.
*Challis, Rev. James, M.A., F.R.S., F.R.A.S., Plumian Professor of Astronomy in the University of Cambridge. 13 Trumpington-street, Cambridge.
1859. ‡Chalmers, John Inglis. Aldbar, Aberdeen.
1859. ‡Chalmers, Rev. Dr. P. Dunfermline.
Chambers, George. High Green, Sheffield.
Chambers, John. Ridgefield, Manchester.
*Chambers, Robert, F.R.S.E., F.L.S., F.G.S. 3 Hall-place, St. John's-wood, London.
*Champney, Henry Nelson. St. Paul's-square, York.
Chance, R. L. Summerfield House, Birmingham.
*Chanter, John. 2 Arnold-terrace, Bow-road, Bromley.
1861. *Chapman, Edward. Hill End, Mottram, Manchester.
1850. ‡Chapman, Prof. E. J. University College; and 4 Addison-terrace, Kensington, London.
1861. *Chapman, John. Hill End, Mottram, Manchester.
Chapman, Captain John James, R.A., F.R.G.S. Adelaide-square, Bedford.
1854. ‡Chapple, Frederick. Canning-street, Liverpool.
Charlesworth, Edward, F.G.S.
1863. ‡Charlton, Edward, M.D. 7 Eldon-square, Newcastle-on-Tyne.
1863. §Charlton, F. Braithwaite, Cockermouth.
Charters, Samuel.
1845. ‡*Chatfield, Henry.*
1864. §Cheadle, Dr. 8 Old Cavendish-street, London.

Year of Election.

*Cheetham, David. Weston Park, Bath.
1852. ‡Cheshire, Edward. Conservative Club, London.
Cheshire, John. Hartford, Cheshire.
1853. *Chesney, Major-General Francis Rawdon, R.A., D.C.L., F.R.S., F.R.G.S. Ballyardle, Kilkeel, Co. Down, Ireland.
*Chevallier, Rev. Temple, B.D., F.R.A.S., Professor of Mathematics and Astronomy in the University of Durham.
*Chichester, Ashhurst Turner Gilbert, D.D., Lord Bishop of. 31 Queen Anne-street, Cavendish-square, London; and The Palace, Chichester.
Chippindall, John.
* *Chiswell, Thomas.*
1863. §Cholmeley, Rev. C. H. Magdalen College, Oxford.
1859. ‡Christie, John, M.D. 46 School-hill, Aberdeen.
1861. ‡Christie, Professor R. C., M.A. 7 St. James's-square, Manchester.
Christison, Robert, M.D., F.R.S.E., Professor of Dietetics, Materia Medica, and Pharmacy in the University of Edinburgh. Edinburgh.
1860. ‡Church, William Selby, M.A. 1 Harcourt Buildings, Temple, London.
1850. ‡Churchill, Lord Alfred. Blenheim, Woodstock.
1857. ‡Churchill, F., M.D. 15 Stephen's Green, Dublin.
1863. ‡Clapham, A. 3 Oxford-street, Newcastle-on-Tyne.
1863. ‡Clapham, Henry. 5 Summerhill-grove, Newcastle-on-Tyne.
1855. §Clapham, Robert Calvert. Wincomblee, Walker, Newcastle-on-Tyne.
1858. ‡Clapham, Samuel. 17 Park-place, Leeds.
1857. ‡Clarendon, Frederick Villiers. 11 Blessington-street, Dublin.
*Clark, Rev. Charles, M.A. Queen's College, Cambridge.
Clark, Courtney K. Haugh End, Halifax.
1859. ‡Clark, David. Coupar Angus.
* *Clark, Francis.*
Clark, G. T. Bombay; and Athenæum Club, Pall Mall, London.
1846. *Clark, Henry, M.D. 4 Upper Moira-place, Southampton.
Clark, Sir James, Bart., M.D., M.A., F.R.S., F.R.G.S., Physician in Ordinary to the Queen. 22B Brook-street, Grosvenor-square, London.
1861. ‡Clark, Latimer. 1 Victoria-street, Westminster, London.
1855. ‡Clark, Rev. William, M.A. Barrhead, near Glasgow.
Clark, William, M.D., F.R.S., F.G.S., Professor of Anatomy in the University of Cambridge. Cambridge.
1857. ‡Clarke, Edward S., M.D. Educational Office, Marlborough-street, Dublin.
Clarke, George.
Clarke, George. Mosley-street, Manchester.
1861. *Clarke, J. H. Earnscliffe, Alderley Edge.
Clarke, Joseph. Waddington Glebe, Lincoln.
1851. ‡Clarke, Joshua, F.L.S. Fairycroft, Saffron Walden.
Clarke, Thomas, M.A. Knedlington Manor, Howden, Yorkshire.
1848. §Claudet, A., F.R.S. 11 Gloucester-road, Regent-park, London.
1861. ‡Clay, Charles, M.D. 101 Piccadilly, Manchester.
*Clay, Joseph Travis, F.G.S. Rastrick, Yorkshire.
1854. ‡Clay, Robert. St. Ann-street, Liverpool.
1855. ‡*Clay, William.*
1856. *Clay, William. 4 Park-hill-road, Liverpool.
1857. *Clayton, David Shaw. Norbury, Stockport, Cheshire.
1850. ‡Cleghorn, Hugh, M.D. Madras Establishment.
1859. ‡Cleghorn, John. Wick.
1861. §Cleland, John, M.D. Queen's College, Galway.

Year of Election.

1857. ‡Clements, Henry. Dromin, Listowel, Ireland.
Clendinning, Alexander, M.R.I.A.
‡Clerk, Rev. D. M. Deverill, Warminster, Wilts.
Clerke, Rev. C. C., D.D., Archdeacon of Oxford and Canon of Christ Church, Oxford. Milton Rectory, Abingdon, Berkshire.
1850. ‡*Clerke, Right Honourable Sir George, Bart.*
1852. ‡Clibborn, Edward. Royal Irish Academy, Dublin.
1861. *Clifton, Professor R. B., B.A. Owens College, Manchester.
1849. ‡Clive, R. H. Hewell, Bromsgrove.
Clonbrock, Lord Robert. Clonbrock, Galway.
1854. ‡Close, The Very Rev. Francis, M.A. Carlisle.
Clough, Rev. Alfred B., B.D. Brandeston, Northamptonshire.
1859. ‡Clouston, Rev. Charles. Sandwick, Orkney.
1861. *Clouston, Peter. Glasgow.
Clow, John.
1863. §Clutterbuck, Thomas. Warkworth, Acklington.
1855. *Coats, Peter. Woodside, Paisley.
1855. *Coats, Thomas. Fergeslie House, Paisley.
Cobb, Edward. 4 St. John's Villas, Haverstock-hill, Hampstead, London.
1851. *Cobbold, John Chevallier, M.P. Tower-street, Ipswich.
1864. §Cobbold, T. Spencer, M.D., F.R.S., Lecturer on Comparative Anatomy at the Middlesex Hospital. 39 Norland-square, Notting-hill, London.
1845. ‡Cocker, John, M.A. Cambridge.
*Cocker, Jonathan. Higher Broughton, Manchester.
1854. ‡Cockey, William. 18 Lansdown-crescent, Glasgow.
1861. *Coe, Rev. Charles C. Leicester.
1864. *Cochrane, James Henry. Dunkathel, Glanmire, Co. Cork.
1853. ‡Colchester, William, F.G.S. Dovercourt, near Harwich.
1850. ‡Coldstream, John, M.D. 51 York-place, Edinburgh.
1859. ‡Cole, Edward. 11 Hyde Park-square, London.
1859. *Cole, Henry Warwick. 3 New-square, Lincoln's Inn, London.
1846. ‡Cole, Robert, F.S.A. 54 Clarendon-road, Notting-hill, London.
1860. ‡Coleman, J. J., F.C.S. Johnson-street, Queen's-road, Manchester.
1854. *Colfox, William, B.A. Bridport, Dorsetshire.
1857. ‡Colles, William, M.D. Stephen's Green, Dublin.
1861. *Collie, Alexander. 23 Sussex-square, Hyde Park, London.
1861. ‡Collinge, John. Saddleworth.
1854. ‡Collingwood, Cuthbert, M.A., M.B., F.L.S. 15 Oxford-street, Liverpool.
1861. *Collingwood, J. Frederick. 54 Gloucester-street, Belgrave-road, London.
1849. ‡Collins, Joseph. Frederick-street, Edgbaston, Birmingham.
Collins, J. V., M.R.D.S.
Collins, Robert, M.R.D.S. Ardsallagh, Navan, Ireland.
Collis, Stephen Edward. Listowel, Ireland.
Colthurst, John. Clifton, Bristol.
1864. §Colton, General F. C. Knolton Hall, Ruabon.
Combe, George. Edinburgh.
*Compton, Lord Alwyn. Castle Ashby, Northamptonshire.
1846. *Compton, Lord William. 145 Piccadilly, London.
1852. ‡Connal, Michael. 16 Lynedock-terrace, Glasgow.
1854. ‡Conolly, John, M.D., D.C.L. Hanwell.
1853. ‡*Constable, Sir T. C., Bart.*
1858. ‡Conybeare, Henry, F.G.S. 20 Duke-street, Westminster, London.
*Conway, Charles. Pontnwydd Works, Newport, Monmouthshire.
1864. *Conwell, Eugene Alfred, M.R.I.A. Trim, Ireland.

Year of Election.

1859. ‡Cook, E. R. Stamford-hill, London.
1861. **Cook, Henry.*
Cooke, Captain Adolphus.
**Cooke, A. B.*
1863. §Cooke, Edward William, F.R.S., F.L.S., F.G.S., A.R.A. The Ferns, Hyde Park-gate, South Kensington, London.
Cooke, James R., M.A. 73 Blessington-street, Dublin.
1854. ‡Cooke, John. Howe Villa, Richmond, Yorkshire.
1850. ‡*Cooke, John William.*
Cooke, J. B. Exchange-buildings, Liverpool.
Cooke, Rev. T. L., M.A. Magdalen College, Oxford.
1854. ‡Cooke, Rev. William, M.A. Gazeley Vicarage, near Newmarket.
Cooke, William Fothergill. Telegraph Office, Lothbury, London.
1859. *Cooke, William Henry, M.A., F.S.A. Elm-court, Temple, London.
1862. *Cookson, Rev. H. W., D.D. St. Peter's College, Cambridge.
1863. ‡Cookson, N. C. Benwell Tower, Newcastle-on-Tyne.
1850. ‡Cooper, Sir Henry, M.D. 7 Charlotte-street, Hull.
Cooper, James. 55 Pembroke Villas, Bayswater.
Cooper, Paul.
1846. ‡Cooper, William White. 19 Berkeley-square, London.
1856. ‡Copeland, George F., F.G.S., 5 Bay's-hill Villas, Cheltenham.
1854. ‡Copland, James, M.D., F.R.S. 5 Old Burlington-street, London.
Copland, William, F.R.S.E. Dumfries.
1863. ‡Coppin, John. North Shields.
*Corbet, Richard. Adderley, Market Drayton, Shropshire.
Corbett, Edward. Ravenoak, Cheadle-hulme, Cheshire.
1855. ‡Corbett, Joseph Henry, M.D., Professor of Anatomy and Physiology, Queen's College, Cork.
Cormack, John Rose, M.D., F.R.S.E. 37 Russell-square, London.
1860. ‡*Corner, C. Tinsley.*
Cory, Rev. Robert, B.D., F.C.P.S. Stanground, Peterborough.
Cottam, George. 2 Winsley-street, London.
1857. ‡Cottam, Samuel. Brazennose-street, Manchester.
Cotter, John. Cork.
Cotton, William, D.C.L., F.R.S., F.S.A. Bank of England, London; and Walwood House, Leytonstone, London.
**Cotton, Rev. William Charles, M.A. New Zealand.*
Couper, James. 12 Royal Exchange-square, Glasgow.
*Courtney, Henry, M.R.I.A. 34 Fitzwilliam-place, Dublin.
Courtney, Richard. 118 Bagot-street, Dublin.
Cowan, John. Valleyfield, Pennycuick, Edinburgh.
1863. §Cowan, John A. Blaydon Burn, Durham.
1863. ‡Cowan, Joseph, jun. Blaydon, Durham.
Cowie, Rev. Benjamin Morgan, M.A. 62 Queen's-gardens, Bayswater, London.
1860. ‡Cowper, Edward Alfred, M.I.C.E. Colne Cottage, Twickenham Common, London.
1850. ‡Cox, John. Georgie Mills, Edinburgh.
*Cox, Joseph, F.G.S. Wisbeach, Cambridgeshire.
Cox, Robert. 26 Rutland-street, Edinburgh.
1847. ‡Cox, Rev. W. H., B.D. Eaton Bishop, Herefordshire.
1854. §Crace-Calvert, Frederick, Ph.D., F.R.S., F.C.S., Honorary Professor of Chemistry to the Manchester Royal Institution. Royal Institute, Manchester.
Craig, J. T. Gibson, F.R.S.E. Edinburgh.
1859. §Craig, S. Clayhill, Enfield, Middlesex.
1857. ‡Crampton, Rev. Josiah., M.R.I.A. The Rectory, Florence-court, Co. Fermanagh, Ireland.

Year of Election.

1858. ‡Cranage, Edward, Ph.D. The Old Hall, Wellington, Shropshire.
Craven, Robert. Hull.
1852. ‡Crawford, Alexander, jun. Mount Prospect, Belfast.
1857. ‡*Crawford, George Arthur, M.A.*
1849. ‡Crawfurd, John, F.R.S., F.R.G.S. Athenæum Club, Pall Mall, London.
*Crewdson, Thomas D. Dacca Mills, Manchester.
Creyke, The Venerable Archdeacon. Beeford Rectory, Driffield.
*Crichton, William. 1 West India-street, Glasgow.
1854. ‡*Crisp, M. F.*
Croft, Rev. John, M.A., F.C.P.S.
1858. ‡Crofts, John. Hillary-place, Leeds.
Croker, Charles Phillips, M.D., M.R.I.A. 7 Merrion-square West, Dublin.
1859. ‡Croll, A. A. 10 Coleman-street, London.
1857. ‡Crolly, Rev. George. Maynooth College, Ireland.
1855. ‡Crompton, Charles, M.A. 22 Hyde Park-square, London.
*Crompton, Rev. Joseph, M.A. Norwich.
Crook, J. Taylor.
Crook, William Henry, LL.D.
Crooke, G. W.
1855. *Cropper, Rev. John. Stand, near Manchester.
1859. ‡Crosfield, John. Rothay Bank, Ambleside.
1861. ‡Cross, Rev. John Edward, M.A. Appleby Vicarage, near Brigg.
1853. ‡Crosskill, William, C.E. Beverley, Yorkshire.
1854. ‡Crowe, John. 3 Mersey Chambers, Liverpool.
1861. §Crowley, Henry. 255 Cheetham-hill-road, Manchester.
1863. §Crowther, B. Wakefield.
1863. ‡Cruddas, George. Elswick Engine Works, Newcastle-on-Tyne.
1860. ‡Cruickshank, John. City of Glasgow Bank, Aberdeen.
1859. ‡Cruickshank, Provost. Macduff, Aberdeen.
1859. ‡Crum, James. Busby, Glasgow.
1855. §Crum, Walter, F.R.S., F.C.S. Thornliebank, near Glasgow.
1849. ‡Cubitt, Thomas. Thames Bank, Pimlico, London.
1851. ‡Cull, Richard. 13 Tavistock-street, Bedford-square.
Culley, Robert. Bank of Ireland, Dublin.
1859. ‡Cumming, Sir A. P. Gordon, Bart. Altyre.
1847. ‡*Cumming, Rev. J. G., M.A.*
1861. *Cunliffe, Edward Thomas. Handforth, Manchester.
1861. *Cunliffe, Peter Gibson. Handforth, Manchester.
1850. ‡Cunningham, James. 50 Queen-street, Edinburgh.
1861. ‡Cunningham, James, F.R.S.E. Queen-street, Edinburgh.
Cunningham, John. Liverpool.
1852. ‡Cunningham, John. Macedon, near Belfast.
1850. ‡*Cunningham, Rev. William, D.D.*
1855. §Cunningham, William A. Manchester and Liverpool District Bank, Manchester.
1850. ‡Cunningham, Rev. W. B. Prestonpans, Scotland.
1857. ‡Curtis, Arthur H. 6 Trinity College, Dublin.
1834. *Cuthbert, J. R. 40 Chapel-street, Liverpool.
Cuthbertson, Allan. Glasgow.

1863. §Daglish, John. Hetton, Durham.
1854. ‡Daglish, Robert, C.E. Orrell Cottage, near Wigan.
1854. ‡Daglish, Robert, jun. St. Helen's, Lancashire.
Dale, Edward.
1863. ‡Dale, J. B. South Shields.
1853. ‡Dale, Rev. P. Steele, M.A. Hollingfare, Warrington.

Year of Election.

Dalmahoy, James, F.R.S.E. 9 Forres-street, Edinburgh.
1850. ‡Dalmahoy, Patrick. 69 Queen-street, Edinburgh.
1859. ‡Dalrymple, Charles Elphinstone. West Hall, Aberdeenshire.
1859. ‡Dalrymple, Colonel. Troup, Scotland.
Dalton, Edward, LL.D., F.S.A. Dunkirk House, Nailsworth.
*Dalton, Rev. James Edward, B.D. Seagrave, Loughborough.
1859. ‡Daly, Lieut.-Colonel H. D. Isle of Wight.
1859. *Dalzell, Allen, M.D. The University, Edinburgh.
Dalziel, John, M.D. Holm of Drumlanrig, Thornhill, Dumfriesshire.
1862. ‡Danby, T. W. Downing College, Cambridge.
1859. ‡Dancer, J. B., F.R.A.S. Old Manor House, Ardwick, Manchester.
Daniel, Henry, M.D.
Danson, Edward.
1847. ‡*Danson, John Towne.*
1849. *Danson, Joseph, F.C.S. 6 Shaw-street, Liverpool.
Danson, William. 6 Shaw-street, Liverpool.
1859. §Darbishire, Charles James. Rivington, near Chorley.
1861. *Darbishire, Robert Dukinfield, B.A., F.G.S. 21 Brown-street, Manchester.
*Darbishire, Samuel D. Pendyffryn, near Conway.
1852. ‡*Darby, Rev. Jonathan L.*
Darwin, Charles R., M.A., F.R.S., F.L.S., F.G.S. Down, near Bromley, Kent.
1854. ‡Dashwood, Charles. Thornage, Thetford, Norfolk.
1848. ‡Da Silva, Johnson. Burntwood, Wandsworth Common.
*Daubeny, Charles Giles Bridle, M.D., LL.D., F.R.S., F.L.S., F.G.S., M.R.I.A., V.P.C.S., Professor of Botany in the University of Oxford. Oxford.
1859. ‡Daun, Robert, M.D., F.G.S., Deputy Inspector-General of Hospitals. The Priory, Aberdeen.
Davey, Richard, M.P., F.G.S. Redruth, Cornwall.
1859. ‡Davidson, Charles. Grove House, Auchmull, Aberdeen.
1859. ‡Davidson, Patrick. Inchmarlo, near Aberdeen.
1847. ‡*Davidson, Rev. Samuel, LL.D.*
1863. ‡Davies, Griffith. 17 Cloudesley-street, Islington, London.
Davies, John Birt, M.D. Birmingham.
Davies, Thomas.
Davies, Dr. Thomas. Chester.
Davis, Charles, M.D., M.R.I.A. 33 York-street, Dublin.
1864. §Davis, Charles E., F.S.A. 55 Pulteney-street, Bath.
Davis, Rev. David, B.A. Lancaster.
1856. *Davis, Sir John Francis, Bart., K.C.B., F.R.S., F.R.G.S. Hollywood, Compton Greenfield, near Bristol.
1859. ‡Davis, J. Barnard, M.D., F.S.A. Shelton, Staffordshire.
1859. *Davis, Richard, F.L.S. 9 St. Helen's-place, London.
1863. *Davison, Joseph. Greencroft, Durham.
1864. §Davison, Richard. Great Driffield.
1857. ‡Davy, Edmund W., M.D. Kimmage Lodge, Roundtown, near Dublin.
1860. §Davy, John, M.D., F.R.S. L. & E. Lesketh How, near Ambleside.
1854. *Dawbarn, William. Wisbeach, Cambridgeshire.
1859. ‡*Dawes, Captain (Adjutant R.A. Highlanders).*
Dawes, John Samuel, F.G.S. Smethwick House, near Birmingham.
1860. *Dawes, John S., jun. Smethwick House, near Birmingham.
1864. §Dawes, R., Dean of Hereford.
*Dawes, Rev. William Rutter, F.R.A.S. Haddenham, near Thame, Oxon.
1864. §Dawkins, W. Boyd, B.A. 2 Bexley-road, Belvedere, Kent.
*Dawson, Christopher H. Low Moor, Bradford, Yorkshire.

Year of Election.

*Dawson, Henry. 14 St. James's-road, Liverpool.
Dawson, James.
Dawson, John. Royds Hall, Bradford, Yorkshire.
1855. ‡Dawson, J. W. Montreal, Canada.
Dawson, Thomas. Glasgow.
1859. *Dawson, William G. Plumstead Common, Kent.
1861. ‡Deacon, Henry. Runcorn Gap, Cheshire.
1859. ‡Dean, David. Banchory, Aberdeen.
1861. ‡Dean, Henry. Colne, Lancashire.
1854. §Deane, Henry. Clapham Common, London.
*Deane, Sir Thomas. Kingstown, Co. Dublin.
1851. ‡De Grey, The Hon. F. Copdock, Ipswich.
*De Grey and Ripon, George Frederick, Earl, F.R.S. 1 Carlton-gardens, London.
1854. *De la Rue, Warren, Ph.D., F.R.S., Pres. R.A.S. Cranford, Middlesex; and 110 Bunhill-row, London.
Denchar, John. Morningside, Edinburgh.
1854. ‡Denison, Hon. William. Grinston, Tadcaster.
Denison, Sir William Thomas, Lieut.-Col. R.E., F.R.S., F.R.G.S., Governor of Madras. Madras.
1847. ‡Dennis, J. C., F.R.A.S. 122 Bishopsgate-street, London.
1845. ‡*Denny, Henry.*
*Dent, Joseph. Ribston Hall, Wetherby.
Dent, William Yerbury. Royal Arsenal, Woolwich.
De Saumarez, Rev. Havilland, M.A. St. Peter's Rectory, Northampton.
De Tabley, George, Lord, F.Z.S. Tabley House, Knutsford, Cheshire.
*Devonshire, William, Duke of, K.G., M.A., LL.D., F.R.S., F.G.S., F.R.G.S., Chancellor of the University of Cambridge. Devonshire House, Piccadilly, London; and Chatsworth, Derbyshire.
1859. ‡Dewar, Rev. D., D.D., LL.D., Principal of Marischal College, Aberdeen.
1858. §Dibb, Thomas Townend. Little Woodhouse, Leeds.
1850. ‡Dick, Professor William. Veterinary College, Edinburgh.
1864. *Dickenson, F. H. Wingweston, Somerset.
1854. ‡Dicker, J. R. 29 Exchange-alley North, Liverpool.
1852. ‡Dickie, G., M.D., Professor of Natural History in Queen's College, Belfast.
1863. ‡Dickinson, G. T. Claremont-place, Newcastle-on-Tyne.
1853. *Dickinson, Joseph, M.D., F.R.S. 92 Bedford-street South, Liverpool.
1861. *Dickinson, W. L. 1 St. James's-street, Manchester.
1848. §Dickson, Peter. 28 Upper Brook-street, London.
1863. *Dickson, William, Clerk of the Peace for Northumberland. Alnwick, Northumberland.
*Dikes, William Hey, F.G.S. Wakefield.
*Dilke, Sir C. Wentworth, Bart., F.L.S., F.G.S., F.R.G.S. 76 Sloane-street, London.
1848. ‡Dillwyn, Lewis Llewelyn, M.P., F.L.S., F.G.S. Parkwern, near Swansea.
1859. *Dingle, Rev. J. Lanchester, Durham.
Dircks, Henry. 65 Basinghall-street, London.
1853. ‡Dixon, Edward, M.Inst.C.E. Wilton House, Southampton.
1854. ‡Dixon, Hugh. Devonshire House, Birkenhead.
1858. ‡*Dixon, Isaiah.*
1852. ‡Dixon, Rev. Robert, M.A. Trinity College, Dublin.
Dixon, Rev. W. H. Bishopthorpe, near York.

Year of Election.

1861. ‡Dixon, W. Hepworth, F.S.A., F.R.G.S. Essex-villas, Queen's-road, St. John's-wood, London.
Dixon, William Joshua.
1859. ‡*Dixon, William Smith.*
*Dobbin, Leonard, jun., M.R.I.A. 27 Gardiner's-place, Dublin.
1851. ‡Dobbin, Orlando T., LL.D., M.R.I.A. Ballivor, Kells, Co. Meath.
1860. ‡Dobbs, Archibald Edward. Balliol College, Oxford.
1864. *Dobson, William. Oakwood, Bathwick-hill, Bath.
Dockray, Benjamin. Lancaster.
1857. ‡Dodds, Thomas W., C.E. Rotherham.
*Dodsworth, Benjamin. St. Leonard's-place, York.
*Dodsworth, George. Clifton-grove, near York.
Dolphin, John. Delves House, Berry Edge, near Gateshead.
1851. ‡Domvile, William C., F.Z.S. Thorn-hill, Bray, Dublin.
*Donaldson, John, Professor of the Theory of Music in the University of Edinburgh. Edinburgh.
*Donisthorpe, George Edmund. Holly Bank, Moortown, Leeds.
Donkin, J. R.
1860. ‡Donkin, William Fishburn, M.A., F.R.S., F.R.A.S., Savilian Professor of Astronomy in the University of Oxford. 34 Broad-street, Oxford.
1861. ‡Donnelly, Captain, R.E. South Kensington Museum, London.
1857. *Donnelly, William, C.B. Auburn, Malahide, Ireland.
Donnelly, William, M.D. Sandgate, Kent.
1857. ‡Donovan, M., M.R.I.A. Clare-street, Dublin.
1863. ‡Doubleday, Thomas. 25 Ridley-place, Newcastle-upon-Tyne.
1863. *Doughty, C. Montague. Downing College, Cambridge.
Douglas, James. Cavers, Roxburghshire.
1855. §Dove, Hector. Trinity, near Edinburgh.
Dowdall, Hamilton.
Downall, Rev. John. Okehampton, Devon.
**Downie, Alexander.*
1857. ‡Downing, S., LL.D., Professor of Civil Engineering in the University of Dublin. Dublin.
1852. ‡Drennan, Dr. Chichester-street, Belfast.
Drennan, William, M.R.I.A. 35 North Cumberland-street, Dublin.
Drummond, David. Stirling.
Drummond, H. Home, F.R.S.E. Blair Drummond, Stirling.
1858. ‡Drummond, James. Greenock.
1859. ‡Drummond, Robert. 17 Stratton-street, London.
1863. ‡Dryden, James. South Benwell, Northumberland.
1856. *Ducie, Henry John Reynolds Moreton, Earl of, F.R.S. 1 Belgrave-square, London; and Tortworth-court, Wotton-under-Edge.
1835. ‡Duckett, Joseph F. Trinity College, Dublin.
1846. ‡Duckworth, William. Beechwood, near Southampton.
1852. ‡Dufferin, The Rt. Hon. Lord. Highgate, London; and Clandeboye, Belfast.
1859. *Duncan, Alexander. Rhode Island, United States.
1859. ‡Duncan, Charles. 52 Union-place, Aberdeen.
*Duncan, James, M.D. Farnham House, Finglass, Co. Dublin.
1861. ‡*Duncan, James. Greenock.*
‡*Duncan, John W.*
Duncan, J. F., M.D. 19 Gardiner's-place, Dublin.
Duncan, W. Henry, M.D. Liverpool.
1848. ‡*Dundas, Colonel, R.A.*
Dundas, Major-General Robert.
Dunlop, Alexander. Clober, Milngavie, near Glasgow.
1853. *Dunlop, William Henry. Annan-hill, Kilmarnock.

Year of Election.

1862. §Dunn, Robert, F.R.C.S. 31 Norfolk-street, Strand, London.
Dunn, William. Glasgow.
Dunnington-Jefferson, Rev. Joseph, M.A., F.C.P.S. Thicket Hall, York.
1857. ‡Du Noyer, George V. 51 Stephen's Green, Dublin.
*Dunraven, Edwin, Earl of, F.R.S., F.R.A.S., F.G.S., F.R.G.S. Adare Manor, Co. Limerick; and Dunraven Castle, Glamorganshire.
1859. ‡Duns, Rev. John, F.R.S.E. Torphichan, Bathgate, N. B.
1852. ‡Dunville, William. Richmond Lodge, Belfast.
1849. ‡Duppa, Duppa. Church Stretton, Shropshire.
1860. ‡Durham, Arthur Edward, F.R.C.S., F.L.S., Demonstrator of Anatomy, Guy's Hospital, London.
Durnford, Rev. R. Middleton, Lancashire.
1851. ‡Durrant, C. M., M.D. Rushmere, Ipswich.
1857. ‡Dwyer, Henry L., M.A., M.B. 67 Upper Sackville-street, Dublin.
Dykes, Robert. Kilmorie, Torquay, Devon.
Dyson, Thomas Wilson. 28 Oldham-street, Manchester.

1861. ‡Eadson, Richard. 13 Hyde-road, Manchester.
1864. §Earle, Rev. A. Rectory, Monkton Farleigh, Bath.
Earle, Charles, F.G.S.
Earle, William. Abercrombie-square, Liverpool.
*Earnshaw, Rev. Samuel, M.A. Broomfield, Sheffield.
1863. §Easton, James. Nest House, near Gateshead, Durham.
Eaton, Rev. George, M.A. The Pole, Northwich.
Ebden, Rev. James C., M.A., F.R.A.S., F.C.P.S. Great Stukeley Vicarage, Huntingdonshire.
1861. §Ecroyd, William Farrer. Spring Cottage, near Burnley.
*Eddison, Edwin. Headingley-hill, Leeds.
1858. *Eddison, Francis. Headingley-hill, Leeds.
*Eddy, James R., F.G.S. Carleton Grange, Skipton.
Eden, Thomas. Riversdale-road, Aigburth, Liverpool.
1852. ‡Edgar, Rev. —, D.D. University-square, Belfast.
1861. ‡Edge, John William. Percy-street, Hulme, Manchester.
*Edgeworth, Michael P., F.L.S., F.R.A.S. Mastrim House, Anerley, near London.
1855. ‡*Edington, Thomas.*
1855. ‡Edmiston, Robert. Elmbank-crescent, Glasgow.
1859. ‡Edmond, James. Cardens Haugh, Aberdeen.
1853. *Edmondston, Rev. John. Free Ashkirk Manse, by Hawick.
Edward, Joshua.
1849. ‡*Edwards, Henry.*
Edwards, James, B.A.
Edwards, John. Halifax.
1855. *Edwards, J. Baker, Ph.D. Royal Institution Laboratory, Liverpool.
*Egerton, Sir Philip de Malpas Grey, Bart., M.P., F.R.S., F.G.S. Oulton Park, Tarporley, Cheshire.
Egginton, Samuel Hall. North Ferriby, Yorkshire.
1859. *Eisdale, David A., M.A. 38 Dublin-street, Edinburgh.
1854. ‡Elcum, Charles Frederick. 3 Crescent-terrace, Cheltenham.
1855. ‡Elder, David. 19 Paterson-street, Glasgow.
1858. ‡Elder, John. 12 Centre-street, Glasgow.
1849. ‡Elkington, G. R. New Hall-street, Birmingham.
Ellacombe, Rev. H. T., F.S.A. Bilton, near Bristol.
1863. ‡Ellenberger, J. L. Worksop.
1855. §Elliot, Robert. 43 Princes-street, Edinburgh.
1861. *Elliot, Walter. Wolflee, Hawick.
1864. §Elliott, E. B. Washington, United States.

Year of Election.

1862. §Elliott, Frederick Henry, M.A. 449 Strand, London.
Elliott, John Fogg. Elvet-hill, Durham.
1859. ‡Ellis, Henry S., F.R.A.S. Fair Park, Exeter.
1857. ‡Ellis, Hercules. Lisnaroc, Clones, Ireland.
1864. *Ellis, John Alexander, B.A., F.R.S. 2 Western-villas, Colney Hatch Park, London.
1864. *Ellis, Joseph. Brighton.
1864. §Ellis, J. W. High House, near Harrogate, Yorkshire.
*Ellis, Rev. Robert, A.M. Grimstone House, near Malton, Yorkshire.
Ellman, Rev. E. B. Berwick, near Lewes, Sussex.
Ellman, Robert Harvey.
1862. ‡Elphinstone, H. W., M.A., F.L.S. Cadogan-place, London.
Eltoft, William. Care of J. Thompson, Esq., 30 New Cannon-street, Manchester.
1856. ‡*Elwait, Mons., LL.D.*
1863. ‡Embleton, Dennis, M.D. Northumberland-street, Newcastle-upon-Tyne.
1863. ‡Emery, Rev. W., B.D. Corpus Christi College, Cambridge.
1858. ‡Empson, Christopher. Headingley, near Leeds.
1853. ‡English, Edgar Wilkins. Yorkshire Banking Company, Lowgate, Hull.
Enniskillen, William Willoughby, Earl of, D.C.L., F.R.S., M.R.I.A., F.G.S. 32A Mount-street, Grosvenor-square, London; and Florence Court, Fermanagh, Ireland.
*Enys, John Samuel, F.G.S. Enys, Cornwall.
*Erle, Rev. Christopher, M.A., F.G.S. Hardwick Rectory, near Aylesbury.
1864. *Eskrigge, R. A. 34 Albany, Old Market-street, Liverpool.
1862. *Esson, William, M.A. Ness House, Cheltenham.
Estcourt, Rev. W. J. B. Long Newton, Tetbury.
Eustace, John, M.D.
1854. ‡Evans, Edward. Rock Ferry, Liverpool.
1849. *Evans, George Fabian, M.D. Waterloo-street, Birmingham.
1848. §Evans, Griffith F. D., M.D. Trewern Lodge, 43 Addison-road, Kensington, London; and Trewern, near Welshpool, Montgomeryshire.
1861. *Evans, John, F.R.S., F.S.A., F.G.S. Nash Mills, Hemel Hempstead.
Evanson, R. T., M.D. Holme Hurst, Torquay.
1854. ‡Everest, A. M. Robert. 11 Reform Club, London.
Everest, Dr.
1840. §Everest, Colonel Sir George, C.B., F.R.S., F.R.A.S., V.P.R.G.S. 10 Westbourne-street, Hyde Park.
1863. *Everette, George Allen, Belgian Consul. Birmingham.
Ewart, William, 6 Cambridge-square, Hyde Park, London; and Broadlands, Devizes.
1859. *Ewing, Archibald Orr. Clermont House, Glasgow.
1855. *Ewing, William. 209 Brandon-place, West George-street, Glasgow.
1846. *Eyre, George Edward, F.G.S., F.R.G.S. Warren's, near Lyndhurst, Hants.
Eyton, Charles. Hendred House, Abingdon.
1849. ‡Eyton, T. C. Eyton, near Wellington, Salop.

Fairbairn, Thomas. Manchester.
*Fairbairn, William, C.E., LL.D., F.R.S., F.R.G.S. Manchester.
1864. §Falkner, F. H. Lyncombe, Bath.
Fannin, John, M.A. 41 Grafton-street, Dublin.
*Faraday, Michael, D.C.L., LL.D., F.R.S., F.G.S., M.R.I.A., Fullerian Professor of Chemistry in the Royal Institution of Great Britain. 21 Albemarle-street, London.

Year of Election.

1859. ‡Farquharson, Robert O. Houghton, Aberdeen.
1861. §Farr, William, M.D., D.C.L., F.R.S., Superintendent of the Statistical Department General Registry Office, London. Southlands, Bromley, Kent.
1857. ‡Farrelly, Rev. Thomas. Royal College, Maynooth.
1859. *Faulkner, Charles, F.S.A., F.G.S., F.R.G.S. Museum, Deddington, Oxon.
1859. *Fawcett, Henry. Trinity Hall, Cambridge.
1854. ‡*Fawcett, John.*
1863. §Fawcus, G. Alma-place, North Shields.
1846. ‡Featherstonhaugh, George William, F.R.S., F.G.S. Havre.
1845. ‡Felkin, William, F.L.S. Nottingham-park.
Fell, John B. Ulverston, Lancashire.
1864. §Fellowes, F. Wolverhampton.
1852. ‡Fenton, Samuel Greame. 9 College-square, Belfast; and Keswick, near Belfast.
1855. ‡Ferguson, James. Gas Coal-works, Lesmahago, Glasgow.
1859. ‡Ferguson, John. Cove, Nigg.
1855. ‡*Ferguson, Peter.*
1857. ‡Ferguson, Samuel. 20 North Great George-street, Dublin.
1854. ‡Ferguson, William, F.L.S., F.G.S. 2 St. Aiden's-terrace, Birkenhead.
1863. *Fernie, John. Clarence Iron Works, Leeds.
Ferrall, J. M., M.D., M.R.I.A. 35 Rutland-square, Dublin.
1862. ‡Ferrers, Rev. N. M., M.A. Caius College, Cambridge.
Ferrier, Alexander James. 69 Leeson-street, Dublin.
Feversham, William, Lord. Duncombe-park, Yorkshire.
1849. ‡*Field, Charles.*
Field, Edwin W. 36 Lincoln's Inn Fields, London.
Fielden, William.
Fielding, G. H., M.D. Tunbridge, Kent.
1854. ‡Fielding, James. Mearclough Mill, Sowerby Bridge, near Halifax.
Finch, Charles. Cambridge.
1864. §Finch, Frederick George. Blackheath Park, near London.
Finch, John. Bridge Work, Chepstow.
Finch, John, jun. Bridge Work, Chepstow.
1859. ‡Findlay, Alexander George, F.R.G.S. 53 Fleet-street, London; and Hayes, Kent.
Finlay, James.
1863. §Finney, Samuel. Sheriff-hill Hall, Newcastle-upon-Tyne.
Firth, Thomas. Northwick.
1854. ‡*Fischel, Rev. Arnold, D.D.*
1851. *Fischer, William L. F., M.A., Professor of Natural Philosophy in the University of St. Andrews, Scotland.
1858. ‡Fishbourne, Captain E. G., R.N. 6 Welamere-terrace, Paddington, London.
Fisher, Rev. John Hutton, M.A., F.G.S., F.C.P.S. Kirkby Lonsdale, Westmoreland.
1858. ‡Fishwick, Captain Henry. Carr-hill, Rochdale.
1857. ‡Fitzgerald, Lord Otho. 13 Dominick-street, Dublin.
1857. ‡Fitzpatrick, Thomas, M.D. 31 Lower Bagot-street, Dublin.
Fitzwilliam, Hon. George Wentworth, M.P., F.R.G.S. 19 Grosvenor-square, London; and Wentworth House, Rotherham.
Fleetwood, Sir Peter Hesketh, Bart. Rossall Hall, Fleetwood, Lancashire.
1850. ‡Fleming, Professor Alexander, M.D. 20 Temple Row, Birmingham.
Fleming, Christopher, M.D. Merrion-square North, Dublin.
Fleming, John, M.A. Tower House, Wimbledon Common, Surrey.

Year of Election.

1855. ‡Fleming, John. 31 Whitevale, Glasgow.
Fleming, John G., M.D. 155 Bath-street, Glasgow.
‡*Fleming, Rev. Professor, D.D.*
*Fleming, William, M.D. Rowton Grange, near Chester.
Fletcher, Edward. 4 India-buildings, Liverpool.
1853. ‡Fletcher, Isaac, F.R.S., F.R.A.S. Tarn Bank, Workington.
Fletcher, T. B. E., M.D. Birmingham.
Flood, Rev. James Charles.
1862. ‡Flower, William Henry, F.R.S., F.L.S., F.R.C.S. Royal College of Surgeons, Lincoln's Inn-fields, London.
1854. *Forbes, David, F.R.S., F.G.S. 7 Calthorpe-street, Birmingham.
Forbes, George, F.R.S.E.
*Forbes, James David, LL.D., F.R.S. L. & E., F.G.S., Principal of the University of St. Andrews. St. Andrews.
1855. ‡Forbes, Rev. John. Symington Manse, Biggar, Scotland.
1855. ‡Forbes, Rev. John, D.D. 150 West Regent-street, Glasgow.
Forbes, Sir John Stuart, Bart., F.R.S.E. Fettercairne House, Kincardineshire.
1856. ‡Forbes, Colonel Jonathan. 12 Lansdowne-terrace, Cheltenham.
Ford, H. R. Morecombe Lodge, Yealand Congers, Lancashire.
Ford, John.
Formby, Richard, M.D. Sandon-terrace, Liverpool.
*Forrest, William Hutton. Stirling.
1849. *Forster, Thomas Emerson. 7 Ellison-place, Newcastle-upon-Tyne.
*Forster, William. Ballynure, Clones, Ireland.
1858. ‡Forster, William Edward. Burley, Otley, near Leeds.
1854. *Fort, Richard, F.G.S. Read Hall, Whalley, Lancashire.
*Foster, Charles Finch. Mill-lane, Cambridge.
1845. ‡Foster, Ebenezer. The Elms, Cambridge.
1857. ‡Foster, George C., B.A., F.C.S. University College, London.
1859. *Foster, George C. Sabden, near Whalley, Lancashire.
*Foster, H. S. Cambridge.
*Foster, Rev. John, M.A. The Oaks Parsonage, Loughborough, Leicestershire.
1845. ‡Foster, John N. St. Andrews, Biggleswade.
1859. *Foster, Michael, F.R.C.S. Huntingdon.
1859. §Foster, Peter Le Neve. Society of Arts, Adelphi, London.
1863. ‡Foster, Robert. 30 Rye-hill, Newcastle-upon-Tyne.
Foster, R. Brooklands, Cambridge.
1859. *Foster, S. Lloyd. Five Ways, Walsall, Staffordshire.
Fothergill, Benjamin. 28 Drayton-grove, West Brompton, London.
1856. ‡Fowler, Rev. Hugh, M.A. College-gardens, Gloucester.
1859. ‡Fowler, Rev. J. C., LL.D., F.A.S. Scotl. The Manse, Ratho, by Edinburgh.
*Fowler, Robert. Rothmolion, Co. Meath, Ireland.
Fox, Alfred. Falmouth.
*Fox, Charles. Trebah, Falmouth.
*Fox, Rev. Edward, M.A. The Vicarage, Romford, Essex.
*Fox, Joseph Hayland. Wellington, Somerset.
1860. ‡Fox, Joseph John. Church-row, Stoke Newington, London.
*Fox, Robert Barclay. Falmouth.
Fox, Robert Were, F.R.S. Falmouth.
*Fox, Samuel Lindoe. Tottenham.
Fox, Thomas.
1848. ‡Francis, George Grant, F.S.A. Burrows Lodge, Swansea.
Francis, William, Ph.D., F.L.S., F.G.S., F.R.A.S. Red Lion-court, Fleet-street, London; and 1 Matson Villas, Marsh-gate, Richmond, Surrey.

Year of Election.

1846. ‡Frankland, Edward, Ph.D., F.R.S., Professor of Chemistry in the Royal Institution and St. Bartholomew's Hospital. 42 Park-road, St. John's Park, Haverstock-hill, London.
*Frankland, Rev. Marmaduke Charles. Chowbent, near Manchester.
Franks, Rev. J. C., M.A. Whittlesea, near Peterborough.
1859. ‡Fraser, George B. Dundee.
Fraser, James. 25 Westland-row, Dublin.
1855. ‡Fraser, James P., F.G.S. 2 Laurence-place, Dowanhill, Partick by Glasgow.
Fraser, James William. 8A Kensington Palace-gardens, London.
1859. *Frazer, Daniel. 103 Buchanan-street, Glasgow.
1860. ‡Freeborn, Richard Fernandez. 38 Broad-street, Oxford.
1847. *Freeland, Humphrey William, F.G.S. The Athenæum Club, Pall Mall, London.
Freeth, Lieutenant.
1855. ‡*Frere, Captain, R.A.*
Frere, George Edward, F.R.S. Royden Hall, Diss, Norfolk.
1856. *Frerichs, John Andrew. 1 Keynsham Bank, Cheltenham.
Fripp, George D., M.D.
1857. *Frith, Richard Hastings, C.E. 51 Leinster-road, Rathmines, Dublin.
1863. *Frith, William. Burley Wood, near Leeds.
Frost, Charles, F.S.A. Hull.
1847. ‡Frost, William, F.R.A.S. Chatham-place, Hackney.
1860. *Froude, William. Emsleigh Paignton, Torquay.
Fry, Francis. Cotham, Bristol.
Fry, Richard. Cotham, Bristol.
Fry, Robert. Tockington, Gloucestershire.
1863. ‡Fryar, Mark. Eaton Moor Colliery, Newcastle-on-Tyne.
*Fullarton, Allan. 19 Woodside-place, Glasgow.
1859. ‡Fuller, Frederick, M.A., Professor of Mathematics in University and King's College, Aberdeen.
1855. *Fulton, Alexander. 7 Woodside-crescent, Glasgow.
1852. ‡Furguson, Professor John C., M.A., M.B. Queen's College, Belfast.
Furlong, Rev. Thomas, M.A. 10 Sydney-place, Bath.
1864. *Furneaux, Rev. A. St. Germain's Parsonage, Cornwall.

*Gadesden, Augustus William, F.S.A. Leigh House, Lower Tooting, Surrey.
1854. ‡Gage, M. A., C.E. 24 Elizabeth-street, Liverpool.
1857. ‡Gages, Alphonse, M.R.I.A. Museum of Irish Industry, Dublin.
1863. *Gainsford, W. D. Darnall Hall, Sheffield.
Gair, S. S.
1850. ‡Gairdner, W. F., M.D. 18 Hill-street, Edinburgh.
1861. ‡Galbraith, Andrew. Glasgow.
Galbraith, Rev. J. A., M.R.I.A. Trinity College, Dublin.
1863. §Gale, Samuel, F.C.S. 338 Oxford-street, London.
1861. ‡Galloway, Charles John. Knott Mill Iron Works, Manchester.
1859. ‡*Galloway, James. Calcutta.*
1861. ‡Galloway, John, jun. Knott Mill Iron Works, Manchester.
Galloway, S. H. Linbach, Austria.
1860. *Galton, Captain Douglas, R.E., F.R.S., F.G.S., F.R.G.S. 12 Chester-street, Grosvenor-place, London.
1860. *Galton, Francis, F.R.S., F.G.S., F.R.G.S. (*General Secretary.*) 42 Rutland-gate, Knightsbridge, London.
Gardiner, Lot. Bradford, Yorkshire.
1862. §Garner, Robert, F.L.S. Stoke-upon-Trent.
Garnett, Jeremiah. Warren-street, Manchester.
1852. ‡Garret, James R. Holywood, Belfast.

Year of Election.

1854. ‡Garston, Edgar. Aigburth, Liverpool.
1847. *Gaskell, Samuel. 19 Whitehall-place, London.
Gaskell, Rev. William, M.A. Plymouth-grove, Manchester.
1846. §Gassiot, John P., F.R.S. Clapham Common, London.
1862. *Gatty, Charles Henry, M.A., F.L.S., F.G.S. Felbridge Park, East Grinsted, Sussex.
1859. ‡Geddes, William D., Professor of Greek, King's College, Old Aberdeen.
1854. ‡Gee, Robert, M.D. Oxford-street, Liverpool.
1855. ‡Gemmell, Andrew. 38 Queen-street, Glasgow.
1855. ‡Gemmell, Thomas. 12 Elmbank-crescent, Glasgow.
1854. §Gerard, Henry. 13 Rumford-place, Liverpool.
1856. *Gething, George Barkley. Springfield, Newport, Monmouthshire.
Gibb, Duncan. Strand-street, Liverpool.
1863. *Gibb, George D., M.D., M.A., LL.D., F.G.S. 19A Portman-street, Portman-square, London.
Gibbins, Joseph. Birmingham.
Gibbins, Thomas. Birmingham.
Gibson, Edward. Hull.
*Gibson, George Stacey. Saffron Walden.
1852. ‡*Gibson, James.*
1852. ‡Gibson, James. North Frederick-street.
1847. §Gibson, Thomas Field, F.G.S. 124 Westbourne-terrace, Hyde-park, London.
1859. §Gibson, William Sidney, M.A., F.S.A., F.G.S. Tynemouth.
1861. ‡Gifford, George, Earl of, F.R.G.S. 2 Wilton-street, Grosvenor-place, London.
1849. ‡Gifford, Rev. E. H. Birmingham.
Gilbert, Dr. J. H. Harpenden, near St. Albans.
1861. *Gilbert, James Montgomery. Bowdon, Cheshire.
1857. ‡Gilbert, J. T. Blackrock, Dublin.
1859. ‡Gilchrist, James, M.D. Crichton Royal Institution, Dumfries.
Gilderdale, Rev. John, M.A. Walthamstow, Essex.
Giles, Rev. William. Netherleigh House, near Chester.
1864. §Gill, Thomas. (*Local Treasurer*). 4 Sydney-place, Bath.
1850. ‡Gillespie, Alexander, M.D. Edinburgh.
Gillies, John, M.D.
1854. ‡*Gillis, F. L.*
1849. ‡Gilpin, Benjamin. Newcastle-on-Tyne.
1861. *Gilroy, George. Hindley House, Wigan.
1850. *Gladstone, George, F.C.S. Clapham Common, London.
1849. *Gladstone, John Hall, Ph.D., F.R.S., F.C.S. 17 Pembridge-square, Hyde Park, London.
1861. *Gladstone, Murray. Broughton, Manchester.
1852. ‡*Gladstone, Thomas Murray.*
1861. *Glaisher, James, F.R.S., F.R.A.S. 1 Dartmouth-place, Blackheath, Kent.
1853. ‡Gleadon, Thomas Ward. Moira-buildings, Hull.
1859. ‡Glennie, J. S. Stuart. 6 Stone-buildings, Lincoln's Inn, London.
Glover, George. Ranelagh-road, Pimlico, London.
1852. ‡Godwin, John. Wood House, Rostrevor, Belfast.
1846. ‡Godwin-Austen, Robert, B.A., F.R.S., V.P.G.S. Chilworth Manor, Guildford.
Goldsmid, Sir Francis Henry, M.P. 62 Portland-place, London.
Gooch, Thomas L.
1857. ‡Good, John. 50 City Quay, Dublin.
1852. ‡Goodbody, Jonathan. Clare, King's County, Ireland.
*Goodman, John, M.D. The Promenade, Southport.

Year of Election.

1850. *Goodsir, John, F.R.S. L. & E., Professor of Anatomy in the University of Edinburgh. 21 Lothian-street, Edinburgh.
Goodwin, Very Rev. Harvey, D.D., F.C.P.S., Dean of Ely. Caius College, Cambridge.
1859. ‡*Gordon, H. G.*
*Gordon, Rev. James Crawford, M.A. Delamont, Downpatrick, Downshire.
Gordon, Lewis.
1857. ‡Gordon, Samuel, M.D. 11 Hume-street, Dublin.
*Gotch, Rev. Frederick William, LL.D. Stokes Croft, Bristol.
*Gotch, Thomas Henry. Ilford, Essex.
1849. ‡Gough, Hon. Frederick. Perry Hall, Birmingham.
1857. ‡Gough, The Hon. G. S. Rathronan House, Clonmel.
Gould, John, F.R.S., F.L.S., F.R.G.S., F.Z.S. 26 Charlotte-street, Bedford-square, London.
1854. ‡*Gourley, Daniel De la C., M.D.*
Gowland, James. London-wall, London.
**Græme, James.*
1861. ‡Grafton, Frederick W. Park-road, Whalley Range, Manchester.
1848. ‡*Graham, John B.*
Graham, Lieutenant David. Mecklewood, Stirlingshire.
*Graham, Thomas, M.A., D.C.L., F.R.S. L. & E., F.G.S., V.P.C.S., Master of the Mint. 4 Gordon-square, London.
1852. *Grainger, John. Rose Villa, Belfast.
Grainger, Richard. Newcastle-upon-Tyne.
1850. ‡*Grainger, Thomas.*
1859. ‡Grant, Hon. James. Cluny Cottage, Forres.
1855. §Grant, Robert, M.A., F.R.A.S., Regius Professor of Astronomy in the University of Glasgow. The Observatory, Glasgow.
1854. ‡Grantham, John, C.E. Liverpool.
1864. §Grantham, Richard F. 7 Great Scotland-yard, London.
1854. ‡Grantham, R. B. 7 Great Scotland-yard, London.
Granville, Augustus Bozzi, M.D., F.R.S., F.G.S., M.R.I.A. 5 Cornwall-terrace, Warwick-square, Pimlico, London.
Grasswell, R. N.
1861. *Gratton, Joseph. 32 Gower-street, Bedford-square, London.
1854. ‡Gravatt, William, F.R.S. 15 Park-street, Westminster.
*Graves, Very Rev. Charles, D.D., M.R.I.A. Dublin Castle, Dublin.
*Graves, Rev. Richard Hastings, D.D. Brigown Glebe, Michelstown, Co. Cork.
1864. *Gray, Rev. Charles. Trinity College, Cambridge.
**Gray, John.*
1857. ‡Gray, John, M.D. Rathgar, Dublin.
*Gray, John. Greenock.
*Gray, John Edward, Ph.D., F.R.S., Keeper of the Zoological Collections of the British Museum. British Museum.
1864. §Gray, Jonathan. Summerhill-house, Bath.
1859. ‡Gray, Rev. J. H. Bolsover Castle, Derbyshire.
*Gray, William, F.G.S. (*Local Treasurer.*) Minster Yard, York.
1861. *Gray, W., M.P. Darcey Lever Hall, Bolton.
1854. *Grazebrook, Henry, jun. 37 Falkner-square, Liverpool.
Green, Rev. Henry. Knutsford.
*Greenaway, Edward. 16 Lansdowne-crescent, Notting-hill, London.
Greene, Joseph.
1857. ‡Greene, Professor J. Reay, Queen's College, Cork. 5 Ebenezer-terrace, Cork.
1845. ‡*Greene, Richard, M.D.*

Year of Election.

1858. *Greenhalgh, Thomas. Sharples, near Bolton-le-Moors.
Greenler, Matthew.
1863. ‡Greenwell, G. E. Poynton, Cheshire.
1862. §Greenwood, Henry. Huyton Park, Huxton, near Prescot.
1849. ‡Greenwood, William. Stones, Todmorden.
1861. *Greg, Robert Philips, F.G.S. (*Local Treasurer.*) Outwood Lodge, near Manchester.
Gregg, T. H. 9 Alfred-terrace, Queen's-road, Bayswater.
1860. ‡Gregor, Rev. Walter, M.A. Macduff, Banff, Scotland.
1861. §Gregson, Rev. Samuel Leigh. Aigburth, near Liverpool.
Gresham, Rev. John, LL.D.
Gresham, Thomas M. Raheny, Dublin.
*Greswell, Rev. Richard, B.D., F.R.S., F.R.G.S. St. Giles's-street, Oxford.
Greville, R. K., LL.D., F.R.S.E. Edinburgh.
Grey, Captain The Hon. Frederick William. Howick, Northumberland.
1863. ‡Grey, W. S. Norton, Stockton-on-Tees.
1859. ‡Grierson, Thomas Boyle. Thornhill, Dumfriesshire.
1855. ‡*Griffin, Charles.*
*Griffin, John Joseph, F.C.S. 119 Bunhill-row, London.
Griffin, S. F.
Griffin, Thomas.
Griffith, Rev. C. T., D.D. Elm, near Frome, Somerset.
1859. §Griffith, George, M.A., F.C.S. (*Assistant General Secretary.*) 5 Park Villas, Oxford.
Griffith, George R. Fitzwilliam-place, Dublin.
*Griffith, Sir Richard, Bart., LL.D., F.R.S.E., M.R.I.A., F.G.S. 2 Fitzwilliam-place, Dublin.
Griffith, Walter H., M.A. 13 Clare-street, Dublin.
Griffiths, Rev. John, M.A. 63 St. Giles's, Oxford.
1847. **Griffiths, S. Y. Oxford.*
1847. ‡Griffiths, Thomas. Bradford-street, Birmingham.
Grimshaw, Samuel, M.A. Errwod, Buxton.
1864. §Groom, C. O. South Mill Cottage, Kingsdown, Bristol.
Grove, William Robert, Q.C., M.A., Ph.D., F.R.S. 46 Upper Harley-street; and 4 Hare-court, Temple, London.
1849. ‡*Grover, Rev. H. M.*
1863. §Groves, T. B. Weymouth, Dorset.
1857. ‡Grubb, Thomas, F.R.S., M.R.I.A. Bank of Ireland, Dublin.
Guest, Edwin, LL.D., M.A., F.R.S., F.L.S., F.R.A.S., Master of Caius College, Cambridge. Caius Lodge, Cambridge; and Sandford-park, Oxfordshire.
Guinness, Henry. 26 South Frederick-street, Dublin.
Guinness, Richard Seymour. 26 South Frederick-street, Dublin.
*Guinness, Rev. William Smyth, M.A. Beaumont, Drumcondra, Co. Dublin.
1856. *Guise, W. V. Elmore-court, Gloucester.
1862. ‡Gunn, Rev. John, M.A. Irstedd Rectory, Norwich.
1860. *Gurney, Samuel, M.P., F.R.G.S. 25 Princes-gate, London.
*Gutch, John James. 88 Micklegate, York.
1850. ‡Guthrie, Frederick. University of Edinburgh.
1864. §Guyon, George. South Cliff Cottage, Ventnor, Isle of Wight.
1857. ‡Gwynne, Rev. John. St. Columbe's College, Dublin.

Hackett, Michael. Brooklawn, Chapelizod, Dublin.
Hackworth, Timothy. Darlington.
1854. ‡*Haddock, John.*

Year of Election.

1862. ‡Haddon, Frederick William, Assistant-Secretary to the Statistical Society of London. 12 St. James's-square, London.
Haden, G. N. Trowbridge, Wiltshire.
Hadfield, George, M.P. Victoria-park, Manchester.
1848. ‡Hadland, William Jenkins. Banbury, Oxfordshire.
*Hailstone, Edward, F.S.A. Horton Hall, Bradford, Yorkshire.
Haire, James, M.A.
1845. ‡Hall, Elias. Castleton, Derbyshire.
1854. *Hall, Hugh Fergus. 17 Dale-street, Liverpool.
1850. ‡Hall, Sir John. Dunglass, Haddington.
1859. ‡Hall, John Frederic. Ellerker House, Richmond, Surrey.
Hall, John R. Sutton, Surrey.
1863. ‡Hall, Thomas Y. Eldon-square, Newcastle-on-Tyne.
*Hall, T. B. Coggeshall, Essex.
1860. §Hall, Walter. 10 Pier-road, Erith.
Halliday, A. H., M.A., F.L.S., M.R.I.A. Carnmoney, Antrim, Ireland.
1861. ‡Halliday, James. Whalley Court, Whalley Range, Manchester.
1857. ‡*Halpin, George, C.E.*
Halsall, Edward. Bristol.
Halswell, Edmund S., M.A.
1858. *Hambly, Charles Hambly Burbridge, F.G.S. 6 Taptonville, Sheffield.
1846. ‡Hambrough, A. J. Isle of Wight.
Hamilton, Archibald.
1857. ‡Hamilton, Charles W. 40 Dominick-street, Dublin.
1859. ‡Hamilton, Claud. New Club, Edinburgh.
Hamilton, The Very Rev. Henry Parr, Dean of Salisbury, M.A., F.R.S. L. & E., F.G.S., F.R.A.S. Salisbury.
*Hamilton, Mathie, M.D. Warwick-street, Glasgow.
1864. §Hamilton, Rev. S. R., M.A. 3 Alma-villas, Lansdown, Bath.
*Hamilton, William John, F.R.S., Pres. G.S. 5 Lyall-place, Belgrave-square, London.
*Hamilton, Sir William Rowan, LL.D., M.R.I.A., F.R.A.S., Astronomer Royal of Ireland, and Andrews Professor of Astronomy in the University of Dublin. Observatory, near Dublin.
1851. ‡Hammond, C. C. Lower Brook-street, Ipswich.
1863. ‡Hancock, Albany, F.L.S. 4 St. Mary's-terrace, Newcastle-upon-Tyne.
1852. ‡*Hancock, Charles Brownlow.*
1863. ‡Hancock, John. 4 St. Mary's-terrace, Newcastle-on-Tyne.
1850. ‡Hancock, John. Manor House, Lurgan, Co. Armagh.
1861. ‡Hancock, Walker. 10 Upper Chadwell-street, London.
1857. ‡Hancock, William J. 74 Lower Gardiner-street, Dublin.
1847. ‡Hancock, W. Nelson, LL.D. 74 Lower Gardiner-street, Dublin.
Handyside, P. D., M.D., F.R.S.E. 11 Hope-street, Edinburgh.
1859. ‡Hannay, John. Montcoffer House, Aberdeen.
1853. ‡Hansell, Thomas T. 2 Charlotte-street, Sculcoates, Hull.
1854. ‡*Hanson, Samuel.*
*Harcourt, A. Vernon, M.A., F.C.S. Christ Church, Oxford.
Harcourt, Rev. C. G. Vernon, M.A. Rothbury, Northumberland.
Harcourt, Egerton V. Vernon, M.A., F.G.S. Whitwell Hall, Yorkshire.
*Harcourt, Rev. William V. Vernon, M.A., F.R.S., F.G.S., Hon. M.R.I.A. Nuneham Park, Oxford.
1849. ‡Harding, Charles. Tamworth.
1864. §Hardwicke, Robert. 192 Piccadilly, London.
1858. *Hardy, Charles. Odsall House, Bradford, Yorkshire.

Year of Election.

*Hare, Charles John, M.D., Professor of Clinical Medicine in University College, London. 41 Brook-street, Grosvenor-square, London.
Hare, Samuel. 9 Langham-place, London.
Harford, John Scandrett, D.C.L., F.R.S., F.G.S. Blaise Castle, Bristol.
Harford, Summers. Reform Club, London.
1858. ‡Hargrave, James. Burley, near Leeds.
1857. ‡Hargreave, Charles James, LL.D., F.R.S. 12 Fitzwilliam-square, Dublin.
1853. §Harkness, Robert, F.R.S. L. & E., F.G.S., Professor of Geology in Queen's College, Cork.
Harkworth, Timothy. Soho Shilden, Darlington.
1862. *Harley, George, M.D., F.C.S., Professor of Practical Physiology and Histology in University College, London.
*Harley, John. Ross Hall, near Shrewsbury.
1862. *Harley, Rev. Robert, F.R.S., F.R.A.S., Professor of Mathematics and Logic in Airedale College, Bradford. The Manse, Brighouse, Yorkshire.
1861. ‡Harman, H. W., C.E. 16 Booth-street, Manchester.
*Harris, Alfred. Ryshwall Hall, near Bingley, Yorkshire.
*Harris, Alfred, jun. Bradford, Yorkshire.
1863. ‡Harris, Charles. 6 Somerset-terrace, Newcastle-on-Tyne.
Harris, The Hon. and Rev. Charles, F.G.S. Bremhill, Chippenham, Wiltshire.
**Harris, George William.*
*Harris, Henry. Heaton Hall, near Bradford.
1845. ‡Harris, Henry H. Cambridge.
1863. ‡Harris, T. W. Grange, Middlesborough-on-Tees.
Harris, Sir William Snow, F.R.S. Windsor Villas, Plymouth.
1862. ‡Harris, William Harry, F.C.S. 33 Gold-street, Northampton.
1860. ‡Harrison, Rev. Francis, M.A. Oriel College, Oxford.
1864. §Harrison, George. Barnsley.
1858. *Harrison, James Park, M.A. Garlands, Ewhurst, Surrey.
1856. ‡Harrison, Rev. Laurence. 11 Lansdowne-terrace, Cheltenham.
Harrison, Robert, M.D., Professor of Anatomy and Surgery in the University of Dublin. 1 Hume-street, Dublin.
1853. ‡Harrison, Robert. 36 George-street, Hull.
1863. ‡Harrison, T. E. Engineers' Office, Central Station, Newcastle-on-Tyne.
1853. *Harrison, William, F.S.A., F.G.S. Galligreaves Hall, near Blackburn, Lancashire.
1854. ‡*Harrison, William.*
1849. ‡Harrowby, The Earl of, K.G., D.C.L., F.R.S., F.R.G.S. 39 Grosvenor-square, London; and Sandon Hall, Lichfield.
1859. *Hart, Charles. 54 Wych-street, Strand, London.
Hart, John, M.D., M.R.I.A. 3 Bloomfield-avenue, Dublin.
1861. *Harter, J. Collier. Chapel Walks, Manchester.
*Harter, William. Hope Hall, Manchester.
1856. ‡Hartland, F. Dixon, F.S.A., F.R.G.S. The Oaklands, near Cheltenham.
Hartley, James. Sunderland.
Hartley, J. B. Bootle, near Liverpool.
Hartnell, Aaron.
Hartnell, M. A., B.A.
1854. §Hartnup, John, F.R.A.S. The Observatory, Liverpool.
Hartop, Henry. Barmborough Hall, near Rotherham.
1850. ‡Harvey, Alexander. 4 South Wellington-place, Glasgow.

Year of Election.

*Harvey, Joseph Charles. Cork.
Harvey, J. R., M.D. St. Patrick's-place, Cork.
1847. ‡Harvey, William Henry, M.D., F.L.S., M.R.I.A., Professor of Botany in the University of Dublin. Trinity College, Dublin.
1862. *Harwood, John, jun. Mayfield, Bolton.
1855. ‡Hassall, Arthur Hill. 8 Bennett-street, St. James's, London.
Hastings, Rev. H. S. Martley Rectory, Worcester.
1863. ‡Hatton, G. D. Old Trafford, Manchester.
*Hatton, James. Richmond House, Higher Broughton, Manchester.
1863. §Hatton, J. W. Old Trafford, Manchester.
Haughton, James, M.R.D.S. 34 Eccles-street, Dublin.
1857. ‡Haughton, Rev. Samuel, M.D., M.A., F.R.S., M.R.I.A., F.G.S., Professor of Geology in the University of Dublin. Trinity College, Dublin.
1857. ‡Haughton, S. Wilfred. Grand Canal-street, Dublin.
*Haughton, William. 28 City Quay, Dublin.
1845. ‡Haviland, John, M.D. Cambridge.
1856. ‡Haville, Henry. Montpellier Spa Buildings, Cheltenham.
1847. ‡Hawkins, Rev. Edward, D.D., Provost of Oriel College, Oxford.
Hawkins, John Heywood, M.A., F.R.S., F.G.S. Bignor Park, Petworth, Sussex.
Hawkins, John Isaac, C.E.
*Hawkins, Thomas, F.G.S. Down Court, Isle of Wight.
1851. ‡Hawkins, W. W. Tower-street, Ipswich.
*Hawkshaw, John, F.R.S., F.G.S. 43 Eaton-place, London.
1864. *Hawkshaw, John Clark, B.A. 43 Eaton-place, London.
1853. ‡Haworth, Benjamin, J.P. Hull Bank House, near Hull.
*Hawthorn, Robert, C.E. Newcastle-upon-Tyne.
1863. §Hawthorn, William. The Cottage, Benwell, Newcastle-upon-Tyne.
1859. ‡Hay, Sir Andrew Leith, Bart. Rannes, Aberdeenshire.
1861. *Hay, Sir John D. United Service Club, London.
1858. ‡Hay, Samuel. Albion-place, Leeds.
1857. ‡Hayden, Thomas, M.D. 30 Harcourt-street, Dublin.
1856. ‡Hayward, J. Curtis. Quedgeley, near Gloucester.
1858. *Hayward, Robert Baldwin, M.A. Harrow-on-the-hill.
1851. ‡Head, Jeremiah. Woodbridge-road, Ipswich.
1861. *Heald, James. Parr's Wood, Didsbury, near Manchester.
1863. ‡Heald, Joseph. 22 Leazes-terrace, Newcastle-on-Tyne.
1854. ‡Healey, Elkanah. Gateacre.
1861. *Heape, Benjamin. Northwood, near Manchester.
1854. ‡Heath, Edward. Everton, near Liverpool.
1863. ‡Heath, G. Y., M.D. Westgate-street, Newcastle-on-Tyne.
Heath, John. 11 Albemarle-street, London.
1861. §Heathfield, W. E., F.R.G.S. 20 King-street, St. James's, London.
1858. *Heaton, John Deakin, M.D. Claremont, Leeds.
1863. §Heckels, Richard. Pensher, near Fencehouses, Durham.
1855. ‡Hector, James, M.D., F.R.S.E., F.G.S., F.R.G.S., Geological Survey of Otago. New Zealand.
1863. ‡Hedley, Thomas. Cox Lodge, near Newcastle-on-Tyne.
*Heelis, Thomas. Princes-street, Manchester.
1854. ‡Heldenmaier, B., Ph.D. Worksop, Notts.
1862. ‡Helm, George F. 58 Trumpington-street, Cambridge.
1857. *Hemans, George William, C.E., M.R.I.A.. 32 Leinster-gardens, Hyde Park, London.
1845. ‡Henderson, Andrew. 120 Gloucester-place, Portman-square, London.
Henn, Richard. 17 Herbert-street, Dublin.
1856. §Hennessy, Henry G., F.R.S., M.R.I.A., F.R.G.S. Wynnefield, Rathgar, Co. Dublin.

Year of
Election.

1857. ‡Hennessy, John Pope. Inner Temple, London.
Henry, Franklin. Portland-street, Manchester.
Henry, J. Snowdon. East Dene, Bonchurch, Isle of Wight.
Henry, Mitchell. Stratheden House, Hyde Park, London.
*Henry, William Charles, M.D., F.R.S., F.R.G.S. Haffield, near Ledbury, Herefordshire.
1846. ‡Henville, Rev. C. B. Hamble Rectory, near Southampton.
Henwood, William Jory, F.R.S., F.G.S. 3 Clarence-place, Penzance.
1855. *Hepburn, J. Gotch. Clapham Common, Surrey.
1855. ‡Hepburn, Robert. 8 Davies-street, Berkeley-square, London.
Hepburn, Thomas. Clapham, London.
Hepworth, John M. Ackworth, Yorkshire.
1856. ‡Hepworth, Rev. Robert. 2 St. James's-square, Cheltenham.
1864. §Herapath, William Bird, M.D., F.R.S. L. & E. Old Market-street, Bristol.
*Herbert, Thomas. Nottingham.
Herbertson, John.
1852. ‡Herdman, John. 9 Wellington-place, Belfast.
Herschel, Sir John Frederick William, Bart., K.H., M.A., D.C.L., F.R.S. L. & E., Hon. M.R.I.A., F.G.S., F.R.A.S. Collingwood, near Hawkhurst, Kent.
1861. ‡Hertz, James. Sedgley-park, Prestwich, near Manchester.
1851. ‡Hervey, The Rev. Lord Arthur. Ickworth, Suffolk.
1863. ‡Heslop, Joseph. Pilgrim-street, Newcastle-on-Tyne.
1832. ‡Hewitson, William C. Oatlands, Surrey.
1847. ‡*Hext, Rev. George, M.A.*
Hey, Rev. William, M.A., F.C.P.S. Clifton, York.
1861. *Heywood, Arthur Henry. Sedgley-park, Manchester.
*Heywood, Sir Benjamin, Bart., F.R.S. 9 Hyde Park-gardens, London; and Claremont, Manchester.
*Heywood, James, F.R.S., F.G.S., F.S.A., F.R.G.S. 26 Palace-gardens, Kensington, London.
Heywood, Lawrence.
1861. *Heywood, Oliver. Acresfield, Manchester.
*Heywood, Robert. Bolton.
Heywood, Thomas Percival. Claremont, Manchester.
1854. ‡*Heyworth, Captain L., jun.*
1864. *Hiern, W. P., M.A. St. John's College, Cambridge.
1854. *Higgin, Edward. Liverpool.
1861. *Higgin, James. Hopwood-avenue, Manchester.
Higginbotham, Samuel. Exchange-square, Glasgow.
1861. ‡Higgins, George. Mount House, Higher Broughton, Manchester.
1854. ‡Higgins, Rev. Henry H., M.A. Rainhill, Liverpool.
1861. *Higgins, James. Stocks House, Cheetham, Manchester.
1854. ‡Highley, Samuel, F.G.S. Boxhill, near Dorking, Surrey.
*Higson, Peter. Irwell-terrace, Lower Broughton, Manchester.
Hildyard, Rev. James, B.D., F.C.P.S. Ingoldsby, near Grantham, Lincolnshire.
1862. *Hiley, Rev. Simeon. St. John's College, Cambridge.
Hill, Arthur. Bruce Castle, Tottenham.
*Hill, Rev. Edward, M.A., F.G.S. Sheering Rectory, Harlow.
1857. ‡Hill, John. Tullamore, Ireland.
1855. ‡Hill, Laurence. Port Glasgow.
*Hill, Sir Rowland, K.C.B., D.C.L., F.R.S., F.R.A.S. Hampstead, London.
1864. §Hill, William. Combe Hay, Bristol.
1863. ‡Hills, F. C. Deptford, Kent.
1850. ‡Hincks, Rev. Edward, D.D. Killyleagh, Ireland.

Year of Election.

1858. ‡Hincks, Rev. Thomas, B.A. Mountside, Leeds.
Hincks, Rev. William, F.L.S., Professor of Natural History in University College. Toronto, Canada West.
Hindley, Rev. H. J. Walton-on-the-hill, Lancashire.
1852. *Hindmarsh, Frederick, F.G.S., F.R.G.S. 17 Bucklersbury, London.
*Hindmarsh, Luke. Alnwick.
1861. *Hinmers, William. Farnworth, Bolton.
1858. §Hirst, John, jun. Dobcross, Saddleworth.
1861. *Hirst, Thomas Archer, Ph.D., F.R.S. 14 Waverley-place, St. John's-wood, London.
1856. ‡Hitch, Samuel, M.D. Sandywell Park, Gloucestershire.
1860. ‡Hitchman, John. Leamington.
*Hoare, Rev. George Tooker. Tandridge, Godstone.
Hoare, J. Gurney. Hampstead, London.
1864. §Hobhouse, Arthur Fane. 24 Cadogan-place, Sloane-street, London.
1864. §Hobhouse, Charles Parry. 24 Cadogan-place, Sloane-street, London.
1864. §Hobhouse, Henry William. 24 Cadogan-place, Sloane-street, London.
1863. §Hobson, A. S. 3 Upper Heathfield-terrace, Turnham Green, London.
1852. ‡Hodges, John F., M.D., Professor of Agriculture in Queen's College, Belfast. 23 Queen-street, Belfast.
*Hodgkin, Thomas, M.D., F.R.G.S. 35 Bedford-square, London.
1863. *Hodgkin, Thomas. (*Local Treasurer.*) Newcastle-on-Tyne.
1847. ‡Hodgkinson, Rev. G. C. The Lodge, Louth.
*Hodgson, Adam. Everton, Liverpool.
Hodgson, Joseph, F.R.S. 60 Westbourne-terrace, London.
1863. ‡Hodgson, Robert. Whitburn, Sunderland.
1863. ‡Hodgson, R. W. North Dene, Gateshead.
Hodgson, Thomas. Market-street, York.
1847. ‡*Hodgson, W. B.*
1845. ‡Hoffman, G. H. Margate.
1860. ‡Hogan, Rev. A. R., M.A. Puddletown, Dorchester.
Hogan, William, M.A., M.R.I.A. Haddington-terrace, Kingstown, near Dublin.
Hogg, John, M.A., F.R.S., F.L.S., F.R.G.S., F.C.P.S. 8 Serjeants' Inn, London; and Norton, Stockton-on-Tees.
1861. ‡Holcroft, George, C.E. Red Lion-court, St. Ann's-square, Manchester.
1854. ‡Holcroft, George. 82 Great Ducie-street, Manchester.
*Holditch, Rev. Hamnet, M.A. Caius College, Cambridge.
1856. ‡Holland, Henry, M.P. Dumbleton, Evesham.
1858. §Holland, Loton. Swanscoe Park, Macclesfield.
**Holland, P. H.*
*Hollingsworth, John. London-street, Greenwich, Kent.
Holmes, Rev. W. R.
Holt, Edward.
Holt, Henry. Notton, near Wakefield.
Hone, Joseph, M.R.D.S. 2 Harcourt-street, Dublin.
*Hone, Nathaniel, M.R.I.A. Doloughs Park, Co. Dublin.
Honeyman, John.
1851. ‡Honywood, Robert. Marks Hall, Essex.
1858. ‡Hook, The Very Rev. W. F., D.D., Dean of Chichester. Chichester.
1847. ‡Hooker, Joseph D., M.D., F.R.S., V.P.L.S., F.G.S. Royal Gardens, Kew.
1861. §Hooper, William. 7 Pall Mall East, London.
1856. ‡Hooton, Jonathan. 80 Great Ducie-street, Manchester.
1845. ‡*Hope, Rev. F. W.*
Hope, Thomas Arthur. Liverpool.
Hope, William. Wavertree, Liverpool.

Year
Election.

*Hopkins, William, M.A., LL.D., F.R.S., F.G.S. (*General Secretary.*) Cambridge.
1858. ‡Hopkinson, Joseph, jun. Britannia Works, Huddersfield.
Hopkinson, William. Stamford.
Hornby, Hugh. Sandown, Liverpool.
1864. *Horner, Rev. J. J. H. Mells Rectory, Frome.
1858. *Horsfall, Abraham. Leeds.
Horsfall, Charles. Everton, Liverpool.
Horsfall, John. Wakefield.
1854. ‡Horsfall, Thomas B., M.P. Liverpool.
1855. *Horsfield, George. Brampton-grove, Smedley-lane, Cheetham, Manchester.
1856. ‡Horsley, John H. 389 High-street, Cheltenham.
Hotham, Rev. Charles, M.A., F.L.S. Roos Patrington, Yorkshire.
1859. §Hough, Joseph. Wrottesley, near Wolverhampton.
Houghton, The Right Hon. Lord. 16 Upper Brook-street, London.
Houghton, James. Rodney-street, Liverpool.
Houghton, William.
*Houldsworth, Henry. Newton-street, Manchester.
1858. ‡Hounsfield, James. Hemsworth, Pontefract.
Houtson, John.
Hovenden, W. F., M.A. Bath.
1859. ‡Howard, Captain John Henry, R.N. The Deanery, Lichfield.
1863. ‡Howard, Philip Henry. Corby Castle, Carlisle.
1849. ‡*Howard, Samuel.*
1857. ‡Howell, Henry H. Museum of Practical Geology, Jermyn-street, London.
Howell, John, M.D. Datchet, near Windsor.
1863. §Howorth, H. H. Castleton Hall, Rochdale.
1863. ‡Howse, R. South Shields.
1854. ‡Howson, Rev. J. S. South-hill, Toxteth Park, Liverpool.
Hudson, George.
*Hudson, Henry, M.D., M.R.I.A. Glenville, Fermoy, Co. Cork.
Hudson, John. Oxford.
1842. §Hudson, Robert, F.R.S., F.G.S., F.L.S. Clapham Common, London.
1858. ‡Huggins, William, F.R.A.S. Upper Tulse-hill, London.
1857. §Huggon, William. 30 Park-row, Leeds.
Hughes, D. L.
Hughes, Frederick Robert.
1845. ‡*Hughes, Alderman Hughes.*
Hughes, H. H.
1863. ‡Hughes, T. W. 4 Hawthorn-terrace, Newcastle-on-Tyne.
Hull, Arthur H. Brighton.
**Hull, William Darley, F.G.S.*
Hulley, Dr.
*Hulse, Sir Edward, D.C.L. 4 New Burlington-street, London; and Breamore House, Salisbury.
1861. ‡Hume, Rev. A., D.C.L., F.S.A. Everton, Liverpool.
1845. ‡Humpage, Edward. Bristol.
1856. ‡Humphreys, E. R., LL.D. Grammar School, Cheltenham.
1856. ‡Humphries, David James. 1 Keynsham-parade, Cheltenham.
1862. *Humphry, George Murray, M.D., F.R.S. Trumpington-street, Cambridge.
1863. *Hunt, Augustus H., Ph.D. Pelaw Main Office, Newcastle-on-Tyne.
1860. ‡Hunt, James, Ph.D., F.S.A. Ore House, Hastings.
1840. §Hunt, Robert, F.R.S., Keeper of the Mining Records. Museum of Practical Geology, Jermyn-street, London.
1864. §Hunt, W. 72 Pulteney-street, Bath.

Year of Election.

Hunter, Adam, M.D., F.R.S.E. Edinburgh.
Hunter, Andrew G. Low Walker, Newcastle-on-Tyne.
1850. ‡*Hunter, J. D., M.D.*
Hunter, Robert, F.R.S., F.G.S., F.R.A.S., F.S.A. Highgate, London.
1859. ‡*Hunter, Dr. Thomas, Deputy Inspector-General of Army Hospitals.*
1855. *Hunter, Thomas C. Greenock.
1863. §Huntsman, Benjaman. West Retford Hall, Retford.
1861. *Hurst, William John. 2A Victoria-street, Manchester.
1851. ‡*Hurwood, George.*
Husband, William Dalla. Coney-street, York.
*Hutchinson, John. Widnes Dock, Warrington.
1863. ‡Hutt, The Right Hon. W., M.P. Gibside, Gateshead.
Hutton, Crompton. Putney-park, Surrey.
Hutton, Daniel. 4 Lower Dominick-street, Dublin.
1864. §Hutton, Darnton. 11 Warnford-court, Throgmorton-street, London.
Hutton, Edward, M.D., M.R.I.A. 29 Gardiner's-place, Dublin.
Hutton, Henry. Eccles-street, Dublin.
1857. ‡Hutton, Henry D. 1 Nelson-street, Dublin.
*Hutton, Robert, M.R.I.A., F.G.S. Putney Park, Surrey.
Hutton, Thomas, F.G.S., M.R.I.A. 14 Summerhill, Dublin.
1861. §Hutton, T. Maxwell. Summerhill, Dublin.
1852. ‡Huxley, Thomas Henry, Ph.D., F.R.S., F.L.S., F.G.S., Professor of Natural History in the Government School of Mines, and Hunterian Professor of Comparative Anatomy in the Royal College of Surgeons. Museum of Practical Geology, Jermyn-street, London.
1846. ‡Huxtable, Rev. Anthony. Sutton Waldron, near Blandford.
Hyde, Edward. Dukinfield, near Manchester.
Hyett, William Henry, F.R.S. Painswick, near Stroud, Gloucestershire.
1847. ‡Hyndman, George C. 5 Howard-street, Belfast.

*Ibbetson, Captain L. L. Boscawen, Chevalier Red Eagle of Prussia *with Swords*, Chevalier de Hohenzollern, F.R.S., F.G.S.
1854. ‡Ihne, William, Ph.D. Carlton-terrace, Liverpool.
1861. ‡Iles, Rev. J. H. Rectory, Wolverhampton.
1858. ‡Ingham, Henry. Wortley, near Leeds.
1849. ‡*Ingleby, Clement.*
1839. ‡*Ingleby, C. Mansfield.*
1858. ‡Ingram, Hugo C. Meynell. Temple Newsam, near Leeds.
1858. *Ingram, Hugo Francis Meynell. Temple Newsam, Leeds.
1852. ‡Ingram, J. K., LL.D., M.R.I.A., Professor of Oratory. Trinity College, Dublin.
1854. *Inman, Thomas, M.D. Rodney-street, Liverpool.
1856. ‡*Invararity, J. D. Bombay.*
Ireland, R. S., M.D. 121 Stephen's Green, Dublin.
1857. ‡Irvine, Hans, M.A., M.B. 1 Rutland-square, Dublin.
Irwin, Rev. Alexander, M.A. Armagh, Ireland.
1845. ‡Irwin, Thomas. Somerset House, London.
1862. ‡Iselin, J. F., M.A. Wimbledon, Surrey.
1839. ‡Ivory, Holmes. 2 South-street, David-street, Edinburgh.
1863. *Ivory, Thomas. 9 Ainslie-place, Edinburgh.

1859. §Jack, John. Belhelvie, Aberdeen.
1863. *Jackson, Mrs. H. 24 Hereford-square, Gloucester-road, Old Brompton, London.
1858. ‡Jackson, Samuel Smith. 9 Brunswick-place, Leeds.
Jackson, Professor Thomas, LL.D. St. Andrew's, Scotland.
1855. ‡Jackson, Rev. William, M.A. St. John's, Workington.

Year of Election.

Jacob, Arthur, M.D. 23 Ely-place, Dublin.
1852. §Jacobs, Bethel. 40 George-street, Hull.
1859. ‡James, Edward. 9 Gascoyne-terrace, Plymouth.
1860. ‡James, Edward H. 9 Gascoyne-terrace, Plymouth.
James, Colonel Sir Henry, R.E., F.R.S., F.G.S., M.R.I.A. Ordnance Survey Office, Southampton.
James, Sir John K., M.R.I.A., Bart. 9 Cavendish-row, Dublin.
1863. *James, Sir Walter. 6 Whitehall-gardens, London.
1858. ‡James, William C. 9 Gascoyne-terrace, Plymouth.
1863. ‡Jameson, John Henry. 10 Catherine-terrace, Gateshead.
1859. *Jamieson, Thomas F., F.G.S. Ellon, Aberdeenshire.
1850. ‡Jardine, Alexander. Jardine Hall, Lockerby.
Jardine, James, C.E., F.R.A.S. Edinburgh.
*Jardine, Sir William, Bart., F.R.S.E. Jardine Hall, Applegarth by Lockerby, Dumfriesshire.
1847. ‡*Jarman, John.*
1853. *Jarratt, Rev. John, M.A. North Cave, near Brough, Yorkshire.
Jarrett, Rev. Thomas, M.A., Professor of Arabic in the University of Cambridge. Trunch, Norfolk.
1862. ‡Jeaks, Rev. James, M.A. Harrow.
Jebb, Rev. John. Peterstow Rectory, Ross, Herefordshire.
*Jee, Alfred S. 2 Oxford-square, Hyde Park, London.
1856. ‡Jeffery, Henry, M.A. 438 High-street, Cheltenham.
1855. *Jeffray, John. 193 St. Vincent-street, Glasgow.
1861. *Jeffreys, J. Gwyn, F.R.S., F.G.S. 25 Devonshire-place, Portland-place, London.
Jeffreys, Rev. R., B.D. Cockfield, Suffolk.
1854. ‡Jeffreys, W. P. Washington-street, Liverpool.
1852. ‡Jellett, Rev. John H., M.A., M.R.I.A. Trinity College, Dublin.
Jellicorse, John. Chaseley, near Rugely, Staffordshire.
1864. §Jelly, Dr. W. Taunton, Somerset.
1862. §Jenkin, Fleeming, F.R.S. 6 Duke-street, Adelphi, London.
1864. §Jenkins, Captain Griffith, C.B., F.R.G.S. Derwin, Welshpool.
*Jenkyns, Rev. Henry, D.D., Professor of Divinity and Ecclesiastical History in the University of Durham. Durham.
Jennette, Matthew. Birkenhead.
1852. ‡Jennings, Francis M., F.G.S., M.R.I.A. Brown-street, Cork.
1861. ‡Jennings, Thomas. Cork.
*Jenyns, Rev. Leonard, M.A., F.L.S., F.G.S. 1 Darlington-place, Bathwick, Bath.
1845. ‡Jerdan, William. Park Wood House, Swanscomb, Kent.
*Jerram, Rev. S. John, M.A. Chobham Vicarage, Bagshot, Surrey.
*Jerrard, George Birch, B.A. Long Stratton, Norfolk.
1845. ‡Jessop, William, sen. Butterley Hall, Derbyshire.
Jessop, William, jun. Butterley Hall, Derbyshire.
1849. ‡Jeune, The Right Rev. Francis, D.D., D.C.L., Bishop of Peterborough.
Job, Samuel. Holmfield House, Aigburth, Liverpool.
Johnson, John.
1861. ‡Johnson, Richard. 27 Dale-street, Manchester.
1863. ‡Johnson, R. S. Hanwell, Fence Houses, Durham.
*Johnson, Thomas. The Hermitage, Frodsham, Cheshire.
1864. §Johnson, Thomas. Stainsby-road, East India-road, London.
Johnson, William. The Wynds Point, Colwall, Malvern, Worcestershire.
1861. ‡Johnson, William Beckett. Woodlands Bank, near Altrincham.
1849. §Johnston, Alexander Keith, LL.D., F.R.S.E., F.G.S., F.R.G.S. 4 St. Andrew-square, Edinburgh.

Year of Election.

Johnston, Alexander Robert, F.R.S. 19 Cumberland-place, London; and York House, Twickenham.
1859. ‡*Johnston, David, M.D. Montrose.*
1864. §Johnston, David. 13 Marlborough-buildings, Bath.
Johnston, Edward. Field House, Chester.
1845. ‡Johnston, G., M.D. Stockport.
1859. ‡Johnston, James. Newmill, Elgin, N. B.
1864. §Johnston, James. Manor House, Northend, Hampstead, London.
Johnston, Percival Norton, F.R.S., F.G.S. Stoke House, Stoke Fleming, Dartmouth.
*Johnstone, James. Alva, near Alloa, Stirlingshire.
*Johnstone, Sir John Vanden Bempde, Bart., M.P., M.A., F.G.S. 27 Grosvenor-square, London; and Harkness.
1864. §Johnstone, John, 1 Barnard-villas, Bath.
Jollie, Walter. Edinburgh.
1864. §Jolly, Thomas. Park View-villas, Bath.
1849. ‡Jones, Baynham. Selkirk Villa, Cheltenham.
*Jones, Christopher Hird. 2 Castle-street, Liverpool.
1856. ‡Jones, C. W. 7 Grosvenor-place, Cheltenham.
**Jones, Major Edward.*
Jones, Rev. Harry Longueville, Inspector of Schools.
1858. ‡Jones, Henry Bence, M.A., M.D., F.R.S., Hon. Sec. to the Royal Institution. 31 Brook-street, Grosvenor-square, London.
1854. ‡Jones, Rev. Henry H. Cemetery, Manchester.
1854. ‡Jones, John. 28 Chapel-street, Liverpool.
1864. §Jones, John. Dudley.
*Jones, Josiah. 2 Castle-street, Liverpool.
*Jones, Robert. 2 Castle-street, Liverpool.
1854. ‡Jones, R. L. Great George-street, Liverpool.
1854. *Jones, R. L. Princes Park, Liverpool.
1847. ‡Jones, Thomas Rymer, Professor of Comparative Anatomy in King's College. 18 St. Leonard's-terrace, Clifton-gardens, Maida-hill, London.
1860. §Jones, T. Rupert, F.G.S., Professor of Geology and Mineralogy, Royal Military Academy, Sandhurst, near Farnborough.
1850. ‡*Jones, William.*
1864. §Jones, Sir Willoughby. Buckley Grange, Isle of Wight.
1853. ‡*Jopling, R. Thompson.*
1851. ‡Josselyn, G. Tower-street, Ipswich.
*Joule, Benjamin St. John B. Thorncliffe, Old Trafford, Manchester.
*Joule, James Prescott, LL.D., F.R.S., F.C.S. Thorncliffe, Old Trafford, Manchester.
*Joy, Rev. Charles Ashfield. Grove Parsonage, near Wantage, Berkshire.
Joy, Henry Holmes, M.A., M.R.I.A. 17 Mountjoy-square East, Dublin.
Joy, Rev. J. H.
Joy, William B., M.D. 48 Leeson-street, Dublin.
1847. ‡Jowett, Rev. B., M.A. Balliol College, Oxford.
1858. ‡Jowett, John, jun. Leeds.
*Jubb, Abraham. Halifax.
1863. §Jukes, Rev. Andrew. Hull.
Jukes, Joseph Beete, M.A., F.R.S., F.G.S., M.R.I.A., Local Director of the Government Geological Survey of Ireland. 51 Stephen's Green, Dublin.

Kane, Sir Robert, M.D., F.R.S., M.R.I.A., Principal of the Royal College of Cork. 51 Stephen's Green, Dublin.

Year of
Election.

1857. ‡Kavanagh, James W. Grenville, Rathgar, Ireland.
1859. ‡Kay, David, F.R.G.S. 6 North-bridge, Edinburgh.
Kay, John Cunliff. Fairfield Hall, near Skipton.
*Kay, John Robinson. Boss Lane House, Bury, Lancashire.
Kay, Robert. Haugh Bank, Bolton-le-Moors.
1847. *Kay, Rev. William, D.D. Lincoln College, Oxford.
1856. ‡Kay-Shuttleworth, Sir James, Bart. Gawthorpe, Burnley.
1855. ‡Kaye, Robert. Mill Brae, Moodies Burn, by Glasgow.
1855. ‡Keddie, William. 15 North-street, Mungo-street, Glasgow.
1850. ‡Kelland, Rev. Philip, M.A., F.R.S.L. & E., Professor of Mathematics in the University of Edinburgh. 20 Clarendon Crescent, Edinburgh.
1849. ‡Kelly, John, C.E. 38 Mount Pleasant-square, Dublin.
1857. ‡Kelly, John J. 38 Mount Pleasant-square, Dublin.
1864. *Kelly, W. M., M.D. The Crescent, Taunton, Somerset.
*Kelsall, Henry. Rochdale, Lancashire.
Kelsall, J. Rochdale, Lancashire.
1864. *Kemble, Rev. Charles, M.A. Vellore, Bath.
1853. ‡Kemp, Rev. Henry William, B.A. Thanet House, Hull.
1858. ‡Kemplay, Christopher. Leeds.
1850. ‡*Kempson, Samuel.*
1857. ‡Kennedy, George A., M.D., M.R.I.A. 15 Talbot-street, Dublin.
1854. ‡Kennedy, James. 33 Erskine-street, Liverpool.
Kennedy, John.
1857. §Kennedy, Lieut-Colonel John Pitt. 20 Torrington-square, Bloomsbury, London.
1858. ‡Kennie, C. G. Colleton. 5A Spring-gardens, London.
Kenny, Matthias, M.D. 3 Clifton-terrace, Monkstown, Co. Dublin.
Kenrick, Rev. George.
Kent, J. C. Chamber-court, near Upton-on-Severn.
1857. ‡Kent, William T., M.R.D.S. 51 Rutland-square, Dublin.
1857. ‡Kenworth, James Ryley. 7 Pembroke-place, Liverpool.
1857. *Ker, André Allen Murray. Newbliss House, Newbliss, Ireland.
1855. *Ker, Robert. Auchinraith, Glasgow.
Ker, Stewart.
1861. *Keymer, John. Parker-street, Manchester.
1854. ‡Kilpin, Thomas Johnstone. 1 Arrad-street, Liverpool.
1860. ‡Kinahan, G. Henry. Geological Survey of Ireland, 51 Stephen's Green, Dublin.
1858. ‡Kincaid, Henry Ellis, M.A. 8 Lyddon-terrace, Leeds.
1857. ‡*Kinehan, John R., M.D.*
1854. ‡King, Alfred. 1 Netherfield-road South, Liverpool.
1855. ‡King, Alfred, jun. Everton, Liverpool.
King, A. J., M.A. Mosstown, Longford, Ireland.
King, The Hon. James, M.R.I.A. Mitchelstown Castle, Co. Cork.
1855. ‡King, James. Levernholme, Hurlet, Glasgow.
1851. ‡*King, John. Ipswich.*
1851. ‡King, John. Rose-hill, Ipswich.
King, Joseph. Anfield, Liverpool.
1864. §King, K. 27 George-street, Bath.
1860. *King, Mervyn Kersteman. 1 Rodney-place, Clifton, Bristol.
King, Richard, M.D. Savile-row, London.
King, Rev. Samuel, M.A., F.R.A.S. St. Aubins, Jersey.
1862. §King, Rev. Samuel William, F.G.S., F.S.A. Saxlingham Rectory, near Norwich.
King, William Poole. Clifton, Bristol.
1862. ‡Kingsley, Rev. Charles, M.A., Professor of Modern History in the University of Cambridge. 1 St. Peter's-terrace, Cambridge.

Year of Election.

1861. ‡Kingsley, John. 30 St. Ann's-street, Manchester.
1845. ‡Kingsley, Rev. W. T. South Kelvington, Thirsk.
1863. §Kinnaird, The Right Hon. Lord., F.G.S. Rossie Priory, Inchture.
Kinnear, J. G., F.R.S.E. Glasgow.
1863. ‡Kirkaldy, David. 28 Bartholomew-road North, Kentish Town, London.
1860. ‡Kirkman, Rev. Thomas P., M.A., F.R.S. Croft Rectory, near Warrington.
Kirkpatrick, Rev. W. B. 44 Wellington-street, Dublin.
1850. §Kirkwood, Anderson. 151 West George-street, Glasgow.
Kirshaw, James.
1849. ‡Kirshaw, John William, F.G.S. Warwick.
1858. ‡Kitson, James. Leeds.
Knight, Sir A. J., M.D.
Knight, Henry.
Knipe, A. J. Moorville, Carlisle.
Knowles, George Beauchamp, Professor of Botany in Queen's College, Birmingham. St. Paul's-square, Birmingham.
Knowles, John. Old Trafford Bank House, Old Trafford, Manchester.
Knowles, L. P.
*Knowles, William. Newport, Monmouthshire.
*Knox, G. James. 2 Finchley New-road, St. John's-wood, London.
Knox, Henry.
Knox, Rev. H. B., M.A., M.R.I.A. Deanery, Hadleigh, Suffolk.
Kutz, Andrew.
1861. *Kyllmann, Max. 28 Brazennose-street, Manchester.

Lace, Ambrose. Liverpool.
1858. §Lace, Francis John. Stone Gapp, Cross-hill, Leeds.
1862. §Lackenstein, Dr. (Care of Messrs. Smith and Elder, Cornhill, London.)
Lacy, Henry C. Withdeane Hall, near Brighton.
1859. §Ladd, William. 11 & 13 Beak-street, Regent-street, London.
1850. ‡Laing, David, F.S.A. Scotl. Edinburgh.
Laird, John. Birkenhead.
1859. §Lalor, John Joseph. 2 Longford-terrace, Monkstown, Co. Dublin.
Lamb, David. Liverpool.
Lambert, Richard. Newcastle-on-Tyne.
1846. *Laming, Richard. 10 Clifton Villas, Maida-hill West, London.
1854. §Lamport, William James. Liverpool.
Lane, Richard.
1859. ‡Lang, Rev. John Marshall. Fyvie, Aberdeen.
1864. §Lang, R. Burlington Bogs, Redlands, Bristol.
*Langton, William. Manchester.
1840. ‡Lankester, Edwin, M.D., LL.D., F.R.S., F.L.S. 8 Savile-row, London.
Lanyon, Charles.
*Larcom, Major-General Sir Thomas Aiskew, K.C.B., R.E., F.R.S., M.R.I.A. Phœnix Park, Dublin.
Lassell, William, F.R.S., F.R.A.S. Malta.
1860. ‡Lassell, William, jun. The Brook, near Liverpool.
1861. *Latham, A. G. Cross-street, Manchester.
1845. ‡Latham, Robert G., M.A., M.D., F.R.S., F.R.G.S. New Malden, near Kingston, Surrey.
*La Touche, David Charles, M.R.I.A. Castle-street, Dublin.
1857. ‡Law, Hugh. 4 Great Denmark-street, Dublin.
1862. ‡Law, Rev. James Edmund, M.A. Little Shelford, Cambridgeshire.
Law, Rev. William, M.A. Orwell Rectory, Arrington, Cambridgeshire.

Year of Election.

Lawley, The Hon. Francis Charles. Escrick Park, near York.
Lawley, The Hon. Stephen Willoughby. Escrick Park, near York.
Lawrence, William, F.R.S., Serjeant-Surgeon to the Queen. 18 Whitehall-place, London.
1857. ‡Lawson, James A., LL.D., M.R.I.A. 27 Fitzwilliam-street, Dublin.
1855. ‡Lawson, John. Mountain Blue Works, Camlachie.
1858. ‡Lawson, Samuel. Kirkstall, near Leeds.
1863. ‡Lawton, Benjamin C. Tynemouth.
1853. ‡Lawton, William. Manor House-street, Hull.
Laycock, Thomas, M.D., Professor of the Practice of Medicine in the University of Edinburgh. 4 Rutland-street, Edinburgh.
1857. ‡Leach, Capt. R. E. Mountjoy, Phœnix Park, Dublin.
Leadbetter, John. Glasgow.
1847. *Leatham, Edward Aldam. Whitley Hall, Huddersfield.
1858. ‡Leather, George. Knostrop, near Leeds.
*Leather, John Towlerton. Leventhorpe Hall, near Leeds.
1858. ‡Leather, John W. Newton Green, Leeds.
1863. §Leavers, J. W. The Park, Nottingham.
1858. *Le Cappelain, John. Highgate, London.
1858. ‡Ledgard, William. Potter Newton, near Leeds.
Lee, Daniel. Springfield House, Pendlebury, Manchester.
1861. §Lee, Henry. Irwell House, Lower Broughton, Manchester.
Lee, Henry, M.D. Weatheroak, Alve Church, near Bromsgrove, London.
*Lee, John, LL.D., F.R.S., V.P.R.A.S., F.L.S., F.G.S., F.S.A., F.R.G.S. 5 College, Doctors' Commons, London; and Hartwell House, near Aylesbury.
1853. *Lee, John Edward, F.G.S. The Priory, Caerleon, Monmouthshire.
Leechman, James.
1845. ‡Lees, Dr. Frederick R. Burmantofts Hall, Leeds.
1850. ‡Lees, George, LL.D. Rillbank, Edinburgh.
1854. ‡Lees, Samuel. Portland-place, Ashton-under-Lyne.
1859. ‡Lees, William. School of Art, Edinburgh.
*Leese, Joseph, jun. Glenfield, Altrincham.
*Leeson, Henry B., M.A., M.D., F.R.S. The Maples, Bonchurch, Isle of Wight.
*Lefroy, John Henry, Brigadier-General R.A., F.R.S., F.R.G.S., President of the Ordnance Select Committee. Blackheath, Kent.
1845. ‡*Legard, Capt. William. India.*
*Legh, George Cornwall, M.P. High Legh, Cheshire.
Legh, Peter Thomas.
1861. *Leigh, Henry. The Poplars, Patricroft, near Manchester.
Leigh, John Shaw. Childerall Hall, near Liverpool.
*Leinster, Augustus Frederick, Duke of, M.R.I.A. 6 Carlton House-terrace, London.
1859. ‡Leith, Alexander. Glenkindie, Inverkindie.
*Lemon, Sir Charles, Bart., F.R.S., F.G.S., F.R.G.S. Carclew, near Falmouth.
1860. ‡Lempriere, Charles, D.C.L. St. John's College, Oxford.
1863. *Lendy, Capt. Augusta Frederic. Practical Military College, Sunbury.
1861. ‡Lennox, A. C. W. 7 Beaufort-gardens, Brompton, London.
Lentaigne, John, M.D. Tallaght House, Co. Dublin; and 14 Great Dominick-street, Dublin.
Lentaigne, Joseph. 12 Great Denmark-street, Dublin.
1861. ‡Leppoc, Henry Julius. Kersal Crag, near Manchester.
1852. ‡*Leslie, T. E. Cliffe, LL.B.*
1859. ‡Leslie, William, M.P. Warthill, Aberdeenshire.

Year of Election.

1846. ‡Letheby, Henry, M.B., F.L.S., Medical Officer to the City of London. 41 Finsbury-square, London.
1845. ‡Lewis, Rev. Thomas T. Bridstow, near Ross.
1847. ‡Ley, Rev. Jacob, M.A. Staverton, near Daventry.
1853. ‡Liddell, George William Moore. Sutton House, near Hull.
1860. ‡Liddell, The Very Rev. H. G., D.D., Dean of Christ Church, Oxford.
1855. ‡Liddell, John. 8 Clelland-street, Glasgow.
1859. ‡Ligertwood, George. Blair by Summerhill, Aberdeen.
1864. §Lighbody, Robert. Ludlow.
Lightfoot, J. J.
1862. ‡Lilford, Right Hon. Lord. Lilford Hall, Northamptonshire.
Lindley, John, Ph.D., F.R.S., F.L.S. South Kensington, London.
*Lindsay, Charles. Glen Osmond, Adelaide, South Australia.
*Lindsay, Henry L., C.E., M.R.I.A. 1 Little Collins-street West, Montreal, Canada.
1855. *Lindsay, John H. 317 Bath-street, Glasgow.
*Lingard, John R., F.G.S. Stockport, Cheshire.
Lingwood, Robert M., M.A., F.L.S., F.G.S. Lytton House, near Ross, Herefordshire.
Lister, James. Liverpool Union Bank, Liverpool; and Greenbank, Everton.
1858. *Lister, John, F.G.S. Shibden Hall, near Halifax.
*Lister, Joseph Jackson, F.R.S. Upton, Essex.
Littledale, Harold. Liscard Hall, Cheshire.
1854. ‡Littledale, Thomas. Highfield House, Liverpool.
1861. *Liveing, G. D., M.A., F.C.S., Professor of Chemistry in the University of Cambridge. 12 Hill's-road, Cambridge.
1864. §Livesay, J. G. Ventnor, Isle of Wight.
1860. ‡Livingstone, Rev. Thomas Gott, Minor Canon of Carlisle Cathedral. 6 Victoria-place, Carlisle.
Lizars, Alexander J., M.D., Professor of Anatomy. Marischal College, Aberdeen.
Lloyd, Rev. A. R. Hengold, near Oswestry.
Lloyd, Rev. C., M.A. Whittington, Oswestry.
1848. ‡Lloyd, Rev. David. Carmarthen.
Lloyd, Edward. King-street, Manchester.
1854. ‡Lloyd, F. Geisler. Belsize, Hampstead.
*Lloyd, George, M.D., F.G.S. Birmingham.
1847. **Lloyd, George Whitelocke.*
*Lloyd, Rev. Humphrey, D.D., LL.D., F.R.S. L. & E., M.R.I.A. Trinity College, Dublin.
Lloyd, Rev. Rees Lewis. Belper, Derbyshire.
1849. ‡Lloyd, William, M.D. Army and Navy Club, London.
1854. *Lobley, James Logan. 13 Mount Vernon-road, Liverpool.
1853. *Locke, John. Royal Dublin Society, Kildare-street, Dublin.
*Lockey, Rev. Francis. Swainswick, near Bath.
Lockhart, Alexander M^cDonald.
1863. §Lockyer, J. N. Victoria-road, Finchley-road, London.
Loder, J. S.
Lodge, Rev. John, M.A., F.C.P.S.
1853. ‡Loft, John. 17 Albion-street, Hull.
*Loftus, William Kennett, F.G.S. Calcutta.
*Logan, Sir William Edmond, LL.D., F.R.S., F.G.S., F.R.G.S., Director of the Geological Survey of Canada. Montreal, Canada.
1864. §Logan, Edmund. 141 George-street, Edinburgh.
1862. ‡Long, Andrew, M.A. King's College, Cambridge.
1851. ‡Long, P. B. Museum-street, Ipswich.
1851. ‡Long, William, F.G.S. Hurts Hall, Saxmundham, Suffolk.

Year of Election.

1857. ‡Longfield, Rev. George. 25 Trinity College, Dublin.
Longfield, Mountifort, LL.D., M.R.I.A., Regius Professor of Feudal and English Law in the University of Dublin. 47 Fitzwilliam-square, Dublin.
1861. *Longman, William, F.G.S. 36 Hyde Park-square, London.
1859. ‡Longmuir, Rev. John, M.A., LL.D. 14 Silver-street, Aberdeen.
Longridge, W. S. Oakhurst, Ambergate, Derbyshire.
1861. *Lord, Edward. York-street, Todmorden.
1855. ‡Lorimer, Rev. J. G., D.D. 6 Woodside-place, Glasgow.
1863. ‡Losh, W. S. Wreay Syke, Carlisle.
1834. ‡*Low, Rev. Alexander, F.S.A.*
1863. *Lowe, Capt. A. S. H. Highfield House, near Nottingham.
1861. *Lowe, Edward Joseph, F.R.A.S., F.L.S., F.G.S. Highfield House Observatory, near Nottingham.
Lowe, George, F.R.S., F.G.S., F.R.A.S. 9 St. John's-wood Park, London.
1850. ‡Lowe, William Henry, M.D., F.R.S.E. Balgreen, Slateford, Edinburgh.
Lowndes, Matthew D. 49 Edge-lane, near Liverpool.
Lowndes, W.
1853. *Lubbock, Sir John, Bart., F.R.S., F.L.S., F.G.S. Lamas, Chislehurst, Kent.
Lucas, Edward.
Lucena, James L. 4 Garden-court, Temple, London.
1849. *Luckcock, Howard. Oak-hill, Edgbaston, Birmingham.
1849. ‡Lucy, William. Edgbaston, Birmingham.
1850. *Lundie, Cornelius. Rhymney Railway, Cardiff.
1853. ‡Lunn, William Joseph, M.D. 23 Charlotte-street, Hull.
1858. *Lupton, Arthur. Newton Hall, Leeds.
1864. *Lupton, D. Leeds.
**Lutwidge, Charles, M.A.*
Lutwidge, R. W. S., M.A., F.C.P.S.
*Lyell, Sir Charles, Bart., M.A., LL.D., D.C.L., F.R.S., F.L.S., V.P.G.S., Hon. M.R.S.Ed. 53 Harley-street, Cavendish-square, London.
1864. §Lyne, Francis. (Care of Sydney Smith, Esq., Charlotte-row, Mansion House, London.)
1857. ‡Lyons, Robert D. 31 Upper Merrion-street, Dublin.
1862. *Lyte, Maxwell F., F.C.S. Bagnères de Bigorre, France.
1849. ‡Lyttelton, Lord. 17 St. James's-place, London.

1859. ‡Mabson, John. Trinity College, Cambridge; and Heyning, Westmoreland.
1852. ‡MacAdam, James, jun. Beavor Hall, Belfast.
1852. ‡MacAdam, Robert. 18 College-square East, Belfast.
1854. *Macadam, Stevenson, Ph.D., F.R.S.E., F.C.S., President of the Royal Scottish Society of Arts. Surgeons' Hall, Edinburgh.
1852. ‡*Macaldin, J. J., M.D. Coleraine.*
*M'All, Rev. Edward, Rector of Brighstone, Newport, Isle of Wight.
*M'Andrew, Robert, F.R.S. Isleworth House, Isleworth, Middlesex.
1855. ‡*M'Arthur, Richard, W. J.*
1840. Macaulay, James. 23 Pelham-street, Brompton, London.
1857. ‡Macauley, James William. Royal Hospital, Dublin.
*MacBrayne, Robert. Messrs. Black and Wingate, 9 Exchange-square, Glasgow.
Macbride, Rev. John David, D.C.L., F.G.S., Principal of Magdalen Hall, and Lord Almoner's Reader in Arabic in the University of Oxford. Oxford.

Year of Election.

1855. ‡M'Callum, Archibald K., M.A. House of Refuge, Duke-street, Glasgow.
1863. ‡M'Calmont, Robert. Gatton Park, Reigate.
1855. ‡M'Cann, James, F.G.S. Holmfrith, Yorkshire.
1857. ‡M'Causland, Dominick. 12 Fitzgibbon-street, Dublin.
M'Clelland, James. 73 Kensington Gardens-square, Bayswater.
1855. ‡M'Clelland, James. 10 Claremont-terrace, Glasgow.
1856. ‡*M'Clelland, John. Calcutta.*
*M'Connel, James. Bent-hill, Prestwich, near Manchester.
1859. **M'Connell, David C., F.G.S.*
1858. ‡M'Connell, J. E. Woodlands, Great Missenden.
1852. ‡M'Cosh, Rev. James, M.A., Professor of Logic, &c., Queen's College, Belfast.
1851. ‡M'Coy, Professor Frederick, F.G.S., Professor of Zoology and Natural History in the University of Melbourne, Australia.
McCullagh, John, A. B.
*M'Culloch, George, M.D. Cincinnati, United States.
1852. ‡M'Dermott, Edward. Grove Park, The Grove, Camberwell, London.
1850. ‡*Macdonald, Alexander.*
Macdonald, William, M.D., F.R.S.E., F.L.S., F.G.S., Professor of Civil and Natural History. St. Andrews, N. B.
MacDonnell, Hercules H. G.
1864. §MacDonnell, The Very Rev. Canon. 8 Montpellier, Bath.
*MacDonnell, Rev. Richard, D.D., Provost of Trinity College, Dublin, M.R.I.A. Dublin.
Macdougall, A. H. 44 Parliament-street, London.
*M'Ewan, John. Glasgow.
1850. ‡Macfarlan, John Fletcher. Park-place, Edinburgh.
1859. ‡Macfarlane, Alexander. 73 Bon Accord-street, Aberdeen.
1855. ‡M'Farlane, Walter. Saracen Foundry, Glasgow.
1854. *Macfie, R. A. 72 Upper Parliament-street, Liverpool.
1852. *M'Gee, William, M.D. 10 Donegal-square East, Belfast.
1855. ‡MacGeorge, Andrew, jun. 21 St. Vincent-place, Glasgow.
MacGregor, Alexander.
1855. ‡M'Gregor, Alexander Bennett. 19 Woodside-crescent, Glasgow.
1855. ‡MacGregor, James Watt. Wallace-grove, Glasgow.
1850. ‡*M'Gregor, Robert, M.D. Glasgow.*
1853. ‡*M'Gregor, Walter. Liverpool.*
1854. ‡*Macgregor, William.*
1859. ‡M'Hardy, David. 54 Netherkinkgate, Aberdeen.
1854. ‡*M'Ilveen, Alexander Sinclair.*
1855. ‡M'Ilwraith, H. Greenock.
Macintosh, General Alexander Fisher, K.H., F.G.S., F.R.G.S. 7 Tilney-street, Park-lane, London.
1859. ‡Macintosh, John. Middlefield House, Woodside, Aberdeen.
1854. *MacIver, Charles. Abercrombie-square, Liverpool.
M'Kenney, John.
1855. ‡M'Kenzie, Alexander. 89 Buchanan-street, Glasgow.
*Mackenzie, James. Glentore, Scotland.
1850. ‡Mackenzie, J. W. 16 Royal Circus, Edinburgh.
Mackenzie, Rev. Kenneth. Borrowstoness, Linlithgowshire.
Mackerral, William. Paisley.
1859. ‡Mackie, David. Mitchell-place, Aberdeen.
*Mackinlay, David. Pollokshields, Glasgow.
1850. ‡Maclagan, Douglas, M.D., F.R.S.E. 28 Heriot Row, Edinburgh.
1860. ‡Maclaren, Archibald. Summertown, Oxfordshire.
1845. ‡MacLaren, Charles, F.R.S.E. Moreland Cottage, Grange Loan, Edinburgh.

Year of
Election.

1864. §MacLaren, Duncan. Newington House, Edinburgh.
1855. ‡MacLaren, John. Spring Bank, Dunoon.
1859. ‡Maclear, Sir Thomas, F.R.S., F.R.G.S., F.R.A.S., Astronomer Royal at the Cape of Good Hope.
1862. ‡Macleod, Henry Dunning. 17 Gloucester-terrace, Camden-hill-road, London.
1855. ‡M'Lintock, William. Lochinch, Pollokshaws, Glasgow.
1861. *Maclure, John William. 2 Bond-street, Manchester.
M'Master, Maxwell. 97 Grafton-street, Dublin.
1852. ‡M'Mechan, John, M.D. White House, Belfast.
1862. §Macmillan, Alexander. 1 Trinity-street, Cambridge.
1855. ‡*M'Nab, John. Edinburgh.*
MacNeill, The Right Hon. Sir John, G.C.B., F.R.S.E., F.R.G.S. Granton House, Edinburgh.
MacNeill, Sir John, LL.D., F.R.S., M.R.I.A., Professor of Civil Engineering in Trinity College, Dublin. Mount Pleasant, Dundalk.
1854. ‡M'Nicholl, H., M.D. 42 Oxford-street, Liverpool.
1850. ‡Macnight, Alexander. 12 London-street, Edinburgh.
1859. ‡Macpherson, Rev. W. Kilmuir Easter, Scotland.
Macredie, P. B. Mure, F.R.S.E. Irvine, Ayrshire.
1854. ‡Macrorie, Dr. 126 Duke-street, Liverpool.
1852. *Macrory, Adam John. Duncairn, Belfast.
*Macrory, Edmund. 7 Fig-tree-court, Temple, London.
1855. ‡M'Tyre, William, M.D. Maybole, Ayrshire.
1855. ‡Macvicar, Rev. John Gibson, D.D. Moffat, near Glasgow.
1857. ‡*Madden, Richard R. Rathmines, Dublin.*
Magor, J. B. Redruth, Cornwall.
1853. ‡Magrath, Rev. Folliot, A.M. Stradbally, Queen's County, Ireland.
*Malahide, Talbot de, Lord, F.R.S. Malahide Castle, Malahide, Ireland.
1853. ‡Malan, John. Holmpton, Holderness.
*Malcolm, Frederick. 8 Paternoster-row, London.
Malcolm, Neil. Portalloch, Lochgilphead.
1850. ‡Malcolm, R. B., M.D., F.R.S.E. 126 George-street, Edinburgh.
Maley, A. J.
1863. ‡Maling, C. T. Lovaine-crescent, Newcastle-on-Tyne.
*Mallet, Robert, Ph.D., F.R.S., F.G.S., M.R.I.A. 11 Bridge-street, Westminster, London; and The Grove, Clapham-road, Clapham, London.
1857. ‡Mallet, Dr. John William. University of Alabama, U. S.
1846. ‡Manby, Charles, F.R.S., F.G.S. 15 Harley-street, London.
*Manchester, James Prince Lee, Lord Bishop of, F.R.S., F.G.S., F.R.G.S., F.C.P.S. Mauldreth Hall, Manchester.
1863. ‡Mancini, Count de, Italian Consul. Newcastle-on-Tyne.
Manning, The Venerable Archdeacon.
1864. §Mansel, J. C. Long Thorns, Blandford.
1864. §Markham, Clements R., F.R.G.S. 21 Eccleston-square, Pimlico, London.
1852. ‡Marland, James William. Mountjoy-place, Dublin.
1863. ‡Marley, John. Mining Office, Darlington.
*Marling, Samuel S. Stanley Park, Stroud, Gloucestershire.
Marriott, John. Allerton, Liverpool.
1857. §Marriott, William. Leeds-road, Huddersfield.
1858. ‡Marriott, William Thomas. Wakefield.
Marsden, Richard. Norfolk-street, Manchester.
Marsh, Sir Henry, Bart., M.D., M.R.I.A. 9 Merrion-square North, Dublin.

Year of Election.

1856. ‡Marsh, M. H. 46 Green-street, Grosvenor-square, London; and Wilbury Park, Wilts.
1864. §Marsh, Thomas Edward Miller. 37 Grosvenor-place, Bath.
Marshall, James. Headingly, near Leeds.
1852. ‡Marshall, James D. Holywood, Belfast.
*Marshall, James Garth, M.A., F.G.S. Headingly, near Leeds.
1847. ‡Marshall, Matthew. Bank of England.
1858. ‡Marshall, Reginald Dykes. Adel, near Leeds.
1849. ‡Marshall, William P. Monument-lane, Birmingham.
Martin, Rev. Francis, M.A. Trinity College, Cambridge.
**Martin, Francis P. Brouncker.*
1848. ‡Martin, Henry D. 4 Imperial Circus, Cheltenham.
Martin, James.
Martin, Studley. 107 Bedford-street South, Liverpool.
*Martindale, Nicholas. Peter-lane, Hanover-street, Liverpool.
*Martineau, Rev. James. 10 Gordon-street, Gordon-square, London.
1849. ‡*Martineau, Robert. Birmingham.*
1847. ‡Maskelyne, Nevil Story, M.A., F.G.S. British Museum, London.
1861. *Mason, Hugh. Ashton-under-Lyne.
*Mason, Thomas. York.
Massey, Hugh, Lord. Hermitage, Castleconnel, Co. Limerick.
*Mather, Daniel. 58 Mount Pleasant, Liverpool.
*Mather, John. 58 Mount Pleasant, Liverpool.
1863. *Mather, Joseph. Beech Grove, Newcastle-on-Tyne.
Mather, William. Newcastle-on-Tyne.
*Mathews, Henry. 30 Gower-street, London.
1861. *Mathews, William, jun., M.A., F.G.S. 51 Carpenter-road, Birmingham.
Mathews, William P.
1859. ‡Matthew, Alexander C. 3 Canal-terrace, Aberdeen.
1858. ‡Matthews, F. C. Mandre Works, Driffield, Yorkshire.
1860. §Matthews, Rev. Richard Brown. The Vicarage, Shalford, near Guildford.
1863. *Matthiessen, Augustus, Ph.D., F.R.S., Lecturer on Chemistry, St. Mary's Hospital. Paddington, London.
1857. ‡*Maughan, Rev. J. D.*
1863. ‡Maughan, Rev. W. Benwell Parsonage, Newcastle-on-Tyne.
1855. ‡Maule, Rev. Thomas, M.A. Partick, near Glasgow.
1863. *Mawson, John. 3 Moseley-street, Newcastle-on-Tyne.
1864. *Maxwell, Francis. Gribton, near Dumfries.
*Maxwell, James Clerk, M.A., F.R.S., L. & E., Professor of Natural Philosophy and Astronomy in King's College, London. 8 Palace Garden-terrace, Kensington, London.
1855. *Maxwell, Sir John, Bart., F.R.S. Pollok House, Renfrewshire.
1852. ‡Maxwell, John Waring. Finnebrogue, Downpatrick, Ireland.
*Maxwell, Robert Percival. Finnebrogue, Downpatrick, Ireland.
Maynard, Henry.
Maynard, Thomas.
*Mayne, Rev. Charles, M.R.I.A. 22 Upper Merrion-street, Dublin.
Mayne, Edward Ellis.
1857. ‡*Mayne, William Annesley. Dublin.*
*Meadows, James. York-place, Rusholme, near Manchester.
1863. §Mease, George D. South Shields.
1863. §Mease, Solomon. North Shields.
Meath, Joseph Henderson Singer, D.D., Lord Bishop of.
1861. §Medcalf, William. 20 Bridgewater-place, Manchester.
1863. §Meier, R. Newcastle-upon-Tyne.

Year of Election.

Mellor, J.
1854. ‡Melly, Charles Pierre. Liverpool.
1847. ‡Melville, Professor Alexander Gordon, M.D. Queen's College, Galway.
1863. §Melvin, Alexander. 6 Fingal-place, Edinburgh.
1862. §Mennell, Henry. 20 Fenchurch-street, London.
Merz, Philip.
1863. §Messent, P. T. 4 Northumberland-terrace, Tynemouth.
1847. ‡*Meyer, Charles, D.C.L.*
1847. *Michell, Rev. Richard, B.D. St. Giles's-street, Oxford.
1855. §Miles, Rev. Charles P., M.D., Principal of the Malta Protestant College, St. Julian's, Malta. Office, 3 St. James's-street, Pall Mall, London.
1857. ‡Millar, George M. Susanvale, Kilmainham, Dublin.
1850. ‡Millar, James S. 9 Roxburgh-street, Edinburgh.
1859. ‡Millar, John. Lisburn, Ireland.
1863. ‡Millar, John, F.L.S., F.G.S. Bethnal House, Cambridge-road, London.
Millar, Thomas, M.A. Perth.
1859. ‡Miller, James, jun. Greenock.
*Miller, Patrick, M.D. Exeter.
1861. *Miller, Robert. 30 King-street; and Whalley Range, Manchester.
1863. ‡Miller, Thomas. Righill Hall, Durham.
*Miller, William Allen, M.D., Treas. and V.P.R.S., Pres. Chem. Soc., Professor of Chemistry in King's College, London.
Miller, William Hallows, M.A., For. Sec. R.S., F.G.S., Professor of Mineralogy in the University of Cambridge. 7 Scroope-terrace, Cambridge.
Milligan, Robert. Acacia in Randon, Leeds.
1846. ‡Mills, George. Southampton.
*Mills, John Robert. Bootham, York.
1851. ‡*Mills, Rev. Thomas.*
1847. ‡Milman, Rev. H. H., Dean of St. Paul's, London.
Milne, Rear-Admiral Sir Alexander, K.C.B., F.R.S.E. Musselborough, Edinburgh.
Milne, Sir David, K.C.B. Edinburgh.
*Milne-Home, David, M.A., F.R.S.E. Wedderburn, Coldstream, N. B.
1854. *Milner, William. Liverpool.
1854. *Milner, William Ralph. Wakefield, Yorkshire.
1864. §Milton, The Right Hon. Lord. Wentworth, Yorkshire.
1855. ‡Mirrlees, James Buchanan. 128 West-street, Tradeston, Glasgow.
1859. ‡Mitchell, Alexander, M.D. Old Rain, Aberdeen.
1863. ‡Mitchell, C. Walker, Newcastle-on-Tyne.
1855. ‡*Mitchell, George. Glasgow.*
1860. ‡Mitchell, John Mitchell. Mayville, Edinburgh.
1863. *Mitchell, William Stephen. St. George's Lodge, Bath.
1855. *Moffat, John, C.E. Ardrossan.
1854. §Moffat, Thomas, M.D., F.G.S., F.R.A.S., M.B.M.S. Hawarden, Chester.
1864. §Mogg, John Rees. High Littleton House, near Bristol.
1848. ‡Moggridge, Matthew. Willows, near Swansea.
1855. §Moir, James. 174 Gallogate, Glasgow.
1850. ‡*Moir, John, M.D. Edinburgh.*
1861. ‡Molesworth, Rev. W. N., M.A. Spotland, Rochdale.
Mollan, John, M.D. 8 Fitzwilliam-square North, Dublin.
1852. ‡Molony, William, LL.D. Carrickfergus.
Molyneux, James.

Year of Election.

1853. ‡Monday, William, Hon. Sec. Hull Lit. and Phil. Soc. 6 Jarratt-street, Hull.
1860. §Monk, Rev. William, M.A., F.R.A.S. Wymington Rectory, Hyham, Ferrers, Northamptonshire.
1853. ‡Monroe, Henry, M.D. 10 North-street, Sculcoates, Hull.
Monteagle, Thomas, Lord, M.A., F.R.S., F.R.G.S., F.S.A. 7 Park-street, Westminster, London.
1850. ‡*Monteith, Alexander E. Inverleith House.*
Montgomery, Matthew Glasgow.
1846. ‡Moody, T. H. C. Bridgefield, Southampton.
1857. §Moore, Arthur. Cradley House, Clifton, Bristol.
1859. §Moore, Charles, F.G.S. 6 Cambridge-terrace, Bath.
1857. ‡Moore, Rev. Dr. Clontarf, Dublin.
Moore, John. 2 Mendiam-place, Clifton.
*Moore, John Carrick, M.A., F.R.S., F.G.S. 8 Grafton-street, Bond-street, London; and Corswall, Wigtonshire.
1854. ‡Moore, Thomas John. Derby Museum, Liverpool.
Moore, William D. 7 South Anne-street, Dublin.
1857. *Moore, Rev. William Prior. The College, Cavan, Ireland.
Morant, Rev. James.
1861. ‡Morewood, Edmund. Cheam, Surrey.
Morgan, Captain Evan, R.A.
Morgan, James.
1849. ‡Morgan, William. Waterloo-street, Birmingham.
Moriarty, Merion, M.D. New South Wales.
Morley, George. Park-place, Leeds.
1863. §Morley, Samuel. Lenton-grove, Nottingham.
1850. ‡Morrieston, Robert, F.R.S.E. 6 Heriot-row, Edinburgh.
1861. *Morris, David. 1 Market-place, Manchester.
1845. ‡Morris, Edward, M.D. Hereford.
*Morris, Rev. Francis Orpen, B.A. Nunburnholme Rectory, Hayton, York.
Morris, Samuel, M.R.D.S. Fortview, Clontarf, near Dublin.
1861. ‡Morris, William. The Grange, Salford.
1863. ‡Morrow, R. J. Bentick Villas, Newcastle.
1854. *Morton, Francis. Hermitage, Oxton, Cheshire; and James-street, Liverpool.
1857. §Morton, George H., F.G.S. 9 London-road, Liverpool.
1858. *Morton, Henry Joseph. Garforth House, West Garforth, near Leeds.
1847. ‡Moseley, Rev. Henry, M.A., F.R.S. 13 Great George-street, Westminster.
1857. ‡Moses, Marcus. 4 Westmoreland-street, Dublin.
1862. ‡*Mosheimer, Joseph.*
Mosley, Sir Oswald, Bart., D.C.L., F.L.S., F.G.S. Rolleston Hall, Burton-upon-Trent, Staffordshire.
Moss, John. Otterspool, near Liverpool.
1853. *Moss, W. H. Kingston-terrace, Hull.
1864. §Mosse, J. R. General Manager's Office, Mauritius Railway, Port Louis.
1862. *Mouat, Frederick John, M.D., Inspector-General of Prisons, Bengal.
1856. ‡Mould, Rev. J. G., B.D. 21 Camden-crescent, Bath.
1863. ‡Mounsey, Edward. Sunderland.
Mounsey, John. Sunderland.
1861. *Mountcastle, William Robert. 22 Dorking-terrace, Cecil-street, Greenheys, Manchester.
Mowbray, James. Combus, Clackmannan, Scotland.
1850. ‡Mowbray, J. T. 27 Dundas-street, Edinburgh.

Year of Election.

Muir, Rev. John. St. Vigean's, by Arbroath.
1855. §Muir, William. 10 St. John-street, Adelphi, London.
Muirhead, James. 90 Buchanan-street, Glasgow.
1852. ‡Mullan, William. Belfast.
1857. ‡Mullins, M. Bernard, M.A., C.E. 1 Fitzwilliam-square South, Dublin.
Munby, Arthur Joseph. 6 Fig-tree-court, Temple, London.
1864. *Munro Colonel William. United Service Club, Pall Mall, London.
1864. §Murch, J. Cranwells, Bath.
*Murchison, John Henry, F.G.S. Surbiton-hill, Kingston.
1864. *Murchison, K. R. Manor House, Bathford, Bath.
*Murchison, Sir Roderick Impey, K.C.B., M.A., D.C.L. Oxon., LL.D. Camb., F.R.S., F.G.S., F.R.G.S., Hon. Mem. R.S.Ed. & R.I.A., Director-General of the Geological Survey of the United Kingdom. 16 Belgrave-square, London.
1864. §Murchison, Captain R. M. Caerbaden House, Cleveland-walk, Bath.
1855. ‡Murdock, James B. 195 Bath-street, Glasgow.
1858. ‡Murgatroyd, William. Bank Field, Bingley.
Murley, Rev. C. H. South Petherton, Ilminster.
1856. ‡*Murley, Stephen. Hempsted, Trowbridge, Wilts.*
1852. ‡Murney, Henry, M.D. 10 Chichester-street, Belfast.
1852. ‡Murphy, Joseph John. Glengall-place, Belfast.
1850. ‡*Murray, Andrew.*
1857. ‡*Murray, B. A.*
Murray, George.
Murray, John, F.G.S., F.R.G.S. 50 Albemarle-street, London; and Newsted, Wimbledon, Surrey.
1859. ‡Murray, John, M.D. Forres, Scotland.
*Murray, John, C.E. 11 Great Queen-street, Westminster, London.
‡Murray, Rev. John. Morton, near Thornhill, Dumfriesshire.
Murray, Stewart.
1863. ‡Murray, William. 34 Clayton-street, Newcastle-on-Tyne.
*Murton, James. Silverdale, near Lancaster.
Musgrave, The Venerable Charles, D.D., Archdeacon of Craven. Halifax.
1861. ‡Musgrove, John, jun. Bolton.
Muspratt, James.
*Muspratt, James Sheridan, Ph.D., F.C.S. College of Chemistry, Liverpool.
Muston, George.
1845. ‡Myers, Rev. Thomas. York.
1859. §Mylne, Robert William, F.R.S., F.G.S., F.S.A. 21 Whitehall-place, London.
1850. ‡Myrtle, J. Y., M.D. 113 Princes-street, Edinburgh.

1850. ‡Nachot, H. W., Ph.D. 113 Princes-street, Edinburgh.
Nadin, Joseph. Manchester.
1855. ‡Napier, James R. 22 Blythwood-square, Glasgow.
1839. *Napier, Right Honourable Joseph. 4 Merrion-square, Dublin.
**Napier, Captain Johnstone.*
1855. ‡Napier, Robert. West Chandon, Garcloch, Glasgow.
Napper, James William L. Loughcrew, Oldcastle., Co. Meath.
1850. *Nasmyth, James. Penge Hurst, Kent.
Nasmyth, Robert, F.R.S.E. 5 Charlotte-square, Edinburgh.
1864. §Natal, Lord Bishop of. London.
1860. ‡Neate, Charles, M.A. Oriel College, Oxford.
1850. ‡*Necker, Theodore. Geneva.*
1845. ‡Neild, Arthur. Ollernshaw, Whaleybridge, by Stockport.

Year of Election.

‡Neild, William. Mayfield, Manchester.
1853. ‡Neill, William, Governor of Hull Jail. Hull.
Neilson, James B. Glasgow.
Neilson, Robert. Woolton-hill, Liverpool.
1855. ‡Neilson, Walter. 28 Woodside-place, Glasgow.
1846. ‡*Neison, F. G. P.*
1861. *Nelson, William. Scotland Bridge, Manchester.
1849. ‡Nesbit, C. J. Lower Kennington-lane, London.
Ness, John. Helmsley, near York.
1861. ‡Nevill, Thomas Henry. 17 George-street, Manchester.
1857. ‡Neville, John, C.E., M.R.I.A. Dundalk, Ireland.
1852. ‡Neville, Parke, C.E. Town Hall, Dublin.
New, Herbert. Evesham, Worcestershire.
Newall, Henry. Hare-hill, Littleborough, Lancashire.
*Newall, Robert Stirling. Gateshead-upon-Tyne.
Newberry, Rev. Thomas, M.A. The Rectory, Hinton, Ilminster, Somerset.
Newbigging, P. S. K., M.D. Edinburgh.
1854. *Newlands, James. 2 Clare-terrace, Liverpool.
1854. ‡*Newman, Charles William.*
*Newman, Francis William. 10 Circus-road, St. John's-wood, London.
*Newman, William. Darley Hall, near Barnsley, Yorkshire.
1863. *Newmarch, William, F.R.S. 17 Palace Gardens-terrace, The Mall, Notting-hill, London.
1853. ‡Newmarch, William, Secretary to Globe Insurance, Cornhill, London.
1858. ‡Newsome, Thomas. Park-road, Leeds.
1860. *Newton, Alfred, M.A., F.L.S. Magdalen College, Cambridge; and Elveden Hall, Thetford, Suffolk.
Nicholl, Iltyd, F.L.S. Uske, Monmouthshire.
1848. ‡Nicholl, W. H. Uske, Monmouthshire.
*Nicholson, Cornelius, F.G.S. Welfield, Muswell-hill, London.
1861. *Nicholson, Edward. 28 Princess-street, Manchester.
*Nicholson, John A., A.M., M.B., Lic. Med., M.R.I.A. Balrath, Kells, Co. Meath.
1858. *Nicholson, William Nicholson. Roundhay Park, Leeds.
1850. ‡Nicol, J., Professor of Natural History in Marischal College, Aberdeen.
1851. ‡*Nicolay, Rev. C. G.*
1856. ‡*Niven, Rev. James.*
Niven, Ninian. Clonturk Lodge, Drumcondra, Dublin.
1864. §Noad, Henry M., Ph.D., F.R.S., F.C.S. 31 Hereford-road, Bayswater, London.
1863. *Noble, Captain. Elswick Works, Newcastle-on-Tyne.
1854. ‡Noble, Matthew. 13 Bruton-street, Bond-street, London.
1860. *Nolloth, M. S., Captain R.N., F.R.G.S. St. Mary's Cottage, Peckham, London; and United Service Club, London.
1859. ‡Norfolk, Richard. Messrs. W. Rutherford and Co., 14 Canada Dock, Liverpool.
1863. §Norman, Rev. A. M. Herington, Fence Houses, Co. Durham.
Norreys, Sir Denham Jephson, Bart. Mallow Castle, Co. Cork.
Norris, Charles. St. John's House, Halifax.
Northampton, Charles Douglas, The Marquis of. 145 Piccadilly, London.
1860. ‡Northcote, A. Beauchamp, F.G.S. Queen's College, Oxford.
1846. ‡*Norton, John Howard, M.D.*
1851. ‡Notcutt, S. A. Westgate-street, Ipswich.
1861. ‡Noton, Thomas. Priory House, Oldham.
1851. ‡Nourse, William E. C., F.R.C.S. West Cowes, Isle of Wight.
Noverre, R., M.D.

Year of Election.

Nowell, John. Farnley Hall, Huddersfield.
1857. ‡*Nuling, Alfred.*
1858. ‡Nunnerley, Thomas. Leeds.
Nurse, William Mountford.
1859. ‡Nuttall, James. Wellfield House, Todmorden.
1849. ‡*Nutter, William. Birmingham.*

O'Beirne, James, M.D.
O'Brien, Baron Lucius. Dromoland, Newmarket-on-Fergus, Ireland.
O'Callaghan, George. Tallas, Co. Clare.
1858. *O'Callaghan, Patrick, LL.D. 16 Clarendon-square, Leamington.
Odgers, Rev. William James. Sion-hill, Bath.
1858. *Odling, William, M.B., F.R.S., Sec. Chem. Soc., Lecturer on Chemistry at St. Bartholomew's Hospital. Sydenham-road, Croydon, Surrey.
1857. ‡O'Donnavan, William John. 2 Cloisters, Temple, Dublin.
1857. ‡O'Donnavan, John. 36 Upper Buckingham-street, Dublin.
1859. §Ogilvie, C. W. Norman. Baldovan House, Dundee.
*Ogilvie, George, M.D., Lecturer on the Institutes of Medicine in Marischal College, Aberdeen.
1863. ‡*Ogilvy, G. R. Dundee.*
1863. ‡Ogilvy, Sir John, Bart. Inverquharity, N. B.
1863. ‡*Ogle, Rev. E. C.*
*Ogle, William, M.D., M.A. Derby.
O'Grady, Michael M., M.D. Lamancha, Malahide, Dublin.
1859. ‡Ogston, Francis, M.D. 18 Adelphi-court, Aberdeen.
1837. ‡O'Hagan, John. 20 Kildare-street, Dublin.
1862. ‡O'Kelly, Joseph, M.A. 51 Stephen's Green, Dublin.
1857. ‡O'Kelly, Matthias J. Dalkey, Ireland.
1853. §Oldham, James, C.E. Austrian Chambers, Hull.
1857. *Oldham, Thomas, M.A., LL.D., F.R.S., F.G.S., M.R.I.A., Director of the Geological Survey of India. Calcutta.
1860. ‡O'Leary, Purcell, M.A. Sydney-place, Cork.
1863. ‡Oliver, D. Richmond, Surrey.
*Ommaney, Erasmus, Rear-Admiral, F.R.A.S., F.R.G.S. 86 Sloane-street, Chelsea, London; and United Service Club, Pall Mall, London.
**O'Reardon, John, M.D.*
1847. **Orlebar, A. B., M.A.*
Ormerod, George Wareing, M.A., F.G.S. Chagford, Exeter.
1861. ‡Ormerod, Henry Mere. Clarence-street, Manchester; and 11 Woodland-terrace, Cheetham-hill, Manchester.
1858. §Ormerod, T. T. Brighouse, near Halifax.
Orpen, John H., LL.D., M.R.I.A. (*Local Treasurer.*) 58 Stephen's Green, Dublin.
1854. ‡Orr, Sir Andrew. Blythwood-square, Glasgow.
Orr, A. S.
Orrell, Alfred.
*Osler, A. Follett, F.R.S. Hazelwood, Edgbaston, Birmingham.
**Ossalinski, Count.*
1854. §Outram, Thomas. Greetland, near Halifax.
Ovenend, Wilson. Sharrow Head, Sheffield.
Overston, Samuel Jones Lloyd, Lord, F.G.S. 22 Norfolk-street, Park-lane, London; and Wickham Park, Bromley.
1857. ‡Owen, James H. Park House, Sandymount, Co. Dublin.
Owen, Richard, M.D., D.C.L., LL.D., F.R.S., F.L.S., F.G.S., Hon. M.R.S.E., Director of the Natural History Department, British Museum. Sheen Lodge, Mortlake, London.

Year of Election.

1863. *Ower, Charles. Dundee.
Oxford, Samuel Wilberforce, D.D., Lord Bishop of, F.R.S., F.S.A., F.R.G.S. 26 Pall Mall, London; and Cuddesdon Palace, Wheatley, Oxon.

1855. ‡Pagan, John M., M.D. West Regent-street, Glasgow.
1850. ‡Pagan, Samuel Alexander, M.D., F.R.S.E. Edinburgh.
1859. ‡Page, David, F.R.S.E., F.G.S. 44 Gilmore-place, Edinburgh.
1863. §Paget, Charles, M.P. Ruddington Grange, near Nottingham.
1845. ‡Paget, George E., M.D. Cambridge.
1847. ‡*Pakington, J. S., B.A.*
1863. ‡Palmer, C. M. Whitley Park, near Newcastle-on-Tyne.
*Palmer, Sir William, Bart. Whitchurch-Canonicorum, Dorset.
Palmes, Rev. William Lindsay, M.A. The Vicarage, Hornsea, Hull.
1854. ‡Pare, William. Seville Iron Works, Dublin.
1859. ‡Paris, Admiral. Brest.
1857. *Parker, Alexander, M.R.I.A.. William-street, Dublin.
*Parker, Charles Stewart. Liverpool.
1863. ‡Parker, Henry. Low Elswick, Newcastle-on-Tyne.
1863. ‡Parker, Rev. Henry. Idlerton Rectory, Low Elswick, Newcastle-on-Tyne.
Parker, Joseph, F.G.S. Upton Chaney, Bitton, near Bristol.
1845. ‡Parker, J. W., jun. Strand, London.
Parker, Richard. Dunscombe, Cork.
Parker, Rev. William. Saham, Norfolk.
1853. ‡Parker, William. Thornton-le-Moor, Lincolnshire.
1861. ‡Parkes, Alexander. 8 Bath-place, Birmingham.
1864. §Parkes, William. 14 Park-street, Westminster.
1859. ‡Parkinson, Robert, Ph.D. Bradford, Yorkshire.
1863. ‡Parland, Captain. Stokes Hall, Jesmond, Newcastle-on-Tyne.
Parnell, E. A.
1862. §Parnell, John, M.A. Upper Clapton, London.
Parnell, Richard, M.D., F.R.S.E. 7 James's-place, Leith.
1854. ‡Parr, Alfred, M.D. New Brighton, Cheshire.
Partington, James Edge.
Partridge, Richard, F.R.S., Professor of Anatomy to the Royal Academy of Arts, and to King's College, London. 17 New-street, Spring-gardens, London.
1855. ‡Paterson, William. 100 Brunswick-street, Glasgow.
1861. ‡Patterson, Andrew. Deaf and Dumb School, Old Trafford, Manchester.
1863. ‡Patterson, H. L. Scott's House, near Newcastle-on-Tyne.
1863. ‡Patterson, John. 16 Bloomfield-terrace, Gateshead-on-Tyne.
*Patterson, Robert, F.R.S. (*Local Treasurer.*) 6 College-square North, Belfast.
1863. ‡Pattinson, William. Felling, near Newcastle-on-Tyne.
1864. §Pattison, Dr. T. H. Edinburgh.
1863. §Paul, Benjamin H., Ph.D. 8 Gray's Inn-square, London.
Paul, Henry. Edinburgh.
1863. §Pavy, Frederick William, M.D., F.R.S., Lecturer on Physiology and Comparative Anatomy and Zoology at Guy's Hospital. 33 Bedford-place, Russell-square, London.
1864. §Payne, Edward Turner. 3 Sydney-place, Bath.
1851. ‡Payne, Joseph. Leatherhead, Surrey.
1847. §Peach, Charles W. Wick, N. B.
1863. §Peacock, R. A. Jersey.
*Pearsall, Thomas John, F.C.S. Mechanics' Institution, Southampton-buildings, Chancery-lane, London.

Year of Election.

1854. ‡Pearson, J. A. Woolton, Liverpool.
1853. ‡Pearson, Robert H. 1 Prospect House, Hull.
Pearson, Rev. Thomas, M.A.
1863. §Pease, H. F. Brinkburn, Darlington.
1852. ‡Pease, Joseph Robinson, J.P. Hesslewood.
1863. §Pease, Joseph W. Woodlands, Darlington.
1863. ‡Pease, J. W. Newcastle-on-Tyne.
1858. *Pease, Thomas, F.G.S. Woodhill, Portishead, near Bristol.
Peckitt, Henry. Carlton Husthwaite, Thirsk, Yorkshire.
1855. *Peckover, Alexander, F.R.G.S. Wisbeach, Cambridgeshire.
*Peckover, Algernon, F.L.S. Wisbeach, Cambridgeshire.
*Peckover, Daniel. Woodhall, Calverley, Leeds.
*Peckover, William, F.S.A. Wisbeach, Cambridgeshire.
*Pedler, Lieutenant-Colonel Philip Warren. Mutley House, near Plymouth.
*Peel, George. Soho Iron Works, Ancoats, Manchester.
1861. *Peile, George, jun. Shotley Bridge, near Gateshead-on-Tyne.
1861. *Peiser, John. Barnfield House, Oxford-street, Manchester.
1861. *Pender, John. Mount-street, Manchester.
1845. ‡Penfold, Rev. James. Christ's College, Cambridge.
1856. §Pengelly, William, F.R.S., F.G.S. Lamorna, Torquay.
1855. ‡Penny, Frederick, Professor of Chemistry in the Andersonian University, Glasgow.
1849. ‡Pentland, J. B. 5 Ryder-street, St. James's, London.
1846. ‡*Peppercorne, George Ryder.*
1845. ‡Percy, John, M.D., F.R.S., F.G.S., Professor of Metallurgy in the Government School of Mines. Museum of Practical Geology, Jermyn-street, London.
*Perigal, Frederick. 28 Hereford-square, Brompton, London.
1856. ‡*Perkins, A. M.*
1861. ‡Perkins, Rev. George. St. James's View, Dickenson-road, Rusholme, near Manchester.
Perkins, Rev. R. B., D.C.L. Wotton-under-Edge, Gloucestershire.
1864. *Perkins, V. R. Wotton-under-Edge.
1861. ‡Perring, John Shae. 104 King-street, Manchester.
Perry, The Right Rev. Charles, M.A., Bishop of Melbourne, Australia.
Perry, James.
*Perry, S. G. F., M.A. Tottington Parsonage, near Bury.
*Peters, Edward. Temple-row, Birmingham.
1856. *Petit, Rev. John Louis. 9 New-square, Lincoln's Inn, London.
1854. ‡Petrie, James, M.D. 13 Upper Parliament-street, Liverpool.
1861. *Petrie, John. Rochdale.
1846. ‡Petrie, William. Ecclesbourne Cottage, Woolwich.
Pett, Samuel, F.G.S. 7 Albert-road, Regent's Park, London.
Peyton, Abel. Birmingham.
1857. ‡*Phayre, George.*
1845. ‡Phelps, Rev. Robert, D.D. Cambridge.
1863. *Phené, John Samuel, F.R.G.S. 34 Oakley-street, Chelsea, London.
1853. *Philips, Rev. Edward. The Bank, near Chendle, Staffordshire.
1853. *Philips, Herbert. 35 Church-street, Manchester.
*Philips, Mark. The Park, near Manchester.
1863. ‡Philipson, Dr. 59 Blackett-street, Newcastle-on-Tyne.
1856. *Phillipps, Sir Thomas, Bart., M.A., F.R.S. Middle-hill, near Broadway, Worcestershire.
1859. *Phillips, Major-General Sir Frowell. United Service Club, Pall Mall, London.
1850. ‡*Phillips, George. Liverpool.*

Year of Election.

1862. ‡Phillips, Rev. George, D.D., Queen's College, Cambridge.
*Phillips, John, M.A., LL.D. (President), F.R.S., F.G.S., Professor of Geology in the University of Oxford. Museum House, Oxford.
1859. ‡*Phillips, Major J. Scott.*
1864. §Pickering, William. 18 Sydney-place, Bath.
1861. ‡Pickstone, William. Radcliff Bridge, near Manchester.
1856. ‡Pierson, Charles. 3 Blenheim-parade, Cheltenham.
Pigott, J. H. Smith. Brockley Hall, Bristol.
*Pike, Ebenezer. Besborough, Cork.
1864. §Pilditch, Thomas. Portway House, Frome.
1857. ‡Pilkington, Henry M., M.A., Q.C. 35 Gardner's-place, Dublin.
1850. ‡Pillans, James. Salisbury-road, Edinburgh.
1863. *Pim, Commander Bedford C. T., R.N., F.R.G.S. Junior United Service Club, London.
Pim, George, M.R.I.A. Brennan's Town, Cabinteely, Dublin.
Pim, Jonathan. Harold's Cross, Dublin.
Pim, William H. Monkstown, Dublin.
1861. ‡Pincoffs, Simon. Crumpsall Lodge, Cheetham-hill, Manchester.
Pinney, Charles. Clifton, Bristol.
1859. ‡Pirrie, William, M.D. 238 Union-street West, Aberdeen.
1864. §Pitt, R. 5 Widcomb-terrace, Bath.
1863. *Platt, John. Werneth Park, Oldham, Lancashire.
Playfair, Lyon, C.B., Ph.D., LL.D., F.R.S. L. & E., V.P.C.S., Professor of Chemistry in the University of Edinburgh. 14 Abercromby-place, Edinburgh.
Plumptre, Charles Frederick, D.D., Master of University College, Oxford. University College, Oxford.
Plumtre, R. B., M.A.
1857. Plunkett, Thomas. Ballybrophy House, Borris-in-Ossory, Ireland.
1861. *Pochin, Henry Davis, F.C.S. Oakfield House, Salford.
1847. ‡Pococke, Rev. N., M.A. Queen's College, Oxford.
*Pollexfen, Rev. John Hutton, M.A., Rector of St. Runwald's, Colchester.
Pollock, A. 52 Upper Sackville-street, Dublin.
1862. *Polwhele, Thomas Roxburgh, M.A. Polwhele, Truro, Cornwall.
*Pontey, Alexander. Plymouth.
1854. ‡*Poole, Braithwaite.*
*Poppelwell, Matthew. Rosella-place, Tynemouth.
Porter, Rev. Charles, D.D.
*Porter, Henry John Ker. St. Martin's Abbey, Perth.
1846. ‡*Porter, John.*
Porter, Rev. T. H., D.D.
1863. ‡Potter, D. M. Cramlington, near Newcastle-on-Tyne.
*Potter, Edmund, F.R.S. 10 Charlotte-street, Manchester.
Potter, Henry Glassford, F.L.S., F.G.S. Reform Club, London; and Jesmond High-terrace, Newcastle-on-Tyne.
Potter, Richard, M.A., F.C.P.S., Professor of Natural Philosophy and Astronomy in University College, London. Ampthill-square, Hampstead-road, London.
Potter, Samuel T.
Potter, Thomas. George-street, Manchester.
Potter, William.
1863. ‡Potts, James. 52½ Quayside, Newcastle-on-Tyne.
Potts, William John. Union Club, Trafalgar-square, London.
1857. *Pounden, Captain Landsdale, F.R.G.S. Junior United Service Club, London; and Brownswood, Co. Wexford.
Powell, Rev. Dr. Madras.

Year of Election.

1851. ‡*Power, David.*
1857. ‡Power, Sir James, Bart. Edermine, Enniscorthy, Ireland.
1859. ‡*Poynter, John. Glasgow.*
1855. *Poynter, John E. Clyde Neuck, Uddingstone, Hamilton, Scotland.
1846. ‡Poyter, Thomas. Wirksworth.
1864. §Prangley, Arthur. Ashfield-villas, Cotham, Bristol.
Pratt, Rev. J. H., M.A., F.C.P.S. Calcutta.
**Pratt, Samuel Peace, F.G.S.*
1864. *Prentice, Manning. Stowmarket, Suffolk.
Prest, Edward, Archdeacon. The College, Durham.
Prest, John. Blossom-street, York.
*Prestwich, Joseph, F.R.S., Treas. G.S. 2 Suffolk-lane, City, London; and 10 Kent-terrace, Regent's Park-road, London.
*Pretious, Thomas. H.M. Dockyard, Devonport.
1848. ‡*Prevost, A. P.*
1846. ‡Priaulx, Nicholas M. 9 Brunswick-place, Southampton.
1856. *Price, Rev. Bartholomew, M.A., F.R.S., F.R.A.S., Sedleian Professor of Natural Philosophy in the University of Oxford. St. Giles's-street, Oxford.
Price, J. T. Neath Abbey, Glamorganshire.
1845. ‡*Pringle, Captain.*
1864. *Prior, R. C. A. Halse House, Taunton.
*Pritchard, Andrew. 87 St. Paul's-road, Canonbury, London.
1846. *Pritchard, Rev. Charles, M.A., F.R.S., V.P.R.A.S., F.G.S. Hurst-hill, Freshwater, Isle of Wight.
1863. ‡Procter, R. S. Summerhill-terrace, Newcastle-on-Tyne.
Proctor, Thomas. Clifton Down, Bristol.
Proctor, William. Cathay, Bristol.
1858. §Proctor, William, M.D., F.C.S. 24 Petergate, York.
1863. *Prosser, John. 38 Cumberland-road, Newcastle-on-Tyne.
1841. ‡Prosser, Richard. King's Norton, near Birmingham.
Protheroe, Captain W. G. B. Dolewilim, St. Clair's, Carnarvonshire.
1863. ‡Proud, Joseph. South Hetton, Newcastle-on-Tyne.
1849. ‡Proud, Thomas Aston. Villa-road, Handsworth.
*Prower, Rev. J. M., M.A. Swindon, Wiltshire.
1854. ‡*Puckle, Hale G.*
1864. §Pugh, John. Aberdovey, Shrewsbury.
1859. ‡Pugh, William. Coalport, Shropshire.
1854. ‡*Pulsford, James.*
*Pumphrey, Charles. 34 Frederick-street, Edgbaston, Birmingham.
Punnett, Rev. John, M.A., F.C.P.S. St. Earth, Cornwall.
1852. ‡Purdon, Thomas Henry, M.D. Belfast.
1860. §Purdy, Frederick, F.S.S., Principal of the Statistical Department of the Poor Law Board, Whitehall, London. Victoria-road, Kensington, London.
1860. *Pusey, S. E. Bouverie. Pusey, Farringdon.
1861. *Pyne, Joseph John. 63 Piccadilly, Manchester.

1860. ‡Radcliffe, Charles Bland, M.D. 4 Henrietta-street, Cavendish-square, London.
Radford, J. G.
*Radford, William, M.D. Sidmount, Sidmouth.
Radstock, The Right Hon. Lord. 30 Bryanstone-square, London.
1861. ‡Rafferty, Thomas. 13 Monmouth-terrace, Rusholme.
1854. ‡Raffles, Thomas Stamford. 21 Canning-street, Liverpool.
1859. ‡Rainey, George, M.D. 17 Golden-square, Aberdeen.
1855. ‡Rainey, Harry, M.D. 10 Moore-place, Glasgow.

Year of Election.

1864. §Rainey, James T. 8 Widcomb-crescent, Bath.
Rake, Joseph. Charlotte-street, Bristol.
1863. §Ramsay, Alexander, jun. 45 Norland-square, Notting Hill, London.
1845. ‡Ramsay, Andrew Crombie, F.R.S., F.G.S., Local Director of the Geological Survey of Great Britain, and Professor of Geology in the Government School of Mines. Museum of Practical Geology, Jermyn-street, London.
1863. ‡Ramsay, D. R. Wallsend, Newcastle-on-Tyne.
1861. ‡Ramsay, John. Kildalton, Argyleshire.
1845. ‡*Ramsay, William. Glasgow.*
1858. *Ramsbotham, John Hodgson, M.D. 16 Park-place, Leeds.
*Rance, Henry. Cambridge.
Rand, John. Wheatley-hill, Bradford, Yorkshire.
1860. ‡Randall, Thomas. Grandepoint House, Oxford.
1855. ‡Randolph, Charles. Pollockshiels, Glasgow.
1847. ‡Randolph, Captain C. G. Wrotham, Kent.
1860. *Randolph, Rev. Herbert, M.A. Marcham, near Abingdon.
Randolph, Rev. John Honywood, F.G.S. Sanderstead, Croydon.
1850. §Rankine, William John Macquorn, LL.D., F.R.S. L. & E., Regius Professor of Civil Engineering and Mechanics in the University of Glasgow. 59 St. Vincent-street, Glasgow.
1861. §Ransome, Arthur, M.A. Bowdon, Cheshire.
1851. ‡Ransome, Frederick. Lower Brook-street, Ipswich.
1851. ‡*Ransome, George.*
1849. *Ransome, Robert. Iron Foundry, Ipswich.
Ransome, Thomas. 34 Princess-street, Manchester.
1863. §Ransome, Dr. W. H. Nottingham.
Rashleigh, Jonathan. 3 Cumberland-terrace, Regent's Park, London
*Ratcliff, Charles, F.L.S., F.G.S., F.S.A., F.R.G.S. Wyddrington, Birmingham.
1864. §Rate, Rev. John, M.A., Lapley Vicarage, Staffordshire.
Rathbone, Theodore W. Allerton Priory, near Liverpool.
Rathbone, William. Green Bank, Liverpool.
Rathbone, William, jun. 7 Water-street, Liverpool.
1863. ‡Rattray, W. Aberdeen.
1848. ‡Ravenshaw, E. C. Athenæum Club, London.
Rawdon, William Frederick, M.D. Bootham, York.
*Rawlins, John. Birmingham.
1855. *Rawlinson, Major-General Sir Henry C., K.C.B., LL.D., F.R.S., F.R.G.S. 1 Hill-street, Berkeley-square, London.
Rawson, Rawson William, F.R.G.S.
Rawson, T. S.
*Rawson, Thomas William. Saville Lodge, Halifax.
Read, John.
1845. ‡*Read, Joseph, M.D.*
1852. ‡Read, Thomas, M.D. Donegal-square West, Belfast.
1858. ‡Read, William Henry. Chapel Allerton, near Leeds.
*Read, W. H. Rudstone, M.A., F.L.S. Hayton, near Pocklington, Yorkshire.
*Reade, Rev. Joseph Bancroft, M.A., F.R.S. Bishopsbourne Rectory, Canterbury.
1862. *Readwin, Thomas Allison, F.G.S. Stretford, near Manchester.
1864. §Reddie, James, F.R.A.S. Bridge House, Hammersmith, London.
1852. *Redfern, Professor Peter, M.D. 4 Lower-crescent, Belfast.
1863. ‡Redmayne, Giles. 20 New Bond-street, London.
1863. ‡Redmayne, R. R. 12 Victoria-terrace, Newcastle.
Redwood, Isaac. Cae Wern, near Neath, South Wales.
1861. *Reé, H. P. 27 Faulkner-street, Manchester.

Year of Election.

1861. ‡Reed, Edward J., Chief Constructor of the Navy. Admiralty, Whitehall, London.
1846. ‡Reeve, Lovell. 5 Henrietta-street, Covent Garden, London.
1854. ‡*Reid, David Boswell, M.D.*
1855. ‡*Reid, James.*
Reid, John.
1857. ‡*Reid, Robert, M.D., M.R.I.A.*
Reid, W.
1850. ‡Reid, William, M.D. Cuivie, Cupar, Fife.
1849. ‡*Reid, Major-General Sir William.*
1863. §Renals, E. 'Nottingham Express' Office, Nottingham.
1863. ‡Rendel, G. Benwell, Newcastle-on-Tyne.
Rennie, George, F.R.S., F.G.S., F.R.G.S., Hon. M.R.I.A. 39 Wilton-crescent, Belgrave-square, London.
Rennie, Sir John, Knt., F.R.S., F.G.S., F.S.A., F.R.G.S. 32 Charing Cross, London.
1860. ‡Rennison, Rev. Thomas, M.A. Queen's College, Oxford.
**Renny, Lieutenant H. L., R.E. Montreal.*
1858. §Reynolds, Richard, F.C.S. 13 Briggate, Leeds.
1849. ‡Reynolds, Thomas F., M.D. 14 Lansdowne-terrace, Cheltenham.
Reynolds, William, M.D. Coeddu, near Mold, Flintshire.
1850. ‡Rhind, William. 121 Princes-street, Edinburgh.
1858. *Rhodes, John. Leeds.
1847. ‡Ricardo, M. Brighton.
Rice, The Hon. S. E. Spring.
1863. §Richardson, Benjamin W., M.A., M.D. 12 Hinde-street, Manchester-square, London.
1861. §Richardson, Charles. Almondbury, Bristol.
1863. *Richardson, Edward, jun. South Ashfield, Newcastle-on-Tyne.
Richardson, James. Glasgow.
1854. ‡Richardson, John. Hull.
1863. ‡Richardson, John W. South Ashfield, Newcastle-on-Tyne.
1859. ‡Richardson, Sir John S., Bart. Pitfour Castle, Perthshire.
Richardson, Thomas. Glasgow.
Richardson, Thomas. Montpelier-hill, Dublin.
Richardson, William. Micklegate, York.
1861. §Richardson, William. 4 Edward-street, Wernith, Oldham.
Richardson, Rev. William.
1861. ‡Richson, Rev. Canon, M.A. Shakespeare-street, Ardwick, Manchester.
1863. ‡Richter, Otto, Ph.D. Bathgate, Linlithgowshire.
*Riddell, Colonel Charles James Buchanan, C.B., F.R.S. Ordnance House, Sheerness.
1861. *Riddell, H. B. The Palace, Maidstone.
1859. ‡Riddell, Rev. John. Moffat, Scotland.
1861. *Rideout, William J. Farnworth, near Manchester.
1862. ‡Ridgway, Henry Akroyd, B.A. Bank Field, Halifax.
Ridgway, John. Cauldon-place, Potteries, Staffordshire.
1861. ‡Ridley, John. 19 Belsize-park, Hampstead, London.
1863. ‡Ridley, Samuel. 7 Regent's-terrace, Newcastle-on-Tyne.
1851. ‡Rigaud, Rev. S. J. Lower Brook-street, Ipswich.
1863. *Rigby, Samuel. Bruch Hall, Warrington.
*Rinder, Miss. Gledhow Grove, Leeds.
1860. §Ritchie, George Robert. 14 Denmark-road, Camberwell, London.
1855. ‡Ritchie, Robert, C.E. 14 Hill-street, Edinburgh.
1853. ‡Rivay, John V. C. 19 Cowley-street, Westminster, London.
1854. ‡Robberds, Rev. John, B.A. Liverpool.
1855. ‡Roberton, James. Gorbals Foundry, Glasgow.

Year of Election.

Roberton, John. Oxford-road, Manchester.
1859. ‡Roberts, George Christopher. Hull.
1859. ‡Roberts, Henry, F.S.A. Athenæum Club, London.
1854. ‡*Roberts, John.*
1853. ‡Roberts, John Francis. 10 Adam-street, Adelphi, London.
1857. ‡Roberts, Michael. Trinity College, Dublin.
*Roberts, William P. 50 Ardwick Green, Manchester.
1859. ‡Robertson, Dr. Andrew. Indego, Aberdeen.
1863. ‡Robinson, Dr. 26 Welbeck-street, Cavendish-square, London.
1861. §Robinson, Enoch. Dukinfield, Cheshire.
1852. ‡Robinson, Rev. George. Tartaragham Glebe, Loughgall, Ireland.
1864. §Robinson, G. A. Widcomb-hill, Bath.
1859. ‡Robinson, Hardy. 156 Union-street, Aberdeen.
1860. ‡*Robinson, Professor H. D.*
*Robinson, H. Oliver. 16 Park-street, Westminster, London.
1863. §Robinson, Isaac Norman. Brunswick House, Carlisle.
**Robinson, John.*
1861. ‡Robinson, John. Atlas Works, Manchester.
1863. ‡Robinson, J. H. Cumberland-row, Newcastle-on-Tyne.
1855. ‡Robinson, M. E. 116 St. Vincent-street, Glasgow.
1860. ‡Robinson, Admiral Robert Spencer. 61 Eaton-place, London.
Robinson, Rev. Thomas Romney, D.D., F.R.S., F.R.A.S., M.R.I.A., Director of the Armagh Observatory. Armagh.
1863. §Robinson, T. W. U. Houghton-le-Spring, Durham.
1863. *Robson, James. Coxlodge Colliery, Bulman's Village, Newcastle-on-Tyne.
*Robson, Rev. John, D.D. Glasgow.
1855. ‡Robson, Neil, C.E. 127 St. Vincent-street, Glasgow.
Rochfort, J. S.
1845. ‡*Rocow, Tattersall Thomas.*
Rodger, Robert.
1851. ‡Rodwell, William. Woodlands, Holbrook, Ipswich.
Roe, Henry, M.R.I.A. 2 Fitzwilliam-square East, Dublin.
1846. ‡Roe, William Henry. Portland-terrace, Southampton.
1861. §Rofe, John, F.G.S.
1860. ‡Rogers, Professor H. D. Glasgow.
1860. ‡Rogers, James E. T., Professor of Political Economy in the University of Oxford. Beaumont-street, Oxford.
*Roget, Peter Mark, M.D., F.R.S. 18 Upper Bedford-place, Russell-square, London.
1859. §Rolleston, George, M.A., M.D., F.R.S., F.L.S., Professor of Anatomy and Physiology in the University of Oxford. 15 New Inn Hall-street, Oxford.
1863. §Romilly, Edward. 14 Hyde Park-terrace, London.
1845. ‡Romily, Rev. Joseph. Trinity College, Cambridge.
1846. ‡Ronalds, Edmund, Ph.D. Stewartfield, Bonnington, Edinburgh.
1845. ‡*Ronalds, Francis.*
1861. *Roscoe, Henry Enfield, B.A., Ph.D., F.R.S., F.C.S., Professor of Chemistry in Owens College, Manchester.
1861. §Rose, C. B., F.G.S. 25 King-street, Great Yarmouth, Norfolk.
Rosebery, Archibald John, Earl of, K.T., M.A., D.C.L., F.R.S. 139 Piccadilly, London; and Dalmeny Park, Linlithgow.
1863. ‡Roseby, John. Haverholme House, Brigg, Lincolnshire.
1851. ‡*Rosling, Alfred.*
1857. ‡Ross, David, LL.D. Drumbrain Cottage, Newbliss, Ireland.
1859. *Ross, James Coulman. Trinity College, Cambridge.
1861. *Ross, Thomas. Featherstone-buildings, High Holborn, London.
Ross, William. Pendleton, Manchester.

Year of Election.

Rosse, William, Earl of, M.A., K.St.P., LL.D., F.R.S., F.R.A.S., F.G.S., M.R.I.A., F.R.G.S., F.A.S., Chancellor of the University of Dublin. Birr Castle, Parsonstown, King's County, Ireland.
Rosson, John. Moore Hall, near Ormskirk, Lancashire.
1855. ‡Roth, Dr. Matthias. 16A Old Cavendish-street, London.
1849. §Round, Daniel G. Hange Colliery, near Tipton, Staffordshire.
1846. ‡Roundall, William B. 146 High-street, Southampton.
*Roundell, Rev. Danson Richardson. Gledstone, Skipton.
1847. ‡Rouse, William. 16 Canterbury Villas, Maida Vale, London.
1861. ‡Routh, Edward J., M.A. St. Peter's College, Cambridge.
1861. ‡Rowan, David. St. Vincent Crescent, Glasgow.
1855. ‡Rowand, Alexander. Linthouse, near Glasgow.
1855. *Rowney, Thomas H., Ph.D., F.C.S., Professor of Chemistry in Queen's College, Galway.
*Rowntree, Joseph. Leeds.
1862. ‡Rowsell, Rev. Evan Edward, M.A. Hambledon Rectory, Godalming.
1861. *Royle, Peter, M.D., L.R.C.P., M.R.C.S. 27 Lever-street, Manchester.
1859. ‡*Ruland, C. H.*
1861. *Rumney, Robert. Ardwick, Manchester.
1856. ‡Rumsay, Henry Wildbore. Gloucester Lodge, Cheltenham.
*Rushout, Capt. the Hon. George, F.G.S. 10 Bolton-street, Piccadilly, London.
1847. ‡Ruskin, John, M.A., F.G.S. Denmark-hill, Camberwell, London.
1857. ‡Russell, Rev. C. W., D.D. Maynooth College.
1849. ‡Russell, James, M.D. Temple-row, Birmingham.
1855. ‡Russell, James, jun. Falkirk.
1859. ‡Russell, John, Earl, K.G., F.R.S., F.R.G.S. 37 Chesham-place, Belgrave-square, London.
Russell, John. Piercefield, Chepstow.
Russell, John. 15 Middle Gardiner's-street, Dublin.
Russell, John Scott, M.A., F.R.S. L. & E. Sydenham; and 5 Westminster Chambers, Westminster, London.
1852. *Russell, Norman Scott. 37 Great George-street, Westminster, London.
1853. ‡*Russell, Robert.*
1863. §Russell, Robert. Gosforth Colliery, Newcastle-on-Tyne.
Russell, Rev. T.
1852. *Russell, William J., Ph.D. 8 Circus-road, St. John's Wood, London.
1862. §Russell, W. H. L., A.B. Shepperton, Middlesex.
Rutson, William. Newby Wiske, Northallerton, Yorkshire.
1852. ‡*Ryan, John, M.D.*
*Ryland, Arthur. Birmingham.
1853. ‡Rylands, Joseph. 9 Charlotte-street, Hull.
1861. *Rylands, Thomas. Glazebrook, Warrington.

*Sabine, Major-General Edward, R.A., LL.D., D.C.L., President of the Royal Society, F.R.A.S., F.L.S., F.R.G.S. 13 Ashley-place, Westminster, London.
1845. ‡Sadler, Rev. Michael F. Hanover Chapel, Regent-street, London.
Salkeld, Joseph. Penrith, Cumberland.
1857. ‡Salmon, Rev. George, D.D., F.R.S., Professor of Mathematics in Trinity College. Trinity College, Dublin.
1864. §Salmon, Henry C., F.G.S., F.C.S. Truro, Cornwall.
Salmon, William Wroughton. 9 Regent's Park-square, London; and Devizes, Wiltshire.
1854. *Salt, Charles F. 24 Grove-street, Liverpool.
1858. *Salt, Titus. Crow Nest, Lightcliffe, Halifax.
1856. ‡Salter, John William, F.G.S. Geological Survey of Great Britain, Museum of Practical Geology, Jermyn-street; and 8 Bolton-road, Boundary-road, St. John's Wood, London.

Year of Election.

Salusbury, Sir John, Knt.
Sambrooke, T. G. 32 Eaton-place, London.
1861. *Samson, Henry. Messrs. Samson and Leppoe, St. Peter's-square, Manchester.
1854. ‡Sandbach, Henry R. Hafodunos, Denbighshire.
1861. *Sandeman, A., M.A. Queen's College, Cambridge.
1857. ‡Sanders, Gilbert. 2 Foster-place, Dublin.
Sanders, John Naish, F.G.S. 12 Vyvyan-terrace, Clifton, Bristol.
*Sanders, William, F.R.S., F.G.S. (*Local Treasurer.*) 21 Richmond-terrace, Clifton, Bristol.
Sandes, Thomas, A.B. Sallow Glin, Tarbert, Co. Kerry.
1864. §Sandford, William. 9 Springfield-place, Bath.
1854. ‡Sandon, Lord. 39 Gloucester-square, London.
1864. §Sanford, William A. Nynehead Court, Wellington, Somersetshire.
1849. ‡*Sargant, Henry.*
Satterfield, Joshua. Alderley Edge.
1861. ‡Saul, Charles J. Smedley-lane, Cheetham-hill, Manchester.
1846. ‡*Saunders, Trelawney William.*
1860. *Saunders, William. Manor House, Iffley, near Oxford.
1863. ‡Savory, Valentine. Cleckheaton, near Leeds.
Saxby, Stephen Martin.
1857. ‡Scallan, James Joseph. 77 Harcourt-street, Dublin.
1850. ‡Scarth, Pillans. 28 Barnard-street, Leith.
*Schemman, J. C. Hamburg.
*Schlick, Commandeur de. 15 Rue Bellechasse, Faubourg St. Germain, Paris.
Schofield, Benjamin.
Schofield, Joseph. Stubley Hall, Littleborough, Lancashire.
*Schofield, Robert. Vicar's Walk, Rochdale.
Schofield, W. F. Fairlawn, Ripon.
Scholefield, William. Birmingham.
*Scholes, T. Seddon. 16 Dale-street, Leamington.
1847. *Scholey, William Stephenson, M.A. Clapham, London.
*Scholfield, Edward, M.D. Doncaster.
1854. ‡*Scholfield, Henry D., M.D.*
Schunck, Edward, F.R.S. Oaklands, Kersall, Manchester.
1861. *Schwabe, Edmund Salis. Rhodes House, near Manchester.
1847. ‡Sclater, Philip Lutley, M.A, Ph.D., F.R.S., F.L.S., Sec. Zool. Soc. 11 Hanover-square, London.
1849. ‡Scoffern, John, M.B. Barnard's Inn, London; and Ilford, Essex.
1859. ‡Scott, Captain Fitzmaurice. Forfar Artillery.
1855. ‡Scott, Montague D., B.A. Hove, Sussex.
Scott, Robert. Stourbridge.
1857. §Scott, Robert H. 18 Ranelagh-road, Dublin.
1861. §Scott, Rev. R. Selkirk, M.A. 7 Beaufort-terrace, Cecil-street, Manchester.
1864. §Scott, Wentworth L. 12 Cornwall-villas, Westbourne Park, London.
1858. ‡Scott, William. Holbeck, near Leeds.
1864. §Scott, William Robson, Ph.D. St. Leonards, Exeter.
1856. ‡*Scougall, James.*
1854. ‡Scrivenor, Harry. Ramsay, Isle of Man.
1859. ‡Seaton, John Love. Hull.
*Sedgwick, Rev. Adam, M.A., LL.D., F.R.S., Hon. M.R.I.A., F.G.S., F.R.A.S., F.R.G.S., Woodwardian Professor of Geology in the University of Cambridge, and Canon of Norwich. Trinity College, Cambridge.
1853. ‡Sedgwick, Rev. James. Scalby Vicarage, Scarborough.
1861. *Seeley, Harry, F.G.S. Woodwardian Museum, Cambridge.

Year of Election.

Selby, Prideaux John, F.L.S., F.G.S. Twizel House, Belford, Northumberland.
1855. ‡Seligman, H. L. 135 Buchanan-street, Glasgow.
1850. ‡Seller, William, M.D. 23 Nelson-street, Edinburgh.
Selwyn, Rev. William, M.A., Prebendary of Ely. Foxton, Royston.
1858. *Senior, George. Barnsley.
Serle, Rev. Philip, B.D.
Seymour, George Hicks. Stonegate, York.
1861. *Seymour, Henry D., M.P. 39 Upper Grosvenor-street, London.
Seymour, John. 21 Bootham, York.
1853. ‡Shackles, G. L. 6 Albion-street, Hull.
*Shaen, William. 8 Bedford-row, London.
1846. ‡Sharp, James. 22 Oxford-street, Southampton.
Sharp, Rev. John, B.A. Horbury, Wakefield.
1861. §Sharp, Samuel, F.G.S., F.S.A. Dallington Hall, Northampton.
*Sharp, William, M.D., F.R.S., F.G.S. Horton House, Rugby.
Sharp, Rev. William, B.A. Mareham Rectory, near Boston, Lincolnshire.
1854. ‡Sharpe, Robert, M.D. Coleraine.
Sharpey, William, M.D., LL.D., Sec. R.S., F.R.S.E., Professor of Anatomy in University College. 33 Woburn-place, London.
1858. *Shaw, Bentley, J.P. Woodfield House, Huddersfield.
1854. *Shaw, Charles Wright. 3 Windsor-terrace, Douglas, Isle of Man.
1858. ‡Shaw, Edward W. 3 Albion-place, Leeds.
1845. ‡Shaw, John, M.D., F.L.S., F.G.S. Boston, Lincolnshire.
1861. *Shaw, John. City-road, Hulme, Manchester.
1858. ‡Shaw, John Hope. Headingley, Leeds.
1853. ‡*Shaw, Norton, M.D.*
Shepard, John. Nelson-square, Bradford, Yorkshire.
1863. §Shepherd, A. B. 7 South-square, Gray's Inn, London.
Sheppard, Rev. Henry W., B.A. The Parsonage, Emsworth, Hants.
*Sherrard, David Henry. 88 Upper Dorset-street, Dublin.
1851. ‡Shewell, John T. Rushmere, Ipswich.
1845. ‡*Shillinglaw, John.*
Shore, Offley. Sheffield.
1849. ‡Shorthouse, Joseph. Birmingham.
1846. *Shortrede, Colonel Robert, F.R.A.S. 6 Medina Villas, Brighton.
1864. §Showers, Lieut.-Colonel Charles L. Cox's Hotel, Jermyn-street, London.
Shuttleworth, John. Wilton Polygon, Cheetham-hill, Manchester.
1861. *Sidebotham, Joseph. 19 George-street, Manchester.
1861. *Sidebottom, James. Portland-street, Manchester.
1861. *Sidebottom, James, jun. Spring-bank Mills, Stockport.
1857. ‡Sidney, Frederick John. 19 Herbert-street, Dublin.
Sidney, M. J. F. Cowpen, Newcastle.
1857. ‡*Siegfried, Rudolph Th.*
1856. §Siemens, C. William, F.R.S. 3 Great George-street, Westminster, London.
Sigmond, George, M.D., F.S.A.
*Sillar, Zechariah, M.D. Bath House, Laurie Park, Sydenham, near London.
1859. ‡Sim, John. Hardgate, Aberdeen.
1855. ‡Sim, William. Furnace, near Inverary.
1851. ‡Sim, W. D. Ipswich.
1862. §Simms, James. 138 Fleet-street, London.
1852. ‡Simms, William. Albion-place, Belfast.
1847. ‡Simon, John. King's College, London.
1850. ‡*Simpson, Professor James Y.*
1859. ‡Simpson, John. Marykirk, Kincardineshire.

Year of Election.

1863. §Simpson, J. B., F.G.S. Hedgefield House, Blaydon-on-Tyne.
1857. ‡*Simpson, Max, M.D.*
*Simpson, Rev. Samuel. Douglas, Isle of Man.
Simpson, Thomas.
Simpson, Thomas. Blake-street, York.
Simpson, William. Bradmore House, Hammersmith, London.
1859. ‡Sinclair, Alexander. 133 George-street, Edinburgh.
1850. ‡Sinclair, Rev. William. Leeds.
1864. §Sircar, Baboo Mohendro Lall, M.D. (Care of Edwin Goodive, Esq., Dunagh, Stoke Bishop, Bristol).
*Sirr, Rev. Joseph D'Arcy, D.D., M.R.I.A. Castle-hill, Winchester.
Sisson, William, F.G.S. Clifton, Bristol.
1850. ‡Skae, David, M.D. Royal Asylum, Edinburgh.
1850. ‡*Skane, William Forbes.*
1859. ‡Skinner, James. Dromin, Listowel, Ireland.
1849. ‡*Slaney, R. A. Shropshire.*
*Slater, William. Princess-street, Manchester.
1853. §Sleddon, Francis. 2 Kingston-terrace, Hull.
**Sleeman, Philip.*
1849. §Sloper, George Edgar, jun. Devizes.
1849. ‡Sloper, Samuel W. Devizes.
1860. §Sloper, S. Elgar. Winterton, near Southampton.
1858. ‡Smeeton, G. H. Commercial-street, Leeds.
Smethurst, Rev. John. Moreton-Hampstead, near Exeter.
1857. ‡Smith, Aquila, M.D., M.R.I.A. 121 Lower Bagot-street, Dublin.
Smith, Archibald, M.A., F.R.S. L. & E. River-bank, Putney; and 3 Stone-buildings, Lincoln's Inn, London.
1860. §Smith, Brooke. 65 Hall-street, Birmingham.
Smith, Rev. B., F.S.A.
1861. *Smith, Charles Edward, F.R.A.S. Fir Vale, near Sheffield.
1853. ‡Smith, Edmund. Ferriby, near Hull.
1859. §Smith, Edward, M.D., LL.B., F.R.S. 16 Queen Anne-street, London.
1855. ‡Smith, George. Port Dundas, Glasgow.
1855. ‡Smith, George Cruickshank. 19 St. Vincent-place, Glasgow.
*Smith, Rev. George Sidney, D.D., M.R.I.A., Professor of Biblical Greek in the University of Dublin. Aughalurcher, Five-mile-Town, Co. Tyrone.
1859. ‡Smith, G. Campbell. Banff.
1859. ‡Smith, Henry A. 5 East Craibstone-street, Aberdeen.
*Smith, Henry John Stephen, M.A., F.R.S., Savilian Professor of Geometry in the University of Oxford. 64 St. Giles's, Oxford.
1860. *Smith, Heywood. 25 Park-street, Grosvenor-square, London.
1845. ‡*Smith, Horatio. Manchester.*
Smith, James.
*Smith, James. Berkeley House, Seaforth, near Liverpool.
Smith, James, F.R.S. L. & E., F.G.S., F.R.G.S. Athenæum Club, London; and Jordan-hill, Glasgow.
1859. ‡*Smith, James. Gibraltar.*
1855. ‡Smith, James. St. Vincent-street, Glasgow.
Smith, John.
*Smith, John. Shelbrook House, Ashby-de-la-Zouch.
1850. ‡*Smith, John, M.D. Edinburgh.*
1853. ‡Smith, John. York City and County Bank, Malton, Yorkshire.
1854. ‡Smith, John. Commerce-court, Liverpool.
1858. *Smith, John Metcalf. (*Local Treasurer.*) Bank, Leeds.
Smith, John Peter George. Liverpool.
1864. §Smith, John S. Wimbledon Park, Surrey.
1852. *Smith, Rev. Joseph Denham. Kingstown, near Dublin.

Year of Election.

1861. ‡Smith, Professor J., M.D. University of Sydney, Australia.
1845. ‡Smith, Rev. J. J. Caius College, Cambridge.
*Smith, Rev. Philip, B.A. St. James's Lodge, St. James's-road, Croydon, Surrey.
1860. *Smith, Protheroe, M.D. 25 Park-street, Grosvenor-square, London.
1837. Smith, Richard Bryan. Villa Noba, Shrewsbury.
1847. ‡Smith, Robert Angus, Ph.D., F.R.S., F.C.S. 20 Grosvenor-square, Manchester.
*Smith, Robert Mackay. Bellevue-crescent, Edinburgh.
Smith, Samuel.
Smith, Thomas.
1859. ‡Smith, Thomas James, F.G.S., F.C.S. Hessle, near Hull.
1852. ‡Smith, William. Eglinton Engine Works, Glasgow.
1857. §Smith, William, C.E., F.G.S. 19 Salisbury-street, Adelphi, London.
1850. *Smyth, Charles Piazzi, F.R.S. L. & E., F.R.A.S., Astronomer Royal for Scotland, Professor of Practical Astronomy in the University of Edinburgh. 1 Hillside-crescent, Edinburgh.
1846. ‡*Smyth, Rev. George Watson.*
1857. *Smyth, John, jun., M.A., C.E. Milltown, Banbridge, Ireland.
1864. §Smyth, Warington W., M.A., F.R.S., Sec. G.S., Lecturer on Mining at the Government School of Mines, and Inspector of the Mineral Property of the Crown. Jermyn-street; and 27 Victoria-street, London.
1854. ‡Smythe, Lieut.-Col. W. J., R.A. Woolwich.
1850. ‡Smyttan, George, M.D. Edinburgh.
Soden, John. Bath.
1853. ‡Sollitt, J. D., Head Master of Grammar School, Hull.
*Solly, Edward, F.R.S., F.S.A. Holme Court, Isleworth, Middlesex.
*Solly, Samuel Reynolds, M.A., F.R.S. 10 Manchester-square, London.
*Sopwith, Thomas, M.A., F.R.S., F.G.S., F.R.G.S. 103 Victoria-street, Westminster, London.
Sorbey, Alfred. South Darley, near Matlock, Derbyshire.
1859. *Sorby, H. Clifton, F.R.S., F.G.S. Broomfield, Sheffield.
1861. ‡Sorensen, Le Chevalier B. Norway.
1859. ‡Southall, Norman. 44 Cannon-street West, London.
1849. ‡Southall, Thomas. Willington-road, Birmingham.
1856. ‡Southwood, Rev. T. A. Cheltenham College.
1863. ‡Sowerby, John. Shipcote House, Gateshead, Durham.
1863. *Spark, H. K. Greenbank, Darlington.
Speir, Thomas.
1859. ‡Spence, Rev. James, D.D. 6 Clapton-square, London.
*Spence, Joseph. Pavement, York.
1854. §Spence, Peter. Pendleton Alum Works, Newton Heath; and Smedley Hall, near Manchester.
1845. §*Spence, W. B.*
1861. §Spencer, John Frederick. St. Nicholas-buildings, Newcastle-on-Tyne.
1861. *Spencer, Joseph. 27 Brown-street, Manchester.
1863. **Spencer, Thomas.*
1855. ‡Spens, William. 78 St. Vincent-street, Glasgow.
1864. *Spicer, Henry, jun. 19 New Bridge-street, Blackfriars, London.
Spicer, Thomas Trevetham, M.A., LL.D.
1864. §Spicer, William R. 19 New Bridge-street, Blackfriars, London.
1847. *Spiers, Richard James, F.S.A. 14 St. Giles's-street, Oxford.
1864. *Spiller, Captain John, F.C.S. Chemical Department, Royal Arsenal, Woolwich.
1846. *Spottiswoode, William, M.A., F.R.S., F.R.A.S., F.R.G.S. (*General Treasurer.*) 50 Grosvenor-place, London.
1864. *Spottiswoode, W. Hugh. 50 Grosvenor-place, London.

Year of Election.

1854. *Sprague, Thomas Bond. 18 Lincoln's Inn Fields, London.
1853. ‡Spratt, Joseph James. West Parade, Hull.
Square, Joseph Elliot. Plymouth.
*Squire, Lovell. Falmouth.
1859. ‡Stables, William Alexander. Cawdor Castle.
1857. ‡*Stack, Thomas. Dublin.*
1858. *Stainton, Henry T., F.L.S., F.G.S. Mountsfield, Lewisham, Kent.
1851. *Stainton, James Joseph, F.L.S., F.C.S. Horsell, near Ripley, Surrey.
Stamforth, Rev. Thomas.
Stanfeld, Hamer. Burley, near Otley.
1858. ‡Stanfield, Alfred W. Wakefield.
1856. *Stanley, The Right Hon. Lord, M.P., LL.D., F.R.S., F.R.G.S. 23 St. James's-square, London; and Knowsley, Liverpool.
Stanley, The Very Rev. Arthur Penrhyn, D.D., Dean of Westminster. The Deanery, Westminster, London.
Stanway, J. Holt.
Stapleton, H. M. 1 Mountjoy-place, Dublin.
1850. ‡Stark, James, M.D., F.R.S.E. 21 Rutland-street, Edinburgh.
1863. ‡Stark, Richard M. Hull.
1848. ‡Statham, Henry Joseph. 27 Mortimer-street, Cavendish-sq., London.
Staveley, T. K. Ripon, Yorkshire.
1848. ‡St. Davids, Lord Bishop of. The Palace, Abergwilli, Carmarthen.
1857. ‡Steel, William Edward, M.D. 15 Hatch-street, Dublin.
1863. §Steele, Rev. Dr. 2 Bathwick-terrace, Bath.
1861. ‡Steinthal, H. M. Hollywood, Fallowfield, near Manchester.
Stenhouse, John, Ph.D. 17 Rodney-street, Pentonville, London.
1863. §Sterriker, John. Driffield.
1861. *Stern, S. J. 33 George-street, Manchester.
§Stevelly, John, LL.D., Professor of Natural Philosophy in Queen's College, Belfast.
1861. *Stevens, Henry, F.S.A., F.R.G.S. 2 Byng-place, Gordon-square, London.
1863. §Stevenson, Archibald. South Shields.
1850. ‡Stevenson, David. 8 Forth-street, Edinburgh.
Stevenson, Rev. Edward, M.A.
Stevenson, H.
1863. *Stevenson, James C. South Shields.
1855. ‡Stewart, Balfour, M.A., F.R.S., Superintendent of the Kew Observatory of the British Association. Richmond, Surrey.
1864. §Stewart, Charles. Plymouth.
1856. *Stewart, Henry Hutchinson, M.D., M.R.I.A. 71 Eccles-street, Dublin.
1859. ‡Stewart, John. Glasgow.
Stewart, Robert. Glasgow.
1847. ‡Stewart, Robert, M.D. The Asylum, Belfast.
*Stirling, Andrew. Lower Mosley-street, Manchester.
Stirling, William.
1849. ‡Stock, T. S. Bourn Brook Hall.
1862. ‡Stockil, William. 5 Church Meadows, Sydenham.
Stoddart, George. 11 Russell-square, London.
1864. §Stoddart, W. W. 9 North-street, Bristol.
1854. ‡Stoep, Charles (Consul). 6 Cook-street, Liverpool.
*Stokes, George Gabriel, M.A., D.C.L., Sec. R.S., Lucasian Professor of Mathematics in the University of Cambridge. Pembroke College, Cambridge.
1845. ‡Stokes, Rev. William H., M.A., F.G.S. Cambridge.
1862. ‡Stone, E. J., M.A. Royal Observatory, Greenwich.
1859. ‡Stone, Dr. William H. 13 Vigo-street, London.
1857. ‡Stoney, Bindon B., M.R.I.A. 89 Waterloo-road, Dublin.

Year of Election.

1861. *Stoney, George Johnstone, M.A., F.R.S., M.R.I.A., Secretary to the Queen's University, Ireland. Dublin Castle, Dublin.
1854. ‡Store, George. Prospect House, Fairfield, Liverpool.
1859. §Story, James. 17 Bryanston-square, London.
Stowe, William. Buckingham.
Stowell, Rev. H. Acton-square, Salford, Manchester.
Strachan, James M. The Grove, Teddington, Middlesex.
1859. ‡*Strachan, Patrick.*
1863. ‡Strachan, T. Y. Lovaine-crescent, Newcastle-on-Tyne.
1863. ‡Straker, John. Wellington House, Durham.
1850. ‡*Strange, John, LL.D. Edinburgh.*
*Strickland, Arthur. Bridlington Quay, Yorkshire.
*Strickland, Charles. Loughglyn, Ballaghadereen, Ireland.
1845. ‡*Strickland, Henry Eustatius.*
Strickland, J. E. French-park, Roscommon, Ireland.
Strickland, William. French-park, Roscommon, Ireland.
1859. ‡Stronach, William, R.E. Ardmellie, Banff.
Strong, Rev. William. Stanground, near Peterborough.
1848. ‡Struvé, William Price. Picton-place, Swansea.
Stroud, Rev. Joseph, M.A.
Stuart, Robert. Manchester.
1854. ‡Stuart, William. 1 Rumford-place, Liverpool.
1861. ‡Stuart, W. D. Philadelphia.
1859. ‡*Stuart, William Henry.*
1864. §Style, Sir Charles, Bart. 102 New Sydney-place, Bath.
1857. ‡Sullivan, William K., Ph.D., M.R.I.A. Museum of Irish Industry; and 53 Upper Leeson-road, Dublin.
Sutherland, Alexander John, M.D., F.R.S., F.G.S. 6 Richmond-terrace, Westminster, London.
1863. ‡Sutherland, Benjamin John. 10 Oxford-street, Newcastle-on-Tyne.
1862. *Sutherland, George Granville William, Duke of, F.R.G.S. Stafford House, London.
1855. ‡Sutton, Edwin. 44 Winchester-street, Pimlico, London.
1863. §Sutton, F. Bank Plain, Norwich.
1861. *Swan, Patrick Don S. Kirkaldy.
1862. *Swan, William, Professor of Natural Philosophy in the University of St. Andrews, N. B.
1863. ‡Swan, William. Walker, Durham.
1853. ‡*Swan, William Thomas.*
1862. *Swann, Rev. T. K. Gedling, near Nottingham.
Swanwick, J. W.
Sweetman, Walter, M.A., M.R.I.A. 4 Mountjoy-square North, Dublin.
1863. §Swindell, J. S. E. Stourbridge.
1863. ‡Swinhoe, Robert, F.R.G.S. Oriental Club, London.
1859. ‡Sykes, Alfred. Leeds.
1847. ‡Sykes, H. P. 47 Albion-street, Hyde Park, London.
1862. §Sykes, Thomas. Cleckheaton, near Leeds.
*Sykes, Colonel William Henry, M.P., F.R.S., Hon. M.R.I.A., F.G.S., F.R.G.S. 47 Albion-street, Hyde Park, London.
1847. ‡Sykes, W. H. F. 47 Albion-street, Hyde Park, London.
Sylvester, James Joseph, M.A., F.R.S., Professor of Mathematics in the Royal Military Academy, Woolwich. Woolwich; and Athenæum Club, London.
1850. ‡Syme, James, Professor of Clinical Surgery in the University of Edinburgh. The College, Edinburgh.
1856. *Symonds, Frederick, F.R.C.S. Beaumont-street, Oxford.
1859. ‡*Symonds, Captain Thomas Edward, R.N.*
1860. ‡Symonds, Rev. W. S., M.A., F.G.S. Pendock Rectory, Worcestershire.

Year of
Election.

1859. §Symons, G. J. 129 Camden-road Villas, London.
1855. *Symons, William. 17 St. Mark's-crescent, Regent's Park, London.
Synge, Rev. Alexander. St. Peter's, Ipswich.
Synge, Francis. Glanmore, Ashford, Co. Wicklow.
Synge, John Hatch. Glanmore, Ashford, Co. Wicklow.

§Talbot, William. Hawkshead, Southport, Lancashire.
Talbot, William Henry Fox, M.A., LL.D., F.R.S., F.L.S. Lacock Abbey, near Chippenham.
Taprell, William. 7 Westbourne-crescent, Hyde Park, London.
1861. *Tarratt, Henry W. Bushbury Lodge, Leamington.
1856. ‡Tartt, William Macdonald, F.S.S. Sandford-place, Cheltenham.
1864. §Tasker, Rev. J. C. W. 1 Upper Lansdown-villas, Bath.
1857. *Tate, Alexander. 41 Upper Sackville-street, Dublin.
1863. §Tate, John. Alnmouth, near Alnwick, Northumberland.
1854. ‡*Tate, Lieut.-Colonel.*
1858. *Tatham, George. Leeds.
1864. *Tawney, Edward. Laleston House, near Budgend, Glamorgan.
*Tayler, Rev. John James, B.A., Principal and Professor of Ecclesiastical History in Manchester New College, London. 22 Woburn-square, London.
Taylor, Captain Edward.
Taylor, Frederick. Messrs. Taylor, Potter & Co., Liverpool.
1854. ‡Taylor, Dr. H. R. 1 Percy-street, Liverpool.
*Taylor, James. Culverlands, near Reading.
*Taylor, John, F.G.S. 6 Queen-street-place, Upper Thames-street, London.
1861. *Taylor, John, jun. 6 Queen-street-place, Upper Thames-street, London.
1856. ‡Taylor, John. Oriental Association, Walbrook, London.
1863. ‡Taylor, John. Earsdon, Newcastle-on-Tyne.
1863. ‡Taylor, John. Lovaine-place, Newcastle-on-Tyne.
**Taylor, Vice-Admiral J. N., C.B.*
Taylor, Captain P. Meadows, in the Service of His Highness the Nizam. Hyderabad, India.
*Taylor, Richard, F.G.S. 6 Queen-street-place, Upper Thames-street, London.
Taylor, Rev. William, F.R.S., F.R.A.S. Thornloe, Worcester.
*Taylor, William Edward. Millfield House, Enfield, near Accrington.
1858. ‡Teale, Joseph. Leeds.
Teale, Thomas Pridgin, F.R.S., F.L.S. 28 Albion-street, Leeds.
1858. ‡Teale, Thomas Pridgin, jun. 20 Park-row, Leeds.
Teather, John. Alstonley, Cumberland.
Tennant, Charles. Glasgow.
1863. ‡Tennant, Henry. Saltwell, Newcastle-on-Tyne.
*Tennant, James, F.G.S., F.R.G.S., Professor of Mineralogy and Geology in King's College, London. 149 Strand, London.
Tennent, R. J. Belfast.
1857. ‡Tennison, Edward King. Kildare-street Club House, Dublin.
1849. ‡Teschemacher, E. F. Highbury-park North, London.
1845. ‡Thacker, Arthur. Cambridge.
1859. ‡Thain, Rev. Alexander. New Machar.
1856. ‡Thodey, Rev. S. Rodborough, Gloucestershire.
Thom, Rev. David, D.D., Ph.D. 3 St. Mary's-place, Edgehill, Liverpool.
Thom, John. Messrs. McNaughton & Co., Moseley-street, Manchester.
Thomas, George. Brislington, Bristol.
1848. **Thomas, George John, M.A.*

Year of Election.

1854. ‡Thompson, Benjamin James. 13 High-street, Liverpool.
1854. ‡Thompson, D. P., M.D. 4 Salisbury-street, Liverpool.
1854. ‡Thompson, Edmund. Claughton Park, Birkenhead.
1863. §Thompson, Rev. Francis. St. Giles's, Durham.
1858. *Thompson, Frederick. South Parade, Wakefield.
1859. §Thompson, George, jun. Pidsmedden, Aberdeen.
1849. ‡*Thompson, George.*
Thompson, George.
Thompson, Harry Stephen. Kirby Hall, Great Ouseburn, Yorkshire.
Thompson, Henry Stafford. Fairfield, near York.
1845. ‡Thompson, James. Kirk Houses, Brampton, Cumberland.
**Thompson, John.*
1861. *Thompson, Joseph. Southbank, Downs, Bowdon, near Manchester.
1864. §Thompson, Rev. Joseph Hasselgrave, B.A. Cradley, near Brierley-hill.
Thompson, Leonard. Sheriff-Hutton Park, Yorkshire.
1853. ‡Thompson, Thomas (Austrian Consul). Hull.
Thompson, Thomas (Town Clerk). Hull.
1863. §Thompson, William. 11 North-terrace, Newcastle-on-Tyne.
1850. ‡Thomson, Alexander. Banchory House, by Aberdeen.
1855. ‡Thomson, Allen, M.D., Professor of Anatomy. The University, Glasgow.
*Thomson, Corden, M.D. Sheffield.
1852. ‡Thomson, Gordon A. Bedeque House, Belfast.
Thomson, Guy. Oxford.
1850. ‡Thomson, James. Kendal.
1845. ‡*Thomson, Prof. James, LL.D.*
1855. ‡Thomson, James. 82 West Nile-street, Glasgow.
1850. *Thomson, Professor James, M.A., C.E. 2 Donegal-square West, Belfast.
*Thomson, James Gibson. Edinburgh.
1863. ‡Thomson, M. 8 Meadow-place, Edinburgh.
Thomson, Thomas. Clitheroe, Lancashire.
1850. ‡Thomson, Thomas, M.D., F.R.S., Superintendent of the Botanic Garden, Calcutta. Hope House, Kew, London.
1847. *Thomson, William, M.A., LL.D., F.R.S. L. & E, Professor of Natural Philosophy in the University of Glasgow. (*Local Treasurer.*) The College, Glasgow.
1850. ‡*Thomson, William Hamilton.*
1850. ‡Thomson, Wyville T. C., LL.D., F.G.S., Professor of Geology in Queen's College, Belfast.
1854. ‡*Thorburn, William, M.D.*
1852. §Thorburn, Rev. William Reid, M.A. Starkies, Bury, Lancashire.
*Thornton, Samuel. The Elms, Highgate, Birmingham.
1845. ‡Thorp, Dr. Disney. Suffolk Laun, Cheltenham.
*Thorp, The Venerable Thomas, B.D., F.G.S., Archdeacon of Bristol. Kemerton, near Tewkesbury.
1864. §Thorp, William, jun. 13 York-terrace, Kingsland-road, London.
Thurnam, John, M.D. Devizes.
1848. ‡Thwaites, G. H. K. Bristol.
1856. ‡Tibbs, Somerset. 58 Regent-street, Cheltenham.
*Tidswell, Benjamin K. Brookfield, Birkdale Park, Southport.
Tinker, Ebenezer. Mealhill, near Huddersfield.
*Tinné, John A., F.R.G.S. Briarly Aigburth, Liverpool.
1846. ‡Tipper, S. Shirley, near Southampton.
Tite, William, M.P., F.R.S., F.G.S., F.S.A. 42 Lowndes-square, London.
Tobin, Rev. John. Liscard, Cheshire.

Year of Election.

1850. ‡Tod, James, Sec. Soc. of Arts. Edinburgh.
Todd, Rev. James Henthawn, D.D., M.R.I.A. Trinity College, Dublin.
1859. ‡Todd, Thomas. Mary Culter House, Aberdeen.
1861. *Todhunter, Isaac, M.A., F.R.S. St. John's College, Cambridge.
Todhunter, J. 3 College Green, Dublin.
1857. ‡Tombe, Rev. H. J. Ballyfree, Ashford, Co. Wicklow.
1856. ‡Tomes, Robert Fisher. Welford, Stratford-on-Avon.
1864. *Tomlinson, Charles. King's College, London.
1863. ‡Tone, John F. Jesmond Villas, Newcastle-on-Tyne.
1861. *Topham, John, A.I.C.E. 2 Paget Villas, Shrubland Grove East, Dalston, London.
1863. ‡Torr, F. S. 38 Bedford-row, London.
1863. §*Torrens, R. R. South Australia.*
Torrie, Thomas Jameson. Edinburgh.
1859. ‡Torry, Very Rev. John, Dean of St. Andrews. Coupar Angus.
Towgood, Edward. St. Neots, Huntingdonshire.
1845. ‡*Towler, George V.*
Townend, John.
Townend, Thomas.
Townend, T. S.
1860. ‡Townsend, John. 11 Burlington-street, Bath.
1857. ‡Townsend, Rev. Richard. 33 College, Dublin.
1861. §Townsend, William. Attleborough Hall, near Nuneaton.
1854. ‡Towson, John Thomas. 47 Upper Parliament-street, Liverpool; and Local Marine Board, Liverpool.
1861. ‡Toynbee, Joseph. Savile-row, Burlington-gardens, London.
1859. ‡Trail, Rev. Robert, M.A. Boyndie, Banff.
1859. ‡Trail, Samuel, LL.D., D.D. The Manse, Hanay, Orkney.
1850. ‡Traill, Professor, M.D. Edinburgh.
Travers, Robert, M.B.
1851. ‡Travis, W. H. Whitton, near Ipswich.
1859. ‡Trefusis, The Hon. C., M.P. Heaton, Devonshire.
Tregelles, Nathaniel. Neath Abbey, Glamorganshire.
Trench, F. A. St. Catherine's Park, Dublin.
*Trevelyan, Arthur. Wallington, Newcastle-on-Tyne.
Trevelyan, Sir Walter Calverley, Bart., M.A., F.R.S.E., F.G.S., F.S.A., F.R.G.S. Wallington, Northumberland; and Nettlecombe, Somerset.
1860. §Tristram, Rev. H. B., M.A., F.L.S. Greatham Hospital, near Stockton.
1864. §Truell, Robert. Ballyhenry, Ashford, Co. Wicklow.
Tuckett, Francis. Frenchay, near Bristol.
1847. *Tuckett, Francis Fox. Frenchay, near Bristol.
Tuckett, Frederick. 4 Mortimer-street, Cavendish-square, London.
Tuckett, Henry. Frenchay, near Bristol.
1848. ‡*Tudor, Edward Scripp. Bromley, Middlesex.*
Tudor, William.
Tuke, J. H. Bank, Hitchen.
Tuke, Samuel. Lawrence-street, York.
1854. ‡Turnbull, James, M.D. 86 Rodney-street, Liverpool.
1855. §Turnbull, John. 276 George-street, Glasgow.
1856. ‡Turnbull, Rev. J. C. 8 Bays-hill Villas, Cheltenham.
*Turnbull, Rev. Thomas Smith, M.A., F.R.S., F.R.G.S. Blofield, Norfolk.
Turner, Charles.
1861. *Turner, James Aspinal, M.P. Pendlebury, near Manchester.
Turner, Thomas, M.D. 31 Curzon-street, May Fair, London.
1863. §Turner, William, M.B., F.R.S.E. The University, Edinburgh.

Year of Election.

1845. ‡*Turner, Rev. William.*
1854. §Tuton, Edward S. Lime-street, Liverpool.
Twamley, Charles, F.G.S. 6 Queen's-road, Gloucester Gate, Regent's Park, London.
1859. ‡Twining, H. R. Grove Lodge, Clapham, London.
1847. ‡Twining, Richard. 13 Bedford-place, Russell-square.
1847. ‡Twiss, Travers, D.C.L., F.R.S., F.R.G.S., Regius Professor of Civil Law in the University of Oxford, and Chancellor of the Diocese of London. 19 Park-lane, London.
1846. ‡Tylor, Alfred, F.G.S., F.L.S. Warwick-lane, London.
1858. *Tyndall, John, Ph.D., F.R.S., F.C.P.S., Professor of Natural Philosophy in the Royal Institution and Government School of Mines. Royal Institution, London.
Tyrrell, John. Exeter.
1861. *Tysoe, John. Sedgley-road, Pendleton, near Manchester.

Upton, Rev. James Samuel, M.A., F.G.S.
1855. ‡Ure, John. 114 Montrose-street, Glasgow.
1859. ‡Urquhart, Rev. Alexander. Tarbat, Ross-shire.
1859. ‡Urquhart, W. Pollard. Craigston Castle, N. B.; and Castlepollard, Ireland.

*Vallack, Rev. Benj. W. S. St. Budeaux, near Plymouth.
1854. ‡Vale, James Theodorick. Hamilton-square, Birkenhead.
*Vance, Rev. Robert. 16 Montpellier-hill, Dublin.
1863. ‡Vandini, le Commandeur le Comte, Chargé d'Affaires de S. M. Tunisienne, Genoa.
1859. §Varley, Cornelius. 337 Kentish Town-road, London.
1854. ‡*Varley, Cromwell F.*
1863. §Vauvert, de Mean A., Vice-Consul for France. Tynemouth.
1849. *Vaux, Frederick. Central Telegraph Office, Adelaide, South Australia.
Vavasour, Sir Henry Mervun, Bart.
Veitch, A. J., M.D.
Verney, Sir Harry, Bart. Lower Claydon, Bucks.
Vernon, George John, Lord. 32 Curzon-street, London; and Sudbury Hall, Derbyshire.
1854. *Vernon, George V., F.R.A.S. Piccadilly Mills; and Old Trafford, Manchester.
1854. *Vernon, John. High Lee, Woolton, Liverpool.
Veysie, Rev. Daniel, B.D. Daventry.
1864. *Vicary, William, F.G.S. 7 Albert-terrace, St. Leonards, Exeter.
1859. ‡*Vickers, Thomas.*
1854. *Vignoles, Charles, C.E., F.R.S., M.R.I.A. 21 Duke-street, Westminster, London,
Visger, Herman. Frenchay, Bristol.
1856. ‡Vivian, Edward, B.A. Woodfield, Torquay.
*Vivian, H. Hussey, M.P., F.G.S. 5 Upper Belgrave-street, London; and Singleton House, Swansea.
1856. §Voelcker, J. Ch. Augustus, Ph.D., F.C.S. 39 Argyll-road, Kensington, London.
Voelker, Professor Charles. Switzerland.
Vye, Nathaniel. Ilfracombe, Devon.

1860. §Waddingham, John. Guiting Grange, Winchcombe, Gloucestershire.
1859. ‡Waddington, John. New Dock Works, Leeds.
1855. *Waldegrave, The Hon. Granville. 26 Portland-place, London.

Year of Election.

1863. ‡Walker, Alfred O. City of Chester.
1849. §Walker, Charles V., F.R.S., F.R.A.S. Fernside Villa, Redhill, near Reigate.
Walker, Sir Edward S. Chester.
Walker, Francis, F.L.S., F.G.S. Rectory House, The Grove, Highgate.
Walker, Frederick John. Little Matford, St. Leonard's, near Exeter.
1859. ‡Walker, James. 16 Norfolk-crescent, London.
1855. ‡Walker, John. 1 Exchange-court, Glasgow.
Walker, John, jun.
*Walker, John. Thorncliffe, Leamington.
1855. ‡Walker, John James, M.A. 2 Trinity College, Dublin.
*Walker, Joseph N., F.L.S. Caldeston, near Liverpool.
*Walker, Rev. Robert, M.A., F.R.S., Reader in Experimental Philosophy in the University of Oxford. Wadham College, Oxford; and Iffley, Oxford.
*Walker, Thomas. 10 York-street, Manchester.
Walker, William. 47 Northumberland-street, Edinburgh.
Wall, Rev. R. H., M.A. 6 Hume-street, Dublin.
1863. §Wallace, Alfred R., F.R.G.S. 5 Westbourne-grove-terrace, London.
Wallace, J. R.
1859. ‡Wallace, William, Ph.D., F.C.S. Chemical Laboratory, 38 Bath-street, Glasgow.
1856. ‡Waller, Augustus V., M.D., F.R.S. Bruges.
1857. ‡Waller, Edward. Lisenderry, Aughnacloy, Ireland.
1862. ‡Wallich, George Charles, M.D., F.L.S., F.G.S. 11 Earls-terrace, Kensington, London.
Wallinger, Rev. William. Hastings.
Walmesley, Sir Joshua, Knt. Liverpool.
Walmesley, Joshua. Lord-street, Liverpool.
1862. §Walpole, The Right Hon. Spencer Horatio, M.A., D.C.L., M.P., F.R.S. Ealing, near London.
1857. ‡Walsh, Albert Jasper. 89 Harcourt-street, Dublin.
Walsh, John (Prussian Consul). 1 Sir John's Quay, Dublin.
1855. ‡Walsh, Richard Hussey, Professor of Political Economy, Dublin.
1863. ‡Walters, Robert. Eldon-square, Newcastle-on-Tyne.
Walton, Thomas Todd. Clifton, Bristol.
1863. §Wanklyn, James Arthur, F.R.S.E. London Institution, Finsbury-circus, London.
Wansey, William, F.S.A. Reform Club, Pall Mall.
1857. ‡Ward, John S. Prospect-hill, Lisburn, Ireland.
1847. ‡Ward, Nathaniel Bagshaw, F.R.S., F.L.S. 14 Clapham Rise, London.
Ward, Rev. Richard, M.A. 12 Eaton-place, London.
1863. ‡Ward, Robert. Dean-street, Newcastle-on-Tyne.
*Ward, William Sykes, F.C.S. Claypit House, Leeds.
Wardell, William. Chester.
1858. ‡Wardle, Thomas. Leek Brook, Leek, Staffordshire.
§Warington, Robert, F.R.S., F.C.S., Chemical Operator to the Society of Apothecaries. Apothecaries' Hall, London.
1864. *Warner, Edwin. Higham Hall, Woodford, Essex.
1856. ‡Warner, Thomas H. Lee. Tiberton Court, Hereford.
Warwick, William Atkinson. Wyddrington House, Cheltenham.
1856. ‡Washbourne, Buchanan, M.D. Gloucester.
1847. ‡Waterhouse, G. R. British Museum, London.
*Waterhouse, John, F.R.S., F.G.S., F.R.A.S. Halifax, Yorkshire.
1854. ‡Waterhouse, Nicholas. 5 Rake-lane, Liverpool.
1854. ‡Watkins, James. Bolton.

Year of Election.

1855. ‡Watson, Ebenezer. 16 Abercromby-place, Glasgow.
*Watson, Henry Hough, F.C.S. The Folds, Bolton-le-Moors.
Watson, Hewett Cottrell, F.L.S. Thames Ditton, Surrey.
Watson, James. Glasgow.
1855. ‡Watson, James, M.D. 152 St. Vincent-street, Glasgow.
1863. ‡Watson, Joseph. Bensham Grove, near Gateshead-on-Tyne.
1859. ‡Watson, J. Forbes. India Office, London.
1845. ‡*Watson, Rev. J. H.*
1863. §Watson, R. S. Moscroft, Gateshead-on-Tyne.
1858. ‡Watson, William. Bilton House, Harrogate.
Watson, William H.
1855. ‡Watt, George. West Regent-street, Glasgow.
1861. ‡Watts, Sir James. Abney Hall, Cheadle, near Manchester.
1846. §Watts, John King, F.R.G.S. St. Ives, Huntingdonshire.
1858. ‡Waud, Major E. Manston Hall, near Leeds.
Waud, Rev. S. W., M.A., F.R.A.S., F.C.P.S. Rettenden, near Wickford, Essex.
1862. §Waugh, Major-General Sir Andrew Scott, R.E., M.R.A.C., F.R.S., F.R.G.S., late Surveyor-General of India, and Superintendent of the Great Trigonometrical Survey. 7 Petersham-terrace, Queen's Gate, London.
1859. ‡Waugh, Edwin. Sager-street, Manchester.
*Way, J. Thomas, F.C.S., Professor of Chemistry, Royal Agricultural Society of England. 15 Welbeck-street, Cavendish-square, London.
1864. §Weare, Rev. B. Clevedon, Somerset.
Webb, Rev. John, M.A., F.S.A. Hardwick Parsonage, Hay, South Wales.
*Webb, Rev. Thomas William, M.A., F.R.A.S. Hardwick Parsonage, Hay, South Wales.
1856. ‡Webster, James. Hatherley Court, Cheltenham.
1859. ‡Webster, John. 42 King-street, Aberdeen.
1858. ‡Webster, John. Broomhall Park; and St. James's-row, Sheffield.
1862. ‡Webster, John Henry, M.D. Northampton.
1864. §Webster, John. Sneinton, Nottingham.
Webster, Thomas, M.A., F.R.S. 2 Great George-street, Westminster.
1853. ‡Weddell, Thomas. Scarborough.
1845. ‡Wedgewood, Hensleigh. 17 Cumberland-terrace, Regent's Park, London.
1854. ‡Weightinan, William Henry. Litherland, Liverpool.
1850. ‡*Welsh, John.*
1850. ‡Wemyss, Alexander Watson, M.D. St. Andrews.
1850. ‡Wemyss, William. 6 Salisbury-road, Edinburgh.
Wentworth, Frederick W. T. Vernon. Wentworth Castle, near Barnsley, Yorkshire.
1864. §Were, Anthony Berwick. Wigton, Cumberland.
1853. ‡West, Alfred. Holderness-road, Hull.
1858. ‡West, F. H. Chapel Allerton, near Leeds.
1853. ‡West, Leonard. Summergangs Cottage, Hull.
1853. ‡West, Stephen. Hessle Grange, near Hull.
Westcott, Jasper.
1851. ‡Western, Thomas Burch. Tattingstone House, Ipswich.
1851. *Western, T. B. Felix Hall, Kelvedon, Essex.
Westhead, Edward. Chorlton-on-Medlock, near Manchester.
Westhead, John. Manchester.
*Westhead, Joshua Proctor. York House, Manchester.
1851. ‡Westhorpe, Stirling. Tower-street, Ipswich.
1857. *Westley, William. 24 Regent-street, London.

Year of Election.

1863. ‡Westmacott, Percy. Whickham, Gateshead, Durham.
1860. §Weston, James Woods. Seedley House, Pendleton, Manchester.
1858. ‡*Weston, William. Birkenhead.*
1864. §Westropp, W. H. S. 2 Idrone-terrace, Blackrock, Dublin.
1860. ‡Westwood, John O., M.A., F.L.S. Henley House, Summertown, Oxon.
Wharton, W. L., M.A. Dryburn, Durham.
1849. ‡Whateley, George. Birmingham.
1853. ‡Wheatley, E. B. Cote Wall, Merfield, Yorkshire.
Wheatstone, Charles, D.C.L., F.R.S., Hon. M.R.I.A., Professor of Experimental Philosophy in King's College, London. 19 Park-crescent, Regent's Park, London.
1847. ‡Wheeler, Edmund, F.R.A.S. 11 William-street, Camden-road, Holloway, London.
*Whewell, Rev. William, D.D., F.R.S., Hon. M.R.I.A., F.G.S., F.S.A., F.R.G.S., F.R.A.S., Master of Trinity College, and Professor of Casuistry in the University of Cambridge. The Lodge, Cambridge.
1853. ‡Whitaker, Charles J. P. Milton Hill, near Hull.
1859. *Whitaker, William, B.A., F.G.S. Geological Survey Office, 28 Jermyn-street, London.
1864. §White, Edmund. New Bond-street, Bath.
White, John. 80 Wilson-street, Glasgow.
1859. ‡White, John Forbes. 16 Bon Accord-square, Aberdeen.
1859. ‡White, Thomas Henry. Tandragee, Ireland.
White, William. Moreton Hampstead, near Exeter.
1861. ‡Whitehead, James, M.D. 87 Mosley-street, Manchester.
1854. ‡Whitehead, James W. 15 Duke-street, Edge-hill, Liverpool.
1858. ‡Whitehead, J. H. Southsyde, Saddleworth.
1861. *Whitehead, J. B. Oakley-terrace, Rawtenstall, Manchester.
1861. *Whitehead, Peter Ormerod. Belmont, Rawtenstall, Manchester.
1855. *Whitehouse, Wildman. 8 Bexley-place, Greenwich, Kent.
Whitehouse, William.
*Whiteside, James, M.A., Q.C., M.P. 2 Mountjoy-square, Dublin.
Whiteside, Rev. J. W., LL.D. Vicarage, Scarborough, Yorkshire.
1861. ‡Whitford, J. Grecian-terrace, Harrington, Cumberland.
1852. ‡Whitla, Valentine. Beneden, Belfast.
Whitley, Rev. Charles Thomas, M.A., F.R.A.S., Reader in Natural Philosophy in the University of Durham. Bedlington, Morpeth.
1857. *Whitty, John Irwine, M.A., D.C.L., LL.D., Civil Engineer. Ricketstown Hall, Carlow.
1863. *Whitwell, Thomas. Stockton-on-Tees.
*Whitworth, Joseph, LL.D., F.R.S. The Firs, Manchester; and Stancliffe Hall, Derbyshire.
1857. ‡Widdup, —. Penzance; and Kilburn, Co. Wexford.
1863. ‡*Wigham, John. Dublin.*
1852. ‡Wigham, Robert. Norwich.
1854. §Wight, Robert, M.D., F.R.S., F.L.S. Grazeley Lodge, Reading.
Wigram, Rev. Joseph C.
1860. ‡Wilde, Henry. 2 St. Ann's-place, Manchester.
1852. ‡*Wilde, William R.*
Wilderspin, Samuel. Wakefield.
1855. ‡Wilkie, John. 46 George-square, Glasgow.
1861. *Wilkinson, Eason, M.D. Greenheys, Manchester.
1857. ‡Wilkinson, George. Monkstown, Ireland.
1859. §Wilkinson, Robert. Totteridge Park, Herts.
Willan, William.
*Willert, Paul Ferdinand. Manchester.

Year of Election.

1859. ‡Willet, John, C.E. 35 Albyn-place, Aberdeen.
*Williams, Caleb, M.D. Micklegate, York.
Williams, Charles James B., M.D., F.R.S., Professor of Medicine in University College, London. 49 Upper Brook-street, Grosvenor-square, London.
1861. *Williams, Charles Theodore, B.A. 40 Upper Brook-street, London.
Williams, Charles Wye. City of Dublin Steam Packet Company, Water-street, Liverpool.
1864. *Williams, Frederick M. Goonorea, Perranarworthal, Cornwall.
1861. *Williams, Harry Samuel. 49 Upper Brook-street, Grosvenor-square, London.
1857. ‡Williams, Rev. James. Llanfairinghornwy, Holyhead.
Williams, Richard. 38 Dame-street, Dublin.
Williams, Robert. Bridehead, Dorset.
Williams, Robert, jun.
1845. ‡*Williams, Rev. Roland.*
1861. ‡Williams, R. Price. 22 Ardwick Green, Manchester.
1848. ‡Williams, Thomas, M.D. Wind-street, Swansea.
Williams, Walter. Oxhill, Handsworth, Staffordshire.
1854. ‡*Williams, William.*
*Williams, William. Highbury-crescent, London.
1850. *Williamson, Alexander William, Ph.D., F.R.S., F.C.S., Professor of Chemistry, and of Practical Chemistry, University College, London. 16 Provost-road, Haverstock-hill, London.
1857. ‡Williamson, Benjamin. Trinity College, Dublin.
1863. ‡Williamson, John. South Shields.
*Williamson, Rev. William, B.D. Datchworth, Welwyn, Hertfordshire.
Williamson, W. C. Manchester.
Willis, Rev. Robert, M.A., F.R.S., Jacksonian Professor of Natural and Experimental Philosophy in the University of Cambridge. 23 York-terrace, Regent's Park, London; and Cambridge.
1857. ‡Willock, Rev. W. N., D.D. Cleenish, Enniskillen, Ireland.
1859. *Wills, Alfred. 4 Harcourt-buildings, Inner Temple, London.
1864. §Wills, W. D. Portland-square, Bristol.
Wills, W. R. Edgbaston, Birmingham.
*Wilson, Alexander, F.R.S. 34 Bryanston-square, London.
1859. §Wilson, Alexander Stephen, C.E. North Kinmundy, Summerhill, by Aberdeen.
1850. ‡Wilson, Dr. Daniel. Toronto, Upper Canada.
Wilson, Edward.
1863. ‡Wilson, Frederic R. Alnwick, Northumberland.
1847. *Wilson, F. Dallam Tower, Milnethorp, Westmoreland.
1863. §Wilson, George. Hawick.
1861. ‡Wilson, George Daniel. 24 Ardwick Green, Manchester.
1855. ‡Wilson, Hugh. 75 Glassford-street, Glasgow.
1847. ‡Wilson, James Hewetson. The Grange, Worth, Sussex.
1857. ‡Wilson, James Moncrieff. 9 College Green, Dublin.
1858. *Wilson, John. Seacroft, near Leeds.
*Wilson, John. Bootham, York.
1855. *Wilson, John, jun. West Hurlet, near Glasgow.
Wilson, Professor John, F.G.S., F.R.S.E. Museum, Jermyn-street, London.
Wilson, J. W.
1847. *Wilson, Rev. Sumner. Horton Heath, Bishopstoke.
*Wilson, Thomas, M.A. Crimbles House, Leeds.
1859. ‡Wilson, Thomas. Tunbridge Wells.
1863. *Wilson, Thomas. Shotley Hall, Gateshead, Durham.
1861. ‡Wilson, Thomas Bright. 24 Ardwick Green, Manchester.

Year of Election.

1847. *Wilson, William Parkinson, M.A., Professor of Pure and Applied Mathematics in the University of Melbourne.
1861. §Wiltshire, Rev. Thomas, M.A., F.G.S., F.R.A.S. Rectory, Bread-street-hill, London.
1846. ‡Winchester, The Marquis of. Amport House, Andover.
1855. ‡*Wingate, Major H. Bendarnoch, Glasgow.*
1864. §Winkworth, Thomas. 18 Canonbury-place, Canonbury, London.
*Winsor, F. A. 60 Lincoln's Inn Fields, London.
1854. ‡*Winter, Thomas.*
1863. *Winwood, Rev. H. H., M.A., F.G.S. 4 Cavendish-crescent, Bath.
1848. ‡Wise, Rev. Stainton, M.D. Banbury.
1856. ‡Witts, Rev. E. F. Upper Slaughter, Cheltenham.
*Wollaston, Thomas Vernon, M.A., F.L.S. Barnpark-terrace, Teignmouth.
1850. ‡Wood, Alexander, F.R.C.P. Edinburgh.
*Wood, Right Hon. Sir Charles, Bart., M.P. 10 Belgrave-square, London; and Hickleston Hall, Doncaster.
1848. ‡Wood, Collingwood L. Hetton Hall, Fence Houses, Durham.
1863. §Wood, C. L. Howlish Hall, Bishop Auckland.
1863. ‡Wood, Edward, F.G.S. Richmond, Yorkshire.
1861. *Wood, Edward T. Brinscall Hall, Chorley, Lancashire.
1860. ‡Wood, George, M.A. Bradford, Yorkshire.
1861. *Wood, George B., M.D. Philadelphia, United States.
1856. *Wood, Rev. H. H., M.A., F.G.S. Holwell Rectory, Sherborne, Dorset.
*Wood, John. St. Saviour Gate, York.
Wood, Peter, M.D.
1864. §Wood, Richard, M.D. Driffield, Yorkshire.
1861. §Wood, Samuel, F.S.A., F.G.S. The Abbey, Shrewsbury.
1850. ‡Wood, Rev. Walter. Elie, Fife.
Wood, William. 1 Harrington-street, Liverpool.
1858. *Wood, William. Monkhill House, Pontefract.
1861. ‡Wood, William Rayner. Singleton Lodge, near Manchester.
*Wood, Rev. William Spicer, M.A. Oakham, Rutlandshire.
1863. *Woodall, Captain John Woodall, M.A., F.G.S. St. Nicholas House, Scarborough.
1850. *Woodd, Charles H. L., F.G.S. Roslyn, Hampstead, London.
*Woodhead, G. Mottram, near Manchester.
*Woods, Edward. 5 Gloucester-crescent, Hyde Park, London.
Woods, Samuel. Angel-court, Throgmorton-street, London.
Woolgar, J. W., F.R.A.S. Lewes, Sussex.
Woolley, John. Staleybridge, Manchester.
1857. ‡Woolley, Rev. J., LL.D. Her Majesty's Dockyard, Portsmouth.
1856. §Woolley, Thomas Smith, jun. South Collingham, Newark.
1853. ‡*Worden, John.*
*Wormald, Richard. 6 Brondesbury-terrace, Kilburn, London.
1863. *Worsley, P. John. Codrington-place, Clifton, Bristol.
1849. ‡Worsley, Samuel. Bristol.
1855. *Worthington, Rev. Alfred William, B.A. Mansfield.
Worthington, Archibald. Whitchurch, Salop.
Worthington, James. Polygon, Ardwick, Manchester.
*Worthington, Robert. Ardwick, Manchester.
Worthington, William. Brockhurst Hall, Northwich, Cheshire.
1856. §Worthy, George S. 130 Vine-street, Liverpool.
Wray, John. 6 Suffolk-place, Pall Mall, London.
1857. ‡Wright, Edward. 43 Dame-street, Dublin.
1861. *Wright, E. Abbot. Castle Park, Frodsham, Cheshire.
1858. ‡Wright, Henry. Stafford House, London.

Year of Election.

1857. §Wright, E. Perceval, A.M., M.D., F.L.S., M.R.I.A., Lecturer on Zoology, and Director of the Museum, Dublin University. 10 Clare-street, Dublin.

Wright, John.

Wright, J. Robinson, C.E. 11 Duke-street, Westminster.

*Wright, Robert Francis. Hinton Blewett, Somersetshire.

Wright, Thomas.

1855. §Wright, Thomas, F.S.A. 14 Sydney-street, Brompton, London.

Wright, T. G., M.D. Wakefield.

Wrottesley, John, Lord, M.A., D.C.L., F.R.S., F.R.A.S. Wrottesley Hall, Wolverhampton; and 34 St. James's-place, London.

Wyld, James, M.P., F.R.G.S. Charing Cross, London.

1863. *Wyley, Andrew. Drumadarragh, Doagh, Belfast.

1845. ‡*Wylie, John, M.D. Madras Army.*

1862. ‡Wynne, Arthur Beevor, F.G.S., of the Geological Survey of Ireland. Sligo, Ireland.

*Yarborough, George Cook. Camp's Mount, Doncaster.

1857. ‡Yates, Edward. 30 Compton-terrace, Islington, London.

Yates, James. Carr House, Rotherham, Yorkshire.

Yates, James, M.A., F.R.S., F.G.S., F.L.S. Lauderdale House, Highgate, London.

1845. ‡Yates, John Aston. 53 Bryanston-square, London.

Yeates, George. 2 Grafton-street, Dublin.

1855. ‡Yeats, John, LL.D., F.R.G.S. Leicester House, Peckham, London.

Yelverton, William.

*Yorke, Colonel Philip, F.R.S., F.R.G.S. 89 Eaton-place, Belgrave-square, London.

Young, James. South Shields.

Young, James. Limefield, West Calden, Midlothian.

Young, John. Taunton, Somersetshire.

1858. ‡Young, John. Hope Villa, Woodhouse-lane, Leeds.

Young, Thomas. North Shields.

Younge, Robert, F.L.S. Greystones, near Sheffield.

*Younge, Robert, M.D. Greystones, near Sheffield.

1854. ‡Zwilchenburt, Emanuel. 3 Romford-street, Liverpool.

CORRESPONDING MEMBERS.

Year of Election.

1857. M. Antoine d'Abbadie.
Louis Agassiz, M.D., Ph.D., Professor of Natural History. Cambridge, U.S.
1852. M. Babinet. Paris.
Dr. Alexander Dallas Bache. Washington.
1857. Dr. Barth.
1861. Dr. Bergsma, Director of the Magnetic Survey of the Indian Archipelago. Utrecht, Holland.
1857. Professor Dr. T. Bolzani. Kasan.
1852. Mr. G. P. Bond. Observatory, Cambridge, U.S.
1846. M. Boutigny (d'Evreux).
1842. Professor Braschman. Moscow.
1864. Dr. H. D. Buys-Ballot, Superintendent of the Royal Meteorological Institute of the Netherlands. Utrecht, Holland.
1861. Dr. Carus. Leipzig.
1864. M. Des Cloizeaux.
1855. Dr. Ferdinand Cohn. Breslau.
1862. Wilhelm Delffs, Professor of Chemistry in the University of Heidelberg.
1845. Heinrich Dove, Professor of Natural Philosophy in the University of Berlin.
Professor Dumas. Paris.
Professor Christian Gottfried Ehrenberg, M.D., Secretary of the Royal Academy, Berlin.
1846. Dr. Eisenlohr. Carlsruhe.
Professor Johann Franz Encke. Berlin.
1842. Dr. A. Erman. Berlin.
1848. Professor Esmark. Christiania.
1861. Professor A. Favre. Geneva.
1846. Professor Johann George Forchhammer. Copenhagen.
1855. M. Léon Foucault. Paris.
1856. Professor E. Frémy. Paris.
1842. M. Frisiani. Milan.
1861. Dr. Geinitz, Professor of Mineralogy and Geology. Dresden.
1852. Professor Asa Gray. Cambridge, U.S.
1862. Dr. D. Bierens de Haan, Member of the Royal Academy of Sciences, Amsterdam.
Professor Henry. Washington, U.S.
1864. Professor E. Hébert. The Larbonne, Paris.
1861. Dr. Hochstetter. Vienna.
1848. Dr. Van der Hoeven. Leyden.
1842. M. Jacobi. St. Petersburg.
1862. Charles Jessen, Med. et Phil. Dr., Professor of Botany in the University of Greifswald, and Lecturer of Natural History, and Librarian at the Royal Agricultural Academy, Eldena, Prussia.
1862. Aug. Kekulé, Professor of Chemistry. Ghent, Belgium.
1861. M. Khanikof. 97 Rue de Lille, Paris.
1856. Professor A. Kölliker. Wurzburg.

Year of
Election.

1856. Laurent-Guillaume De Koninck, Professor of Chemistry and Palæontology in the University of Liége.

1845. Dr. A. Kupffer. St. Petersburg.

Dr. Lamont. Munich.

Baron von Liebig. Munich.

1862. Professor A. Escher von der Linth. Zurich.

1857. Professor Loomis. New York.

1850. Professor Gustav Magnus. Berlin.

1847. Professor Matteucci. Pisa.

1862. Professor P. Merian. Bâle, Switzerland.

1846. Professor von Middendorff. St. Petersburg.

1848. Dr. J. Milne-Edwards. Paris.

1855. M. l'Abbé Moigno. Paris.

1864. Dr. Arnold Moritz. Tiflis.

1864. Herr Neumayer. Munich.

1848. Professor Nilsson. Sweden.

1852. Dr. N. Nordenskiöld. Helingfors, Russia.

1856. M. E. Peligot, Memb. de l'Institut, Paris.

1861. Professor Benjamin Pierce. Cambridge, U.S.

1857. Gustave Plaar. Strasburg.

1849. Professor Plücker. Bonn.

1852. M. Constant Prévost. Paris.

M. Quetelet. Brussels.

M. De la Rive. Geneva.

1850. Professor W. B. Rogers. Boston, U.S.

1857. Herman Schlagintweit. Berlin.

1857. Robert Schlagintweit. Berlin.

1861. M. Werner Siemens. Vienna.

1849. Dr. Siljestrom. Stockholm.

1862. J. A. de Souza, Professor of Physics in the University of Coimbra.

1864. Adolph Steen, Professor of Mathematics, Copenhagen.

1845. Dr. Svanberg. Stockholm.

1852. M. Pierre Tchihatchef.

1864. Dr. Otto Torell. University of Lund.

1864. M. Vambery. Hungary.

1861. Professor E. Verdet. Paris.

1861. M. de Verneuil, Memb. de l'Institut, Paris.

1848. M. Le Verrier. Paris.

Baron Sartorius von Waltershausen. Göttingen.

1842. Professor Wartmann. Geneva.

1864. Dr. Frederick Welwitsch. Lisbon.

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