REPORT

OF THE

TWENTY-SECOND MEETING

OF THE

BRITISH ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE;

HELD AT BELFAST IN SEPTEMBER 1852.

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The Editors of the preceding Notices consider themselves responsible only for the fidelity with which the views of the Authors are abstracted.

OBJECTS AND RULES

OF

THE ASSOCIATION.

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.

I. 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, 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. MAKDOUGALL 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 Robison, 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., Chan. Univ. 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 T. D. 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. Prof. Owen, M.D., F.R.S. Prof. 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. Rev. Wentworth Acland, Esq., B.M.
The MARQUIS OF NORTHAMPTON, President of Royal Society, &c. SWANSEA, August 9, 1848.	The Marquis of Bute, K.T. Viscount Adare, F.R.S. Sir H. T. De la Beche, 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. EDINBURGH, July 31, 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. De la Beche, F.R.S. Rev. Edward Hincks, D.D., M.R.I.A. Rev. P. S. Henry, D.D., Pres. Queen's Coll. 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.,
WILLIAM HOPKINS, Esq., M.A., V.P.R.S., F.G.S., & Pres. Camb. Phil. Soc. 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. & 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.

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

Acland, Sir Thomas D., Bart., M.P., F.R.S.
Acland, Professor H. W., B.M., F.R.S.
Adamson, John, Esq., F.L.S.
Adare, Edwin, Viscount, M.P., F.R.S.
Ainslie, Rev. Gilbert, D.D., Master of Pembroke Hall, Cambridge.
Airy, G. B., D.C.L., F.R.S., Astronomer Royal.
Alison, Professor W. P., M.D., F.R.S.E.
Ansted, Professor D. T., M.A., F.R.S.
Argyll, George Douglas, Duke of, F.R.S.
Arnott, Neil, M.D., F.R.S.
Ashburton, William Bingham, Lord, D.C.L.
Babbage, Charles, Esq., F.R.S.
Babington, C. C., Esq., F.L.S.
Baily, Francis, Esq., F.R.S.
Balfour, Professor John H., M.D.
Barker, George, Esq., F.R.S.
Bengough, George, Esq.
Bentham, George, Esq., F.L.S.
Bigge, Charles, Esq.
Blakiston, Peyton, M.D., F.R.S.
Boileau, Sir John P., Bart., F.R.S.
Boyle, Right Hon. David, Lord Justice-General, F.R.S.E.
Brand, William, Esq.
Brewster, Sir David, K.H., D.C.L., LL.D., F.R.S. Principal of the United College of St. Salvator and St. Leonard, St. Andrews.
Breadalbane, John, Marquis of, K.T., F.R.S.
Brisbane, General Sir Thomas M., Bart., K.C.B., G.C.H., D.C.L., F.R.S.
Brown, Robert, D.C.L., F.R.S.
Brunel, Sir M. I., F.R.S.
Buckland, Very Rev. William, D.D., Dean of Westminster, F.R.S.
Burlington, William, Earl of, M.A., F.R.S., Chancellor of the University of London.
Bute, John, Marquis of, K.T.
Carlisle, George Will. Fred., Earl of, F.G.S.
Carson, Rev. Joseph.
Cathcart, Lt.-Gen. Earl of, K.C.B., F.R.S.E.
Chalmers, Rev. T., D.D., late Professor of Divinity, Edinburgh.
Chance, James, Esq.
Chester, John Graham, D.D., Lord Bishop of.
Christie, Professor S. H., M.A., Sec. R.S.
Clare, Peter, Esq., F.R.A.S.
Clark, Rev. Prof., M.D., F.R.S. (Cambridge).
Clark, Henry, M.D.
Clark, G. T., Esq.
Clear, William, Esq.
Clerke, Major Shadwell, K.H., R.E., F.R.S.
Clift, William, Esq., F.R.S.
Cobbold, John Chevalier, Esq., M.P.
Colquhoun, J. C., Esq., M.P.
Conybeare, Very Rev. W. D., Dean of Llandaff, M.A., F.R.S.
Corrie, John, Esq., F.R.S.
Currie, William Wallace, Esq.
Dalton, John, D.C.L., F.R.S.
Daniell, Professor J. F., F.R.S.
Dartmouth, William, Earl of, D.C.L., F.R.S.
Darwin, Charles, Esq., F.R.S.
Daubeny, Prof. Charles G. B., M.D., F.R.S.
De la Beche, Sir Henry T., C.B., F.R.S., Director-General of the Geological Survey of the United Kingdom.
Dillwyn, Lewis W., Esq., F.R.S.
Drinkwater, J. E., Esq.
Durham, Edward Maltby, D.D., Lord Bishop of, F.R.S.
Egerton, Sir Philip de M. Grey, Bart., F.R.S.
Eliot, Lord, M.P.
Ellesmere, Francis, Earl of, F.G.S.
Enniskillen, William, Earl of, D.C.L., F.R.S.
Estcourt, T. G. B., D.C.L.
Faraday, Professor, D.C.L., F.R.S.
Fitzwilliam, Charles William, Earl, D.C.L., F.R.S.
Fleming, W., M.D.
Fletcher, Bell, M.D.
Forbes, Charles, Esq.
Forbes, Professor Edward, F.R.S.
Forbes, Professor J. D., F.R.S., Sec. R.S.E.
Fox, Robert Were, Esq., F.R.S.
Gassiot, John P., Esq., F.R.S.
Gilbert, Davies, D.C.L., F.R.S.
Graham, Professor Thomas, M.A., F.R.S.
Gray, John E., Esq., F.R.S.
Gray, Jonathan, Esq.
Gray, William, jun., Esq., F.G.S.
Green, Professor Joseph Henry, F.R.S.
Greenough, G. B., Esq., F.R.S.
Grove, W. R., Esq., F.R.S.
Hallam, Henry, Esq., M.A., F.R.S.
Hamilton, W. J., Esq., Sec.G.S.
Hamilton, Sir William R., Astronomer Royal of Ireland, M.R.I.A.
Harcourt, Rev. William 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.
Hatfeild, William, Esq., F.G.S.
Henslow, Rev. Professor, M.A., F.L.S.
Henry, W. C., M.D., F.R.S.
Henry, Rev. P. S., D.D., President of Queen's College, Belfast.
Herbert, Hon. and Very Rev. William, late Dean of Manchester, LL.D., F.L.S.
Herschel, Sir John F. W., Bart., D.C.L., F.R.S.
Heywood, Sir Benjamin, Bart., F.R.S.
Heywood, James, Esq., M.P., F.R.S.
Hill, Rev. Edward, M.A., F.G.S.
Hincks, Rev. Edward, D.D., M.R.I.A.
Hodgkin, Thomas, M.D.
Hodgkinson, Professor Eaton, F.R.S.
Hodgson, Joseph, Esq., F.R.S.
Hooker, Sir William J., LL.D., F.R.S.
Hope, Rev. F. W., M.A., F.R.S.
Hopkins, William, Esq., M.A., F.R.S.
Horner, Leonard, Esq., F.R.S., F.G.S.
Hovenden, V. F., Esq., M.A.
Hutton, Robert, Esq., F.G.S.
Hutton, William, Esq., F.G.S.
Ibbetson, Capt. L. L. Boscawen, K.R.E., F.G.S.
Inglis, Sir Robert H., Bart., D.C.L., M.P., F.R.S.
Jameson, Professor R., F.R.S.
Jeffreys, John Gwyn Jeffreys, Esq.
Jenyns, Rev. Leonard, F.L.S.
Jerrard, H. B., Esq.
Johnston, Right Hon. William, Lord Provost of Edinburgh.
Johnston, Professor J. F. W., M.A., F.R.S.

Keleher, William, Esq.
Kelland, Rev. Professor P., M.A.
Lansdowne, Henry, Marquis of, D.C.L., F.R.S.
Lardner, Rev. Dr.
Latham, R. G., M.D., F.R.S.
Lee, Very Rev. John, D.D., F.R.S.E., Principal of the University of Edinburgh.
Lee, Robert, M.D., F.R.S.
Lefevre, Right Hon. Charles Shaw, Speaker of the House of Commons.
Lemon, Sir Charles, Bart., M.P., F.R.S.
Liddell, Andrew, Esq.
Lindley, Professor John, Ph.D., F.R.S.
Listowel, The Earl of.
Lloyd, Rev. Bartholomew, D.D., late Provost of Trinity College, Dublin.
Lloyd, Rev. Professor, D.D., Provost of Trinity College, Dublin, F.R.S.
Lubbock, Sir John W., Bart., M.A., F.R.S.
Luby, Rev. Thomas.
Lyell, Sir Charles, M.A., F.R.S.
MacCullagh, Professor, D.C.L., M.R.I.A.
Macfarlane, The Very Rev. Principal.
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Meynell, Thomas, Jun., Esq., F.L.S.
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Nicol, Rev. J. P., LL.D.
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Robinson, Rev. T. R., D.D., Pres. R.I.A., F.R.A.S.,
Robison, Sir John, late Sec.R.S.Edin.
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Roget, Peter Mark, M.D., F.R.S.
Ronalds, Francis, F.R.S.
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Ross, Capt. Sir James C., R.N., F.R.S.
Rosse, William, Earl of, M.A., M.R.I.A., President of the Royal Society.
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Stevelly, Professor John, LL.D.
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Strickland, H. E., Esq., F.G.S.
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Turner, Samuel, Esq., F.R.S., F.G.S.
Turner, Rev. W.
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Wharncliffe, John Stuart, Lord, F.R.S.
Wheatstone, Professor Charles, F.R.S.
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Williams, Professor Charles J.B., M.D., F.R.S.
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Wills, William.
Winchester, John, Marquis of.
Woollcombe, Henry, Esq., F.S.A.
Wrottesley, John, Lord, M.A., F.R.S.
Yarrell, William, Esq., F.L.S.
Yarborough, The Earl of, D.C.L.
Yates, James, Esq., M.A., F.R.S.

THE GENERAL TREASURER'S ACCOUNT from 2nd of July

RECEIPTS.

	£ s. d.	£ s. d.
To Balance brought on from last account		693 5 11
Life Compositions at Ipswich and since		90 0 0
Annual Subscriptions at Ipswich and since		202 0 0
Associates' Subscriptions at Ipswich		244 0 0
Ladies' Tickets at Ipswich		141 0 0
Book Composition		5 0 0
Dividends on Stock (eighteen months' Dividends on £3500 3 per cent. Consols)		152 18 3
From the Sale of Publications :—Reports, Catalogues of Stars, &c. :—		
Volume 1	0 18 0	
2	0 16 0	
3	1 5 0	
4	0 13 0	
5	1 4 6	
6	0 16 6	
7	0 15 0	
9	2 15 0	
10	0 9 0	
11	0 10 6	
12	0 16 0	
13	1 6 8	
14	2 0 0	
15	0 15 0	
16	5 8 0	
17	2 8 0	
18	5 6 8	
19	64 10 0	
British Association Catalogue of Stars	56 3 6	
Lalande's Catalogue of Stars	5 3 0	
Lacaille's Catalogue of Stars	0 16 0	
Dove's Isothermal Lines	7 9 0	
Lithographic Signatures	0 9 0	
		162 13 4
		1690 17 6

Audited and found correct,

CHARLES C. BABINGTON, *Auditor.*

1851 (at Ipswich) to 1st of September 1852 (at Belfast).

PAYMENTS.

	£	s.	d.	£	s.	d.
For Sundry Printing, Advertising, Expenses of Ipswich Meeting, and Petty Disbursements made by General and Local Treasurers				206	14	2
Printing Report of 20th Meeting (paid on Account)				300	0	0
Engraving, &c. for Report of the 21st Meeting				17	6	10
Salaries, Assistant General Secretary and Accountant, (eighteen months)				525	0	0
Dove's Isothermal Lines				100	0	0
Maintaining the Establishment at Kew Observatory:—						
Balance of Grant of 1850	29	13	0			
Part of Grant for 1851	204	4	8			
				233	17	8
On account of Grant—						
For Experiments on the Conduction of Heat				5	2	9
Influence of Solar Radiations				20	0	0
For a Geological Map of Great Britain and 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
Balance at the Bankers	226	17	3			
Ditto in the hands of the General Treasurer and Local Treasurers	10	12	8			
				237	9	11
				1690	17	6

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Charles Wheatstone, Esq., F.R.S., Professor of Experimental Philosophy in King's College, London.

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Henry Cooper, Esq., M.D., V.P. Hull Lit. & Phil. Soc.
Bethel Jacobs, Esq., President of the Hull Mechanics Institution.

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Edmund Smith, Esq.

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Report on the Proceedings of the Council in 1851–52, as presented to the General Committee at Belfast, Wednesday, Sept. 1, 1852.

"I. With reference to the subjects referred to the Council by the General Committee at Ipswich, the Council have to report as follows:—

(*a*) The Council having requested the President, Mr. Airy, to use his best endeavours to obtain from Government a grant towards the publication of Mr. Huxley's Zoological and Anatomical Researches, made during the voyage of H.M.S. 'Rattlesnake,' have been informed by Mr. Airy that the Government have expressed their inability to make a grant for that purpose in the present year: the Council recommend that the application should be repeated.

(*b*) The Council requested the President, Mr. Airy, to communicate to Her Majesty's Government, and to the Court of Directors of the East India Company, the recommendation approved by the General Committee, that the necessary aid should be given for the speedy publication of the Botanical Researches of Drs. Hooker and Thomson, Captain Strachey and Mr. Winterbottom, so as to constitute, by combination with former publications, a general Indian Flora. The Council have been informed by Mr. Airy, first, that Dr. Hooker is engaged under an instruction from Government, in arranging his materials for publication, in three volumes, the first of which will not be ready before November 1852; and that no immediate application for further assistance is required; and secondly, that, having ascertained the state of preparation of Dr. Thomson's researches, he has laid the case fully before the Court of Directors in a letter to Mr. Melvill, to which he has as yet received no reply.

(*c*) The Council requested the President, Mr. Airy, to make the necessary application to the Court of Directors of the East India Company to afford Captain Strachey such aid as would enable him to publish his explorations in the Himalaya Mountains and in Thibet, with the necessary maps and illustrations; and have learned from Mr. Airy that he has been informed that the Chairman of the Court of Directors has signified his intention of giving to Captain Strachey the assistance contemplated by the Association, and that he has therefore taken no further step.

"II. The President, as one of the Committee for Tidal Observations in the Atlantic appointed by the General Committee at Ipswich, has communicated to the Council the Memorial which the Tidal Committee has presented to Government. It is as follows:—

"'We beg leave to make to Her Majesty's Government a representation with which we have been charged by the British Association for the Advancement of Science, respecting the importance of sending out a ship or ships to extend our acquaintance with the phænomena of the Tides of the Atlantic Ocean.

"'The importance of an acquaintance with the phænomena of the Tides, both for practical and theoretical purposes, is sufficiently obvious, and has been recognised by the Government of this country in many ways. At most of the points of our own coast, and at several places in other countries, observations have long been made which suffice for most of these purposes. But perhaps it is not generally understood how far these observations, hitherto, are from giving us such a connected knowledge of the subject as may enable us to follow the course of the tide over any considerable portion of the Ocean. Even with regard to our own shores, such accurate knowledge hardly existed till observations were made and continued for a fortnight at the coast-guard stations of Great Britain and Ireland in June 1834, and again in June 1836. On the latter occasion application was also made to foreign maritime states, to make a similar and simultaneous series of observations, the Duke of Wellington, at that time Foreign Secretary of State, promoting the object in a manner which procured from them the most cordial and effective co-operation. The results of these observations were inserted and discussed in the Philosophical Transactions for 1836 (Part II.); and, in consequence, the course of the tides along the shore from the Strait of Gibraltar to the coast of Norway, was made out, as to some general features and also along the coast of the United States. But beyond these limits we may be said to have no connected knowledge of the course of the tides of the Atlantic; and even within these limits it is impossible, for want of other observations, to connect those which were made; for instance, the tides on the American and the European shores. Along the coasts of Africa and of South America we are ignorant of the course and progress of the tides, although we know some of the phænomena at detached points, and know some of them to be remarkable and perplexing. Nor is it at all likely that these defects in our knowledge will be removed by any collection of detached observations. It is only by systematic observations made with the express view of connecting our knowledge on this subject, and pursued from place to place, as the results themselves suggest, that we shall ever obtain a general view of the facts. Such observations might be made in no long time if an expedition were sent out with this special and exclusive object; and might, in that case, be so conducted as to lead with certainty to the result.

"'The best mode of making observations would, probably, be found to be to place observing parties at certain distances along the coast, the intervals being various according to the nature of the phænomena; and to direct them to make simultaneous observations for a few days, and then to proceed farther along the coast with the expedition; or the tides at any place might (on any day) be referred to the moon's transit, and this would afford sufficient means of comparison with any neighbouring case, unless the phænomena were peculiar. In this way the progress of the tide-wave along the coasts of Africa and America would be determined; from what points it diverges, and towards what points it converges; the latter points being, it is presumed, generally those of very high tides, such as occur on the east coast of Patagonia. With these observations, combined with others at oceanic islands, the general course of the tide elevation might be traced; and if this were done for the Atlantic, it would be the first time that the course of the tide in such an ocean-space has been made known to us.

"'It would also be desirable to observe at the same time the streams of flood and ebb. From such observations, combined with those of High and Low water, it has appeared in Captain Beechey's recent researches, results may be deduced, giving a new and unexpected view of the tidal movements of the sea, and supplying knowledge useful for the practical purposes of navigation.

"'As has been said, it is probable that an expedition devoted especially to such a purpose might attain the leading features of the required results in no long time; perhaps in a year or eighteen months. This must be on the supposition that it did not attempt to follow the details of the tides out of the oceanic space into collections of islands like the West Indies, the details of which would employ a much longer time.

"'One ship, with several boats to set down and take up observing parties, would probably be the fittest scale of the expedition; and standard points, where the observations should be longer continued, and to which the observations at secondary points should be referred, would be established from place to place in the course of the operations.'

"III. It has been reported to the Council, by the officers of the Association, that from accidental circumstances, the three following recommendations from the Committee of Section C, at Ipswich, had not reached the Committee of Recommendations in sufficient time to be included in their Report to the Committee:—

"1. That a Committee be appointed to take into consideration and report upon the exact position, number and nature of the phosphatic beds of the Crag, and to connect this subject with that of mineral manures generally with reference to their scientific and economic value; and further to investigate the geological conditions under which the so-called 'Coprolites' and other drifted Organic and Inorganic bodies occur in the Red Crag, and the probable sources from which these bodies have been respectively derived. The Committee to consist of Professor Henslow, Mr. Searles Wood and Mr. Long, with power to add to their number.

"2. That Mr. Searles Wood be requested to prepare for the next meeting of the Association, a Report of the observed distribution of the specific forms of Vertebrata and Invertebrata in the supracretaceous deposits in the vicinity of Ipswich.

"3. That Mr. Logan's paper on the Geology of Canada be printed in full in the next volume of the Reports of the Association.

"The Council have requested the gentlemen named in the two first recommendations to proceed in the matters referred to, pending a decision of the General Committee, that may be taken at Belfast; and have ordered that Mr. Logan's paper on the Geology of Canada should be printed in full in the Ipswich volume of Reports.

"IV. In concurrence with the Belfast Provisional Committee, the Council directed that the meeting should commence on Wednesday, the 1st September; and requested the following gentlemen to undertake the offices of Presidents, Vice-Presidents and Secretaries of Sections respectively, subject to confirmation by the General Committee, viz.—

Section A.—President, William Thomson, Esq., Professor of Mathematics, Glasgow. Vice-President, Rt. Rev. Dr. Denvir. Secretary W. J. M. Rankine, Esq.

B.—President, Dr. Andrews, M.R.I.A. Secretaries, Dr. Hodges, Dr. Blyth.

C.—President, Lieutenant Colonel Portlock, R.E. Secretaries, James M'Adam, Esq., J. Bryce, Esq., Professor Nicol, Professor M'Coy.

D.—President, Wm. Ogilby, Esq. Secretaries, Dr. Lankester, J. C. Hyndman, Esq., Dr. Dickie.

E.—President, Colonel Chesney, R.A. Secretaries, R. Cull, Esq., Dr. Norton Shaw, R. M'Adam.

F.—President, the Archbishop of Dublin. Vice-President, V. Whitla, Esq. Secretaries, Professor Hancock, J. M'Adam, Esq., jun.

G.—President, James Walker, Esq., F.R.S. Vice-President, C. Lanyon, Esq., C.E. Secretary, James Thomson, Esq., C.E.

"V. The Council have added the names of the following cultivators of science who attended at the Ipswich meeting to the list of Corresponding Members of the British Association:—

M. Babinet, Paris.
Mr. P. G. Bond, Cambridge, U.S.
M. Dufrenoy, Paris.
M. Constant Prevost, Paris.
M. Pierre Tchihatchef, Russian Embassy, Paris.
Dr. N. Nordengsciold, Finland.
Professor Asa Gray, U.S.

"VI. The Council have great pleasure in submitting the following list of invitations from which the General Committee will have to select the place of meeting in 1853, viz.—

"Hull: from whence invitations were also received in 1838, 1839, 1842, 1849, 1850 and 1851; in which invitations the Municipal Council and all the other public bodies of the town united.

"Liverpool: from the Mayor and Corporation; the Literary and Philosophical Society; the Royal Institution; the Architectural and Archæological Society; the Polytechnic Society; Historic Society of Lancashire and Cheshire; being a renewal of the invitation presented at Edinburgh in 1850.

"Brighton: from the Earl of Chichester and sixty-eight other gentlemen, in addition to the application made to the meeting at Ipswich, on the part of the Commissioners of Brighton, by their clerk.

"Glasgow: from the Magistrates and Town Council, and from the Glasgow Philosophical Society.

"Leeds: for a meeting some year after the year 1853.

"VII. The Council are happy to have it in their power to report most favourably on the proceedings in the last year at the establishment at Kew. The experimental trial of Mr. Ronalds's magnetographs, which was in progress when the last Report of the Council was made, has been completed, and detailed statements of the performance of each of the three instruments have been furnished by Messrs. Ronalds and Welsh, and are inserted in the volume of Reports for 1851. The Council have great pleasure in referring to these statements as showing that Mr. Ronalds's adaptation of photography to record the magnetic variations is an effective and practically useful invention, supplying to those who may desire it the means of making and preserving a continuous registry of the phænomena. The processes employed for the construction and verification of standard thermometers, have proved remarkably successful, and will form the subject of a distinct and detailed Report from the Committee of the Kew Observatory. The thermometers prepared by Mr. Welsh, under the direction of the Committee, have been found, on intercomparison, and also on comparison with Mr. Regnault's standard, to furnish results highly satisfactory. They have already been supplied on application to the observatories at the Cape of Good Hope and Toronto, and to several persons under the following regulation of the Council:—'That standard thermometers made at Kew be supplied on application to members of the British Association, and Fellows of the Royal Society, at 1*l.* each.' The Council have also directed that the Kew Committee be authorized, at their discretion, to supply standard thermometers on official application to any department of Her Majesty's Government, or to the East India Company; and 2nd, that the Committee be authorized, at their discretion, to present standard mercurial thermometers to certain of the philosophical instrument makers. In compliance with the first of these regulations, the Committee have supplied, on application from the Admiralty, fourteen thermometers graduated to extreme low temperatures, to be employed in the Arctic Expeditions; and, in compliance with the second regulation, they have presented standard thermometers to each of the following artists, viz.—Messrs. Adie, Barrow, Watkins and Hill, Negretti, Newman, and Simms. Applications have been received from Professors James Forbes of Edinburgh, and William Thomson of Glasgow, for suitable thermometers for very delicate experimental researches in which these gentlemen are engaged, and which thermometers are now in preparation.

"The preparations for the construction of standard barometers are far advanced; and with a view to the further prosecution of these objects, the Committee for the construction and verification of standard instruments have taken steps for procuring authentic standards of length and weight, by placing themselves in communication with the Commission appointed by Her Majesty's Government to prepare such standards.

"At the request of the East India Company, twenty sets of instruments for proposed meteorological observations in India have been examined and verified at Kew.

"The arrangements required for Professor Stokes's experiments have been completed, and the experiments are now in progress.

"The Council have great pleasure in repeating their former expressions of entire approbation of the zeal and intelligence with which Mr. Welsh continues to discharge the various duties entrusted to him from time to time, by the Superintending Committee. These qualities have been especially shown in the manipulations required in the construction of the standard thermometers, and in the processes for their verification.

"At the request of the Council, the Superintending Committee have made arrangements with Mr. Green for four ascents of the Nassau balloon, for the purpose of investigating the meteorological phænomena of the atmosphere. Two of these ascents have already taken place, one on the 17th and the other on the 26th of August, on each of which days Mr. Green ascended to between 19,000 feet and 20,000 feet, accompanied by Mr. Welsh and Mr. Nicklin, taking with them instruments prepared in the Kew Observatory. The observations made in these two ascents had reference chiefly to the laws of the decrement of temperature and of aqueous vapour in ascending into the atmosphere, and will be the subject of a communication from Mr. Welsh to the Mathematical and Physical Section.

"In closing this report of the proceedings at the establishment at Kew, the Council are glad to be able to state that the expenditure during the year has not exceeded the sum placed at their disposal by the General Committee, and that there are no debts; and the Council strongly recommend that the establishment should continue to receive the support of the British Association."

Report of the Parliamentary Committee of the British Association for the Advancement of Science, presented to the General Committee at Belfast, Wednesday, September 1, 1852.

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

The Committee met for the first time on the 3rd of February last, they met again on the 11th of March and on the 17th of June.

At these several meetings the following, among other business, was transacted. The Committee agreed to meet yearly on the day succeeding the meeting of Parliament, and on the second Thursday in July.

In consequence of the dissolution of Parliament, the meeting of June was this year substituted for that of July. The Committee resolved to cooperate with the President and Council of the Royal Society, who had already taken steps in this behalf, in urging upon the Government the expediency of facilitating the cheap and rapid international communication of scientific publications; and the Council of the Royal Society, by a resolution dated the 19th of February, informed this Committee that they would be much gratified by such cooperation.

In pursuance of these resolutions, Lord Wrottesley, as Chairman of this Committee, in company with the Earl of Rosse as President, and Colonel Sabine as Treasurer of the Royal Society, had, on the 10th of March, an interview with Sir Thomas Freemantle, the Chairman of the Board of Customs, who suggested a plan by which eminent scientific individuals and institutions might be permitted to receive from abroad their presentation copies of scientific works duty free, through the medium of the Royal Society, and whereby certain facilities in this behalf might likewise be afforded to the Smithsonian Institution of the United States, in return for privileges conceded to that Institution by the Government of those States; and he recommended that a letter should be written to the Lords of the Treasury embodying these suggestions.

In conformity with this recommendation a letter was addressed to the Lords of the Treasury by the Earl of Rosse, as President of the Royal Society, in concurrence with Lord Wrottesley as Chairman of this Committee. To this letter no reply has as yet been received.

With the view of promoting the same general object, viz. the cheap and rapid international communication of scientific publications, it was resolved that Lord Wrottesley should address, and he addressed accordingly, a letter to the Earl of Malmesbury, as Secretary for Foreign Affairs, of which the following is a copy:—

"March 15, 1852.

"My Lord,—As Chairman of a Committee composed of Members of both Houses of Parliament, selected by the British Association for the Advancement of Science, to watch over the interests of science and inspect the various measures from time to time introduced into Parliament likely to affect such interests, and which met for the first time on the 3rd of February last, I am requested to represent to your Lordship the great inconvenience to which the cultivators of the various branches of science in this country are now exposed by the extravagant charges levied by Foreign Governments on the conveyance by post of Presentation Copies of Scientific Publications sent from this country to eminent scientific men, pursuing similar branches of science in foreign parts; and I am further directed respectfully to request your Lordship, by negotiating Postal Conventions or otherwise as you shall think proper, to endeavour to prevail on the governments of other countries to afford greater facilities for the transmission by post of such publications.

"The undersigned believes that he cannot better illustrate the extent of the evils complained of than by subjoining the following list of charges for the conveyance by post to the various countries named therein, of a communication printed in the Philosophical Transactions for 1851, and which was conveyed by our own post office to every place within the United Kingdom at a charge of 8*d.*:—

	s.	*d.*		*s.*	*d.*
To Modena	14	10	To Berlin	9	0
Palermo	15	0	Seeberg	9	0
Milan	18	4	Dreissen	9	0
Turin	12	8	Brussels	5	0
Padua	18	4	Cadiz	7	4
Bonn	9	0	Göttingen	6	0

"Your Lordship will at once perceive that such charges as these are far beyond the means of many of the most distinguished cultivators of science, who are absolutely disabled thereby from forwarding by post to their friends abroad the copies of their scientific memoirs which are presented to them gratuitously for the purpose of distribution by the respective societies, to which such communications are sent and in whose Transactions they appear.

"From this cause, combined with the duties levied at the Custom House on similar publications imported from abroad, at present the interests of science are very injuriously affected, for it happens continually, to use the expressions of the Treasurer of the Royal Society in a letter addressed to the undersigned, 'That a quantity of intellectual labour of a very high class is unproductively consumed in doing over again in one country that which has already been done in another, from the want of a more rapid interchange of knowledge.'

"Mr. Rowland Hill of the Post Office Department, has suggested a mode by which these evils might be remedied, viz. if Foreign Countries could be induced to adopt the arrangement, by which books are now forwarded to some of our Colonies, at charges very reasonable as compared with the above.

"I remain, &c.,

"WROTTESLEY."

To the above letter the following reply was received from Mr. Addington, the Under Secretary for Foreign Affairs:—

"Foreign Office, March 17, 1852.

"MY LORD,—I am directed by the Earl of Malmesbury to acquaint your Lordship that he has referred to the Postmaster-General your letter of the 15th inst., urging that steps be taken by Her Majesty's Government to induce Foreign Governments to reduce their rates of Postage on printed papers, with a view of facilitating the distribution of scientific works.

"I am, &c.,

"H. U. ADDINGTON."

The Committee also requested Lord Wrottesley and Sir Robert Inglis to represent to the Earl of Derby the inadequacy of the present fund out of which Pensions are provided in certain cases for eminent scientific men.

In pursuance of this resolution Lord Wrottesley and Sir Robert Inglis requested and obtained an interview with the Earl of Derby on the 19th of March last, at which they directed his attention to the ill-success which had lately attended the applications for Scientific Pensions, and instanced the cases of Mr. Hind and Dr. Mantell, in whose behalf the Earl of Rosse, as President of the Royal Society, had applied for a grant of Pensions.

The Earl of Derby, in reply, stated it to be the wish of the Government to apportion the fund equitably amongst all the separate classes into which the List is divided, or to that effect, and requested to know the share of the whole fund which had in fact been allotted to Science. In answer to this latter question Lord Wrottesley addressed to the Earl of Derby a letter, of which the following is a copy:—

"Wrottesley, April 24, 1852.

"DEAR LORD DERBY,—When I had the honour of an interview with you in the matter of Pensions to Scientific men, you asked me for the exact amount of those that had been granted in favour of Science. I could not answer this question, as I had not then been able to obtain either the earliest or latest returns. I have since procured all the papers and the account stands as follows: out of £16,800 (1200 × 14), the total sum granted for Pensions, since the Civil List was settled at the commencement of the Queen's reign, a sum of £2150 has been appropriated to Science, properly so called, or not quite 13 per cent.

"I give this detail because it was required from me; but I would not be understood to ground any argument upon it: our complaint is, that in a country like this, which owes so much to Science, there should be *at any time* no means of rewarding, either by money payments, or in any other manner both appropriate and acceptable to the candidates for distinction, cases of great merit, which have been brought to the notice of the Government by Scientific Societies in whose recommendations confidence may be securely reposed. I say Scientific *Societies*, for however trustworthy an individual may be, there can never be the same reliance on a single opinion in cases of this description*.

* * * * * * *

"I may add, that when I saw you I was not aware that Lord Rosse had

* A paragraph is here omitted as referring to personal matters.

applied on behalf of Mr. Ronalds of the Kew Observatory, and that this would likewise seem to be a very deserving case; it was favourably entertained, but the funds were exhausted*.

"Yours, &c.,
"WROTTESLEY."

In closing their Report the Committee cannot but express a hope that their negotiations with the Government, with respect to the cheap and rapid international communication of scientific works, may ultimately result in the complete accomplishment of this desirable object.

June 17th, 1852.

RECOMMENDATIONS ADOPTED BY THE GENERAL COMMITTEE AT THE BELFAST MEETING IN SEPTEMBER 1852.

Involving Grants of Money.

That the sum of £200 be placed at the disposal of the Council for the maintenance of the establishment of the Observatory at Kew.

That Dr. Hodges be requested to investigate the chemical changes which are observed to occur in the technical preparation of flax; and that £20 be placed at his disposal for the purpose.

That Mr. Robert Hunt and Dr. Gladstone be requested to continue their experiments on the influence of the solar radiations on chemical combinations, electrical phænomena, and the vital powers of plants growing under different atmospheric conditions; with £15 at their disposal for the purpose.

That Mr. Mallet be requested to continue his experiments on the propagation of earthquake waves, availing himself of the operations now carrying on at Holyhead; with £50 at his disposal for the purpose.

That Dr. Lankester, Professor Owen, and Dr. Dickie, be a Committee to continue the superintendence of the publication of tabular forms in reference to periodical phænomena of animals and vegetables; with £10 at their disposal for the purpose.

That Mr. H. E. Strickland, Dr. Lindley, and the other members of a Committee already named, be requested to continue their experiments on the vitality of seeds; with £5 10*s*. at their disposal for the purpose.

That Mr. R. Patterson, Dr. Dickie, Mr. Hyndman, and Mr. Grainger, be requested to carry out a system of dredging on the North and East coasts of Ireland; with £10 at their disposal for the purpose.

That Mr. Wyville Thomson, Professor Balfour, Professor Goodsir, Mr. Peach, and Dr. Greville, be requested to carry out a system of dredging on the East coast of Scotland; with £15 at their disposal.

That Professor E. Forbes and Professor T. Bell be requested to assist in the publication of the remaining part of Dr. Williams's Report on the Structure of the Annelida; with £10 at their disposal for the purpose.

That the sum of £5 be granted for defraying the expenses attending the distribution of a Manual of Ethnological Inquiry prepared by Mr. Cull and a Sub-committee appointed in 1851.

That a large outline Map of the World be provided for the use of the Geographers and Ethnologers; and that Sir R. I. Murchison, the Lord Bishop of St. Asaph, and the Secretaries of the Geographical and Ethnological Societies, be a Committee for carrying this into effect; with £15 at their disposal for the purpose.

* See page lxi.

Involving Application to Government or Public Institutions.

That in order to meet the growing wants of science, and remedy, in some degree, the inconvenience caused to its cultivators by the dissociated, incomplete, and discontinuous publication of scientific researches, it is expedient that the British Association, which, by its constitution, includes representatives of the various scientific institutions of the empire, should propose such general views on the subject as may be suggested by the experience of its members.

That a Committee be formed for the purpose of considering of a plan by which the Transactions of different Scientific Societies may become part of one arranged system, and the records of facts and phænomena be rendered more complete, more continuous, and more convenient than at present.

That it be an instruction to this Committee to place itself in communication with the Council of the Royal Society, and the Councils of other Scientific Societies which receive scientific communications at regular meetings.

That the Committee consist of Prof. W. Thomson, Prof. Andrews, Leonard Horner, Esq., Prof. Owen, Sir R. I. Murchison, Col. Sykes, W. J. Rankine, Esq., J. C. Adams, Esq., Dr. Lloyd, Prof. Wilson, Dr. Robinson, Prof. Bell, Prof. Graham, W. R. Grove, Esq., Sir D. Brewster, and *ex officio* the General Officers, with power to add to their number.

That it is important to have a Quarterly Record of British and Foreign scientific publications and discoveries, and that the consideration of the practicability of obtaining this be referred to the same Committee.

That a representation be made to the Royal Society of the importance attached by M. Otto Struvé to the determination of the constant of "Irradiation" for the Huyghenian object-glass of 123 feet radius.

That it is expedient to proceed without delay with the establishment in the Southern Hemisphere of a Telescope not inferior in power to a three feet reflector; and that the President, with the assistance of the following gentlemen, viz. Lord Rosse, Dr. Robinson, Lord Wrottesley, J. C. Adams, Esq., the Astronomer Royal, J. Nasmyth, Esq., W. Lassell, Esq., Sir D. Brewster, and E. J. Cooper, Esq., be requested to take such steps as they shall deem most desirable to carry out the preceding Resolution.

That the publication of the reduction upon a scale of one inch to the mile of the Townland Survey of Ireland, ordered to be made in connection with the Geological Survey by the Ordnance, and for which a vote was taken for 1852–53, upon the Estimates of that department, be recommended to the Government to be accelerated.

That the Council of the British Association be requested to continue their efforts to obtain the assistance of the Government for the publication of Mr. Huxley's researches.

That, with the view of obtaining an accurate knowledge of the countries on and near the Eastern coast of Africa, from the Red Sea to 10° S. lat., the very important products of which have been enumerated by the late Sir Charles Malcolm and Mr. D. Cooley, the British Association do call the attention of the Court of Directors of the Honourable the East India Company, to the desirableness of sending an expedition thoroughly to explore that region, as recommended by the Royal Geographical Society of London. The deputation to consist of the President of the British Association, and the President and Vice-Presidents of the Royal Geographical Society.

That most important meteorological data are attainable by balloon ascents; and that the Council be requested to solicit the cooperation of the Royal Society in this investigation.

That it is important that Professor W. Thomson and Mr. J. P. Joule be enabled to make a series of experiments, on a large scale, on the thermal effects experienced by air in rushing through small apertures; and that a representation to this effect be made to the Royal Society.

That the Government be requested, on the part of the British Association, to connect with the survey of the Gulf-stream an examination of the Zoology and Botany of that current; and also of the temperature of the sea round the shores of the British Islands.

The Committee having been informed that an expedition has been proposed for ascending the Niger to its source, by Lieut. Lyons Macleod, R.N.; and that it has been recommended to Her Majesty's Government by the Royal Geographical Society and the Chamber of Commerce of Manchester, resolve that the President be requested to concur with the President of the Royal Geographical Society in bringing the subject before the Government.

The Committee having understood that Dr. Bakie, Mr. A. Adams and Mr. W. T. Alexander, each of them in the medical branch of Her Majesty's Navy, have proposed to undertake a thorough exploration of the countries watered by the river Magdalena in South America, in respect to their botanical, zoological, and geological products, on the condition of being allowed their full pay, request the President of the Association and Sir R. I. Murchison to urge the Government to accede to this proposition.

The Committee being aware of the liberality with which the Master-General and Board of Ordnance have supplied the several engineer stations with instruments for meteorological observations, would suggest the advantage of adding to their instruments, in the Ionian Islands, others for measuring the direction and amount of earthquake vibrations, so frequent in these islands.

That a systematic collection of the Agricultural Statistics of Great Britain, of a similar nature with the returns of the agricultural produce of Ireland, prepared under the care of Major Larcom, R.E., is a desideratum, and would be of great public utility; and that the President, Mr. Heywood, Major Larcom and Col. Sykes, be requested to communicate the above resolution to Her Majesty's Government.

That a Committee, consisting of Rev. Dr. Robinson, Prof. C. P. Smyth, W. Fairbairn, Esq., W. J. M. Rankine, Esq., C.E., and W. S. Ward, Esq., be requested to take into consideration the methods of cooling air for the ventilation of buildings in tropical climates by mechanical processes, and should they see fit to prepare a memorial in the name of the British Association to the Hon. the East India Company, representing the advantage of making a trial of a process of that kind on a large scale, *e.g.* in a hospital.

Not involving Grants of Money or Application to Government, &c.

That the thanks of the British Association be given to the Smithsonian Institution for the communication of Charts illustrating the plan adopted by that Institution for deducing the general facts of the Meteorology of North America, bearing on the laws of the great North American Storms; and that it be referred to the Council to consider what steps it may be advisable to take for the purpose of extending the system of observations over the British portion of North America.

That the thanks of the British Association be given to Prof. Dove for his valuable communication respecting the lines of abnormal temperature on the globe; and that it be referred to the Council to consider of the expediency of procuring copies of the map of the abnormal temperatures in different months of the year, for the supply of members of the Association.

That Mr. Sylvester be requested to draw up a complete Report on the Theory of Determinants, to be laid before the next meeting of the Association.

That the Earl of Rosse, Dr. Robinson, and Professor Phillips be requested to draw up a Report on the physical character of the moon's surface as compared with that of the earth.

Printing of Communications.

That the observations of mean daily temperature and fall of rain at 127 stations of the Bengal Presidency, be printed at length in the next volume of Transactions.

That Mr. James Thomson's paper, on Vortex Water-wheels, be printed at length in the Transactions of the Association.

Synopsis of Grants of Money appropriated to Scientific Objects by the General Committee at the Belfast Meeting in Sept. 1852, *with the Name of the Member, who alone, or as the First of a Committee, is entitled to draw for the Money.*

	£	s.	d.
Kew Observatory.			
At the disposal of the Council for defraying Expenses	200	0	0
Chemical Science.			
Hodges, Prof.—Researches on Chemical Changes in the preparation of Flax	20	0	0
Hunt, Mr. R.—Influence of the Solar Radiations on Chemical Combinations, Electrical Phænomena, and the Vital Powers of Plants growing under different atmospheric conditions.	15	0	0
Geology.			
Mallet, Mr. R.—Experiments on the Propagation of Earthquake Waves	50	0	0
Natural History.			
Lankester, Dr. E.—Periodical Phænomena of Animals and Vegetables	10	0	0
Patterson, Mr. R.—Dredging on the North and East Coasts of Ireland	10	0	0
Strickland, Prof. H. E.—Vitality of Seeds	5	10	0
Thomson, Mr. Wyville.—Dredging on the East Coast of Scotland	15	0	0
Forbes, Prof. E.—Researches on Annelida	10	0	0
Geography and Ethnology.			
Cull, Mr. R.—Manual of Ethnological Inquiry	5	0	0
Murchison, Sir R. I.—Large outline Map of the World....	15	0	0
Grants	£355	10	0

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

1834.

	£	s.	d.
Tide Discussions	20	0	0

1835.

	£	s.	d.
Tide Discussions	62	0	0
British Fossil Ichthyology	105	0	0
	£167	0	0

1836.

	£	s.	d.
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.

	£	s.	d.
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	3
Vitrification Experiments	150	0	0
Heart Experiments	8	4	6
Barometric Observations	30	0	0
Barometers	11	18	6
	£918	14	6

1838.

	£	s.	d.
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
Carried forward	£800	12	9
Brought forward	800	12	9
Subterranean Temperature	8	6	0
Steam-vessels	100	0	0
Meteorological Committee	31	9	5
Thermometers	16	4	0
	£956	12	2

1839.

	£	s.	d.
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.

	£	s.	d.
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
Carried forward	£1006	15	7

	£	s.	d.
Brought forward	1006	15	7
School Statistics	50	0	0
Forms of Vessels	184	7	0
Chemical and Electrical Phænomena	40	0	0
Meteorological Observations at Plymouth	80	0	0
Magnetical Observations	185	13	9
	£1546	16	4

1841.

	£	s.	d.
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
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
Carried forward	£432	8	3

	£	s.	d.
Brought forward	432	8	3
Stars (Histoire Céleste)	59	0	0
Stars (British Association Catalogue 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 Co-operation	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
Carried forward	£789	8	4

	£	s.	d.
Brought forward	789	8	4
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 Observations 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 Co-operation	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
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
Carried forward	£538	11	8
Brought forward	538	11	8
Researches into the 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
Researches on Exotic Anoplura	15	0	0
Experiments on the 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
Experiments on 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
Carried forward	£814	15	1

	£	s.	d.
Brought forward	814	15	1
Registration of 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
Experiments on the 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
Researches on Atmospheric Waves................	3	3	3
Captive Balloons 1844	8	19	8
Varieties of the Human Race 1844	7	6	3
Statistics of Sickness and Mortality at 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
Researches on 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
Researches on 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 Phænomena	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
Periodical Phænomena	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
Experiments on the Theory of Heat	20	1	1
Periodical Phænomena 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

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, John Taylor, Esq., 6 Queen Street Place, Upper Thames Street, London, 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, Sept. 1st, at 8 P.M., in May Street Church, Sir Roderick I. Murchison, G.C.St.S., F.R.S., on the part of G. B. Airy, Esq., M.A., D.C.L., F.R.S., Astronomer Royal, resigned the office of President to Colonel Edward Sabine, R.A., Treas. and V.P. R.S., who took the Chair at the General Meeting, and delivered an Address, for which see p. xli.

On Thursday, Sept. 2nd, a Soirée took place from 8 to 10 P.M., in the rooms of Messrs. Workman, which had been arranged for the purpose.

On Friday, Sept. 3rd, at 8 P.M., in May Street Church, G. G. Stokes, F.R.S., Lucasian Professor of Mathematics at Cambridge, delivered a Discourse on some recent discoveries in the properties of Light.

On Saturday, Sept. 4th, at 8 P.M., a Soirée took place in the rooms of Messrs. Workman.

On Monday, Sept. 6th, at 8 P.M., Colonel Portlock, R.E., F.R.S., delivered a Discourse on the recent discovery of Rock-salt at Carrickfergus, and the geological and practical considerations connected with it.

On Wednesday, Sept. 8th, at 3 P.M., the concluding General Meeting of the Association was held in May Street Church, 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 Hull*.

* The Meeting is appointed to take place on Wednesday, the 7th of September, 1853.

ADDRESS

BY

COLONEL EDWARD SABINE, R.A.,

TREASURER AND VICE-PRESIDENT OF THE ROYAL SOCIETY.

GENTLEMEN OF THE BRITISH ASSOCIATION,

MY first duty in addressing you from this Chair, must be to express my grateful thanks for the high honour you have conferred upon me by placing me in so distinguished a position. My acknowledgements are due in the first place to the gentlemen of Belfast, who by their Provisional Committee brought my name before the Council as that of a person whose nomination to the Presidency would give satisfaction at Belfast; next, to my colleagues in the Council, who adoped the suggestion of the Provisional Committee, strengthening it by their approval; and finally, to the General Committee (the governing body), by whom it was confirmed. The strong attachment which I am known to have felt for so many years to the British Association will be my best guarantee that no endeavours shall be wanting on my part to perform the duties of the Office to the utmost of my power.

Gentlemen, we meet for the third time in the Sister Kingdom, on the invitation, which has been most welcome to us, of a part of the kingdom which has furnished to the British Association so large a proportion of distinguished members actively engaged in almost every department of science. On our arrival, we find ourselves surrounded by faces familiar to us in the recollections of many previous meetings, and long recognised as amongst the warmest and steadiest friends of our Association. Our meeting is graced and honoured by the presence of Her Most Gracious Majesty's representative in Ireland. With ample and excellent accommodation liberally provided in the fullest anticipation of our wants, and with the evidence which forcibly impresses itself on every side of rapidly increasing prosperity, opening a wide field for the practical applications of science, our satisfaction in assembling here would be complete, were it not clouded by the absence of one friend who would have been among the foremost to have welcomed us to this meeting which he prepared, the Naturalist of Ireland, whose memory will long be honoured and cherished by the members of the British Association.

The ever-increasing activity of the various branches of science embraced by the British Association is such, as to render it scarcely possible to comprehend within the limits of an address of the usual length, even a brief review of the progress made in the seven departments which constitute our Sections. In the selection which I have thus found myself compelled to make, I have been guided by a practical principle, which appears not unsuited to an Association in which the Presidency is an annual office, viz. that the President for the year should notice by preference those subjects with which he is most familiar, in which the Association as a body have taken a part, or which are likely to be discussed at the meeting over which he presides.

Among the subjects which are likely to come before the Mathematical and Physical Section, there is none perhaps of greater importance, or requiring more careful consideration, than the question whether the time is arrived, when the establishment of an Observatory in the Southern Hemisphere, furnished with instruments of suitable optical power for the examination of the Nebulæ of the southern heavens, and devoted exclusively to that branch of sidereal astronomy, should be again brought under the consideration of Her Majesty's Ministers. I need not occupy your time by restating on this occasion the reasons both of scientific and national concernment, which induced the two principal Scientific Institutions of the United Kingdom, conjointly, to recommend to those entrusted with the administration of public affairs, the formation of an establishment of this description in some fitting part of Her Majesty's southern dominions. I would rather refer you to the memorial presented to Government by the Earl of Rosse on the part of the Royal Society, and by Dr. Robinson on the part of the British Association, not only because it contains such a complete and formal exposition, as may be most advantageously consulted by those who will now be called upon to take part in the reconsideration of the subject, but also because it appears to me to furnish an admirable model both in spirit and in matter, for communications designed to fulfil the important purpose of conveying in an official form the opinions and suggestions which the united body of scientific men of this Kingdom may desire from time to time to bring under the consideration of the Executive.

In the discussions which took place at a former period, the only difficulty which appeared to be apprehended in reference to the successful working of such an establishment, arose from a doubt whether mirrors of the required magnitude could be repolished, as they would frequently need to be, on the *spot*. This difficulty has now it is understood been entirely removed by the improvements which the noble Earl, the President of the Royal Society, to whom science is so deeply indebted for the instrumental means of prosecuting these researches, has made in the apparatus for repolishing the mirrors, and in the instructions for the guidance of those who may have occasion to employ it, which his own great personal experience has enabled him to prepare.

In this happy country, in which men are free to consider and to discuss the propriety of public support being given to undertakings conducive to national honour, and are encouraged to do so by the experience that public men of all parties who succeed each other in administration, seek to be guided by enlightened public opinion, we may justly entertain the full conviction that measures which from their intrinsic importance deserve to be adopted will sooner or later obtain the consideration they merit. When such propositions are brought in the first instance,—as in the class of subjects with which we are here concerned it is desirable they should be,—before those public bodies which are justly regarded as possessing the highest scientific authority in this country, and as most competent to judge of them, they cannot be too carefully considered and discussed, before by their adoption they become invested with the authority and weight which those bodies have it in their power to impart. But when after due deliberation they have been so adopted, it is equally fitting that those public bodies should be true to their own convictions, and should steadily persevere in urging on all proper occasions, both publicly and privately, the measures which they believe will add to their country's honour, as well as to that general advancement of science by which all nations benefit freely and alike in proportion to their degree of mental cultivation. That an Observatory for the purpose specified, in a part of the globe where it can render peculiar service, and where we possess facilities which other nations do not possess, will ere long be established, no one I believe entertains a doubt. The importance was admitted by the Ministry to whom the recommendation was made, the only question with them appearing to be one of time. When therefore we view the intrinsic merit of the proposition itself, the general interest which it has excited at home and abroad, and its already, to a certain extent, favourable reception by Government, we cannot doubt that we have but to persevere, and by a judicious selection of times and opportunities the object will be secured. It will be for the Members of the Mathematical and Physical Section to consider in the first instance, and for the General Committee, subsequently, to consider and decide whether any official step shall be taken by the British Association in the present year. Should such be your decision, it will be the duty of the Officers and Council of the Association to confer with the President and Council of the Royal Society, and in conjunction with them to take such steps as may appear most fitting to bring the subject again, and in the most impressive manner, under the consideration of the Authorities of the State. On the former occasion it was thought most respectful to abstain from any suggestion in regard either to a suitable locality, or to the Astronomer who might be advantageously selected to direct an establishment of this novel description. Such may still be deemed, perhaps, the least exceptionable course; but at the same time it may be desirable that it should be fully known, that we are not unprepared on these and other points, if it be the pleasure of Her Majesty's Government to desire our opinion.

Hitherto the researches of Sidereal Astronomy, even in their widest extension, had manifested the existence of those forces only with which we are familiar in our own solar system. The refinements of modern observation and the perfection of theoretical representation, had assured us that the orbits in which the double stars, immeasurably distant from us, revolve around each other, are governed by the same laws of molecular attraction which determine the orbits of the planetary bodies of our own solar system. But the Nebulæ have revealed to us the probable existence in the yet more distant universe, of forces with which we were previously wholly unacquainted. The highest authorities in this most advanced of all the sciences, acknowledge themselves unable even to conjecture the nature of the forces which have produced and maintain the diverse, yet obviously systematic arrangement of the hosts of stars which constitute those few of the Spiral Nebulæ which have been hitherto examined. Hence the importance of increasing our knowledge of the variety of forms in which the phænomena present themselves, by a similar examination of the Southern Heavens to that which Lord Rosse is accomplishing in the Northern Heavens; hence also, we may believe, in great measure, the devotion with which his Lordship has directed the unprecedented instrumental power which he has created almost exclusively to the observation of nebulæ. But whilst we cannot but admire the steadiness of purpose with which an object regarded as of paramount importance is undeviatingly pursued, we can scarcely forbear to covet at least an occasional glance at bodies which from their greater proximity have more intimate relations with ourselves, and which, when viewed with so vast an increase of optical power, may afford instruction of the highest value in many branches of physical science. In our own satellite, for example, we have the opportunity of studying the physical conformation and superficial phænomena of a body composed, as we believe mainly at least, of the same materials as those of our own globe, but possessing neither atmosphere nor sea. When we reflect how much of the surface of the earth consists of sedimentary deposits, and consequently how large a portion of the whole field of geological research is occupied with strata which owe their principal characteristics to the ocean in which they were deposited, we cannot but anticipate many instructive lessons which may be furnished by the points of contrast, as well as of resemblance, which the surface of the moon, viewed through Lord Rosse's telescope, may present to the best judgement we are able to form of what the appearance of the earth would be if similarly viewed, or with what may be more difficult perhaps to imagine,—what we may suppose the earth would appear if it could be stript of its sedimentary strata, which conceal from us for the most part the traces of that internal action which has played so large a part in moulding the great outlines of the present configuration of its surface. It is understood that Lord Rosse himself participates in the wish that such an examination of the surface of the moon should be made, and, should the desire of the Association be expressed to that effect, is willing to undertake it in conjunction with one or two other gentlemen possessing the necessary physical and geological knowledge. It will be for the Members of the Association to determine the form in which a Report on the "Physical Features of the Moon compared with those of the Earth" may most appropriately be requested.

In connection with Astronomy, I permit myself to notice the publication, now in progress, of two works of considerable magnitude and value, because they do honour to the science and public spirit of the part of the United Kingdom in which we are assembled; I refer to the Markree Catalogue of Ecliptic Stars, and to the results of the Observations at the Armagh Observatory. The establishments from which these publications emanate belong to the class which owe their endowment and support to private munificence, but by the extent and character of the work they perform entitle themselves to rank with the Institutions, which in this and other countries testify the liberality of a nation's patronage. The Markree Observatory, which has already distinguished itself under the personal superintendence of its founder, amongst other services by the discovery of one of the thirteen planets by which our knowledge of the solar domain has been enriched in the last seventeen years,—will hereafter take its position amongst the establishments which have most largely contributed to the perfection of modern astronomy by its catalogue of the approximate places of all the stars in the ecliptic down to the twelfth magnitude inclusive; by which catalogue the detection of any still undiscovered planetary bodies belonging to our system will be greatly facilitated. One volume has already been published in the year which has elapsed since our Ipswich Meeting, and a second is in preparation, and both, by the aid of funds supplied from the annual grant now placed at the disposal of the Royal Society, to be applied in the advancement of science. The publication of the results of the observations of the Armagh Observatory, since it has been under the very able direction of Dr. Robinson, has been for some time a desideratum. At the instance of the Royal Irish Academy it was recommended by the Irish Executive, but without success. It is now being accomplished by aid from the same source as the Markree Catalogue. I have the more satisfaction in noticing these appropriations in favour of Irish science from funds designed for the general benefit of the United Kingdom, because they indicate the fairness and equality with which the distribution of those funds is administered: it is also I believe strictly in character with the prevailing principles which sanction public aid, that it should be given, when needed, to those who, as in the case of these private observatories, have already largely contributed from their own resources.

The Mathematical and Physical Theories of *Light* have afforded subjects for many interesting and profitable discussions in Section A, and have usually had one day in the six specially allotted to them. Those discussions will derive a more than usual interest at this meeting from the remarkable discovery recently made by Prof. Stokes, that under certain circumstances a change is effected in the refrangibility of light, and from the advantage we possess in having amongst us on this occasion the eminent mathematician and physicist by whom this most important contribution to the science of physical optics has been made. His researches took their origin from an unexplained phænomenon discovered by Sir John Herschel and communicated by him to the Royal Society in 1845. A solution of sulphate of quinine examined by transmitted light, and held between the eye and the light, or between the eye and a white object, appears almost as transparent and colourless as water; but when viewed in certain aspects and under certain incidences of light, exhibits an extremely vivid and beautiful celestial blue colour. This colour was shown by Sir John Herschel to result from the action of the strata which the light first penetrates on entering the liquid; and the dispersion of light producing it was named by him epipolic dispersion, from the circumstance that it takes place near the surface by which the light enters. A beam of light having passed through the solution was to all appearance the same as before its entrance; nevertheless it was found to have undergone some mysterious modification, for an epipolised beam of light, meaning thereby a beam which had once been transmitted through a quiniferous solution, and had experienced its dispersive action, is incapable of further epipolic dispersion. In speculating upon the possible nature of epipolised light, Prof. Stokes was led to conclude that it could only be light which had been deprived of certain invisible rays which in the process of dispersion had changed their refrangibility and had thereby become visible. The truth of this supposition, novel and surprising as it at first appeared, has been confirmed by a series of simple and perfectly decisive experiments; showing that it is in fact the chemical rays of the spectrum more refrangible than the violet, and invisible in themselves, which produce the blue superficial light in the quiniferous solution. Professor Stokes has traced this principle through a great range of analogous phænomena, including those noticed by Sir David Brewster in his papers on "Internal Dispersion," and has distinguished between "cases of false internal dispersion" or "opalescence," in which the luminous rays are simply reflected from fine particles held in mechanical solution in the medium, and those of "true internal dispersion," or "fluorescence," as it is termed by Mr. Stokes. By suitable methods of observation the change of refrangibility was detected, as produced not only by transparent fluids and solids, but also by opake substances; and the class of media exhibiting "fluorescence" was found to be very large, consisting chiefly of organic substances, but comprehending, though more rarely, some mineral bodies. The direct application of the fact, as we now understand it, to many highly interesting and important purposes, is obvious almost on the first announcement. The facility with which the highly refrangible invisible rays of the spectrum may be rendered visible by being passed through a solution of sulphate of quinine or other sensitive medium, affords peculiar advantages for the study of those rays; the fixed lines of the invisible part of the solar spectrum may now be exhibited to our view at pleasure. The constancy with which a particular mode of changing the refrangibility of light attaches to a particular substance, exhibiting itself independently of the admixture of other substances, supplies a new method of analysis for organic compounds which may prove valuable in organic chemistry. These and other applications of the facts as they are now explained to us, will probably form subjects of notice in the Chemical and Physical Sections, and a still higher interest may be expected from the discussion of the principle itself, and of the foundation on which it rests. A discovery of this nature cannot be otherwise than extremely fertile in consequences, whether of direct application, or by giving rise to suggestions branching out more and more widely, and leading to trains of thought and experiment which may confer additional value on the original discovery, by rendering it but the first step in a still more extensive generalization.

As the interest of this discovery is not confined to a single branch of science, the Officers, with the approbation of the Local Committee, have requested Mr. Stokes to favour the Association with an exposition of the subject at an evening meeting, when the members of the different sections may be able to attend without prejudice to their respective sectional duties: and in that view I have thought that this brief introductory notice might not be misplaced, a notice which I cannot conclude without adverting to the gratification which all who cultivate science in this part of the United Kingdom must feel at the rising eminence of their highly accomplished fellow-countryman.

Among the subjects of chemical inquiry which may well deserve the attention of a combination of philosophers, perhaps few could more usefully occupy their joint labours than the revision of the Equivalent Numbers of the Elementary Bodies. This is a task which must necessarily require the cooperation of several properly qualified individuals, if it be accomplished within anything like a reasonable period of time. Most of the Numbers now in use depend upon experiments performed by Berzelius, at a time when the methods of research then known were inadequate, even in such hands, to determine these constants with an accuracy sufficient for the wants of science at the present day. So much has this been felt to be the case, that many of the most accomplished chemists now living have undertaken extensive and laborious, though isolated researches, upon the combining quantities of some of the most important elements. But much more than has been already performed still remains undone. Such a subject it is believed might be highly proper for consideration by the Chemical Section, to whose notice it would be introduced by the distinguished chemist, Dr. Andrews, who presides over that Section, and than whom no one could be named as more competent to estimate the importance of such a revision, or to judge more truly of the qualifications that would be required for its execution.

We are deprived by the illness, I trust only temporary, of our valued associate Prof. James Forbes, of the Report he would have given us of the progress of the experiments which he has undertaken at the request of the Association to test the *Theory of Heat*. But this branch of Physics abounds more perhaps than any other at the present time in subjects which may be most profitably discussed. The theory of Heat has made great advances within the last ten years. Mr. Joule has by his experiments confirmed and illustrated the views demonstrated about the end of the last century by Davy and Rumford regarding the nature of heat, which are now beginning to find general acceptance. He has determined with much accuracy, the numerical relation between quantities of heat and of mechanical work. He has pointed out the true principles upon which the mechanical value of any chemical change is to be estimated, and by very careful experiments he has arrived at numerical expressions for the mechanical equivalents in some of the most important cases of chemical action, in galvanic batteries, and in combustion. These researches appear to be laying the ground-work for the ultimate formation of a *Mechanical Theory of Chemistry*, by ascertaining experimentally the mechanical equivalents expressed in absolute motive force of the thermic, electric and magnetic forces. Mathematical developments of the theories of heat and electro-dynamics, in accordance with these principles, are given in various papers by MM. Helmholz, Rankine, Clausius and Thomson, published principally within the last two years. In discussing these subjects the Section will have a great advantage in being presided over by the last-named of these gentlemen, a native of Belfast, who at so early an age has attained so high a reputation, and who is taking a leading part in the investigations to which I have referred.

In connexion with the subjects of Heat, I would advert to the experiments in which Mr. Hopkins is engaged for investigating the possible influence of high pressure on the temperature at which substances, in a state of fusion, solidify—an inquiry which was shown by Mr. Hopkins, in a report recently presented to the British Association, to have an important bearing on the questions of the original and present state of the interior of the earth. It is well known that the temperature of the earth increases as we descend, and it has been calculated that at the rate at which the increase takes place in such depths as are accessible to us, the heat at the depth of eighty or a hundred miles would be such as to fuse most of the materials which form the solid crust of the globe. On the hypothesis of original fluidity, and assuming that the rate of increase known to us by observation continues further down, and is not counterbalanced by a considerable increase in the temperature of fusion occasioned by pressure, the present state of the earth would be that of a solid crust of eighty or a hundred miles in thickness, enveloping a fluid nucleus. Mr. Hopkins considers this state to be inconsistent with the observed amount of the precession of the equinoxes, and infers that if the temperature of fusion be considerably heightened by pressure, the conclusion must be unavoidable that the earth is solid at the centre. Mr. Hopkins is assisted in these experiments, which are carried on at Manchester, by the well-known engineering knowledge of Mr. Fairbairn, and the equally well-known experimental skill of Mr. Joule. The principal difficulties attending the experiments with substances of low temperatures of fusion have been overcome, and strong hopes are entertained of success with substances of more difficult fusibility. The pressures employed are from three to four tons to eight and ten tons on the square inch. The latter is probably equal to the pressure at several miles beneath the earth's surface.

From *Heat* the transition is easy, and by many may be deemed natural, to *Terrestrial Magnetism*, a science which, more perhaps than any other, has profited by the impulse and systematic direction communicated to it by the British Association, and which perhaps more than any other required such external aid. In the infancy of a science, the phænomena of which present on our first acquaintance with them a great appearance of complexity, the path by which its progress may be advanced may be by no means easy to discern; and individual explorers may well, under such circumstances, be discouraged by doubts whether their labour will be recompensed by proportionate success, as well as disheartened by the little sympathy which is usually given to investigations which hold out but little immediate prospect of practical utility. Some there have been however from time to time, who, impressed with a persuasion of the position which magnetism deserves to take, and which sooner or later they believe it will take, amongst the physical sciences of the highest order, have not spared this precursive labour, and have been uniformly conducted by it to the same general conclusion, viz. that in order to obtain a sufficient foundation of facts upon which to raise a fitting superstructure of inductive reasoning, it would be necessary to organize a system of cooperative research, in which the labours of many might be united agreeably to concerted arrangements; and that as such researches would require to be carried on nearly at the same epoch at many distant parts of the globe, for which private resources were inadequate, public assistance must be sought. That this conclusion was extensively recognised and acquiesced in is sufficiently attested by the readiness so generally manifested by governments and individuals in all countries where mental cultivation is regarded to take part in the general system of magnetic cooperation proposed by this country in 1838. In the years which have since elapsed, the energy and zeal of those who have engaged in these researches have accumulated a mass of observations, which, as the fruit of systematic and concerted labour, is, I believe, wholly unprecedented. The labour of digesting, comparing, and coordinating the body of facts thus obtained may certainly be stated to be *not less* than that expended in obtaining them; and as the one process must necessarily be in great measure carried out subsequently to the other, we are only now beginning to reap the first-fruits of this great co-operative undertaking in the bearing of its results upon theory. At the Ipswich meeting of the British Association, I was requested by the General Committee to draw up a report on the state and progress of the magnetic researches consequent on the application of the British Association to Her Majesty's Government in 1838. I regret that, from the other very pressing duties above alluded to, I have not been able to complete this report in time to present at this meeting, but as I may assume, from the request just made to me, that the subject retains with the British Association the interest which it there so happily acquired, I may venture to avail myself of this opportunity to make a very few remarks on some of its most important results; confining myself for the most part to results obtained by persons of our own country as the direct and immediate consequences of the recommendation of the British Association, leaving to a more fitting occasion a more general and comprehensive view.

We recognise in terrestrial magnetism the existence of a power present everywhere at the surface of our globe, and producing everywhere effects indicative of a systematic action; but of the nature of this power, the character of its laws, and its economy in creation, we have as yet scarcely any knowledge. The apparent complexity of the phænomena at their first aspect may reasonably be ascribed to our ignorance of their laws, which we shall doubtless find, as we advance in knowledge, to possess the same remarkable character of simplicity which calls forth our admiration in the laws of molecular attraction. It has been frequently surmised, and the anticipation is I believe a strictly philosophical one, that a power which, so far as we have the means of judging, prevails everywhere in our own planet, may also prevail in other bodies of our system, and might become sensible to us, in the case of the sun and moon particularly, by small perturbing influences measurable by our instruments, and indicating their respective sources by their periods and their epochs. As yet we know of neither argument nor fact to invalidate this anticipation; but, on the contrary, much to invest it with a high degree of probability. Be this however as it may, we have in our own planet an exemplification of the phænomena which magnetism presents in one of the bodies of our system, on a scale of sufficient magnitude, and otherwise convenient for our study. Accordingly the first object to which the British Association gave its attention was to obtain a correct knowledge of the direction and amount of the magnetic force generally over the whole surface of the globe corresponding to a definite epoch. It has been customary to represent the results of magnetic observations by three systems of Lines, usually called isogonic, isoclinal, and isodynamic lines. [Lines of equal horizontal direction, of equal inclination, and of equal force.] In the maps of these lines existing in 1838, large spaces of the earth's surface were either blank, or the lines passing across them were very imperfectly supported by observations. In the more frequented parts, where observations were more numerous, the discrepancies of their dates impaired their suitability for combination; for the position and configuration of the magnetic lines has been found to undergo a *continual process of systematic change*, with the causes of which we are as yet wholly unacquainted, but which has obtained the name of *secular* change to distinguish it from periodical variations of known and limited duration. Amongst the most marked deficiencies in these maps, were the greater part of the extra-tropical portion of the southern hemisphere,—the British possessions in North America, and British India;—magnetic surveys of these were expressly recommended, and the practicability and advantage of making the observations on board-ship, and of thus extending them over the surface of the ocean, were pointed out. It is most pleasing to recall to recollection, and gratifying to acknowledge from this chair, the favourable manner in which the recommendations of the British Association were received by Her Majesty's Government and by the East India Company, and how promptly and effectually they have been carried out. The blanks in the southern hemisphere have been filled up by maritime expeditions appointed expressly for the purpose. Magnetic surveys have been completed of British North America at the expense of our own Government, and of the Indian Archipelago at that of the East India Company, and India itself is now in progress; whilst from the zeal of our naval officers contributions have flowed in from almost every accessible part of the ocean. The coordination and mutual connection of so large a mass of materials is necessarily a work of time, but is progressing steadily towards completion, and when presented in one connected view, will form the groundwork on which will securely rest a general theory of terrestrial magnetism corresponding to the present epoch. Until these combinations and calculations are performed, it would be obviously premature to speak of numerical values by which the magnetic forces at one part of the globe may be compared with those of another, or with forces of other descriptions; and for the same reason it is desirable to abstain for the present from notices of the geographical positions which particular lines, or as some may deem them, critical points in the magnetic resultants may occupy on the earth's surface at the present epoch. Such notices could only be as yet provisional and liable to the amendments which more exact and extended calculation must be expected to produce. But thus much may be safely stated in reference to the general character of the three systems of lines which have been spoken of, that when derived afresh and exclusively from the observations of the last few years, they do most fully confirm the general conclusions derived from the observations of earlier date, which were submitted to the British Association in the Report on the "Variations of the Intensity of the Magnetic Force at different points of the Earth's surface," which preceded the recommendations of 1838. The magnetic phænomena, or as it is now customary to call them, the three magnetic elements, appear to be everywhere and in both hemispheres the resultants of a duplicate system of magnetic forces, of which one at least undergoes a continuous and progressive translation in geographical space, the motion being from west to east in the northern hemisphere, and from east to west in the southern. It is to this motion that the secular change in all localities is chiefly if not entirely due, affecting systematically and according to their relative positions on the globe, the configurations and geographical positions of the magnetic lines, and producing conformable changes in the direction and amount of the magnetic elements in every part of the globe. The comparison of the earlier recorded observations with those of the present epoch gives reason to believe, that viewed in its generality, the motion of the system of forces which produces the secular change has been uniform, or nearly so, in the last two or three centuries. Under favourable conditions the regularity of this movement can be traced down to comparatively very minute fractions of time; by the results of careful observations continued for several years at the observatory of St. Helena, where, in common with the greater part of the district of the South Atlantic, the secular change of the declination exceeds eight minutes in the year, and from its magnitude therefore may be advantageously studied,—every fortnight of the year is found to have its precise aliquot portion of the annual amount of the secular change at the station. This phænomenon of secular change is undoubtedly one of the most remarkable features of the magnetic system, and cannot with propriety be overlooked, as too frequently it has been, by those who would connect the phænomena of terrestrial magnetism generally, mediately or immediately, with climatic circumstances, relations of land and sea, or other causes to which we are assuredly in no degree entitled to ascribe secular variation, and who reason therefore as if the great magnetic phænomena of the earth were persistent instead of being as they are subject to a continual and progressive change. It may confidently be affirmed that the secular magnetic variation has no analogy with, or resemblance to, any other physical phænomenon with which we are acquainted. We appear at present to be without any clue to guide us to its *physical causes*, but the way is preparing for a future secure derivation of its *laws* to be obtained by a repetition, after a sufficient interval, of the steps which we are now taking to determine the elements corresponding to a definite epoch.

The periodical variations in the terrestrial magnetic force, which I have before adverted to as distinguished from its secular change, are small in comparison with the force itself, but they are highly deserving of attention on account of the probability that by suitable methods of investigation they may be made to reveal the sources to which they owe their origin and the agency by which they are produced. They formed accordingly the subject of a distinct recommendation from the British Association, which met with an equally favourable reception. To investigate these variations by suitable instruments and methods, to separate each from the others, and to seek its period, its epochs of maximum and minimum, the laws of its progression, and its mean numerical value or amount, constituted the chief purposes for which magnetic observatories were established for limited periods at certain stations in Her Majesty's dominions, selected in the view that by a combination of the results obtained at them, a general theory of each at least of the principal periodical variations might be derived, and tests be thus supplied whereby the truth of physical theories propounded for their explanation might be examined. We are just beginning to profit by the collocation and study of the great body of facts which have been collected. Variations corresponding in period to the earth's revolution around the sun, and to its rotation around its own axis, have been ascertained to exist, and their numerical values approximately determined in each of the three elements, the Declination, Inclination, and Magnetic Force. We unhesitatingly refer these variations to the sun as their *primary source*, since we find that in whatever part of the globe the phænomena are observed, the solstices and equinoxes are the critical epochs of the variation whose period is a year, whilst the diurnal variation follows in all meridians nearly the same law of local solar hours. To these unquestionable evidences of solar influence in the magnetic affections of the earth, we have now to add the recently ascertained fact, that the magnetic storms, or disturbances, which in the absence of more correct knowledge were supposed to be wholly irregular in their occurrence, are strictly periodical phænomena, conforming with systematic regularity to laws in which the influence of local solar hours is distinctly traced.

But, whilst we recognise the sun as the primary cause of variations whose periods attest the source from whence they derive their origin, the mode or modes in which the effects are produced constitute a question which has been and may still be open to a variety of opinions: the direct action of the sun as being itself a magnet, its calorific agency occasioning thermo-electric and galvanic currents, or in alternately exalting and depressing the magnetic condition of substances near the surface of the earth, or in one of the constituents of its atmosphere,—have been severally adduced as hypotheses affording plausible explanations. Of each and all such hypotheses the facts are the only true criterion; but it is right that we should bear in mind that in the present state of our knowledge, the evidence which may give a decided countenance to one hypothesis in preference to others does not preclude their possible coexistence. The analysis of the collected materials and the disentanglement of the various effects which are comprehended in them, are far from being yet complete. The correspondence of the critical epochs of the annual variation with the solstices and equinoxes rather than with the epochs of maximum and minimum temperature, which at the surface of the earth, in the subsoil beneath the surface, or in the atmosphere above the surface, are separated by a wide interval from the solstitial epochs, appears to favour the hypothesis of a direct action; as does also the remarkable fact which has been established, that the magnetic force is greater in both the northern and southern hemispheres in the months of December, January, and February, when the sun is nearest to the earth, than in those of May, June, and July, when he is most distant from it: whereas if the effects were due to temperature, the two hemispheres should be oppositely instead of similarly affected in each of the two periods referred to. Still there are doubtless minor periodical irregular variations yet to be made out by suitable analytical processes, which, by their possible accordance with the epochs of maximum and minimum temperature, may support in a more limited sense, not as a sole but as a coordinate cause, the hypothesis of calorific agency so generally received, and so ably advocated of late in connection with the discovery by our great chemist and philosopher of the magnetic properties of oxygen and of the manner in which they are modified and affected by differences of temperature. It may indeed be difficult to suppose that the magnetic phænomena which we measure at the surface of the globe, should not be in any degree influenced by the variations in the magnetic conditions of the oxygen of the atmosphere in different seasons and at different hours of the day and night; but whether that influence be sensible or not, whether it be appreciable by our instruments or inappreciable by them, is a question which yet remains for solution by the more minute sifting of the accumulated facts which are now undergoing examination in so many quarters.

To justify the anticipation that conclusions of the most striking character, and wholly unforeseen, may yet be derivable from the materials in our possession, we need only to recall the experience of the last few months, which have brought to our knowledge the existence of what may possibly prove the most instructive, as it is certainly at first sight the least explicable, of all the periodical magnetic variations with which we have become acquainted. I refer to the concurrent testimony which observations at parts of the globe the most distant from each other bear to the existence of a periodical variation or inequality, affecting alike the magnitude of the diurnal variations, and the magnitude and frequency of the disturbances or storms. The cycle or period of this inequality appears to extend to about ten of our years; the maximum and minimum of the magnitudes affected by it being separated by an interval of about five years, and the differences being much too great, and resting on an induction far too extensive, to admit of uncertainty as to the facts themselves. The existence of a well-marked magnetic period which has certainly no counterpart in thermic conditions, appears to render still more doubtful the supposed connexion between the magnetic and calorific influences of the sun. It is not a little remarkable that this periodical magnetic variation is found to be identical in period and in epochs of maxima and minima with the periodical variation in the frequency and magnitude of the *solar spots* which M. Schwabe has established by twenty-six years of unremitting labour. From a cosmical connexion of this nature, supposing it to be finally established, it would follow, that the decennial period which we measure by our magnetic instruments is, in fact, a *solar period*, manifested to us also by the alternately increasing and decreasing frequency and magnitude of obscurations on the surface of the solar disc. May we not have in these phænomena the indication of a cycle or period of *secular change in the magnetism of the sun*, affecting visibly his gaseous atmosphere or photosphere, and sensibly modifying the magnetic influence which he exercises on the surface of our earth?

The determination of the figure and dimensions of the globe which we inhabit may justly be regarded as possessing a very high degree of scientific interest and value, and the measurements necessary for a correct knowledge thereof, have long been looked upon as proper subjects for public undertakings and as highly honourable to the nations which have taken part in them. Inquiries in which I was formerly engaged led me fully to concur with a remark of Laplace, to the effect that it is extremely probable that the first attempts were made at a period much anterior to those of which history has preserved the record; the relation which many measures of the most remote antiquity have to each other and to the terrestrial circumference strengthens this conjecture, and seems to indicate, not only that the earth's circumference was known with a great degree of accuracy at an extremely ancient period, but that it has served as the base of a complete system of measures the vestiges of which have been found in Egypt and Asia. In modern times the merit of resuming these investigations belongs to the French nation, by whom the arc of the meridian between Formentera and Dunkirk was measured towards the close of the last century. The Trigonometrical Survey of Great Britain, commenced in 1783, for the specific object of connecting the Observatories of Greenwich and Paris, was speedily expanded by the able men to whom its direction was then confided into an undertaking of far greater scientific as well as topographical importance, having for its objects on the one hand the formation of correct maps of Great Britain, and on the other the measurement of an arc of the meridian, having the extreme northern and southern points of the Island for its terminations. A portion of this arc, amounting to 2° 50′, viz. from Dunnose in the Isle of Wight to Clifton in Yorkshire, was published in the Phil. Trans. in 1803. As the whole arc, extending from Dunnose to Unst and Balta, the most northern of the Shetland Islands, would comprise more than 10°, and as nearly half a century had elapsed since the publication of the earlier part of the Survey, it is not surprising that some degree of impatience should have been felt, both by those who desired the results for scientific use, and by those who were interested for the scientific character of the nation, that the general results of the Survey applicable to scientific purposes should at length be given to the world. Accordingly, at the Birmingham Meeting of the British Association in 1849, a Resolution was passed appointing a deputation to confer with the Master-General of the Ordnance, and a similar resolution was passed about the same time by the President and Council of the Royal Society. On communicating with the Master-General, it appeared that the want of special funds for the requisite calculations formed the only obstacle, a difficulty which was happily immediately surmounted by an application of the President and Council of the Royal Society to Lord John Russell, then First Lord of the Treasury. The Report of the Council of the British Association to the General Committee at the Meeting of the last year at Ipswich, contained an official statement from the Inspector-General of Fortifications of the progress of the reduction and examination of the observations preparatory to the desired publication, and concluded with expressing the expectation of the Director of the Survey, that he "should be able to furnish for communication to the British Association that would probably assemble in 1852, the principal results obtainable from the geodetic operations in Great Britain and Ireland." By a recent letter to my predecessor from Captain Yolland of the Royal Engineers, who is entrusted with the direction of the publication, I am enabled to have the pleasure of announcing that the "printing of the observations made with the Zenith Sector, for the determination of the latitudes of stations between the years 1842 and 1850, is finished, and will be presented in time for the meeting of the British Association, and that the calculations connected with the triangulation are rapidly advancing towards their completion."

In the meantime the great arc of Eastern Europe has been advancing with unexampled rapidity and to an extent hitherto unparalleled. Originating in topographical surveys in Esthonia and Livonia, and commenced in 1816, the operations, both geodesical and astronomical, have been completed between Izmaïl on the Danube and Fugleness in Finnmarken, an extent of $25\frac{1}{3}$ meridional degrees. Next to this in extent is the Indian arc of 21° 21′ between Cape Comorin and Kaliana; and the third is the French arc already referred to of 12° 22′. It appears by a note presented to the Imperial Academy of Sciences at St. Petersburgh by M. Struve, that a provisional calculation has been made of a large part of the great arc of Eastern Europe, and that it has been found to indicate for the figure of the earth a greater compression than that derived by Bessel in 1837 and 1841, from all the arcs then at his command,—Bessel's compression having also been greater than Laplace's previous deduction. It is naturally with great pleasure that I perceive that the figure of the earth derived by means of the measurement of arcs of the meridian approximates more and more nearly, as the arcs are extended in dimension, to the compression which I published in 1825 as the result of a series of Pendulum Experiments, which, by the means placed by Government at my disposal, I was enabled to make from the equator to within ten degrees of the pole, thus giving to that method its greatest practicable extension.

The observations hitherto made on the *tides of the ocean* have been insufficient to furnish such a connected knowledge of the subject as would enable us to follow the course of the tide over any considerable portion of the ocean, and in the opinion of persons most competent to judge, it is only by systematic observations specially directed for the purpose, that this connected knowledge is likely to be obtained. Accordingly a resolution was passed at the Ipswich Meeting of the Association, appointing a Committee to prepare a Memorial to Her Majesty's Government, representing the importance of determining the progress of the tide-wave along the coasts of Africa and South America by an Atlantic Tidal Expedition. This Memorial was presented to Government by my predecessor, and, having been referred to the Hydrographer, has been most favourably reported upon. We may therefore expect that the survey will be very shortly commenced. The recent researches of Captain Beechey, which have given a new and unexpected view of the tidal movements of the ocean, show how much yet remains to be learnt respecting the tides even for the practical purposes of navigation.

The facts derived a few years since from the barometrical observations at St. Helena, showing the existence of a *lunar atmospheric tide*, have been corroborated in the last year by a similar conclusion, drawn by Captain Elliot of the Madras Engineers from the barometrical observations at Singapore. The influence of the moon's attraction on the atmosphere produces, as might be expected, a somewhat greater effect on the barometer at Singapore, in lat. 1° 19′, than at St. Helena, in lat. 15° 57′. The barometer at the equator appears to stand on the average about 0·006 in. (more precisely 0·0057, in lat. 1° 19′) higher at the moon's culminations than when she is six hours distant from the meridian.

We have received from our valued corresponding member Prof. Dove, for presentation to this Meeting, an important continuation of his researches on the temperatures at the surface of the globe. In former communications he has furnished us with maps showing, so far as observation permits, the isothermals of the whole globe in every month of the year. He has now given us, first, the *normal* temperatures of each parallel of latitude in each month; being the average of all the temperatures in that parallel in such month; and second, the *abnormal* temperatures, or the difference between the temperature of each place and the mean temperature of its parallel. From these again are formed lines of *abnormal temperature* for each month, surrounding and marking out those districts or localities, which, from peculiarities of the surface or other causes affecting the distribution of heat, are characterized by excessive abnormal heat or abnormal cold. The importance of these researches on the general theory of the causes which interfere with the equable distribution of heat according to latitude is obvious.

The activity which has prevailed so greatly of late, in the collection of meteorological data, has been almost exclusively confined to that portion of the surface of the globe which is occupied by land, although the portion covered by the ocean is not only much greater in extent, but is also better suited for the solution of several meteorological problems. Many striking examples might be adduced to show that it is "systematic direction," and not "individual zeal" in naval men, which has been wanting, and it has been therefore with great satisfaction that meteorologists have learnt that a proposition has recently been made from the United States Government to the British Government, to undertake, conjointly and in cooperation, a system of meteorological observations, to be made at sea in all ships belonging to the naval service of the two countries, and sufficiently simple to be participated in by the merchant service also. In a partial trial which has been already made of this system in the United States, it has been found to produce results which, exclusive of their scientific bearing, are of great importance to the interests of navigation and commerce, in materially shortening passages by the knowledge of prevailing winds and currents at particular seasons. The practical advantages arising from the coordination of the observations in the Hydrographic Office of the United States, and of the circulation of the charts of the winds and currents, and of the sailing directions founded on them, have been such and so appreciated, that there are now, as it is stated, more than 1000 masters of American ships engaged in making them. The request for British cooperation in an undertaking so honourable to the country in which it originated, was referred in the spring of this year by the Earl of Malmesbury to the President and Council of the Royal Society for a Report; from which I permit myself to quote the concluding sentence, in the persuasion that it would find an echo, if necessary, in every part of the United Kingdom, and that it cannot fail to be promptly acted upon by the Government of a country in which maritime interests hold so prominent a place:—"To the Government of this country the demand for cooperation and for the interchange of observations is most earnestly addressed by the Government of the United States; and the President and Council of the Royal Society express their hope that it will not be addressed in vain. We possess in our ships of war, in our packet service, and in our vast commercial navy, better means for making such observations, and a greater interest in the results to which they lead, than any other nation; for this purpose every ship which is under the control of the Admiralty, should be furnished with instruments properly constructed and compared, and with instructions for using them; similar instructions for making and recording observations, as far as their means will allow, should be given to every ship that sails, with a request that they will transmit the results to the Hydrographer's Office of the Admiralty, where an adequate staff of Officers or others should be provided for their prompt examination, and the publication of the improved charts and sailing directions to which they would lead; above all, it seems desirable to establish a prompt communication with the Hydrographer's Office of the United States, so that the united labours of the two greatest naval and commercial nations of the world may be combined, with the least practicable delay, in promoting the interests of navigation."

Amongst the most valuable results which the Physical Sciences may expect to obtain from this extensive system of nautical observation, we may reckon the construction of charts of the isothermals of the surface of the ocean corresponding to every month in the year, similar to Dove's monthly isothermals of the temperature of the air; and a knowledge of the normal condition as well as the abnormal variations, with their special causes and effects, of the great Gulf-stream which connects the shores of the Old and New World, and in its normal effects is influential in many ways on the climate of the United States and Western Europe, whilst its abnormal effects are principally known, so far as we are yet aware, by the peculiarities of climate they occasionally produce on the European side of the Atlantic. Of the extent, depth, and limits of this remarkable current in ordinary and extraordinary years we are as yet very imperfectly informed. Of the zoology of the great tracts of ocean which are covered by its banks of seaweed, we know nothing beyond the fact that they are the habitation of a countless number of oceanic animals,— giving rise possibly to deposits which may have distinctive characters from littoral deposits or from those of marine estuaries. But doubtless, we can now estimate only a very small part of the advantages which Terrestrial Physics as well as Hydrography and Navigation would derive from the concurrent exertions of the two great maritime nations in the way that has been pointed out.

The analogy of the configuration of the land and sea on the north of the continents of Asia and America, has for some time past caused an opinion to be entertained that the sea on the north of the Parry Islands might be as open as it is known to be throughout the year in the same latitude on the north of the Siberian Islands. The expectation that Wellington Strait might, as the continuation of Barrow's Strait, prove a channel of communication from the Atlantic into that part of the Polar Ocean, has been considerably strengthened in the last year by the discoveries which we owe to the hardihood and intrepidity of our merchant seamen. The access to the Polar Ocean, and the degree in which it may be navigable for purposes of discovery or of scientific research, are amongst the few geographical problems of high interest which remain to be solved; and we may confidently look for a solution, in the direction at least that has been adverted to, by the Expedition which has been despatched under Sir Edward Belcher to follow up the discovered traces of Sir John Franklin's vessels.

The success which the Kew Observatory Committee have had in their undertaking to make Standard Thermometers, encourages us to hope that they will be equally successful in the endeavour in which they are now engaged to introduce a greater degree of precision in the construction of meteorological instruments generally, as well as in the more delicate kinds which are so frequently required in physical experiments. An establishment has long been a desideratum in which instruments for various physical researches employed in foreign countries should be tried in comparison with the instruments used here, and the relative merits of each examined, and in which new and promising inventions and suggestions should receive a practical trial. Amongst its other services rendered to Science and to the country, the British Association is now entitled to claim the merit of having organized an establishment which appears extremely well-suited to supply this deficiency, and needs only more extensive means to supply it to any required extent. The applications which have been made to Kew in the past year by Profs. Forbes and Thomson for thermometers of particular kinds, required in very delicate experiments in which those gentlemen are engaged, and by the Admiralty for Standard Thermometers for very low temperatures to be employed by the Arctic Expeditions, show that the advantages to be derived from such an establishment are already beginning to be recognised; and as these become more known and felt, it may confidently be anticipated that means will not be wanting for such an extension of the establishment at Kew, as may be necessary to meet fully the public requirements. The desire which is so frequently manifested by voyagers and travellers in distant countries to contribute to our knowledge of terrestrial physics, would be greatly aided by increased facilities afforded to them of obtaining suitable and well-assured instruments, and still more if practical instruction or advice could be added. It is not from deficiency of interest, or of a desire to be useful in such inquiries, that our British travellers do not reap the full advantages of the great opportunities which they possess, so much as from the absence of any provision for supplying instruments on which reliance can be placed with practical instructions for their use. In no department is the "systematic direction," which it is the object of the British Association to communicate to the sciences generally, more needed than in Physical Geography. To carry this desirable purpose into effect, might with great propriety and public benefit be made to form a branch of the duties of the Kew Observatory.

In compliance with a resolution of the Council, the Kew Committee have made arrangements for four aëronautic ascents in the Nassau Balloon, chiefly for the purpose of investigating the laws of the decrement of temperature and of aqueous vapour in ascending into the atmosphere. The two first of these ascents took place on the 17th and 26th of August, attaining in each case between 19,000 and 20,000 feet, and will be the subject of a communication to the Association, which will doubtless excite much interest, from Mr. Welsh of the Kew Observatory, who was charged by the Superintending Committee with the conduct of the observations.

The opportunity which the Observatory furnishes to the Association, of a convenient locality, presenting many facilities for carrying on a series of delicate experiments, has been taken advantage of by Professor Stokes for experiments in which he is engaged on the *Index of Friction in different*

Gases. Experiments reported by myself to the Royal Society in 1829, showed that the retardation of a pendulum vibrating in different gases was not proportionate to their respective densities, but appeared to depend also on some inherent quality, whereby the different gases present different degrees of resistance to the motion of bodies passing through them. I was interrupted in the prosecution of this subject by a recall to military duty, and I now rejoice to see it in hands so far more able to do it justice.

The Parliamentary Committee appointed at the Ipswich meeting to watch over the interests of Science, consisting of Members of the British Association who are also Members of the Legislature, have this morning made their first Report to the General Committee, and some notice of the subjects which have chiefly occupied them in the past year may not be unacceptable to the Members of the Association at large. One of these subjects is that of Scientific Pensions. It is known to all that since the commencement of the reign of Her present Majesty pensions to the amount of £1200 have been at the disposal of the First Minister of the Crown, to be granted each year in recompense of civil services, chiefly, though not exclusively, in literature and science, and that several persons of various degrees of literary and scientific eminence have received pensions accordingly, many of which have given much public satisfaction. On examining the appropriations which have been made in the fourteen years since this fund became available, it appeared that only about thirteen per cent., or an eighth part of the whole amount, had been allotted to *scientific* pensions. Considering this to be a proper subject to be brought under the notice of Government, Lord Wrottesley, the Chairman, and Sir R. H. Inglis, one of the Members of the Committee, obtained an interview with the Earl of Derby for that purpose. The readiness of Government to attend to such representations has been fully shown in the scientific pensions granted in the present year, amounting to nearly a third of the whole sum available for the year. These pensions have been granted, on the recommendation of the President of the Royal Society,—to Mr. Hind, who has the unique distinction of being the discoverer of no less than six out of the twenty-five known planets of the solar system,—to Dr. Mantell, so well known for his successful researches in palæontology,—and to Mr. Ronalds, for the electrical and kindred researches in which he has been engaged for so many years. The intimate association of the scientific services of Mr. Ronalds for several years past with the Observatory of the British Association at Kew, must render this last selection peculiarly gratifying to our Members.

Another subject which has occupied the attention of the Parliamentary Committee in the last year, is one to which their attention was requested by the Council of the Association, with a view of carrying into effect the desire of the General Committee for a more cheap and rapid international communication of scientific publications. The credit of the first move towards the accomplishment of this desirable object is due to the Government of the

United States, by whom an arrangement was made for the admission duty free of all scientific books addressed as presents from foreign countries to all institutions and individuals cultivating science in that country, such books being sent through the Smithsonian Institution, by whom their further distribution to their respective destinations was undertaken. This arrangement was notified to our Government through the British Minister at Washington, and a similar privilege was at the same time requested for the admission duty free into England of books sent as presents from the United States to public institutions and individuals cultivating science in this country, under such regulations as might appear most fitting. This proposition gave rise to communications between the President of the Royal Society and the Chairman of the Parliamentary Committee on the one part, and the Treasury and the principal Commissioner of Customs on the other; the result of which has been the concession of the privilege of admission, duty free, into England of scientific books from all countries, designed as presents to institutions and individuals named in lists to be prepared from time to time by the Royal Society, after communication with other scientific societies recognized by charter, under the regulation, however, that the books are to be imported in cases addressed to and passing through the Royal Society. This arrangement has come into operation; and it may be interesting to notice, as giving some idea of its extensive bearing, that the first arrival from the United States which has taken place under these regulations consists of packages weighing in all no less than three tons. There is another branch of the same subject which is more difficult to arrange, viz. the international communication *by post* of scientific pamphlets and papers at reduced rates of postage; the Parliamentary Committee have directed their attention to this part of the subject also, and I earnestly hope that their exertions will be successful.

Allusions have been made by influential men, and in influential places, to a direct representation of Science in Parliament; and we frequently hear opinions expressed that Parliament might be improved by a greater admixture of men who might be chosen as the representatives of the intellectual cultivation of the nation, amongst those who represent its material interests. The benefit which the Legislature might derive from a change of this description, is a question rather for statesmen than for men of science, and would be quite unsuitable for discussion here: but in respect to the influence which such change would exercise on Science itself and on its cultivators, it does belong to us to consider both its probable advantages and disadvantages. I have no hesitation in expressing as an individual opinion, my belief that the possible gain would be incalculably outweighed by the too certain evils; and that scientific men cannot too highly value and desire to retain the advantage they now possess in the undisturbed enjoyment of their own pursuits untroubled by the excitements and distractions of political life. Some there are amongst us, and some there ever have been, who, born to a station which brings with it public duties, but gifted with a strong natural taste for the pursuits of science, do manage to succeed in a greater or less degree in combining both. Success is in such cases the more honourable, and is the more admired, because it manifests the strength of the original disposition, and indicates how much more might probably have been accomplished by an undivided attention. The economy of human labour points specially to such men as the most suitable representatives of science in the legislature of which they already form a part. The selection from amongst them of a certain number to be particularly charged with the duties of watching over and promoting the interests of science, either with Government or in the Legislature appears in this view a most happy expedient. We cannot read over the names of the noblemen and gentlemen who form the Parliamentary Committee of the British Association, without being satisfied that science would not be likely to be more honourably or more ably represented by any system of direct representation; nor can we look to the discretion and practical wisdom with which the proceedings of the Committee have been conducted in the first year of its existence, without being impressed with the belief that it is destined to render important services both to the country and to ourselves.

Gentlemen, I have now occupied fully as much of your time and attention as I can venture to trespass upon, and yet have found it impossible to comprehend within the limits of a discourse all the topics to which I would gladly have called your notice, even in those branches of knowledge in which I may consider myself least uninformed, in three of the seven departments into which our science is divided. I have left wholly untouched those wide fields of Geology and Natural History, which would of themselves have furnished fitting subjects for an address of still longer duration. No one can be more sensible of this, and of many other imperfections and deficiencies, than the individual who addresses you; yet, if he has not wholly failed in the purpose he designed—if the impression which he has endeavoured to convey, however faint may be the image, be true to that which it is intended to represent,—you have not failed to recognise the gratifying picture of British Science in the full career of energetic action and advancement, pressing forward in every direction to fill the full measure of the sphere of its activity in the domain of intellectual culture; regardful on the one hand of the minutest details in the patient examination of natural facts, and on the other hand diligent in combining them into generalizations of the highest order, by the aid of those principles of inductive philosophy, which are the surest guide of the human intellect to the comprehension of the laws and order of the material universe.

REPORTS

ON

THE STATE OF SCIENCE

Third Report on the Facts of Earthquake Phænomena.
By Robert Mallet, *C.E., M.R.I.A.*

ERRATA IN MR. MALLET'S SECOND REPORT ON EARTHQUAKES.

Since the printing of the preceding Report the following errata have been discovered:—

In page 288, line 5 from bottom, *for* $0''{\cdot}014206$ *read* $0''{\cdot}014286$.
—— 289, line 14, *for* $0''{\cdot}013910$ *read* $0''{\cdot}013903$.
—— — line 30, *for* $0''{\cdot}41743$ *read* $0''{\cdot}41726$.
—— — line 31, *for* $0''{\cdot}013914$ *read* $0''{\cdot}013909$.

[The preceding corrections apply also to the table of chronograph ratings at foot of p. 289.]

In page 290, line 2, *for* $0''{\cdot}013914$ *read* $0''{\cdot}013909$.
—— — —— — *for* $0''{\cdot}006956$ *read* $0''{\cdot}006954$.
—— 293, line 1, *for* ratio *read* rate.
—— 298, line 33, *for* 307·05 *read* 307·50.
—— 299, line 12, *for* 9·607 *read* 9·609.
—— 306, line 13, supply a comma after the word "dial".
—— 306, line 4 from bottom, supply a comma after "dial".

These errors are all small, and affect the results within limits much less than those of the differences between one experiment and another. A single arithmetical mistake remains however to be noticed, which alters considerably the constant of wave transit *in sand* as deduced from the experiments; namely, that in page 292, line 3 from bottom, ·8 was read instead of ·3, at the beginning of the number representing the average of col. 4. The result of the subtraction should therefore be $3''{\cdot}411639$ instead of $2''{\cdot}911639$, and hence the gross rate of transit in sand =774·568 feet per second. Using this corrected number in the calculation (p. 307) of the distance lost in raising the wave in the seismoscope, and applying throughout the small corrections mentioned above, the true rates of transit are—

In Sand	824·915	feet per second.
In discontinuous Granite	1306·425	,,
In more solid Granite	1664·574	,,

which numbers should therefore be substituted for those given in pp. 307, 308.

This correction still further removes any probability of aërial commotion having at all interfered in the Killiney experiments: see pp. 303–305.

The Catalogue of Earthquakes contained in Mr. Mallet's Report will be continued in the next volume.

Catalogue of recorded Earthquakes from 1606 B.C. *to* A.D. 1850.

1. *Date.* BEFORE CHRIST.	2. *Locality.*	3. *Direction, duration, and number of shocks.*	4. *Phænomena connected with the sea.*	5. *Meteorological and other phænomena.*	6. *Authority.*
1606	Mount Sinai			Accompanied by thunder and lightning; on the occasion of the delivery of the law.	Exodus, xix. 18.
Between 1604 and 1586.	Arabia			Korah, Dathan, and Abiram swallowed up	Numbers, xvi. 31.
1566	Jericho			The walls of the city thrown down	Joshua, vi.
About 1450	Lacus Cimini, in central Italy.			A city swallowed up, and a lake produced in its place.	Sotion, quoted in Aristot. Op. ed. Sylburgi, vol. ii. sec. 6. p. 128; and Amm. Marcell. lib. xvii. c. 7. sec. 13.
About 900	Palestine			After Elijah had prayed for rain from heaven	1 Kings, xix. 11.
About 900	The Alban Lake, in Italy				Aurel. Victor, de orig. gent. Rom. c. 18; and Dion. Halic. lib. i. c. 71.
880, or betwⁿ this and 870.	Palestine				Amos, i. 1; and Zechariah, xiv. 5.
595	China				Du Halde, Déscription de la Chine, t. i. p. 326.
About 550, or between this and 530.	Lacedæmon			A portion of Mount Taygetus thrown down	Strabo, lib. viii. iii. p. 202; and Pliny, lib. ii. c. 79 (81).
486	The Island of Delos			Herodotus remarks that this was the first time, up to the period at which he wrote, that this island had experienced earthquake shocks. Others also speak of it as free from such calamities.	Herodotus, Erato, c. 98; and Strabo, lib. x. iv. p. 313.
469	Sparta				Palassou, Mém. pour servir à l'Hist. Natur. des Pyrénées, p. 379.
459	Roman territories			Accompanied, according to Livy, by other prodigies, as an ox speaking, &c.	Livy, lib. iii. c. 10.

1.	2.	3.	4.	5.	6.
432, or 431...	Roman territories	....	....	Houses were thrown down	Livy, lib. iv. c. 21.
431, or soon after.	Delos	....	....	....	Thucydides, lib. ii. c. 8.
426	Athens, Eubœa, Bœotia, and especially Orchomenos.	....	....	....	Thucydides, lib. iii. c. 87.
425	In Greece, especially in Eubœa, and Atalante.	....	Accompanied by great inundations of the sea.	....	Thucydides, lib. iii. c. 89; and Diodorus, lib. xii. c. 59.
424. In spring	In the Peloponnesus......	....	....	Shortly after an eclipse of the sun	Thucydides, lib. iv. c. 52.
377	Lisbon	....	....	....	Balbi, Essai politique sur la Royaume de Portugal, t. i. p. 102.
373	Peloponnesus, especially at Helike and Bura.	....	Great inundations of the sea, overwhelming Helike.	....	Strabo, lib. i. and viii.; and Pausanias, lib. vii.; Achaica, c. 24—25.
370	Lisbon	....	....	....	Balbi, t. i. p. 102.
364	Rome	....	....	A great chasm opened in the forum, which afterwards filled with water, forming the Lacus Curtius. *Probably* an earthquake.	Livy, lib. vii. c. 6; and Pliny, Hist. Nat. lib. xv. c. 18 (20).
Before 323 ...	Island of Chryse, near Lemnos.	....	....	The island was sunk into the sea	Ukert upon Lemnos and Mosychlos in the allgem. geograph. Ephem. for Dec. 1812.
285, or 284...	In the provinces Oomi and Sourouga of the Japanese island Niphon.	....	....	In the province of Oomi a large tract of land sank in one night, forming a lake $72\frac{1}{2}$ miles long and $12\frac{1}{4}$ wide. In Sourouga volcanic eruptions, and the mountain Fousi-no-Yama, still an active volcano, was thrown up.	Kämpfer, (v. Dohm.) Japan, vol. i. p. 190; v. Humboldt, Frag. de Géogr. Asiat. vol. i. p. 223.
282	Delphi	....	....	A portion of a hill thrown down; the earthquake followed by a violent storm of hail.	Justinus, lib. xxiv. c. 8.
About the same time.	Country about the Chersonesus and Hellespont.	....	....	The city Lysimachia destroyed	Justinus, lib. xvii.; at the beginning.
276, or perhaps 271.	Probably near Picentia in the south of Campania.	....	....	Accompanied "horrendo fragore"	Orosius, lib. iv. c. 4.
224	Caria, and the island of Rhodes.	....	....	The colossus of Rhodes thrown down. Eusebius (ii. p. 235 and 247) mentions this occurrence in the 168th Olympiad = 105 B.C.	v. Hoff, Chronik, vol. iv. p. 149. No authority quoted.
221	Central Italy	Fifty-seven shocks occurred during the year.	....	On the day of the battle with Hannibal at the Lake Thrasymene. Many cities were destroyed, rivers turned from their course, and hills thrown down.	Livy, lib. v. c. 6; Pliny, lib. ii. c. 86.

time, or very soon after.				A hundred towns destroyed	Augustinus de Mirabilibus, lib. ii.
218	"In vico Istrico (or Insteio)."			No shock mentioned. The water of a well burst forth in an extraordinary manner.	Livy, lib. xxiv. c. 10.
197	Rome, or the country round.				Livy, lib. xxxiv. c. 55.
197, or 196	Italy			Shocks continuing for thirty-eight days	Livy, lib. xxxv. c. 40.
About the same time.	Rhodes, and parts of Asia Minor.			Many towns ruined	Justinus, lib. xxx. c. 4.
184, or 183	Rome			The public statues of the gods were moved	Livy, lib. xli. c. 59.
177, or 178	Country of the Sabines			Many buildings thrown down	Livy, lib. xli. c. 28.
175	China				Edinburgh Encyclopædia, Article Chronology.
140	China	Three earthquakes in this year.			Kämpfer, Japan, vol. i. p. 193.
138	Luna, near Carrara			Perhaps only a landslip	Julius Obsequens.
123—122	Privernum, in Latium			Seven acres of land sank into the earth. Perhaps not an earthquake.	Julius Obsequens.
122—121	Probably at Rome: place not mentioned.			Accompanied by subterranean noise	Julius Obsequens.
104—103	In the territory of Picenum.			Ditto	Julius Obsequens.
103—102	Nursia			Buildings thrown down; accompanied by subterranean noise.	Julius Obsequens.
101—100	Pesaro			Accompanied by noise; buildings thrown down	Julius Obsequens.
99—98	Venafrum			No shock mentioned; the earth opened and sank down.	Julius Obsequens.
96—95	Fesulæ			No shock, but subterranean noise (fremitus)	Julius Obsequens.
95—94	Rhegium			Buildings injured	Julius Obsequens.
92	Syria, and the Island of Cyprus.				v. Hoff, vol. ii. p. 137; without quoting authority.
85, or 82	Province of Oomi in Niphon, Japan.			An island (now called Tsikou-bo-sima) was raised in the lake produced in the year 285 B.C.	v. Humboldt, Frag. de Géogr. Asiat. t. i. p. 223.
80—79	Reate, in the country of the Sabines.			Great damage done to buildings, bridges, &c.; attended by subterranean noise.	Julius Obsequens.
67—66	Spoleto				Julius Obsequens.
57	China			Mountains fell in many places and filled the valleys.	Du Halde, Déscription de la Chine, t. i. p. 356.
41	China				Edinburgh Encyclopædia, Article Chronology.

1.	2.	3.	4.	5.	6.
33, or 32	Palestine			30,000 men lost their lives	Josephus de bello Jud. lib. i. c. 14; and Antiqu. lib. xv. c. 6.
31, or 30	Tralles, in Lydia (and, according to the Collection Académique, many cities also in Ionia, Mysia and Ætolia).				Eusebius, p. ii. p. 257. (Not found in the Greek text.)
About the same time, or shortly before or after.	Thebes, in Upper Egypt				Eusebius. Like the last, only found in the Armenian and Latin translations.
26	Cyprus				Eusebius, p. 259. Not in the Greek.
21	The villa of Livia, the consort of Augustus, at the foot of the Apennines.				Julius Obsequens.
10, or according to others 6	Cos, in the Archipelago				Eusebius, p. 261. Not in the Greek.
ANNO DOMINI.					
11 or 12	Tralles, in Lydia				Münster's Cosmogr. lib. v.
15	Rome			Produced great destruction	Calvisius.
17	Asia Minor	Two shocks on the same day.		Thirteen cities of note destroyed	Tacitus, Annal. lib. ii. c. 47; Eusebius, p. 263.
33	Bithynia and Palestine			At the crucifixion. The city of Nisæa was destroyed.	Matthew, xxvii; Luke, xxiii.; Eusebius, p. 265.
34	Sicily				v. Hoff, vol. ii. p. 227; without quoting authority.
52	Philippi, in Macedonia				Acts, xvi.
58, or 60	The cities of Laodicea, Hierapolis, and Colosse in Phrygia.				Eusebius, p. 272. Only in the Armenian and Latin.
62	Achaia and Macedonia				Seneca, Natural. Quæst. lib. vi. c. 1.
63. Feb. 5	Pompeii, Herculaneum, Colonia Nucerinorum, and Naples.				Tacitus, Hist. lib. xv. c. 22; Seneca, Nat. Qu. lib. i. c. 1 and 27.
67, or 68	Ager Marrucinus near the Adriatic sea, on the Aternus.			No shock recorded. A meadow and field planted with olives moved from one place to another; perhaps only a landslip.	Pliny, Hist. Nat. lib. ii. c. 83 (85).
77, or 78	Island of Cyprus			Three cities overwhelmed	Eusebius, p. 277; Orosius, lib. vii. c. 9.

	try round.		The sea receded from the coast.	The houses trembled, followed the day after by the eruption of Vesuvius, in which Herculaneum and Pompeii were destroyed.	Pliny the younger, Epist. 6, 16–20.
105, or 106...	Asia Minor, and parts of Greece.	......	......	......	Eusebius, p. 281. Only in the Armenian and Latin; Orosius, lib. vii. c. 12.
109, or 110...	Galatia......	......	......	Three cities destroyed	Eusebius, p. 283; Orosius, lib. vii. c. 12.
115	China	......	......	From 107 to 115 several earthquakes took place in China, of which this was the most violent.	Du Halde, i. 365.
115, or 117...	Antiochia......	......	......	Violent winds and thunder preceded the earthquake.	Eusebius, p. 283. Not in the Greek. Calvisius.
121, or 122...	Nicomedia and Nicæa in Bithynia.	......	......	......	Eusebius, p. 283. Not in the Greek.
127, or 128...	Nicopolis and Neocæsarea in Pontus, and Hierapolis, Laodicea, and Nicomedia; also at Syracuse.	The earthquake was experienced twice at Syracuse.	......	......	Eusebius, p. 285.
131	Sicily	......	......	......	v. Hoff, vol. ii. p. 227. Authority not quoted.
150, or shortly before.	Caria, Lycia, and the island of Rhodes.	......	......	......	Calvisius refers to Pausanias in Arcad.
160	Smyrna	......	......	......	v. Hoff, vol. ii. p. 146.
169	Parts of Germany	......	......	......	Bernhertz, p. 51.
176, or 177...	Smyrna	......	......	......	Eusebius, p. 293.
223. (On the 9th and 17th December, according to Calvisius).	Rome	Violent shocks for three days.	......	Accompanied by an eclipse	Calvisius quotes Fasti Sic.
262	Rome, Libya, and Asia Minor.	Violent shocks......	Many cities inundated by the sea	Attended by an eclipse. The earth opened in many places and salt water gushed out: dreadful subterranean noises heard.	Trebellius Pollio in Gallien. ii. c. 5. Calvisius.
272	Japan	Many shocks at various periods from 200.	......	......	Kämpfer (v. Dohm), i. p. 197.
Between 287 and 307.	Syria	......	......	Tyre and Sidon greatly injured......	Orosius, lib. vii. c. 25.
306	Opus, in Greece	......	......	......	v. Hoff, vol. ii. p. 174.
315	Areopolis, on the Dead Sea.	......	......	......	K. Ritter's Erdbeschreibung, vol. ii. p. 339.

1.	2.	3.	4.	5.	6.
322	Place not mentioned				Anastasi, Bibl. Hist. p. 25.
325	Campania			Twelve towns destroyed	Sigonius, Hist. de Occid. Imp. t. i. lib. iii. p. 122.
336	Rome				Baglivi, p. 542.
340	All through the East	Very many and violent shocks.		The shocks began this year and were continued the next.	Lycosthenes; Baronius, t. iii. p. 536.
341	Ditto, especially at Antioch.	Ditto			Calvisius. Socrates, lib. ii. c. 10.
342	Throughout the East			Many cities overturned	Chron. Eusebii, lib. post. p. 182.
343	Ditto				Lycosthenes and Frytschius.
——	Neocæsarea			The city ruined	Sigonius, i. lib. v. p. 169; Frytschius.
344	Island of Rhodes, Dyrrachium, and twelve towns in Campania; and at Rome.	Lasted three days at Rome.		The dates for the three or four years immediately preceding appear to be very uncertain, several authors differing in them slightly.	Sigonius, *loc. cit.* p. 170; Cedrenus.
348. In summer.	Berytus in Syria				Sigonius, *loc. cit.* p. 178; Agathias de reb. Just. p. 51.
358. Aug. 24	Asia Minor, Bithynia, and Macedonia.				Sigonius, p. 204; Muratori, Annali, t. ii. p. 392.
359. Nov. or Dec. (mense Hyperberetæo).	Nicomedia in Bithynia				Chronicon Paschale, p. 293; Eusebius, p. 185.
362. Dec. 2. Towards evening.	Nicomedia and Nicæa				Sigonius, p. 227; Baronius, t. iv. p. 117.
363. Jan. or Feb.	Constantinople				Sigonius, p. 228.
365. July 21	Greece and Asia Minor; also Crete.		The sea retired, and then flowed in again with violence, doing great damage.	Accompanied by thunder and lightning	Baronius, p. 187; Sigonius, p. 236; Calvisius.
366	Neocæsarea and Nicæa.	Many shocks			Frytschius.
368. Oct. 11	Nicæa				Chronicon Paschale, p. 301; Sigonius, p. 249; Calvisius.
368. A little after 11th October.	The Hellespont				Baronius, t. iv. p. 211.

372	Nicæa			This date is by no means well fixed, authors varying from 367 to 379.	Evagrius; Baglivi.
382	Constantinople and Rome.				Marcellinus Comes, p. 37.
394. From Sept. to Nov.	Throughout Europe				Sigonius, p. 345; Baronius, p. 706.
395. Sept. to Ján. following.	Ditto				Sigonius, p. 355.
396	Principally at Constantinople.	Violent shocks for several days.		Marcellinus Comes mentions, as occurring at the same time, an appearance in the heavens as if they were on fire (probably an aurora—Perrey).	Baronius, t. v. p. 178.
403. During the night.	Constantinople				Chronicon Paschale, p. 308.
407. April 1 (mense Xanthico), beginning of the night.	Place not mentioned; probably Constantinople.			Attended with thunder	
408	Rome			Subterranean noises heard for seven days	Sigonius, p. 393; Marcellinus Comes.
——	Utica			Ditto. Perhaps confounded with the last	Prosperi Tyronis Chron.; Dom Bouquet, t. i. p. 637.
417. April 20	Probably Constantinople; also Kybera in Asia Minor.				Chron. Pasch. p. 310; Marcellinus Comes.
419	Palestine			Many towns and villages destroyed	Marcellinus Comes, p. 38.
422	Constantinople?			In the same year a comet appeared	Chronicon Paschale, p. 343.
423. April 7; 10 o'clock A.M. or P.M.?	Constantinople?	Many shocks			Ditto.
——	"In multis locis"				Marcellinus Comes.
427	Constantinople			Fifty-seven towers thrown down; v. Hoff places this earthquake in the year 447.	Marcellinus Comes, p. 41.
431. June 20; 4th hour of the night.	Place not mentioned				Baronius, p. 628.
434	Constantinople			Violent shocks lasting for four months	Anciennes Révolutions du Globe.
442. In winter	Rome			Buildings thrown down	Baronius, t. vi. p. 12.
444	Constantinople			Shocks lasting for four months	Hist. Rerum Germanicarum, Schard. f. 70.
446	Throughout most of the civilized world.			Lasting six months	Baronius, t. vi. p. 37; Christ. Math. Theat. Hist. p. 377.

1.	2.	3.	4.	5.	6.
447. Nov. 8...	Constantinople; also felt in Thrace, the Chersonesus, the Troad, Bithynia, Phrygia, and the Hellespont.	....	....	Violent shocks; probably included in the last...	Chronicon Paschale, p. 317.
448	Gallicia in Spain........	....	....	....	Idatius, Chronicon.
450. Jan. ...	Constantinople	....	....	Violent shocks. Lycosthenes gives the date 454	Chron. Pasch. pp. 318, 319; Christ. Math. Theat. Hist. p. 378.
455. July 10 (O.S.).	Sabaria (Sarwar) in Pannonia.	....	....	....	Sigonius, lib. xiv. p. 516.
——	Gallicia in Spain........	....	....	....	Idatius, Chronicon.
458. Sept. 11; 4th hour of the night.	Antioch; also felt throughout Asia Minor, and in Thrace.	....	....	Others give the dates 450, 460 and 462	Baronius, t. vi. p. 244; Idatius.
460, or 464...	Cyzicus in Mysia........	....	....	....	Marcellinus Comes.
465, or 468... March 27...	Vienne in Dauphiny ...	....	....	Several other dates given for this occurrence ...	Sidonius Apollinaris, lib. vii. Ep. i. ad Mamertum; Gregorius Turonensis, &c.
467	Ravenna	....	....	....	Sigonius, *loc. cit.* p. 538.
471, or 472...	In Asia Minor........	....	....	Several cities overwhelmed	Marcellinus Comes.
477, or 478... Sept. 25 ...	Constantinople; also at the Hellespont, the Cyclades, Cos, and Cnidos.	The shocks lasted for four days.	....	....	Marcellinus Comes, Cedrenus, Evagrios, lib. ii. c. 14.
—— Sept. 23	Rome	....	....	....	Baglivi, *loc. cit.*
480, or 81. Nov.	Place not mentioned ...	....	....	....	Gregor. Turon. lib. ii. cc. 19, 20.
487. Sept. 26	Constantinople; extended as far as Taurus.	Lasted but a short time.	....	....	Chronicon Paschale, p. 327.
492. June 7	Place not mentioned ...	....	....	....	Sigonius, p. 579.
494	Syria and Asia Minor; especially at Laodicea, Hierapolis, Tripolis, and Agathicum.	....	....	The cities mentioned were overwhelmed........	Marcellinus Comes, p. 46.
499	Neocæsarea, and the rest of Pontus.	....	....	This date is very uncertain, others giving various years up to 506.	Baronius, t. vi. p. 541.
518	Hungary ("in provincia Dardania.")	....	....	The earth opened in many places to the extent of twelve feet in width, from some of which boiling water came forth. Great damage done to buildings, &c.	Marcellinus Comes, p. 50; Baronius, t. vi. p. 702.

524, or 525...	Anazarbus in Cilicia ...	....	....	....	Cedrenus, p. 365.
525. May 29, noon.	Antioch; also felt at Constantinople.	....	....	Accompanied by unusual heat. The shocks continued at intervals for a whole year, and appear to have recurred with violence on the 4th October. The date of the year, however, is very uncertain.	Cedrenus, p. 365; Sigonius, *loc. cit.* p. 629; Evagrius, &c.
528. Nov. 29, 3rd hour of the day.	Antioch	Many violent shocks; lasting one hour.	....	All the buildings which had been reconstructed after the former earthquake, were thrown down.	Cedrenus, p. 368; Sigonius, p. 634, &c.
533. Nov. In the evening.	Constantinople	....	....	....	Chronicon Paschale, p. 341.
536	Pompeiopolis in Mysia	....	....	....	Theoph. p. 183; Anastasius, p. 62.
542. Aug. 16	Constantinople	....	....	....	Theophanes, p. 188.
543. Sept. 6...	Throughout the then known world.	....	....	Half of the city of Cyzicus destroyed	Cedrenus, p. 371. Theophanes gives the year after.
546	Constantinople	....	....	The Nile rose unusually high this year...........	Anastasius, p. 64; Procopius, Lycosthenes.
547	Byzantium and other localities.	Many shocks	....	....	Frytschius, Lycosthenes.
548. Especially in Feb.	Constantinople	....	....	Accompanied by great rain	Theophanes, p. 191; Cedrenus, p. 375, &c.
About 549 ...	Auvergne...........	....	....	....	Greg. Turon.; Dom. Bouquet, t. iii. p. 410.
550, or 551. July 7, or 9.	Palestine, Arabia, Mesopotamia, Syria and Phœnicia; also in Greece.	....	....	....	Theophanes, p. 192; Cedrenus, p. 376, &c.
552	Greece	....	....	Naupacte, Petra, Corona, &c., ruined	Procopius, quoted by Calvisius.
553, or 555. Aug. 15; at dawn.	Constantinople, and many other parts of the world, even extending to part of Egypt.	The shocks lasted forty days.	....	The city of Berytus was ruined...........	Cedrenus, p. 384; Baronius, t. vii. p. 474; Anastasius; Agathias.
554. July 11	Constantinople	....	....	....	Theophanes, p. 194; Cedrenus, p. 385.
556. April 2	Ditto	....	....	....	Theophanes, p. 195.
557. Oct. 6...	Ditto	Many shocks	....	....	Theophanes, pp. 195, 196; Cedrenus, p. 385; Baronius, &c.
—— Dec. 14	Ditto, and at Antioch and other cities; also at Rome.	Many shocks, continuing for ten days.	....	Attended by various meteorological phænomena, as lightning, thunder, shooting stars, &c.; also subterranean noise. Many shocks during the whole year.	Ditto.

1.	2.	3.	4.	5.	6.
558 (May 3, according to Pogg. Ann. t. lviii. p. 650).	Constantinople	Shocks still continuing			Cedrenus, p. 386.
560. Dec. (24 according to Pogg. Ann. quoted above).	Ditto			A conflagation and a pestilence in the same year.	Theophanes, p. 199; Cedrenus, p. 387, &c.
——	Berytus, and in the island of Cos.				Frytschius; Marmont, Voyage en Hongrie, t. ii. p. 259.
562, or 563...	A mountain on the banks of the Rhone; according to v. Hoff, the Dent du Midi in the Valais.			The mountain gave forth a subterranean noise like bellowing for some days, and then fell with houses, men, &c. upon it, into the stream below.	Matthew of Westminster, lib. i. p. 195; Gregor. Turon. lib. vi. c. 31; Frytschius, &c.
577	Chinon			The church trembled during the celebration of the service.	Dom. Bouquet, t. ii. p. 242.
579. At noon	Antioch and Daphne				Baronius, p. 626; Evagrius.
579, or 580...	Bordeaux and in the Pyrenees.			In the Pyrenees great stones were rolled down from the mountains.	Dom Bouquet, t. ii. pp. 252 and 409. t. iii. pp. 83 and 227.
582	Soissons and Angers			Subterranean commotions	Ditto, t. ii. p. 277. t. iii. pp. 88 and 234.
583	Constantinople?				Theophan. p. 213; Cedren. p. 394.
584 (Dec.?)...	Angers				Dom Bouquet, t. ii. p. 297. t. iii. p. 243.
586	Rome				Baglivi, p. 542.
587. Sept. 30, 3 hours after twilight.	Antioch				Baronius, p. 699; Ch. Mathias, p. 426.
589. Oct. 21 (31, at nine in the evening according to Evagrius).	Ditto				Mémorial de Chronologie, t. ii. p. 909; Evagrius, lib. vi. c. 8.
590. June 14, at dawn.	Place not mentioned; probably in France.				Dom Bouquet, t. ii. p. 379.
600	Japan. Extended throughout the whole empire.				Kämpfer, v. Dohm, vol. ii. p. 204.

611. April 20, at the 7th hour.	Constantinople?				Chronicon Paschale, p. 383.
615. August.	Throughout Italy			Followed by a dreadful pestilence. The date somewhat uncertain.	Sigonius, De Regno Italiæ, t. ii. p. 86; Beuther; Bernherz, &c.
631, or 632	Palestine and Arabia	The shocks lasted thirty days.		Date uncertain	Simon Schard, f. 89; Ch. Mathias, p. 440, &c.
639. About 3rd hour of night.	Antioch			Accompanied by a dreadful noise	Lycosthenes.
640	Arabia, particularly Medina and the neighbourhood.				K. Ritter, Erdkunde, vol. ii. p. 339.
650	Medina			Followed by apparently the breaking out of a small volcano.	Ditto.
658. June	Palestine and Syria			Great damage done	Theophanes, p. 288.
677	Constantinople				Collection Académique.
678, or 680	Mesopotamia				Theophanes, p. 296; Anastasius, p. 112; Centuriæ Magdeburgenses, t. ii. p. 312.
684, or 685	The Japanese province of Tosa, which is the south-western portion of the island Sikokf.			More than 500,000 acres of land sank into the sea.	Kämpfer, v. Dohm, vol. i. p. 207; v. Humboldt, Fragmens Asiatiques, t. i. p. 224.
Beginning of the 8th century.	Valley of Eghegik in the Caucasus.				Déscription d'Edchmiadsin par l'Évêque Chakhathouno, t. ii. p. 18 (in Armenian).
707?	Italy				Vite de' Duchi di Venezia, Muratori, t. xxii. p. 446.
713. Feb. 28	Syria				Theophanes, p. 320; Anastasius, p. 125.
717, or 718	Syria				Theophanes, p. 334; Anastasius, p. 132; Cedrenus, p. 452.
740. Oct. 26, 8th hour of the day.	Constantinople; also felt in Thrace, Asia Minor, &c.	The shocks continued at intervals for eleven months.	In some places the sea retired from the land.	Several cities ruined, and many lives lost	Cedrenus, p. 457; Theophanes, p. 345; Anastasius; Sigonius, &c.
742	Egypt and the desert of Saba in Arabia			Said to have been felt at 600 places. Portions of mountains thrown down.	Theophanes, p. 349; Cedrenus, p. 460; Baronius, p. 144.
743	Caspiæ portæ (now pass of Dariel), in the Caucasus.				Theophanes, p. 351; Cedrenus, p. 461; Anastasius, p. 140.

1.	2.	3.	4.	5.	6.
746. Jan. 18, 4th hour.	Syria and Palestine, especially round Jerusalem.	....	....	Great damage done, both to buildings and life...	Theophanes, p. 354; Cedrenus, p. 462; Anastasius, p. 143; Baronius, p. 184.
749 (Jan.?)...	Syria and Mesopotamia	....	....	Parts of the hills thrown down. A chasm opened in the earth of more than 1000 paces long. The date somewhat uncertain.	Theophanes, p. 357; Cedrenus, p. 463; Anastasius; Baronius, &c.
757. March 9.	Syria and Palestine......	....	....	....	Theophanes, p. 361; Anastasius, p. 146; Centuriæ Magdeburg. p. 491.
775	Antioch	....	....	....	v. Hoff, vol. ii. p. 173.
778	Italy, at Trevisa, &c. ...	....	....	Buildings thrown down; forty-eight people killed.	Dom Bouquet, t. v. p. 70.
786. In the latter months of the year.	Germany. Principally in Bavaria.	....	....	....	Beuther quotes Avent. Annal. lib. iii. in fine.
789. Feb. 9...	Constantinople	....	....	....	Theophanes, p. 392; Cedrenus, p. 471; Anastasius, p. 162, &c.
——	Rome	....	....	....	Baglivi, p. 542.
794	Alexandria in Egypt ...	....	....	The Pharos overturned	Hadschi Chalifa.
795, or 797. Apr. During the night.	Island of Crete	....	....	....	Theophanes, p. 397; Anastasius, p. 165.
—— May, 4	Constantinople. (Either this or the last also felt in Sicily, according to v. Hoff.)	....	....	....	Ditto.
801. Apr. 25, or 30; 2nd hour of the night (v. Hoff gives the date March 31, or April 30).	France, Germany, Italy, and on the Rhine.	....	....	Many buildings in Italy thrown down. Amongst others the basilica of St. Paul at Rome. It does not seem certain that the shocks happened on the same day or even month in Italy as in Germany, France, &c.	Dom Bouquet, pp. 24, 365; Collection de Duchêne; Simon Schard; Hondorf, Annal. Francorum, &c.
802. April 13	Throughout all Switzerland.	....	....	Followed by a terrible pestilence	Bertrand, Diarium Histor. p. 129; Mémorial de Chronol. t. ii. p. 910.
803. In winter	Aix-la-Chapelle	....	....	....	Dom Bouquet, t. v. pp. 54, 251, 321; Duchêne; Simon Schard; &c.
815. August	Thrace, especially at Constantinople.	Lasted five days	....	....	Sigonius, de Regno Italiæ, 2. lib. iv. p. 266; Martène et Durand, &c.
815. Sept. ...	Saintes........	Several shocks	....	....	Aimoini Chron. p. 240; Duchêne, t. ii. p. 260.

818	"In regione Transoxiana."	The shocks continued for seventy days.		Probably the same with the last	K. Ritter, Erdkunde, vol. ii. p. 880.
823. Towards the end of the year ...	Aix-la-Chapelle, and other parts of Germany, principally in Upper Saxony, and especially about the Arendsee.			Accompanied at Aix-la-Chapelle by subterranean noise. Falling stars also observed. At Arendsee and the country round the earth was greatly disturbed and upheaved, and the form of several lakes changed.	Dom Bouquet, t. vi. pp. 181, 208 and 225; Simon Schard, fol. 107; Vita et Gesta Caroli Magni, &c.
829. March (24?) (4 days before Easter) At night.	Aix-la-Chapelle				Dom Bouquet, t. v. pp. 110–233; Duchêne, t. ii. pp. 272 and 306; Baronius, t. ix. p. 489.
——	Switzerland			Followed by very violent winds	Bertrand, p. 29.
832	Some parts of Italy				Ragor quotes Frank. Beuther.
837. Dec. 30. At night.	Pavia	Eight shocks			Dom Bouquet, t. vi. pp. 206 and 226.
838. Feb. 18. In the evening.	"Apud S. Nazarium (now Lauresheim, territory of Mayence) in Wormanse, in Spirense, et Lobadunense."				Dom Bouquet, t. vi. p. 210.
840. August	Constantinople	Shocks during 5 days			Centuriæ Magdeburgenses, t. ii. p. 348.
—— Sept. ...	Saintes				Ditto.
841. June 2	Würzburg	More than twenty shocks.		Storms with lightning, &c.	Ragor quotes Funccius. Bernherz quotes Chronic. Antiq. Univ. Lycosthenes.
842. Oct. 24. 1st hour of the night.	Throughout almost all the north of Gaul.	The accompanying subterranean noise lasted seven days.		Attended with subterranean noise, which was heard either at the first hour of the day, or at the ninth, or in the middle of the night, or beginning of the morning. Followed by a very severe "tussis," of which many died.	Dom Bouquet, t. vii. pp. 32 and 41.
843. Sept. 6 and 7. At dawn and the middle of the night on the first day; at the first and second hours of the day on the second.	Ditto				Dom Bouquet, t. vii. p. 41.

1.	2.	3.	4.	5.	6.
844	Different parts of Italy	Many and violent shocks.			v. Hoff, vol. ii. p. 202.
847. June ...	Country between Rome and Beneventum.				Sigonius, p. 301; Baronius, t. x. p. 53; Christ. Mathias, p. 498, &c.
849. Feb. 17. 10th hour of the night.	Through Gaul; also at Auge (now Richenaw) near Constance, in Switzerland.				Dom Bouqnet, t. vii. pp. 65, 207, 235 and 272.
855. Jan. 1	Mayence; also at Worms	Twenty shocks		Accompanied by thunder, lightning, hail, &c.	Simon Schard, fol. 109; Dom Bouquet, t. vii. pp. 217 and 233; Duchêne, t. ii. p. 553.
—	Japan	Many violent shocks			Kämpfer, v. Dohm, vol. i. p. 213.
856. Dec. 13	Bâle			Chasms opened in many places in the mountains and rocks.	Martène et Durand, t. v. p. 271.
—	Persia, Khorassan, Syria, Arabia; and especially at Kumis, Rai, and Hamadan.			Accompanied by violent storms of wind	Hadschi Chalifa; El Makin, p. 150; D'Herbelot, Bibl. Orient.
858. Jan. 1	Many countries and towns, but especially at Mayence.	Many violent shocks			Dom Bouquet, t. vii. p. 166; Duchêne, t. ii. p. 554.
— Dec. 25	Ditto	Many and violent shocks by night and day.			Dom Bouquet, t. vii. p. 73.
— (About winter?)	Constantinople	Violent shocks			Cedrenus, p. 552.
—	Switzerland				Bertrand, p. 29.
859	Mayence	Many shocks		Followed, the next year, by a very severe winter. This earthquake is probably confounded with the one in 858.	Dom Bouquet, t. vii. p. 234.
—	Antioch, Laodicea, and other towns of Syria.			More than 1500 houses thrown down at Antioch. A part of the mountain Askræos near Laodicea fell into the sea. Possibly the same as the one mentioned by Cedrenus in the year before.	Hadschi Chalifa; Abulfaradsch, p. 166; El Makin, p. 190.
860	Persia, Syria, and many countries of Europe.	Many shocks		A considerable upturning of the earth took place in Holland. One of the mouths of the Rhine was closed.	Collection Académique.
861. Aug. ...	Constantinople	Shocks lasting for forty days.			Baronius, t. x. p. 198.

[illegible] May 25	Constantinople, and in the province of Bagdad.			Other authors give the dates 855 and 860	El Makin; Purchas; Chr. Mathias; Zonaras, p. 162; Baronius, p. 213.
863	Neighbourhood of Erivan.	Very violent		Did immense damage to buildings and life	Mkhitor d'Ani, Chakathouno, *loc. cit.*
867. Jan. 9	Constantinople	Shocks for forty days and forty nights.			Leonis, Grammat. Chronog. p. 470; Georgii Mon. novi Imper. p. 544.
—— Oct. 9	"Per plurima loca"				Dom Bouquet, t. vii. pp. 173, 208, 235 and 275.
——	Switzerland				Bertrand, p. 30; Scheuchzer.
867	Neighbourhood of Mecca.			All the wells stopped flowing	Mémorial de Chronologie, t. ii. p. 910.
870. Dec. 3, 1st hour.	Mayence				Dom Bouquet, t. vii. pp. 176 and 236.
872. Dec. 3, 1st hour.	Ditto			Most probably confounded with the last-mentioned earthquake.	Ditto. Lerner's Chronik von Frankfurt, &c.
880. Jan. 1	Ditto			Accompanied by an eclipse of the sun	Ragor, Beuther, &c.
881. Dec. 30. Before the crowing of the cock.	Ditto	Very violent			Dom Bouquet, t. viii. pp. 41 and 246; Collection Académique, Cent. Magdeb., &c.
885	Ditto			The church of St. Alban was overthrown. Probably confounded with one of the other earthquakes at the same place.	Münzenus in Chronographia; Cent. Mag.
887	Egypt	Very violent		Abulfaradsch mentions an earthquake in 883 probably the same with this.	El Makin.
893	India			The capital (the name of this city is not given) was destroyed, and 180,000 men perished. Preceded by an eclipse of the sun, and followed by great storms. The same year white and black meteoric stones fell, accompanied by thunder and lightning.	Abulfaradsch, p. 178–80; El Makin.
894	Environs of Erivan; town of Doun.			20,000 persons lost their lives	Chakathouno; Michael Tchomtchian.
895. During the council of Tibue or Tuver, which began on the 22nd August, or a little later.	In many regions of the Western Franks.				Dom Bouquet, t. viii. p. 56.

1.	2.	3.	4.	5.	6.
896	Rome			The basilica of the Lateran thrown down	Sigonius, p. 367.
898. Jan. 9	At Sens? "Circa cænobium S. Columbæ Virginis."				Dom Bouquet, t. viii. p. 322, and t. ix. p. 16.
——	Rai and Thabarestan				Hadschi Chalifa.
911	Rome				Collection Académique, Baglivi, *loc. cit.*
922	"In pago Cameracensi" (Cambrésis).			Many buildings thrown down	Dom Bouquet, t. viii. p. 179; Duchêne, t. ii. p. 592.
929, or 930	Thrace			The earth opened	Leon. Grammatici Chronol. p. 502; Hist. Byzantinæ, Combefisius, pp. 256, 486 and 582.
931	Japan	Very violent			Kämpfer, v. Dohm, vol. i. p. 215.
935. Jan.	Monastery of S. Colomba. At Sens?				Centuriæ Magdeburgenses.
938	Japan				Kämpfer, v. Dohm, *loc. cit.*
944. Apr. 16. "Circa pullorum cantum."	Switzerland. (Other authors do not mention any place.)			Followed by an exceedingly rainy summer	Dom Bouquet, t. viii. p. 251, and t. ix. p. 92; Cent. Magd.; Ragor.; Bertrand, &c.
950, or 951, or 952.	"Per multa Germaniæ et Galliæ loca."	Several violent shocks		Many buildings and trees overthrown. v. Hoff gives the date, from Æneas Sylvius, as late as 956.	Chronicon Hirsaugiense; Wittekind. Gesta Sax. lib. iii.; Sigeberti Chron., &c.
957	Rai and Thalekan		The (Caspian?) sea retreated from its shores, disclosing new islands to view.		Ibn el Atsir in Abulfeda, Ann. ii. p. 467; Hadschi Chalifa; Bar Hebræus; El Makin.
958	Deisan and Kaschaa in Persia, and the country round.	More violent than that of the preceding year.			Abulfaradsch, p. 196; El Makin.
965, or 967	Egypt				Marai, Geschichte der Regenten v. Ægypten. übersetzt v. Reiske in Büsching's Magazin, t. v. p. 369.
967. Sept. 2. Midnight.	In Paphlagonia, Honorias, and Claudiopolis.	Very violent		Attended with noise	Cedrenus, p. 660; Zonaras, p. 206; Léon Diacre, p. 41.
968. Nov. 17.	Island of Coriphus	Three shocks during the day.			Baronius, p. 796.
——	Germany				Bernherz; Collection Académique.
974	England				Simeon Dunelmensis; Collection Académique.

975. Oct. 26. In the evening.	Constantinople	....	....	....	Leon Diacre, p. 109.
982	Capua and Beneventum	....	....	Others give the date 983, and others that of 997, saying that it was accompanied by an aurora. An eruption of Vesuvius took place in 983.	Philippi Bergomat. Suppl. Chron. fol. 265.
985. Sept. 23.	Cyzicum, Nicæa, and other places.	....	....	....	Beuther quotes Peucer in exposit. 3. part. Chron. Carion.
——	Laybach in Carniola ...	....	....	....	Collection Académique.
986. October.	Constantinople; also felt all through Greece.	....	....	....	Cedrenus, p. 696; Michael Glycas, p. 309; Baronius, p. 843; Ch. Mathias, p. 554.
990	Beneventum and Capua	....	....	....	Muratori, t. vii. p. 164.
991	Borgo S. Sepolcro	....	....	....	Sarti, su i terremoti, cap. 3.
992. Aug. ...	Damascus	Shocks did not cease until the 14th day of the following month (Saphar).	....	....	Vattier, Vie des 49 chalifs par Le Macine, p. 262.
996. Aug. ...	Place not mentioned ...	....	....	....	Philippi Bergomat. Suppl. Chron. fol. 286.
997	Egypt	Very violent	....	....	El Makin.
——	Magdeburg	Several shocks......	....	....	Beuther quotes Fabricius.
999. Dec. 14.	Place not mentioned ...	....	....	Extreme drought. The Collection Académique adds that meteors were seen at this time.	Beuther quotes Naucler; Curio; Collection Académique; Cent. Magd.
1000. Mar. 29	Throughout Europe. No particular place mentioned.	....	....	....	Almost all the chronicles of the time.
——	Poland	....	....	....	Gazette de France, 14th April 1786; Gentleman's Mag. vol. lvii. p. 175.
——	Rome	....	....	....	Baglivi, *loc. cit.*
1001	Switzerland	....	....	Accompanied by igneous meteors	Bertrand, Coll. Académique, p. 516.
1004, or 1005	Campania	Lasted fifteen days ...	....	Overthrew many buildings; amongst others the monastery of Monte-Cassino, the chronicle of which house gives the date 1005, which would probably make it coincide with the one following.	Sigonius, p. 474.
1005. Jan. to March.	Rome	Shocks during the time mentioned.	....	....	Collection Académique, Baglivi, *loc. cit.*
1007	Deinar in Irak	....	....	10,000 persons were buried in the ruins of buildings, and many more swallowed up by the earth. At Bagdad great snow.	Hadschi Chalifa; Abulfaradsch, p. 219.
1009	"Lisbon, and the countries of the south."	....	....	....	Collection Académique; Mémorial de Chronol. t. ii. p. 911.

1.	2.	3.	4.	5.	6.
1010. Jan. to March 9. On this day (9th March) at the 10th hour.	Constantinople	Very many and violent shocks. The principal one on the 9th March.		Accompanied on the 9th March by a terrible noise. Baronius gives the date 1011.	Cedrenus, p. 706; Michael Glycas, p. 310.
1012	Place not mentioned				Beuther quotes Sabellicus and Nauclerus.
1013, or 1014. Sept. 18 and Nov. 18. On the first occasion about midday.	Place not mentioned. The one of the 18th September probably felt at Liège.			Some uncertainty as to the date	Chron. Leodienense, Labbe, t. i. p. 337; Chron. Magdeburg.; Dom Bouquet, t. x. pp. 218 and 321.
1016	Poland				Gazette de France, April 14, 1786; Gentleman's Mag. vol. lvii. p. 175.
1017	Rome				Collection Académique.
——	Lisbon				Mémorial de Chronol. t. ii. p. 911.
1021. May 12.	Many parts of southern Germany, especially in Bavaria; and at Bâle.			The wells all through Switzerland were troubled, and the water in many became red like blood. Great inundations were produced in many places. Igneous meteors were observed. Some authors (as Chron. Alberti) give the date 12th May 1020.	Bertrand; Scheuchzer; Collection Académique; Bernherz quoting Aretius; Dom Bouquet, t. x. p. 193; Simon Schard, &c.
1029	Damascus			Half the city was ruined	El Makin.
1031. Aug. 13. 1st hour of the night.	Constantinople			v. Hoff gives the date 1032	Cedrenus, p. 730.
1032. March 6.	Constantinople. Also felt (according to v. Hoff) in different parts of Egypt, Palestine and Syria; as at Jerusalem, Askalon, Gaza, &c.			v. Hoff gives the date 1033, or 1034	Cedrenus; also Abulfaradsch, p. 233.
1034. Feb. 17.	Syria			Possibly confounded as to date with the one last mentioned.	Cedrenus, p. 732.
1035	Jerusalem	Shocks for forty days		Many buildings overthrown.	Cedrenus, p. 737.
1036	Throughout the empire	Many more shocks, lasting until the following year.			Collection Académique.

1037. Dec. 18 ... the night.	Constantinople	... two were slight, and one violent.		... and five villages were swallowed up.	
——	China, in the province Schen-si. (Extending from the west side of the river Hoangho to 150 Li (=12 geogr. miles) beyond its eastern bank?)	....	....	....	De Mailla, Hist. Gén. de la Chine, t. viii. p. 201.
1038. Nov. 2 (Nov. 6, according to v. Hoff), 10th hour of the day.	Constantinople	Shocks lasting until the following January.	....	....	Cedrenus, p. 740; Baronius, t. xi. p. 130.
1039	Ditto	....	....	Not mentioned by the Byzantine writers	Baronius, *loc. cit.*
1040. Feb. 2.	Smyrna. Several other towns also injured.	....	....	....	Cedrenus, p. 742; Diar. Hist. p. 44.
——	Tabriz in Persia; also felt in Africa.	....	....	Many buildings thrown down; 50,000 persons perished. Probably on the same day as that at Smyrna.	Hadschi Chalifa.
——	In Lombardy, and throughout Italy.	....	....	....	Jacobi Malvecii Chron. Muratori, t. xiv. p. 872.
1041. June 10, 12th hour of the day.	Constantinople	....	....	....	Cedrenus, p. 748.
—— (Dec. 14?)	Ditto	Shocks lasting for four months.	....	....	Ditto.
——	Japan	Very violent	....	....	Kämpfer, v. Dohm, vol. i. p. 217.
1043	England	....	....	....	Courrier Français, 27th March, 1843.
1048. May 1.	Worcester, Derby, and many other parts of England.	....	....	Followed by a mortality amongst man and beast	Collection Académique, Anciennes Révolutions du Globe, Rerum Anglic. Script. fol. 51.
—— Oct. 13, or 15 and 16	Constance, and on the lake of same name.	Violent shocks	....	....	Lycosthenes; Cent. Mag.; Dom Bouquet, t. xi. p. 20.
1052	Chusestan, and especially in the city Ardschan; also in the city of Bihak in Khorassan.	....	....	A large mountain in the neighbourhood of the city of Ardschan cleft in two, so that one could see into the interior.	Abulfeda, ii. p. 143.
1057. In the 4th month.	China, in the district Yu-tschu.	....	....	Many buildings thrown down	De Mailla, Hist. Gén. de la Chine, t. viii. p. 245.

1.	2.	3.	4.	5.	6.
1058	Mesopotamia and Mosul	Lasted an hour	....	Great damage done both to buildings and life...	Abulfeda, iii. 1.
1059	Germany	....	....	....	Bernherz quotes Schubert.
1060. April 7 (Easter-day).	Brescia	Several shocks.........	....	....	Sigonius, p. 543.
1061	In the East, probably, but no place is mentioned.	....	....	....	El Makin.
1062. Feb. 8.	Bâle, Constance, Neufchatel, and other parts of Switzerland.	....	....	Accompanied at Neufchatel and Constance by thunder and lightning.	Stumpffius; Hermannus Contractus; Bertrand; Cent. Mag.; Lycosthenes; Dom Bouquet, t.xi. p.22.
1063	Syria, especially at Tripoli.	Very violent	....	The walls of Tripoli thrown down	Abulfeda, ii.
1064. Sept. 23. About the second watch of the night.	In Thrace, especially at Constantinople; and also in Asia Minor, particularly at Cyzicus and Nicæa.	Exceedingly violent. The shocks were frequently repeated for two years, and appeared to proceed from the west.	....	....	Joann. Scylitzæ Curopal, Breviar. Histor. p. 816, Paris edition; Zonaras, p. 274; Glycas, p. 325, &c.
1065. Mar. 27 (Easter-day).	In Germany	....	....	....	Calvisius.
1069	Syria, especially at Ramla, in the south-west of Palestine; also in Egypt.	....	The sea retired from the coast, leaving the shore dry, and then returned with such vehemence as to inundate the country.	Many persons lost their lives..........................	Hadschi Chalifa; El Makin; Abulfeda.
1070. May 11.	Cologne and the country round.	....	....	....	Beuther quotes Chron. Univers.
1076. Mar. 26.	Throughout all England	....	....	Accompanied by subterranean noise..............	Matthew of Westminster, lib. ii. p. 6; Collection Académique; Dom Bouquet, &c.
—— April 6.	Ditto	More shocks	....	....	Ditto.
—— —— 22 (19th day of the moon).	Ditto	More shocks	....	The frosts were very severe from November to April.	Ditto.
1077.	Laybach in Carniola ...	....	....	Followed by an abundant harvest	Collection Académique.
1079. July 16 or 17. In	At Sens?	....	....	....	Chron. S. Petri Vivi Senon; Dom Bouquet, t. xii. p. 279.

					ther quotes Mechonius in Chron. Polon. lib. ii. c. 20.
1081. Mar. 27, 1st hour of the night.	Throughout England; and also in Germany, especially at Mayence, and in Carniola.	....	....	Accompanied by subterranean noise. The date appears doubtful as respects Germany.	Matthew Paris, t. i. p. 11; Matthew of Westminster, lib. ii. p. 8; Dom Bouquet; Simon Schard; Polydore Virgil; Beuther quoting Sigebertus and Massæus; Collection Académique, and many other chronicles.
——	Spain	Shocks lasting for many weeks.	....	....	Die Mauren in Spanien Conde, übersezt v. Rutschmann, B. ii. p. 61.
1082, or 83 (?). Dec. 6.	Constantinople	....	....	Many houses and churches thrown down........	Glycas, p. 333; Zonaras, p. 299; Cent. Magdeb. t. iii. p. 367.
1083. Mar. 21.	Angers........	....	....	The second chronicle of St. Albin d'Angers gives the date 1082.	Dom Bouquet, t. xii. p. 479.
—— Oct. 18 (Day of St. Luke).	Probably in central France. (In Poitou and Limousin?)	....	....	A church is said to have been burned. Qu. by volcanic fire?	Chron. S. Maxentii, Dom. Bouquet, t. xii. p. 402.
1085	In England	....	....	Followed by great cold. Probably confounded with one of the preceding earthquakes.	Lycosthenes.
——	Different parts of Europe. Possibly in Lorraine.	....	....	A great pestilence is said to have prevailed in the western part of Lorraine, and this occurrence is coupled with the earthquake in an ambiguous sentence, from which one cannot distinctly learn whether the latter was felt there or not. Followed the next year by great floods.	Chron. Hirsaug., Chron. Turon., Dom Bouquet, t. xii. p. 465.
1086. In the evening.	Sicily; especially at Syracuse.	....	....	At Syracuse a church fell at the time of vespers, and killed many people. Others give the dates 1070 and 1100.	Hermannus Gigas; Nauclerus; Platina.
1087. July 14.	Soissons	....	....	"Cum aeris concussione"	Baronius, t. ix. p. 587; Trithemii Chron.
——	Throughout la Puglia in Italy.	....	....	....	Romualdi Salernitanii Chron. t. vii. p. 176.
1087	Place not mentioned. Probably in the East.	....	....	....	Abulfeda, Ann. iii. p. 267.
1088. May 12.	Thuringia and Hesse ...	....	....	....	Fabricius; Rivander, Düringische Chron. p. 210.
—— Sept. 10. Beginning of the day.	Throughout the Terra-di-Bari.	....	....	....	Anonymi Barensis Chron. t. v. p. 154.

1.	2.	3.	4.	5.	6.
1088. Sept. Day not given.	Throughout la Puglia in Italy.				Lupi Protospatæ Chron. t. v. p. 46.
1089. Aug. 11, 3rd hour of the night.	Throughout all England			Houses were seen to leap upwards and return to their position. There was a great scarcity of fruits this year, and the harvest was not got in until the 30th November.	Simeon Dunelmensis, Hist. Cal. 215; Collection Académique; Dom Bouquet, &c.
1090	England			Probably the same with the last	Courrier Français of 27th Mar., 1843.
1091. Nov. 2.	Angers			Accompanied by great thunder and lightning. Great stones were thrown from the arches of the windows of the large tower of the church.	Dom Bouquet, t. xii. p. 557. t. xiv. p. 79; Christ. Mathias, p. 582.
1092. Feb. 8.	Constance and the shores of the lake of same name.				Eberus in Calendario.
——	Antioch and Damascus			The walls thrown down	Abulfeda, Ann. iii.
1095. Sept. 10. Middle of the night.	Place not mentioned. Probably in Germany.	Many shocks		Accompanied by a great storm of wind	Simon Schard; Chron. Hirsaug.; Cent. Magd.; Dom Bouquet, t. xiii. p. 714.
1096? Sept. Middle of the night.	Venice			Followed by a dreadful pestilence. Date should probably be 1095.	Vite de' Duchi di Venezia, Muratori, t. xxii. p. 479.
1097. Oct. 13.	Place not mentioned. Central France?				Chron. S. Maxentii; Dom Bouquet, t. xii. p. 403; Labbe, t. i. p. 214.
1098. Sept. 26.	Ditto			"Cœlum apparuit rubicundum"	Dom Bouquet, t. xii. pp. 403 and 484; Labbe, t. xv. pp. 215 and 281; Chron. S. Maxentii.
—— Oct. 5.	Ditto				Ditto.
—— —— 6. 1st watch of the night.	Ditto				Ditto.
——	Bâle				Berghaus in v. Hoff's Chronik.
1099. Nov. 3.	England				Roger de Hoveden in Rerum Anglic. Script. fol. 268.
1100	Rome				Baglivi, p. 542.
——	Sicily				Edinburgh Encyclopædia, Article Chronology, without quoting any authority.
1104. Jan. 3.	Throughout the district of Parma.				Chronicon Parmense, Muratori, t. ix. p. 759.
1105. Apr. 13.	Central France?			In February there was a severe frost, and in June great rain followed by disastrous inundations.	Chron. S. Maxentii; Dom Bouquet, t. xii. p. 404.

1105. Dec. 24	Jerusalem				Lycosthenes; Simon Schard, p. 132; Cent. Magd.; Muratori, &c.
—— Probably the 40th, or 68th day after the 28th Jan.	Island of Malamocco near the Italian coast; also at Venice.		The island was engulphed by the sea during an earthquake.	Muratori does not mention the *earthquake*, and gives the date 1106.	Sigonius, p. 609; Muratori, Annali d'Italia, t. vi. p. 351; Vite de' Duchi, &c., p. 483 and 486.
——	Ely in England.				Gentleman's Magazine, vol. for 1750, p. 56.
1106. May 4. In the morning.	Angers?				Dom Bouquet, t. xii. p. 486.
About 1107	In Italy. Exact place not mentioned.			Houses and even hills thrown down	J. Malvecii Chron. *loc. cit.* p. 874.
1109	Antioch			The earth opened and houses were swallowed up	Frytschius.
1110. From morning to evening.	Shrewsbury and Nottingham in England.			The river Trent stopped for a mile in length, so that it could be passed with dry feet. This continued from morning until the third hour of the day.	Simeon Dunelmensis, Hist. X. Script. col. 251; apud Salopiam Chron. Henrici de Knyghton, X. Script. col. 2379.
——	Lombardy	Shocks for forty days			Martène et Durand, t. v. p. 805.
1112. Jan. 3.	Southern Germany; especially Rothenburg on the Necker.			The town of Rothenburg was overthrown; Liège also was inundated by the waters of the Meuse.	Lycosthenes; Frytschius; Collection Académique; Centuriæ Magdeburgenses; Münsterus, Cosmogr., lib. iii.
—— —— 4.	"In partibus Britanniæ." Query in England or in Brittany.				Dom Bouquet, t. xii. p. 557.
1113. April 2.	Toledo				Jean de Ferréras, Histoire d'Espagne, t. iii. p. 324.
——	Italy; at a place called Villa Magnerans.				Labbe, t. ii. p. 218.
——	Jerusalem	Two earthquakes during the year.			Muratori, t. vii. p. 590.
1114	All Syria, and part of Asia Minor.				Ch. Mathias, p. 587; Cent. Magdeb. t. xii. p. 863; Muratori, t. xxii. p. 484.
——	Antioch and the country round.	Two separate earthquakes.		Trialeth, Mariscum, Manistria, and other towns were destroyed wholly or in part.	Purchas, Pilgrimes, vol. ii. p. 1208; Collection Académique; Muratori, t. xii. p. 591.
1115. About Dec. 25.	Syria			Aleppo, Samosate, Jerusalem, Antioch, Haran, and Balasch were greatly injured. Possibly the same with the last.	Bar Hebræus, p. 298; El Makin; Muratori; Ch. Mathias, &c.

1.	2.	3.	4.	5.	6.
1115	Sumatra and Java	....	....	These two islands, which before were one, experienced a violent earthquake, by which they were separated, and the Strait of Sunda formed.	Raffles's History of Java, vol. i. p. 25. vol. ii. p. 232.
1117. Jan. 3.	Upper Italy, Southern Germany, Switzerland, and Lisbon in Portugal.	According to some authors, lasted forty days.	....	Accompanied in some places by thunder and lightning. The fact of there having been a great earthquake about this time is confirmed by almost all the chronicles, but they differ considerably from one another as to date and attendant circumstances.	Bernherz; Ragor; Bertrand; Collection Académique, and almost all the old chronicles.
—— May 3.	Liège	....	....	Attended with thunder and lightning. Many storms of wind, thunder, &c. are mentioned by the chronicles as having occurred during this year.	Chronicle of Sigebert.
—— About December 1.	Lombardy	The shocks appear to have been very frequent about this time.	....	....	Henrici Huntingdoniensis Hist. lib. vii.
—— —— 10. Middle of the night.	England?	....	....	The moon appeared the colour of blood	Matthew of Westminster, lib. ii. p. 29.
—— —— 30.	"En plusieurs lieux" ...	....	....	....	Dom Bouquet, t. xii. p. 276.
1118. June 4.	Italy	....	....	Exceedingly violent	Chron. Veronense, Muratori, t. viii. p. 621.
——	Laybach and elsewhere in Carniola.	....	....	....	Collection Académique.
1119. Sept. 28, 3rd hour of the day.	Different parts of England.	....	....	....	Rerum Anglic. Script. fol. 272; Collection Académique; Simeon Dunelmensis.
1120. First watch of the night.	Monastery of Monte-Cassino in Italy.	....	....	....	Chron. S. Monast. Cassin. p. 492; Frytschius.
——	"In valle Tridentina"	Seven, ten, and even twenty shocks felt each day.	....	Great numbers of buildings ruined	Cent. Magdeb.
1122. Dec. 10. At the 3rd hour.	Place not mentioned.	....	....	....	Simon Schard, fol. 135; Dom Bouquet, t. xii. p. 782; Cent. Magd., &c.
——	Arabia	....	....	The temple at Mecca was injured by the shock	Abulfeda, Ann. iii. p. 413.
1123	Hira	....	....	....	Cod. Gothanæ, No. 237.

At night.		shocks recurred for fifteen days.			nius, t. xii. p. 160.
1127	Tyre			The earth opened, and many people perished. Others give the date 1128.	The Chronicles of Rabbi Joseph ben Joshua ben Meir the Sphadi, t. i. p. 97. Comm. to M. Perrey by M. Rossignol, Secretary to the Academy of Dijon.
1128	Switzerland and elsewhere.	Shocks lasting at intervals for forty days.			Baronius; Collection Académique.
1129	Bagdad				Bar Hebræus, p. 308.
1131	Laybach in Carniola				Rapport de Vassali Eandi sur les tremblemens de terre du 2 Avril, 1808, p. 132.
1133. Aug. 4. In the morning.	In England	Very violent		Preceded by a very loud subterranean noise	Matthew of Westminster, lib. ii. p. 34; Matthew Paris, vol. i. p. 72; Polydore Virgil, p. 255; Simeon Dunelmensis.
——	Ceccano in the States of the church.			An eclipse of the sun is mentioned in connection with the earthquake; and as the former occurrence took place on the 2nd of August, the earthquake was probably simultaneous with the one last mentioned in England.	Chron. Fossæ Novæ, Muratori, t. vii. p. 869.
1134. Oct. 1. Middle of the night.	The coasts of England and the Netherlands.	No land shock felt	The sea rose suddenly with such violence as to inundate the country, and retired to its usual level as suddenly.		Anselmi Gemblæ Appendix ad Sigebertum; Dom Bouquet, t. xiii. p. 270.
——	The city of Dogodoph in Armenia.			The city ruined...	Bar Hebræus, p. 312.
1135	Liguria in Italy	Violent shocks			Anonymi Cassinensis Chron.; Muratori, t. v. p. 62 and 141.
——	Bagdad				Bar Hebræus, p. 314.
1138. June 5	Würzburg	Twenty shocks		During a storm of hail, thunder and lightning. A violent tempest three days afterwards. An eruption of Mount Vesuvius began on the 29th of May and lasted forty days.	Beuther quotes Lycosthenes. Anonymi Cassinensis Chron.; Muratori, t. v. p. 62 and 141.
——	Syria and Mesopotamia, especially at Aleppo.	At Aleppo the shocks lasted more than two months.			Abulfeda, Ann. iii. p. 479.

1.	2.	3.	4.	5.	6.
1139. Jan. 22. At the first crowing of the cock.	Beneventum	....	....	....	Falconis Benev. Chron.; Muratori, t. v. p. 131.
——	In Hira, especially at the Persian town Gansana, and also at Aleppo and Ambar.	....	....	The town Gansana was destroyed, 100,000 persons losing their lives. Black water came out of the earth at this place.	Hadschi Chalifa; Abulfeda, p. 329; El Makin; Bar Hebræus, &c.
1140	Place not mentioned. Probably in Italy.	....	....	....	Cass. Chron.; Muratori, t. v. p. 64 and 141.
——	In the neighbourhood of Kalunikus.	....	....	No shock said to be felt. The earth opened and swallowed up forty horsemen, whose cries were heard long after (!).	Bar Hebræus, p. 323.
1142. Dec....	Lincoln	Three shocks during the same day.	....	....	Simeon Dunelmensis, Col. 268; Collection Acad.
——	Rouen	....	....	This earthquake is not mentioned in the Rouen Chronicle.	Breve Chron. Uticensis Cœnobii; Dom Bouquet, t. xii. p. 774.
1143	Rome	....	....	....	Baglivi, p. 543.
About 1144...	Paphos and several other islands in the Mediterranean.	....	....	....	Matthew Paris, t. ii. p. 634.
1146	At Mayence. Also in Switzerland, Portugal (especially at Lisbon), and other parts of Europe.	At Mayence fifteen shocks were felt during one day and night.	....	....	Chron. Hirsaugiense; Balbi, Essai sur le Royaume de Portugal; Bertrand; Cent. Magd.
1151, or 1152	Italy.....................	Great and numerous earthquakes.	....	....	Cassinensis Chron., Muratori, t. v. p. 66 and 142; Simon Schard; Lycosthenes; Cent. Magd.
1154. Feb. 15	In Burgundy	At Cluniacum it was felt three times during the same night.	....	A castle near Cluniacum was swallowed up, and a pool of water of great depth appeared in its place. Authors differ somewhat as to the date of the year.	Roberti de Monte append. ad Sigebert.; Dom Bouquet, t. xiii. p. 297.
1155. Jan. 18	Ditto	Felt three times in one night.	....	From being reported by the same author who mentions the last, one would be led to suppose them different events; yet the circumstances are so precisely similar in the two, that they may very probably be only the same event incorrectly reported as to date. Others speak of it as occurring in 1155 and lasting the whole season of Lent, while others again give the dates 1156 and 1157.	Ditto. Also Chron. Turon.; Chron. Cluniacense, &c.

[illegible] Before the rising of the sun.	[illegible]				[illegible] bert.; DomBouquet, t. xiii. p. 298.
—— (During winter ?).	Italy and Sicily			5000 persons lost their lives in Sicily	Beuther quotes Vincent, lib. xxix. c. 3; Chron. Martini Poloni; Fascic. temporum, &c.
——	Antioch, Damascus, and Tripoli.			2000 persons killed.	Ditto.
1157	Spain				Edinburgh Encyclopædia, Article Chronology.
1158	Syria, &c.	At Malatia it was felt in the direction S. to N.		20,000 persons perished, and Antioch, Tripoli, Damascus, Aleppo, and many other towns were ruined. Other authorities give the dates 1159 and 1160.	Bar Hebræus, p. 348; Nicetas Choniat.; Cent. Magd., &c.
——	London and other parts of England.			The Thames dried up, so that it could be passed dryshod.	Chron. Gervasii Dorobernensis; Coll. Académique; Révolutions du Globe.
1159	Sicily				Mémorial de Chronol. t. ii. p. 911. No ancient authority given.
——	Japan	Very violent			Kämpfer, v. Dohm, t. i. p. 222.
1160. Oct. 15	Ceccano				Chron. Fossæ Novæ, Muratori, t. vii. p. 872.
1161. Jan. 1. first hour.	Village of Coutances in the territory of St. Lo in Normandy.			Robertus de Monte gives the date 1160	Simon Schard, f. 147; Lycosthenes; Cent. Magd.
—— —— 16. At dawn.	Ceccano in Italy				Chron. Fossæ Novæ, Muratori, t. vii. p. 872.
——	The southern part of Iceland.				Voyage en Island, publié sous la direction de M. Gaimard, p. 313; v. Hoff.
1163. Aug. 2	Most probably in Anjou				Chroniques de Saumur et d'Angers; Dom. Bouquet, t. xii. p. 482; Martène et Durand, t. v. p. 1145; Labbe, t. i. p. 279.
1164	Southern part of Iceland				Voyage en Island, p. 313; v. Hoff.
1165. Jan. 25, or 26. At night.	In the counties of Ely (?), Norfolk and Suffolk.			Persons who had been standing were thrown down, and the bells were made to ring. One chronicle gives 1164 as the year.	Matthew of Westminster, lib. ii. p. 47; Matthew Paris, t. i. p. 104.
—— June 20	Most probably in Anjou				Chron. S. Florentii Salmur, Dom Bouquet, t. xii. p. 491; Martène et Durand, t. v. p. 1145.

1.	2.	3.	4.	5.	6.
1165.	South of Iceland.........	....	....	....	Voyage en Island, p. 313; v. Hoff.
1168. Jan. 10	At Pisa	....	....	Accompanied by considerable subterranean noise. From the 8th to the 20th the Arno was frozen over, so that horsemen could pass over the ice. Instead of "terræmotus maximus cum mugitu," Muratori writes "tonitruus fortis cum mugitu." Hence perhaps this does not refer to an earthquake at all.	Bernardi Marangonis vetus Chron. Pisanum, nell' Archivio storico Italiano, t. vi. part ii. p. 50.
1169. Feb. 4, or 5.	Sicily and part of Calabria.	....	....	Catania and other towns ruined, and 15,000 people killed. Others give the dates 1170, 1173, 1175, and even 1183. Doglioni reports it in 1166, and adds that it was felt in Greece.	Baronius, t. xii. p. 604; Muratori, t. vi. p. 588; Martène et Durand, &c.
—— Feb. 18, or 20.	Toledo and other parts of Spain.	....	....	....	Mariana, Historiæ de rebus Hispanicis libri xxx. lib. xi. c. 10; Jean de Ferréras, Histoire d'Espagne, t. iii. p. 483.
1170. May 9	Ceccano in Italy	....	....	The greater part of the walls of the town thrown down. The bells sounded of themselves for ten days.	Chron. Fossæ Novæ, Muratori, t. vii. p. 874.
—— June 29	In Syria. Also felt in Hungary, Germany, Switzerland, Sicily, and the north coast of Africa.	Recurring at intervals for fifteen days, or according to others for twenty-five.	....	Exceedingly violent. Great damage done to both life and property.	Hadschi Chalifa; Abulfeda; Robertus de Monte; Bar Hebræus; Dom Bouquet, t. xii. p. 345; and many other chronicles.
1172. Probably either Jan. 13, or July 7.	Place not mentioned. Probably near the monastery of Monte Cassino in Italy.	....	....	Accompanied by an eclipse of the moon. The latter phænomenon occurred this year on the two days mentioned.	Cassinensis Chron., Muratori, t. v. p. 69.
——	In the East. Probably Syria, or Asia Minor.	....	....	....	Collection Académique.
1173	Catania	....	....	Perhaps confounded with the great earthquake of 1169.	Edinburgh Encyclopædia, Article Chronology.
1174. Aug. 17. At dinner hour (!).	Bologna?	....	....	....	Chron. di Bologna, Muratori, t. xviii. p. 243.
1179 (or 1180). Aug. 1. In the 4th watch of the night.	Place not mentioned ...	....	....	....	Chron. Saxonicum, Dom Bouquet, t. xiii. p. 723; Chron. Lamberti Parvi; Martène et Durand, t. v. p. 12.

1179. Dec. ...	Oxenhall near Arlington, Durham.	....	....	The earth swelled up to a great height from nine in the morning to the setting of the sun, and then with a loud noise sank down again so far that three new pools of water appeared where the rising had been.	Rerum Anglicarum Scriptores, fol. 332; Camden's Britannia.
1180. About Sept. 29.	In England	Two or three shocks	....	....	Simon Schard, f. 163; Lycosthenes.
1180	Naples	....	....	The town of Arrian was swallowed up	Bertrand, 2e Mém. p. 32; Mercure Hist. et Polit. t. xiv. p. 261.
——	In Switzerland	....	....	Followed by storms of wind and rain	Bertrand, p. 32.
1182	Syria and Judæa........	....	....	Very many buildings, &c. overthrown	v. Hoff; Collection Académique.
1183	Switzerland........	....	....	....	Bertrand, p. 32.
——	Syria	....	....	Antioch, Damascus, and Tripoli, all partly ruined. More than 20,000 victims. Possibly confounded with one of the former earthquakes in the same country.	Muratori, t. ix. p. 178; Philippi Bergomat, Suppl. Chron. fol. 291.
1184. Beginning of Jan.	Verona........	....	....	The exterior of the amphitheatre thrown down. A Verona chronicle gives the date of this event 1183.	Muratori, t. vii. p. 47; Sigonius, pp. 826, 827.
—— May 24	Calabria	....	....	In March of this year Vesuvius threw forth ashes for several days.	Chron. Cassin., Muratori, t. v. p. 70.
1185. April 15, 16, or 17.	All England, especially at Lincoln.	....	....	The cathedral of Lincoln and many other buildings were thrown down. Baker's English Chronicle gives the date 1180, April 25.	Dom Bouquet, t. xvii. p. 465, t. xviii. pp. 60, 188, 328; Martène et Durand; Rerum Anglic. Script., &c.
——	In Italy	The author calls it in one place "non modicus," and lower down "modicus."	....	....	Siccardi Chron., Muratori, t. vii. p. 602.
1186. March	In a country called Uceericum, or Uceticum in Gothis. According to another author, in Greece.	....	....	Followed in April by an eclipse of the moon. The date should probably be 1185.	Chron. de St. Denis, Dom Bouquet, t. xviii. p. 362; Lycosthenes, &c.
—— Beginning of autumn (after the middle of September).	Almost universal in Europe; especially in England, Calabria, and Sicily.	....	....	In England houses were thrown down, and in Calabria and Sicily many towns ruined.	Matthew Paris, t. i. p. 144; Matthew of Westminster, lib. ii. p. 59; Collection Académique; Cent. Magd., &c.
1187	Verona........	....	....	Perhaps only the same with the one in 1184 ...	Chron. Gervasii Dorobernensis in Script. Col. X. 1505.

1.	2.	3.	4.	5.	6.
1189	Rome				Baglivi, p. 543.
1198. May 4	Village of Longaw in Bohemia.	The shocks recurred for eighteen months after.		Great number of buildings thrown down	Lycosthenes and Frytschius.
1199. May 3. Noon.	Poland. Also felt at Constantinople.	The shocks lasted several days.		Others mention 1200 as the year in which this earthquake occurred. Very probably only the same with the last.	Cent. Magd. p. 877; Diarium Hist. p. 134.
——	In England; principally in Somersetshire.			Persons were thrown from their feet in some places.	Ymagin, Hist. Radulfi de Diceto. Col. 709; Révolutions du Globe, &c.
1200	Ceccano				Chron. Fossæ Novæ, Muratori, t. vii. p. 886.
1201. Jan. 9	York and the neighbourhood.			Accompanied by noise	Rerum Anglic. Script. fol. 464.
—— May 22. About the 6th hour of the day.	In the counties of Somerset (Suffolk?) and Norfolk.			Persons were thrown from their feet	Dom Bouquet, t. xvii. p. 660.
—— or 1202.	Syria, Palestine, Mesopotamia, &c. Also felt in Cyprus.			Many towns greatly injured. Some authors (not Arabian) give the date 13th, or 20th, or 30th May 1202.	Hadschi Chalifa; Abulfeda, Ann. iv. p. 195; Bar Hebræus, p. 435.
1202	Different parts of England.				Dom Bouquet, t. xviii. p. 97.
1204	Egypt, Syria, Mesopotamia, Irak, Asia Minor, Cyprus and Sicily.			The walls of Tyre thrown down	Abulfeda, Ann. iv. p. 211; Abulfaradsch, p. 405.
——	Java			The small island of Bali, which before formed part of the island of Java, was separated from it by this earthquake.	Raffles's History of Java, vol. i. p. 95, and vol. ii. p. 232.
1207. Feb. 26. Midnight.	In Anjou?			Accompanied by loud peals of thunder	Addenda Chron. Andegav. S. Albini, Dom Bouquet, t. xviii. p. 327.
1208. June 13	In Aquitaine				Dom Bouquet, t. xviii. p. 275.
1209	In Nisabur and Choratan				Bar Hebræus, p. 452.
1212	Antioch				Cent. Magdeb. p. 630.
——	Venice			Buildings were thrown down	Cent. Magdeb; Sabellicus, Decas 1. lib. viii.
——	In Bavaria	Shocks during six months.			Cent. Magdeb. p. 630.

		months.			
[illegible] At night.	In Normandy	Three shocks			Chron. Mortui-Maris, Chron. Rotomag, Dom. Bouquet, t. xviii. pp. 356 and 361.
1215. Mar. 3. Midnight.	In Burgundy, or Limousin?			Others give the dates 1216 and 1217	Chron. Cluniac. Cœnobii, Dom Bouquet, t. xviii. p. 743.
1217. Jan. 8. At dinner hour (!).	At Genoa	Lasted a short time.			Caffari, Annales Genuenses, Muratori, t. vi. p. 412.
1218. In winter.	In England				Cent. Magdeb.
About 1218	In Franche Comté			No shock felt, but a mountain opened and swallowed up 5000 men. Possibly not an earthquake. The dates given for this event vary very much.	Collection Académique, t. vi. p. 524, quoting Nauclerus.
1219	In England				Beuther quotes Polydor. lib. xvi.
——	In the southern part of Iceland.		Accompanied by a submarine eruption off the coast at Näss Repp.		v. Hoff; Voyage en Island, p. 313.
1221	In England			Perhaps only the same with the last two earthquakes mentioned for this country.	Lycosthenes.
1222. Aug. At dinner hour.	Bologna			A comet seen at the same time	Muratori, t. iv. p. 109.
——. Dec. 25 to 1223, Jan. 11.	Italy, Lombardy, the Tyrol, Germany and Cyprus; especially at Cologne and Brescia.	Shocks during the time mentioned.		The dates given for this event are very confused, but the one here given seems the best supported. The shocks were probably not all felt at each of the places mentioned.	Trithemius, Chron. Hirsaugiense; Baronius; Sigonius; Dom Bouquet, &c.
1223. Apr. 21. Midnight.	Cremona, Brescia, &c. in Italy.	Many shocks.		A rain of sand of the colour of blood is also mentioned.	Ant. Campo, Hist. di Cremona, p. 46; Dom Bouquet, t. xviii. p. 116; Sigonius, p. 228.
1224. Nov. 15. 9 o'clock.	Barcelona				Chronol. Barcinon, Marca Hispanica, p. 755.
1227. In winter.	Territory of the Salvii (now Pays d'Aix in the Département des Bouches du Rhône).			5000 persons killed by the masses of rock which fell from the mountains.	Lycosthenes, p. 433; Baronius, t. xiii. p. 272; Aventinus, &c.
1228. July	Monte Isola in Italy			No shock mentioned, but the mountain is said to have fallen and killed 700 people. Perhaps only a landslip.	Richardi de S. Germano Chron., Muratori. t. vii. p. 1006.

1.	2.	3.	4.	5.	6.
1230. April 5.	Reggio in Calabria			From the 1st to the 15th March subterranean bellowings (mugissements) had been heard throughout all Calabria.	G. Fiore, Calabria Illustrata, p. 286.
—	In Bohemia			At the same time part of Holland was inundated.	Hist. Bohemica, lib. xv.; Rerum Bohemic. Fréher, p. 124.
1231. June 1. About noon.	Monastery of St. Germain. The earthquake extended from Capua to Rome.	The shocks continued at intervals for more than a month afterwards.		The fountains were troubled, and the water remained salt for two hours, and exhaled a fœtid odour.	Richardi de S. Germano Chron.; Muratori, t. vii. p. 1026; Baglivi, p. 542.
1233	In Burgundy				Frytschius.
1236	Laybach in Carniola			Followed by a most abundant year	Vassali—Eandi sur les Tremblemens de Terre du 2 Avril 1808, p. 132; Collection Académique.
1240	Guldbringe Syssel in Iceland.		A submarine eruption at the same time near Reikia Näss.		v. Hoff.
1242. Oct. 24. In the evening.	Vicenza?	Very violent			Ant. Godi Chron., Muratori, t. viii. p. 86.
1244	Lucca	Three earthquakes		Buildings of various kinds thrown down	Annales Ptolomæi Luccensis, Muratori, t. xi. p. 1281.
1245	Nardo (province of Otranto) in Italy.				Chron. Neritinum, Muratori, t. xxiv. p. 897.
1246. June 1; 9th hour.	England, especially in Kent.			v. Hoff gives the 19th May as the day on which this earthquake took place.	Higden's Polychronica; Fabyan's Chronicle; Camden, &c.
—	Island of Candia			The walls of the town Canea thrown down	Petri Justiniani Hist. Venetor. lib. iii.
1247. Feb. 13.	Different parts of England, (especially London,) bordering on the Thames.				Matthew Paris, t. ii. p. 723; Collection Académique, &c.
1248. Nov. 5	Naples	Very violent			Ephemerides Neapolitanæ, Muratori, t. vii. p. 1065.
— Dec. 21.	In England, in the diocese of Bath and Wells. Also felt in Piedmont and Savoy, and in Syria.			The Cathedral of Wells was much injured. It was remarked that the summits of the buildings were violently shaken, whilst their foundations were not.	Matthew Paris, t. ii. p. 756; Polydore Virgil, p. 397; Lycosthenes; Bertrand.
1249. Nov. 24. Midnight.	The abysses of Mians, half a league from Chambery.			No shock recorded. The mountain parted and one part fell, destroying a monastery at its foot, and many villages round. Perhaps only a landslip.	De Saussure, Voyage dans les Alpes. No. 1181. t. iii. p. 18, on the authority of a missal at Mont St. Jean.

3rd hour.	neighbourhood, at the Chilterns (Hertford).			Pigeons and other birds were frightened.	p. 243; Matthew Paris, t. ii. p. 803.
1253. Nov. 25. At night.	Throughout the kingdom of Naples.	....	....	....	Ephemerides Neapolitanæ, Muratori, t. vii. p. 1077.
1255. Beginning of the year.	At Arzengan, or Arzenjan, in the paschalik of Siwas, district of Divrigki, Asia Minor.	Terrible shocks for three days. The direction was nearly the same as that of 1158, viz. S. to N.	....	Many thousand persons perished. A lake was formed in Natolia.	Collection Académique, t. vi. p. 526.
—— In summer.	Lombardy	....	Extraordinary motion of the water of the rivers and lakes, which alternately inundated the country beyond their usual level, and retired considerably below the same.	No land-shock felt. There was no wind at the time.	Jacobi Malvecii Brixiense Chronicon, Muratori, t. xiv. p. 922.
1256. Sept....	Rome and Agnano	....	....	At Rome the bell of St. Sylvester sounded of itself.	D'Acheri, t. xi. p. 546; Duchêne, Histoire des Gaules, t. v. p. 362.
1257	Poland	....	....	....	Gentleman's Mag. vol. lvii. p. 175; Gazette de France of 14th April 1786.
1258	Ditto	....	....	....	M. Cromeri de reb. Polon. p. 159; Annales Silesiæ, p. 82, &c.
——	Japan	....	....	....	Kämpfer v. Dohm, p. 222.
1259. Oct. 4	In Italy. Exact place not specified.	....	....	....	Chron. Cavense, Muratori, t. vii. p. 928.
——	Trapani in Italy	....	....	....	Ditto.
1260	Java	....	....	The small islands now called Giling and Travangan were separated by this earthquake from the northern side of the island of Java.	Raffles's History of Java, vol. i. p. 25; and vol. ii. p. 232.
—— and 1261	The little island of Flatey, in Breidafiord, Iceland.	....	....	....	v. Hoff; Voyage en Island, p. 313.
1264	Brescia	....	....	A comet visible at the same time	J. Malvecii Chron., Muratori, t. xiv. p. 938.
1267. Apr. 10	Bari, in Italy	....	....	The date 21st March 1266 is also given, Palm Sunday being the day mentioned by the chronicler.	Ephem. Neapol., Muratori, t. vii. p. 1103.

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1268. Night, between the 1st and 2nd Nov.	Modena, and elsewhere in Italy.	....	....	....	Annales veteres Mutinensium, Muratori, t. xi. p. 70.
—— Nov. 3 or 4. Middle of the night.	Padua	Two great shocks ...	....	....	Regimina Paduæ, Muratori, t. viii. p. 379; Monachi Patavini Chron., Muratori, t. viii. p. 730.
——	Kingdom of Naples, at the lake Celano.	....	....	This earthquake, and the last two probably took place at the same time, although the dates are not exactly concordant.	Leander and Albertus Bononiensis.
——	In Cilicia	....	....	60,000 persons were killed.	Abulfaradsch, p. 572.
1273. Beginning of Mar.	Durazzo	The movement was at first oscillatory, and afterwards appeared as if the surface of the earth were alternately contracted and dilated with great violence.	....	Preceded by subterranean noises for some time, which gradually increased in intensity up to the time of the earthquake.	Pachymeris Hist. i. lib. v. c. 7. pp. 242 and 537.
——	Azerbidschan and Tabriz in Persia. Also in Thrace.	....	....	....	Bar Hebræus, p. 548; Cent. Magd.
1274. Dec. 5	Throughout England ...	....	....	Accompanied by thunder and lightning, a comet, and *a fiery dragon*.	Matthew of Westminster, p. 363; Polydore Virgil, p. 414.
——	Pays de Galles	....	....	Accompanied by a *rain of blood*.	Polydore Virgil, *loc. cit.*; Fascic. temporum.
1275. Sept. 11. Between the 1st and 3rd hours of the day.	In England	....	....	Many of the most famous churches of England thrown down or injured; among others that of St. Michel-du-Mont near Glaston.	Matthew of Westminster, p. 364.
——	At S. Damiano in Piedmont.	....	....	....	Chron. Astense, Muratori, t. xi. p. 163.
1276. July. At sunset.	Genoa	....	....	....	Caffari, Annales Genuenses, Muratori, t. vi. p. 566.
——	Arcastia, in the province of Argisch; also at the town Cilath.	At Cilath the shocks lasted nine hours.	....	The walls and other buildings were thrown down, and many lives lost.	Bar Hebræus, p. 553.
1277. May 25	Germany	....	....	....	Diarium Hist. p. 158.

	Italy.				terremoti, c. 3.
1278. April 24.	Venice, and almost all the rest of Italy.	Very violent. Recurred again on the 30th.	....	Other authorities place this event in 1279, giving the same days and month, while others again mention it on the 1st of May.	Andreæ Danduli Chron., Muratori, t. xii. p. 397; Vite de' Duchi di Venezia, p. 571.
——	In France and England	....	....	....	Polydore Virgil, lib. xvi.
1280	The island Sumbava near Java.	....	....	The little island Selo Parang was produced by this earthquake, being separated by it from the island of Sumbava.	Raffles's History of Java, vol. i. p. 25, and vol. ii. p. 232.
1282. Jan. 17. Hour of vespers.	At Venice	....	....	The date 1283 is also given	Vite de' Duchi di Venezia, p. 574.
——	Gap in Dauphiny	....	....	....	v. Zach, Corréspondance Astronomique, t. vi. p. 32.
——	In the neighbourhood of Naples.	....	....	....	Johann de Oppido; Cent. Magdeb.
1283. At Easter.	Mtskhitha in the Caucasus.	The earthquake began on Thursday, recurred on Friday and Saturday, and again occurred on Easter Sunday.	....	The cathedral of Mtskhitha fell into ruins	Philadelphine sur les tremblemens de terre dans le Caucase.
1284	In England	....	....	....	Collection Académiqne.
1285. Dec. 13	Ferrara in Italy	....	....	....	Chron. Estense, Muratori, t. xv. p. 339.
——	In the East. Particular locality not specified; said to be widely extended.	....	....	....	Abulfaradsch.
1286. Some time before the 8th Oct.	In Brittany, especially at Vannes.	Lasted forty days. The shocks recurred at intervals for a year.	....	....	Morice, Histoire de Bretagne, t. i. col. 31.
1287	Rome	Several shocks........	....	....	Cent. Magdeb.
1289. July 15	"Per universum orbem terrarum."	....	....	....	Ditto.
——	France	....	....	....	Mémorial de Chron. t. ii. p. 912.
——	Pistoia in Italy	Violent shocks, which continued a long time.	....	This event and the last two probably happened at the same time.	Ann. Ptolomæi Luccensis, Muratori, t. xi. p. 1298.

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1290	Nearly universal in Europe. Felt most violently in Iceland, Switzerland, and at Lisbon; especially at the last of these.	....	....	Probably all these earthquakes in various places did not occur at the same time of the year.	Bertrand; Collection Académique; Voyage en Island, &c.
1292	Rome	....	....	....	Baglivi, p. 542.
——	Borgo-S-Sepolcro	....	....	....	Sarti, c. 3.
1293. July 10 and 11.	Parma and Pistoia	Many violent shocks. At Pistoia they recurred for 24 days.	....	Accompanied by violent storms of wind	Chron. Parmense, Muratori, t. ix. p. 825.
——	In Spain	....	....	....	Palassou, Nouveaux Mémoires sur les Pyrénées, Pau, 1823.
1294	Iceland.........	....	....	An eruption of Hecla began at this time, and during the six following years the volcano was never altogether inactive.	v. Hoff.
1295. Sept. 4. About noon.	In the bishopric of Tours. Also in the Rhetic Alps, and at Constance.	Probably lasted several days.	....	In the Rhetic Alps fifteen castles were destroyed.	Epitome Mundi; Cent. Mag.; Lycosthenes; Diarium Hist.; Eberus.
1296. June 1. Middle of the night.	Constantinople	Several shocks	....	....	Nicephori Gregoræ Hist. Byzant. lib. vi. c. 9. p. 124; Pachymeris, 1. lib. v. c. 7. p. 158.
1298. Jan. 5. At twilight.	In England	....	....	....	Matthew of Westminster, p. 412.
—— Nov. 30	Spoleto, Reati, and Pistoia in Italy.	Shocks lasting for several days.	....	Others give the dates 1295, and 1300	Giovanni Villani, lib. vii. c. 25, Muratori, t. xiii. p. 361; Martène et Durand; Labbe, &c.
1299	In Germany.........	....	....	....	Edinburgh Encyclopædia, Article Chronology.
End of the 13th century.	Karakorum (Holin, or Khorin) in central Asia.	....	....	This place was destroyed	v. Humboldt, Asie Centrale, t. ii. p. 110.
1300. Dec. 28	Country around Mt. Hecla in Iceland.	....	....	Hecla had been in eruption for some time before.	v. Hoff.
——	Throughout Italy	Many violent shocks.	....	....	Ant. Campo, Hist. di Cremona, p. 84.
1301. June 11, At dawn, about noon, after vespers, and about midnight.	Place not mentioned. Somewhere in Italy.	Four shocks, at the hours mentioned.	....	....	Fragmenta Hist. Forojuliensis, Muratori, t. xxiv. p. 1208.

1301. Nov. 30	In Italy. Felt but slightly at Venice.				p. 582.
1302	At Riette (Rieti?) in Italy.				Collection Académique.
1303. Aug. 8. In the morning.	Alexandria and Acre, throughout the Peloponnesus, Candia, and all the Adriatic Sea. Felt but little at Venice.			The walls of Hama and Alexandria were partly thrown down. Some other chroniclers give the dates 1302 and 1304.	Hadschi Chalifa; Abulfeda, v. p. 191; Vite de' Duchi di Venezia, *loc. cit.* p. 772.
——	In Poland				Gentleman's Magazine, vol. lvii. p. 175; Gazette de France, 14 Avril, 1786.
1304. Oct. 23	In Italy. Exact place not mentioned. Probably felt at Ferrara and Placenza.				Chron. Estense, Muratori, t. xv. p. 351; Chron. Placent., Muratori, t. xvi. p. 485.
1306? Some time after the earthquake in Candia.	Rimini			Many houses thrown down	Ricobaldi Ferrar Chron., Muratori, t. ix. p. 254.
1307. In the 8th month.	Japan	Very violent			Kämpfer (v. Dohm), p. 229.
1311	Laybach in Carinthia				Vassali—Eandi sur les tremblemens de terre du 2 Avril 1808, p. 132.
1316. Sept.	At St. Denis in France				D'Acheri, Spicilegium, t. xi. p. 667.
1317. Dec.	In Italy	Two shocks in twenty-four hours.			Martène et Durand, t. v. p. 561.
1318. Sept.	At Cologne	Lasted a long time			Acta Trevir. Archiepisc.; Martène et Durand, t. v. p. 407.
—— Nov. 14.	In England				Thom. Walsingham, Hist. Angl.; Camden, Angl. Norm., p. 111; Collection Académique.
1319	In the provinces of Ararat and Sini in Armenia.	Very violent		The capital Ani or Ana was completely ruined, and many other towns and villages were reduced to the same condition.	Dubois de Montpéreux, Voyages autour du Caucase, t. v. p. 287; Chakhathouno, t. ii. p. 19.
1320. Oct. and Dec.	Sienna in Italy	Shocks during several days and nights.			Chron. Sanese, Muratori, t. xv. p. 62.
——	In England				Edinburgh Encyclopædia, article Chronology.
1321	Rome		Venice was inundated.		Baglivi, p. 542.
1322. May 25 or June 1.	In Germany	Exceedingly violent.			Lycosthenes; Diarium Hist. p. 158.

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1322. End of Nov.	At Geneva				Bertrand; Collection Académique.
——	At Pisa	Several very violent shocks.			Chron. di Pisa, Muratori, t. xv. p. 998; and t. xxvi. p. 648.
1325. May 21. After 3 o'clock.	Florence	Very violent, but lasting a very short time.		Followed by a luminous meteor the night after.	G. Villani Chron. lib. ix. c. 297, Muratori, t. xiii. p. 571.
1326. In summer.	Bohemia, Thuringia, Mysnia (Meissen ?), and other parts of Germany.				Chron. Aulæ Regiæ, Rerum Bohemic., Fréher, p. 55.
1328. Aug. 4. 1st hour of the day.	At Brünn			During a period of very rainy weather, which had been preceded by extreme heat and drought.	Ditto, p. 62.
—— Sept.	Italy, especially at Perugia and the neighbourhood.			In the following month (October) violent storms were experienced in France.	D'Acheri, *loc. cit.* p. 733.
—— Dec. 1. 1 A.M.	Rome, Norcia, &c., in the states of the church. Most violent at Norcia.	The shocks continued at intervals for some months afterwards.		Norcia was completely ruined: 5000 persons perished.	G. Tarcagnota, fol. 182; G. Villani; Collection Académique, &c.
1329. May 22. In the evening.	At Prague. Also felt in the remainder of Bohemia and in Bavaria.				Chron. Aul. Reg., Rerum Bohemic., Fréher, p. 66.
1331. March 13.	Cesena in Italy	Eighteen shocks during the day and following night. They did not entirely cease for a month.	The sea was agitated.		Annales Cæsenates, Muratori, t. xiv. p. 1152.
1332. Feb. 12. In the evening.	Thuringia and at Meissen. Also at Constantinople.			Accompanied at Constantinople by violent atmospheric perturbations.	Eberus; Niceph. Gregoras, Hist. Byzantinæ, p. 283 and 772.
1334. Feb. 23. In the morning.	Cesena in Italy				Annales Cæsenates, Muratori, t. xiv. p. 1157.
—— Dec. 4	Verona				Chron. Veronense, Muratori, t. viii. p. 649.
1335. May 15	Mugello in Italy			In consequence of this earthquake, Monte Falterona near Decomanno separated, and an immense landslip took place, the body of earth moving more than four miles. The Arno and its affluents were troubled as far as Pisa for more than two months.	G. Villani, Muratori, t. xiii. p. 769.

1336. Sept. 5.	Bologna?				Chron. di Bologna, Muratori, [illegible] p. 369.
1337. Jan. 15, and middle of the following night.	Cesena in Italy?	Violent shocks			Annales Cæsenates, Muratori, t. xiv. p. 1175.
——	In Japan	Very violent			Kämpfer v. Dohm, p. 230.
1338	In Iceland				Gaimard, Voyage en Islande, p. 313.
1339. June 21	Cremona	Very violent			Ant. Campo, Hist. di Cremona, p. 117.
——	Arezzo in Italy				Annales Arretini, Muratori, t. xxiv. p. 879.
——	Tripolis in Syria				Hadschi Chalifa.
——	Southern part of Iceland			Followed the next year by a violent eruption of all the volcanoes of the south of Iceland.	Voyage en Islande, p. 313; v. Hoff.
1342. Towards the end of the year.	Province of Utrecht				Guill. Heda, Hist. Ultrajectina, p. 242.
1343. Jan. 25, 20th hour (Italian time).	Venice	Very violent shocks, which continued more or less for 15 days.		Many buildings were injured. The Diarium Historicum gives the date 1340.	Tarcagnota, fol. 191; Sansovino, Hist. di Vinegia, p. 569; Magnati, p. 121.
—— Nov. 25	Naples			During a tempest	Petrarch, Op. epist. lib. v. epist. 72 (editio princeps).
1344. Middle of the autumn.	Constantinople, Syria, and Egypt.	Many and violent shocks.	The sea inundated its shores at Constantinople.	Accompanied at Constantinople by atmospheric commotions.	Hadschi Chalifa; Niceph. Gregoras, Hist. Byzantinæ, p. 434.
——	At Lisbon, and along the sea coast.	Many violent shocks.			Baronius, t. xiv. p. 961; Charenton, Histoire d'Espagne, t. iii. lib. xvi. p. 500.
——	Southern part of Iceland; and the province of Guuldalen in Norway.			Fifty farms were destroyed at Gaularass in Norway; and the river Guul disappeared under ground, reappearing several days after, and carrying with it so much débris as to choke up the valley and produce an inundation. Arngrim Jonsen reports this event in the year 1339.	Keilhau on Norwegian earthquakes in the 'Magazin for Naturvidenskaberne," Christiania, 1835, vol. xii., 82nd and following pages.
1345. Jan. 31	Reggio in Italy	Very considerable			Chron. Regiense, Muratori, t. xviii. p. 60.
—— Feb. 1	Venice	The shocks lasted fifteen days.		Probably confounded with the earthquake of 25th Jan. 1343 at the same place.	Lycosthenes; Frytschius.
—— Sept. 12	Florence, and other places in Tuscany.				G. Villani, *loc. cit.* p. 930.

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1345. Dec. 22. At night.	Florence, and other places in Tuscany.	....	....	....	G. Villani, *loc. cit.* p. 930.
——	Western part of Iceland.	....	A hitherto unseen rock was elevated in Breidafiord.	....	v. Hoff.
1346. Feb. 22. In the evening.	At Reggio?	....	....	....	Chron. Regiense, Muratori, t. xviii. p. 62.
—— Nov. Night between 24 and 25.	Switzerland, especially at Bâle.	....	....	Many buildings thrown down.	Bertrand; Collection Académique.
——	Constantinople	....	....	Caused very great destruction of buildings.	Poggendorff's Annalen, t. lviii. p. 652.
1348. Jan. 25.	Hungary, the Tyrol, Italy as far south as Rome and Naples, Bavaria, Carinthia, Switzerland, parts of Germany, and Poland. Especially violent at Rome, Venice, and Bâle.	Very violent. The shocks recurred at intervals for forty days.	....	The earth opened in different places, and pestilential exhalations came forth. A *rain of blood* is mentioned as having fallen in several localities. Great damage was done to buildings, &c. The date of the year seems very doubtful, as different authors vary from 1343 up to 1349, and indeed, it does not seem certain that there was not more than one earthquake of great extent about this time.	Martène et Durand, t. v. p. 254; Baronius, t. xiv. p. 1048; Conrad v. Lichtenau, p. 193; Chron. Hirsaug.; Lycosthenes; Frytschius, &c.
—— Feb. 6.	Frankfort on the Maine	....	....	....	Lerner's Chronik; Kriegk. p. 14.
—— Feb. 7. At night.	Modena?	....	....	....	Annales veteres Mutinensium, Muratori, t. xi. p. 82.
1349. Sept. 9. At the hour of mass.	Bologna, Orvieto, and as far as Pisa.	....	....	The rivers, &c. were troubled for more than twelve days.	Chron. d'Orvieto, Muratori, t. xv. p. 654; Chron. di Bologna, Muratori, t. xviii. p. 414; Chron. Cassinense, &c.
—— —— 10.	Rome, Naples, and all the south of Italy. Also felt throughout most of the other parts of Europe.	The shocks which commenced now lasted more than eight days.	....	Great damage done to buildings	Baglivi, p. 542; G. Villani, Muratori, t. xiv. p. 46.
1350	Rome. Also felt at Nardo.	....	....	....	Baglivi; Collection Académique; Chron. Neritinum, Muratori, t. xxiv. p. 905.
——	At Lisbon	....	....	....	Fr. Kries, von den Ursachen der Erdbeben, S. 16.
——	In Switzerland	....	....	A mountain was cleft by this earthquake........	Schmieder's Geognosie, p. 141.
1352. Dec. 25. In the evening.	Borgo-S-Sepolcro in Italy.	Continued until the 31st.	....	....	Mathæo Villani, Muratori, t. xiv. p. 189.

1353. Jan. 1. At night.	Borgo-S-Sepolcro and Modena.	The shocks were very violent, and continued at intervals for more than a month.	....	2000 people lost their lives	Mathæo Villani, and Chron. Mutinense, Muratori, t. xv. p. 618.
—— March 1.	In Romagna, extending all along the coast, and even to Constantinople.	Very violent shocks.	....	....	Mathæo Villani, Muratori, t. xiv. p. 227.
1354. In the beginning of spring.	All the coast of Thrace.	....	....	Great damage done to both life and buildings. Probably only the same event with the last.	Cantacuzene, Hist. 2. p. 861.
1355. Sept. About the 9th hour.	Bâle and Strasburg ...	....	....	Buildings thrown down. The two-vol. edition of the chronicle cited does not mention this event.	Chron. Hirsaug. (one-vol. edition), p. 295.
——	Rome	....	....	....	Collection Académique; Baglivi, p. 542.
1356. Aug. 24	Lisbon	The shocks lasted a quarter of an hour, and contiued at intervals for a year.	....	Many buildings thrown down	Tavares, über die mineralwasser Portugals; Mém. de Chronol. t. ii. p. 912.
—— End of Sept. and beginning of Oct.	Spain, especially at Cordova, Seville, and Basala. Also slightly in Tuscany.	Many shocks	....	....	Mathæo Villani, Muratori, t. xiv. p. 404.
—— Oct. 18. 10 P.M.	All the upper Rhine, especially at Strasburg and Bâle, district of Constance, Lausanne, Berne, and the borders of Bavaria. Guillaume de Nangis says that Rheims and Paris also experienced it.	The shocks recurred at Bâle during the whole of the year.	....	Thirty-eight chateaux were destroyed in the bishopric of Constance. At Bâle, after the shocks, the town took fire, and the flames were not extinguished for some days.	Bertrand; Lycosthenes; Frytschius; Chron. Hirsaug.; Guillaume de Nangis, &c.
1357. May 14. About 7 or 8 A.M.	Bâle, Strasburg, and all through Alsace, Neufchatel and Soleure in Switzerland. Also in Swabia, and in Spain at Seville and Cordova.	Very violent shocks.	....	....	Chron. Hirsaug.; Martène et Durand; Lycosthenes; Frytschius; Bertrand, &c.
1358	Laybach in Carniola ...	....	....	Followed by an abundant harvest	Collection Académique.
——	Poland	....	....	....	Gentleman's Magazine, vol. lvii. p. 175; Gazette de France, 14 Avril, 1786.

1.	2.	3.	4.	5.	6.
1361. July 17. Hour of vespers.	District of La Puglia in Italy.	Violent shocks	....	At Ascoli 4000 persons perished	Mathæo Villani, Muratori, t. xiv. p. 664.
—— Dec. 27. In the morning.	At Sienna	Seven terrible shocks, and in the next twenty-four hours seventeen or eighteen, great and slight. The shocks did not entirely cease for four days.	....	Great destruction of buildings. The inhabitants encamped under tents. Followed by diseases.	Chron. Sanese, Muratori, t. xv. p. 169.
1363. (On a Thursday.) Midnight.	Modena?	Three shocks	....	Accompanied by noise	Annales veteres Mutinensium, Muratori, t. xi. p. 83.
1364. Feb. 1	Bologna?	Two violent shocks...	....	....	Chron. di Bologna, Muratori, t. xviii. p. 473.
1365. Mar. 4. At night.	Venice, Padua, Trevisa, Ferrara, and the country round..............	Great shocks for an hour.	....	The Chron. Estense says the 6th March, and only mentions Ferrara as affected.	Ditto, p. 477.
—— July 25	Bologna	Violent shocks	....	Accompanied by thunder, and followed, the next day, by a violent storm.	Ditto, p. 478.
1367. Sept. 21. At the rising of the sun.	Verona....................	A violent shock, followed after an interval of half an hour by a second.	....	....	Chron. Veron., Muratori, t. viii. p. 658.
1368. In Whitsun-week. (Whit-Sunday being on the 21st May.)	In Thuringia, at Mühlhausen, Eisenach, and other places.	....		....	Rivander's Düringische Chronica, p. 426.
1370	Province of Alves in Iceland.	....	....	....	Voyage en Islande, p. 313; v. Hoff.
1372. June 1	At Bâle	Some slight tremulous motion, not felt except in the immediate environs.	....	The Collection Académique mentions a second earthquake at the same place on the 1st July of the same year, but it is probably only a mistaken date for the single event here mentioned. Five days after the earthquake a ring round the sun and two crosses were observed.	Bertrand; Collection Académique; Lycosthenes.

1372	District of Ribagorça in Arragon, Spain.	Terrible earthquakes.	....	Mountains were reduced to ruins (landslips) ...	Turquet, Histoire d'Espagne, p. 822.
1373. Jan.	Vicenza in Italy	Two very violent earthquakes on the same day.	....	Accompanied by noise	Annales Vicentini, Muratori, t. xiii. p. 1240.
—— Mar. 1. 2nd hour of the day.	Venice	A great earthquake...	....	....	Marino Sanuto, Vite de' Duchi di Venezia, Muratori, t.xxii. p. 673.
—— —— 11. Middle of the night.	Arragon in Spain	One shock	....	....	Chron. Vliacense, Marca Hispanica, p. 759.
—— —— 19. After the setting of the sun.	Ditto	A second shock	....	....	Ditto.
—— April. At night.	Vicenza in Italy	....	....	Accompanied by noise	Annales Vicentini, Muratori, t. xiii. p. 1240.
—— May 19	Venice	Another great earthquake.	....	....	Marino Sanuto, *loc. cit.*
—— June 5	Ditto	Ditto	....	....	Ditto.
1374	Montpellier in France...	Four earthquakes during the year.	....	....	Petit Thalamus de Montpellier, MS. communication from M. de Christol to M. Perrey.
1376. March 12. In the morning.	Vicenza in Italy	Preceded by three others betw^{n} the 25th Dec. and this date.	....	Accompanied by noise. Every one considered this earthquake as not less violent than that of the 25th January 1348.	Annales Vicentini, Muratori, t. xiii. p. 1244.
—— —— 19. At night.	Ditto	Very violent........	....	The morning bright and clear. Much hail and snow during the day and evening. The earthquake accompanied by noise.	Ditto.
—— April. Night between 10 and 11.	Ditto	Four more shocks ...	....	Attended with noise	Ditto.
1378. Jan....	In the north of Spain...	....	....	Masses of rock were detached from the Pyrenees and fell into the valleys below.	Palassou quotes Abrégé nouveau de l'Histoire d'Espagne, t. xi. p. 122. (Edit. in 12mo.)
—— June 1	In Switzerland	A considerable earthquake.	....	Bertrand and the Collection Académique give the date 1st July 1380, but it is probably the same with that mentioned here.	Lycosthenes; Bertrand; Collection Académique.
1382. April 20	Various parts of France and Switzerland. Also in Italy.	....	....	....	Bertrand, p. 38; Massæus.

1.	2.	3.	4.	5.	6.
1382. May 21 and 24.	In Britain. Also in France, Brabant, Flanders, and the country round.	....	Some days after, vessels were violently dashed against one another by the agitation of the waves.	Most violent in England. The Collection Académique says that there were reiterated shocks this year in Switzerland and Italy, and great disease in the former country, as also in Germany, there being a complete absence of winds there. Lycosthenes gives the date 1381.	Martène et Durand, t. v. p. 321; Baronius, t. xv. p. 88; Collection Académique, &c.
1383. Aug. Hour of nones.	At Mytilene........	Extremely violent shocks.	....	The buildings were rocked from side to side like trees in a tempest. After midnight all were in ruins. 500 persons perished.	Muratori, t. xviii. p. 90.
1385. July 16 At night.	In England	Followed by another earthquake the same year, the exact date of which is not given.	....	....	Thom. Walsingham, Hist. Angl., Camden, Anglic. Norm. p. 315 and 326; Collection Académique.
—— Sept. 19. Middle of the day.	Vicenzà	....	....	Accompanied by noise	Annales Vicentini, *loc. cit.* p. 1262.
1389. Feb. 10. Immediately before sunrise.	Ferrara?	Lasted twenty minutes.	....	....	Chron. Estense, Muratori, t. xv. p. 503.
—— Oct....	In Tuscany, especially at Castello, Mercatello, and Borgo-S-Sepolcro. *Feebly* felt throughout almost all Italy.	....	....	Many buildings thrown down	Annales Forolivienses, Muratori, t. xxii. p. 196.
1391. March 22.	In Switzerland	....	....	A comet appeared to the people of Germany, followed by great rains, inundations, famine, and pestilence.	Lycosthenes; Collection Académique.
——	Throughout almost the whole of Iceland.	....	....	....	Voyage en Islande, p. 313; v. Hoff.
1392. Jan. 27	All the Neapolitan coast.	No land shock mentioned.	The sea retired more than 40 paces, leaving the shore dry.	....	Annales Bonincontrii, Muratori, t. xxi. p. 60.
1393. May 30 to June 15.	Galiata in Italy	Numerous shocks	....	Caused great damage	Chron. di Piero Minerbetti, Muratori, t. xxvii. p. 317.
—— July 5	Bologna	Violent shocks	....	"On the 11th little children had the small-pox, and on the 18th there was a terrible tempest."	Chron. di Bologna, Muratori, t. xviii. p. 356.
1394. Mar. 22	Switzerland, France, and Germany.	Exceedingly violent	....	The mountains were shaken to their summits. Followed by excessive heat, and an abundant and early harvest.	Bertrand; Scheuchzer; Mém. de Chronol. t. ii. p. 913.

9 A.M. to 4 P.M.	at Tortosa in Spain.	Many shocks	....	Many buildings, &c. ruined. At Alcira two fountains gave forth water of an abominable smell, and the colour of ashes.	Ferreras, Histoire générale d'Espagne; Palassou.
—— Middle of December.	Valentino in Italy	....	....	....	Baronius, t. xv. p. 167.
——	Nardo, and all through the province of Otranto.	....	....	....	Chron. Neritinum, Muratori, t. xxiv. p. 908.
——	At Antwerp..........	....	....	So violent that dishes, &c. would not remain at rest on the tables.	Communication of M. Quetelet to M. Perrey.
——	In Germany	....	....	....	Physicalische Betrachtungen über das Erdbeben, u. s. w. Vorrede.
1397	Montpellier in France...	....	....	Accompanied by an epidemic	Petit Thalamus de Montpellier, MS. Communication of M. de Christol to M. Perrey.
1399. July 20. 5th and 6th hours.	Modena?	Two violent shocks .	....	....	Annales veteres Mutinensium, Muratori, t. xi. p. 83.
—— —— 21. 6th hour of the night.	Ferrara..........	....	....	A pestilence in the country, the same year	Annales Estenses, Muratori, t. xviii. p. 958.
1402	Syria	....	The sea retired, so that the bottom could be seen at more than a mile from the ordinary beach, and then returned with great impetuosity.	Many towns were ruined, and mountains overthrown.	Muratori, t. xviii. p. 974.
1403. Mar. 17	Rome	A violent earthquake.	....	....	Baglivi, p. 542; Collection Académique.
——	Japan	....	....	....	Kämpfer v. Dohm, t. i. p. 232.
1405	Ditto	....	....	Accompanied by an eruption of a volcano in the province of Simotsky in Japan.	Ditto.
1406. Sept. 16. 3rd hour of the night.	Naples	....	....	....	Giornali Napolitani, Muratori, t. xxi. p. 1070.
1408. Jan. 3. At dawn.	Ferrara?	Slight, and lasting but a short time.	....	....	Annales Estenses, Muratori, t. xviii. p. 1045.
——	Japan	....	....	....	Kämpfer v. Dohm, t. i. p. 232.
1409. Aug. 16. At night.	Ferrara. Not felt elsewhere.	....	....	....	Diario Ferrar., Muratori, t. xxiv. p. 174.

1.	2.	3.	4.	5.	6.
1410. Aug. Night between 9 & 10.	Venice	A slight shock		Followed, on the evening of the 10th, by a terrible tempest, which did great damage.	Vite de' Duchi di Venezia, *loc. cit.* p. 853.
1413. Aug. 8	Sienna	The shocks continued night and day (for how long?).		Many houses, &c. were thrown down	Archivio dello Spedale.
1414. Aug. 3. 22nd hour.	Pisa, Lucca, Florence, and Borgo-S-Sepolcro.	Very violent shocks.		At Borgo-S-Sepolcro houses were thrown down, and 200 persons perished.	Archivio storico Italiano, t. vi.
—— —— 7. Hours of nones and vespers.	Florence	Two very violent shocks.		Overthrew 200 chimneys, and cracked some of the walls.	Istorie di Fiorenze, Muratori, t. xix. p. 956.
1415. June 21	Bâle			The inhabitants took flight	Bertrand and Coll. Académique.
1416. July 22	Ditto			Possibly only the same with the last	Bertrand; Collection Académique; Lycosthenes; Scheuchzer.
1418. A little before Apr. 7.	Throughout Dalmatia	Shocks on several days and nights. Very violent.		Many houses ruined, and the walls of a castle overthrown.	Muratori, t. xxii. p. 920.
1419. (Sept.?)	Above Trente, towards Morano in Italy.			The earthquake caused an inundation between two mountains. 600 cabins were ruined, and 800 persons perished. (By the earthquake or the inundation?)	Vite de' Duchi di Venezia, *loc. cit.* p. 930.
1420	Sienna	Very great. It lasted the time one would take to make twenty steps.			Annali Sanesi, Muratori, t. xix. p. 428.
——	Province of Catalonia in Spain.	The earth trembled every day (for how long?).		The town of Amer was overthrown	Palassou, Suite des Mém. pour servir à l'Histoire nat. des Pyrénées, p. 379.
1421. Sept. 18	Negropont	Violent shocks lasting for four days.		The people lived in tents during this earthquake.	Muratori, t. xxii. p. 940.
1425. Aug. 10. 1 P.M.	Ferrara	One great shock at the time mentioned, and two others an hour and a half after.		Chimneys were thrown down by the last two shocks.	Diario Ferrar., Muratori, t. xxiv. p. 185.
1426. Sept. 29. Between 1 and 2 A.M.	Throughout the whole of Great Britain.	The shocks lasted for two hours.		Preceded by a dreadful tempest	Stow's Annals, p. 368; Collection Académique; Mém. de Chronol. &c.
——	Naples				Edinburgh Encyclopædia, Article Chronology.

1427. (May 15, according to an ancient Catalan manuscript.)	In Spain, especially at Olot in Catalonia. Also felt at Montpellier in France.	Numerous shocks ...	....	Twenty towns were much injured. In this year one of the well-known risings of the island of Santorin in the Archipelago took place.	Huot, Cours de Géologie, t. i. p. 109; Palassou, p. 378.
1428. Feb. 2	Ditto	....	....	Many towns ruined........	The Catalan manuscript cited above, as quoted by M. Fournet in the memoir of M. Perrey on the earthquakes of the basin of the Rhone, Notes additionnelles.
—— July 4	In Romagna	....	....	Chimneys thrown down in many places	Annales Foroliviensess, Muratori, t. xxii. p. 215.
—— Dec. 13. In the evening.	Bâle, and the country round.	....	....	Tiles were thrown from the roofs, chimneys overthrown, and walls cracked. Great damage was done throughout the canton.	Lycosthenes; Bertrand; Collection Académique; Scheuchzer.
1429. Sept. 16. 18th hour.	Forli in Italy	Lasted but a short time.	....	....	Chron. Foroliv., Muratori, t. xix. p. 902.
1430. Aug. 12. 6th hour of the night.	Sienna	A great and sudden earthquake.	....	....	Tizio, Hist. Senens. t. i. p. 212.
1431. April 24. 2 P.M.	Catalonia, Arragon, and at Roussillon. Also at Ciudad Real.	Exceedingly violent.	....	Some fortifications were thrown down	Charenton, Histoire d'Espagne, t. iv. liv. 21. p. 263; Palassou, p 261.
Some time after the 24th.	Grenada	....	....	....	Ditto.
——	Laybach in Carniola ...	....	....	Followed by great fertility	Collection Académique.
1433. May...	Bologna	Very violent shocks.	....	....	Sigonius, de episc. Bononien. lib. iv. p. 470.
——	Throughout Silesia	....	....	....	Annales Silesiæ, Cur. Freistadiensi, p. 312.
1436. March. Towards the end of the month.	Sienna	Very violent	....	The bells were made to sound, and houses were overthrown.	J. Bandini, Hist. Senen., Muratori, t. xx. p. 48.
1438. Jnne 10. Last hour of the night.	Placenza, Parma, and the neighbourhood.	....	....	Houses thrown down	Annales Placentini, Muratori, t. xx. p. 875.
1443. June 5	Bohemia, Silesia, Poland, and especially Hungary.	....	....	Many buildings ruined	Annales Silesiæ, p. 137; Martini Cromeri, de Reb. Polon. p. 328; Bonfinius, Rerum Hungar. dec. 3. lib. vi. pp. 456, 465, &c.

1.	2.	3.	4.	5.	6.
1444. Nov. 30. Before sunrise.	Bâle and its environs ...	A slight earthquake...	....	In the beginning of this year there were eruptions of Etna, and volcano in the Lipari islands, each accompanied by earthquake shocks.	Bertrand; Scheuchzer; Collection Académique. [part 2. p. 1132.
1448. Nov. 4	Rome	....	....	All the houses were much shaken..................	Vitæ Rom. Pontif., Muratori, t. iii.
——	Naples	....	....	Some thousand people perished.....................	Lycosthenes; Frytschius.
1448 or 1449	Ravenna	....	....	Preceded by continuous rain	Collection Académique; Bertholon, Électr. des Météores, t. i. p. 370.
1449. Apr. 23	"In Flanders and some other places."	....	....	....	Platina and Massæus.
——	Laybach in Carinthia ...	....	....	Followed by a frightful pestilence.................	Collection Académique.
1450	In the kingdom of Naples.	Extremely violent ...	....	Naples, Ariano, Cara, and other towns suffered greatly.	Frytschius; Casp. Goldwurm, Beschreibung göttlicher und teuflischer Wunderzeichen, Frankfurt, 1567; Sebast. Franckens, Chronicon Germaniæ.
1453. Sept. 28. 4th–5th hour of the night.	Florence	According to Martène & Durand the shocks lasted seven hours. The Chron. di Bologna says that they recurred on the 30th Sept. and 1st Oct.	....	Many walls cracked, and chimneys thrown down.	Chron. di Bologna, Muratori, t. xviii. p. 703; Martène et Durand, t. v. p. 482.
1454. Dec. 4	In La Puglia, the Calabrias, and Naples.	Shocks during three days.	....	....	Mémorial de Chronologie, t. ii. p. 913.
1455. Dec. 20. $4\frac{1}{2}$th, $5\frac{1}{2}$th, and 9th hours of the night.	Bologna	Three shocks at the hours mentioned.	....	The first shock threw down some chimneys, &c., and was accompanied by noise. Sigonius gives the date Dec. 21.	Chron. di Bologna, *loc. cit.* p. 719; Annal. Bonon., Muratori, t. xxiii. p. 888.
1456. Aug. 22	Sienna	....	....	....	Sarti, Saggio di congetture su i terremoti, *loc. cit.*
—— —— 26. 2 A.M.	Liège	....	....	....	Martène et Durand, t. v. p. 491.
—— Dec. 5. Between the 10th and 11th hours of the night. (v. Hoff says 6 in the evening).	Throughout the kingdom of Naples. Also felt at Rome, and probably further north. Lausanne and all the Canton du Vaud were violently shaken.	Very violent and destructive shocks.	....	A great many towns very much injured. 60,000 persons perished. Sarti reports it as having been felt at Sienna on the 9th, but it is probably only the same earthquake.	Baronius, t. xvii. p. 176; Giannone, Hist. di Napoli, t. iii. p. 7; Martène et Durand, t. v. p. 494; Collection Académique, &c.

1456. Dec. 25. About 6 A.M.	Ditto				Ditto.
—— —— 30.	Ditto				Ditto.
1457. Apr. 26. 22nd hour.	Castello and Perugia			180 houses were thrown down at Castello, at Perugia no damage was done.	Chron. di Bologna, Muratori, t. xviii. p. 725.
—— —— 29. From evening to morning.	Ditto	Twenty-five shocks in the time mentioned, of which the last was the most violent.			Ditto
—— —— 30. 5¾ hour.	Ditto, principally at Perugia.			These three earthquakes do not appear to have extended beyond the territory of the two towns mentioned.	Ditto
——	Island of Hydra in the Archipelago.	Violent shocks		During the shocks the island was increased in size by land raised from the sea.	Expédition scientifique en Morée, Part. géol. p. 269.
1458. April 7.	Castello	Several shocks		A large portion of the town ruined	Annales Foroliv., Muratori, t. xxii. p. 225.
1459. Mar. 18. 1st hour of the night.	Sienna				Philippi de Lignamine Chron., Muratori, t. ix. p. 270.
—— Nov. 7th hour of the night.	Ditto				Ditto.
1461. June.	Bocino				Istoria Napolitana, Muratori, t. xxiii. p. 235.
—— Aug.	Ditto				Ditto.
—— —— 22. 2nd hour of the night.	Sienna	One very violent shock, followed by other slighter ones.			Allegretti, Diari Senesi, Muratori, t. xxiii. p. 772.
—— Sept. 3.	Ditto	A shock which did great damage.		Preceded for some months by great heat and drought.	Ditto.
—— Nov. 20.	Aquila			Some houses overthrown	Annales Foroliv., Muratori, t. xxii. p. 225.
—— —— 27. 5th hour of the night.	Ditto	Very violent shocks		200 persons lost their lives	Philippi de Lignamine Chron., Muratori, t. ix. p. 271; Chron. di Bologna, Muratori, t. xviii. p. 742, &c.
1463	Rome				Funccius and Palmerius.
1465. Jan. 22. 5½ hour of the night.	Bologna?	Moderate			Chron. di Bologna, *loc. cit.* p. 758.

1.	2.	3.	4.	5.	6.
1465. (May 13?).	Gubbio?	Two great earthquakes, followed by a third still greater during the night.			Chron. Eugubinum, Muratori, t. xxi. p. 1009.
1466. Jan. 14. 9th hour.	Naples and the country round, especially at Bocino, Piescopagano, &c.	Lasted the time of a *miserere*, decreasing however in violence towards the end.			Istoria Napolitana, Muratori, t. xxiii. p. 234.
—— In summer.	Soissons and the neighbourhood.	Great earthquakes		Many buildings thrown down. Accompanied by a pestilence and great storms.	Mézerai, t. ii. p. 126 (3 vol. edit.).
—— Oct. Night between 27 and 28.	Gubbio				Chron. Eugub., Muratori, t. xxi. p. 1013.
—— Dec. 26. 15th hour.	Ditto				Ditto.
——	Japan	Many earthquakes in the same year.			Kämpfer, v. Dohm, p. 233.
1467. Aug. End of the month.	Sienna	Very violent shocks, lasting for twenty days.			Hist. Senen., Muratori, t. xx. p. 63.
1468. Feb.	Vienna	A disastrous earthquake.			Chronicon Haselbergii Viennense.
1470. Feb. 6. 5 P.M.	Bâle	One shock		Accompanied by great cold and a heavy fall of snow. Mérian gives the date 21st Feb.	Bertrand; Collection Académique.
1471. March	Gubbio?	Great and numerous shocks.			Chron. Eugub., Muratori, t. xxi. p. 1020.
—— Aug. 15. 22nd hour.	Brescia			The author who reports this event, says that there fell this year in Italy hailstones larger than ostrich eggs.	Philippi Bergomat. suppl. chron. fol. 388.
1473. May 7. 13th hour.	Milan, Pavia, and Placenza.			Rain continuous for almost the whole month	Annales Placentini, Muratori, t. xx. p. 942.
1474. Dec. 17. 17th hour.	Sienna	Five great shocks			Allegretti, *loc. cit.* p. 781.
—— —— 18. 12 in the morning.	Ditto	One shock			Ditto.
1475. Aug. 24.	Frankfort on the Maine.				Lerner's Chronik; Kriegk. *loc. cit.*

1479. Middle of Oct. In the afternoon.	Ravenna				Martène et Durand, t. iii. p. 1071.
1481. Feb. 7. 5th hour of the night.	Parma	Three shocks			Diarium Parmense, Muratori, t. xxii. p. 364.
—— ——	Pisa and Lucca	Very great shocks			Matthiæ Palmerii, *loc. cit.* p. 269.
—— About the middle of May.	Territory of Fivizzano in Tuscany, and the neighbourhood.	Sixteen shocks		Seventeen houses entirely overthrown, and several others injured.	Diarium Parmense, *loc. cit.* p. 373.
—— After Aug. 19.	Island of Rhodes				Collection Académique.
——	Ragusa				Paul Partsch, Bericht über das Detonations-Phänomen auf der Insel Meleda bei Ragusa, Wien, 1826, 8. p. 188.
1482	Ditto				Ditto.
1483. Mar. 11.	Ferrara	A very great earthquake. The bell of Rigebello sounded five strokes.			Diario Ferrar., Muratori, t. xxiv. p. 266.
1484. Jan. 20. About midnight.	Rome. Also felt at Lamentana, Castel-Nuovo, &c. in the neighbourhood.	Lasted an *Ave Maria*.			Vitæ Roman. Pontif., Muratori, t. iii. part ii. p. 1083.
1486. Sept. 30.	Sienna	Two shocks, followed a little after by a third much more violent.			Allegretti, *loc. cit.* p. 821.
——	Naples			Caused great injuries to the city	Vivenzio, Istoria de' tremuoti, &c. p. 11.
1487. Dec.	Padua	Very violent		The church of the Carmelites was thrown down.	Tarcagnota, *loc. cit.* fol. 315.
1489	S-Sepolcro	One shock		Some houses were thrown down	Sarti, Saggio di congetture, &c.
——	Constantinople			Bernherz and v. Hoff give the date 1490, without however quoting any authority.	Edinburgh Encyclopædia, Article Chronology.
1490	In Italy, extending even to Constantinople.			The town of Avano was destroyed	Huot, Géol., t. i. p. 110.
——	The whole of the island of Candia.			Did great damage	Olivier, Voyage dans l'Empire Ottoman, t. ii. p. 298.
1491. End of Oct.	In the Archipelago, especially in the island of Cos.	Very violent shocks		In Cos, 5000 people perished under the ruins. The Collection Académique gives the date 1493.	Tarcagnota, Hist. del Mondo, t. iv. fol. 318.
1492. Nov. 7.	Bâle	Very violent			Bertrand; Collection Académique.

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1493. Jan. 18. In the evening.	Sienna			Followed by a high wind, which increased during the night.	Allegretti, *loc. cit.* p. 828.
1494. Nov. 19. In the evening.	Pisa	During the course of the month, many shocks both by day and night, of which some were very violent.			Portoveneri, Memoriale, nell' archivio storico Italiano, t. vii. part 2. p. 293.
1495. Dec. 13. About the 2nd hour.	Ferrara	Lasted the time of saying a *pater* and an *ave Maria.*		Threw down thirty chimneys. It had been raining or snowing since the 1st, and the Po was much swollen.	Diario Ferrar. *loc. cit.* p. 316.
—— —— 30. 11 P.M.	Bologna				G. Agricola, Mineralog. Schriften Teutsch. übersetzt von Lehmann, Freiberg, 1807, B. ii. p. 209.
——	"In the East"				Mémorial de Chronologie, t. ii. p. 913.
——	Japan				Kämpfer, v. Dohm, p. 234.
1496. June 4.	Sienna	Two very great shocks.			Allegretti, *loc. cit.* p. 857.
1498. Nov. 10.	Bâle				Mérian, über die in Basel wahrgenommenen Erdbeben.
1500. May	Different parts of Switzerland.				Bertrand; Collection Académique.
1501. June 5. 13th and 14th hours.	Modena	Considerable shocks		Some chimneys were thrown down, and almost all the houses injured.	Annal. vet. Mutinensium, Muratori, t. xi. p. 86; Diario Ferrar., Muratori, t. xxiv. p. 396.
—— —— 9.	Ditto	Another shock		Threw down the church of St. Blaise.	Ditto.
——	Island of Candia				G. Doglioni, Theat. Univ. t. ii. p. 462.
1503	Venice	Shocks, lasting for several hours.			Mémorial de Chronologie, t. ii. p. 913.
1504. April 5. Between 9 and 10 A.M.	In Andalusia, especially at Carmona, Seville, and Torina on the Guadalquivir.	Exceedingly violent		Buildings were thrown down	Ferréras, Histoire d'Espagne, t. viii. p. 262; Turquet, Histoire d'Espagne, p. 1334.
—— May 27.	Geneva	A violent earthquake			Bertrand; Collection Académique.
—— June 10.	Ditto	Violent shocks			Ditto.
—— Aug. 23. About the 11th hour of the night.	In Belgium	Lasted but a short time.			Johannes de Los Chron. p. 119; Bulletin de l'Acad. de Bruxelles, t. ix. part 1. p. 559.

1504. At the end of the autumn.	Portugal	Many shocks	....	Some buildings thrown down. The date 1505 is also given.	Jean de Ferréras, *loc. cit.* p. 273.
1505. June 30. 4 A.M.	In Belgium	Lasted but a single instant.	....	....	Johannes de Los Chron. p. 120.
—— About the middle of the year.	The high land of Cabul in Afghanistan.	Extremely violent. On one day thirty-three shocks were counted, and each day and night for four weeks there were two or three.	....	The earth opened in many places, and closed again, often throwing forth water, which took the place of the dry land. For a space of six to seven German miles the surface of the earth was so altered and disturbed that parts were sometimes raised as high as an elephant above their former level, and then sunk as deeply below it.	Berghaus' Annalen der Erdkunde, 3te Reihe. Bd. 1. p. 312, quoting Sultan Baber's Memoiren.
—— Dec. 30. 9th hour of the night.	Bologna	....	....	....	Sigonius, p. 521.
1506. Jan. 1. 11th hour of the night.	Ditto	More violent than the last.	....	Accompanied by subterranean bellowing noises	Ditto.
1507	Constantinople	....	....	....	Huot, Géol. t. i. p. 110.
——	Island of Santorin	....	....	A part of the island sank into the sea	Dapper, Beschryving der Eilanden in de Archipel. p. 183.
——	Laybach in Carinthia ...	....	....	....	Vassali—Eandi, *loc. cit.*
1508. May 29.	In the Archipelago; especially in Candia, Paros, Naxos, and Chios.	Many shocks	....	....	Tarcagnota, t. iv. fol. 365; Muratori, t. xxiv. p. 595; Martin Baumgarten, lib. iii. c. 26.
——	Constantinople	Shocks for forty days.	....	Probably at the same time with the last mentioned.	Mém. de Chronol. *loc. cit.*
——	In Italy and Germany...	Several earthquakes	....	Accompanied by atmospheric perturbations......	J. Naucleri Chron. t. ii. p. 547; Stumpffius.
1509 Sept. 14.	Constantinople, and all the rest of the Turkish dominions, both in Europe and Asia Minor.	The shocks were the most violent ever known here, and lasted, according to some, 18 days, and to others 25.	The sea came over the walls at Constantinople and Galata.	1700 houses and large portions of the walls were thrown down, and some thousand people lost their lives. Tschorum, Gallipoli, Demitoka, and other towns were ruined. v. Hoff gives the date 1510.	Hadschi Chalifa; v. Hammer, Geschichte des Osmanischen Reiches, vol. ii. p. 349; Lycosthenes; Nauclerus, &c.
—— Nov. 1 and 2. The 1st at night; the 2nd towards evening.	Freiburg in the Brisgau	Two shocks	....	The second was rather a noise and disengagement of gas than an earthquake. The first lifted the roofs into the air, and let them fall again, alternately.	Frytschius, Meteor. method. dialectica, fol. 142, verso.
—— —— 16.	Adrianople	....	....	....	Hadschi Chalifa; v. Hammer, *loc. cit.*

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1509. Dec. 13.	Manosque (Basses-Alpes).	....	....	....	Statistique des Bouches du Rhône, Communication from M. Aug. Bravais to M. Perrey.
1510. June 10.	Nordlingen in Bavaria...	....	....	2000 individuals perished	Huot, Cours de Géologie, t. i. p. 110.
— During the winter.	In Italy; especially at Florence, Ravenna, and Venice.	Several earthquakes.	....	Accompanied by very high winds, and intense cold.	Mézerai, t. ii. p. 335 (4to edit.); Lycosthenes; Collection Académique.
1511. Mar. 26.	Venice. Also felt at Padua, Trevisa, &c.	Rather considerable, but lasting a very short time.	The water in the canals was much agitated.	Some houses and statues were thrown down ...	Tarcagnota, *loc. cit.* fol. 373.
—	Laybach in Carinthia ...	....	....	Followed by a dreadful pestilence........	Collection Académique.
—	Japan	....	....	....	Kämpfer, v. Dohm, p. 234.
1512	Valley of Palenza in Switzerland.	No shock felt	....	Two mountains separated, but whether this was caused by an earthquake or not, is not certain.	Bertrand; Collection Académique.
1513. Aug. 17.	Meissen in Saxony	Several shocks	....	....	Rivander's Düringische Chronik.
—	A mountain at the foot of the Alps, above Bellizone.	....	....	The mountain, shaken by an earthquake, fell with a great noise into the valley below, thereby diverting the course of the river Brennio.	Paul Joves, trad. de D. Sauvage, t. i. pp. 218 and 345.
1514. Jan. 20.	Bâle........		....	....	Merian, über die in Basel wahrgenommenen Erdbeben.
—	Zante	A violent shock	....	....	Montgomery Martin, History of the British Colonies, vol. v. p. 431.
1517. June 26.	Nordlingen in Bavaria, and the country for two miles round.	....	....	During a violent storm. Produced great ruins.	Lycosthenes; Fincelinus, lib. iii.; Münsteri Cosmograph. Univ. lib. iii.
1519	The lower valley of Djandul, one of the valleys of Cabul in Afghanistan.	A violent earthquake.	....	....	Berghaus's Annalen der Erdkunde, quoting Sultan Baber's Memoiren.
1520	Ragusa........	....	....	....	Partsch, Detonations-Phänomen zu Meleda, p. 188.
1521	Milan	....	....	....	Frundspergersche Geschichtschreiber, lib. ii.; Funccius.
—	Milan	....	....	....	Huot, Cours de Géologie, t. i. p. 110; v. Hoff.
1522	Bâle........	....	....	....	Merian, über die, &c. *loc. cit.*
—	Angers........	....	....	During an eclipse of the moon. There were two lunar eclipses this year, namely on the 12th March and 5th September.	Philippi Bergomat. Suppl. Chron. fol. 437.

1523. May 19. 3 A.M.	In Switzerland; especially at Neufchatel, and at Yverdun in the Pays de Vaud.	....	....	....	Bertrand; Collection Académique.
— Dec. 27.	Bâle	Three shocks	....	Berghaus in his preface to v. Hoff, quoting Merian, gives the date 28th Dec.	Ditto.
—	Different points in the kingdom of Naples.	Many shocks	....	....	v. Hoff.
—	Grenada in Spain	Ditto	....	....	Ditto.
1524. April 22.	Bâle	....	....	....	Merian, *loc. cit.*
— Sept....	Angers	Several shocks........	....	The French authors use the expression "un tremblement de terre *avait pensé* renverser la ville."	Chron. Nic. Gellen; Mézerai; Philippi Bergomat.
1528	Mayence	Ditto	....	....	Fr. Nauseæ, Blancicampiani, de præcipuo hujus anni 1528 apud Moguntiam terræ motu Responsum, 4to, p. 25.
1529. Sept. 11.	Bâle	....	....	....	Merian, *loc. cit.*
1530. Sept. 1.	Coast of Paria and Cumana, near the island of Cubagua, South America.	....	The sea rose four fathoms and sank again.	The earth opened in several places, and black fœtid salt water and asphalt came out. A mountain at the side of the gulf of Cariaco remained cleft. A fort and many houses were destroyed.	Humboldt, Voyage aux régions équinoxiales, t. ii. p. 272; Hist. des anciennes Rév. du Globe, p. 267.
— About Oct. 10.	Flanders, Holland, and Zealand.	....	During an inundation	Accompanied by heavy rain, thunder, and lightning.	Tarcagnota, Hist. del Mondo, t. v. fol. 69.
1531. Jan. 26.	Lisbon, the remainder of Portugal, Spain, the opposite coast of Africa, the Canton du Vaud in Switzerland, and Flanders.	At Lisbon there were extremely violent shocks seven or eight times a day for eight days.	The sea was greatly agitated, and swallowed up several vessels. The waters of the Tagus were driven upon the banks by the rushing in of the waves.	In Lisbon 1500 houses and all the churches were thrown down. v. Hoff does not seem to think that the shocks in Flanders occurred at the same time with the rest. Tavares gives the date Jan. 1. The Coll. Acad. says that earthquakes were very general the whole of this year and the next.	Turquet, Hist. d'Espagne, p. 1482; Collection Académique; Lycosthenes; Palmer; Naucler.; Goldwurm, &c.
— Beginning of the year	Bâle	....	....	Some houses were thrown down	Bertrand; Collection Académique.
1532	Lisbon	Another violent earthquake.	....	....	Lycosthenes.
1533. March 7.	Bâle	Very violent	....	....	Bertrand; Collection Académique.
— Nov. 25 or 26.	Throughout Switzerland, principally at St. Gall, the lake of Constance, and Neufchatel.	Several shocks........	....	Caused but little damage. The course of a river in Thurgovia was altered. The whole year was very stormy in Switzerland. Others give as the day of the month the 9th.	Bertrand; Coll. Acad.; Scheuchzer; Chron. German. u. Contin. Sleidani.

1.	2.	3.	4.	5.	6.
1533. Dec. 27.	Bâle	Three shocks			Lycosthenes; Merian, *loc. cit.*
——	In Italy	Several shocks			v. Hoff.
1534. Oct. 22. At night.	Zurich and the neighbourhood.			v. Hoff gives the date 11–12 Oct. (O. S.?), and says that it was felt at Baden, Bremgarten, Mellingen, Bruck, Windisch and Königsfelden. Followed by a violent storm in the cantons of Zurich and Lucerne. Ragor says that he himself was born at Windisch during this earthquake.	Bertrand; Coll. Acad.; Ragor.
1536	Valley of Mazaria in Sicily.			The earth opened, and a little town was swallowed up. On the 23rd March of this year an exceedingly violent eruption of Etna began, and lasted until the middle of April.	Fazelli, p. 212.
1537. May 1 to 13.	Naples, and throughout the whole of Sicily.	Slight shocks		Accompanied by subterranean noises like thunder. On the 11th Etna burst into eruption.	Fazelli, p. 55; Collection Académique.
—— Sept. 26.	Pozzuoli near Naples	Ditto, continuing slightly the whole of this year and the next.			Diarium Hist. p. 292.
——	Bâle				Merian; Collection Académique.
1538. Jan. 20 or 28.	Ditto	Several shocks		Both at Bâle, and throughout the canton, igneous meteors were seen after the shocks.	Bertrand; Coll. Acad.; Merian.
—— Sept. 27 and 28.	Pozzuoli, Naples, and all through Calabria.	Almost continuous shocks for these two days. More than twenty violent ones. All, however, ceased as soon as the eruption began.	The sea retired many paces from the shore.	On the 29th at about 2 o'clock at night, Monte Nuovo was raised, and afterwards entered into eruption.	Maria della Torre, Storia e fenomeni del Vesuvio, p. 61; Hamilton; Pietro di Toledo; Kircher, Mund subt., and many other authorities.
——	Quito and the country round.	Very violent		Followed by an eruption of Ruchu Pichincha	Hist. Gén. des Voyages, t. xix. p. 82; v. Humboldt, Ideen zur geogr. u. s. w. der Tropenwelt, p. 51.
1539. June 27. 7 P.M.	The Saxon Erzgebirge, and some other parts of Germany.			Lycosthenes mentions Chemnitz as having experienced this earthquake, and gives the date 25th June, 1540.	Agricola, Mineral. Schriften, Teutsch. übersetzt, t. ii. p. 209; Chron. German.
1540. July 18.	Bâle				Merian.
—— Dec. 14.	In Germany, probably as before in the Erzgebirge.			Lycosthenes gives this date, but it should probably be 1539.	Lycosthenes.
1541. End of Oct.	Algiers			Accompanied by a violent tempest	Collection Académique.

1542. June 9, or 12 or 13.	Tuscany. Also at Constantinople.	Six shocks in Tuscany	....	The little town of Scarparia was ruined	Tarcagnota, t. v. p. 124; Paul Joves, p. 560; v. Hoff.
—— Dec. 12. 23rd hour.	Sicily, Italy, and Turkey; especially in Sicily.	....	....	Syracuse, Leontium, Calatagirona, Catania, and several other towns in Sicily were ruined. The fountain of Arethusa and the wells of Syracuse for some days gave forth water more salt than usual.	Fazelli, pp. 71 and 567; Huot, p. 110; Goldwurm; Coll. Acad.
——	Mexico........	....	....	....	Memoir of M. Perrey on the earthquakes of Mexico and Central America.
1544. Jan. ...	Calabria	Violent shocks	....	Many houses were almost destroyed........	G. Fiore, *loc. cit.* p. 287.
1545. Sept. 6.	Throughout Europe ...	....	....	....	Mémorial de Chronologie, t. ii. p. 915.
——	Mechlin, Brabant, &c....	....	....	Probably the same with the last	A pamphlet in the British Museum.
1546	In Palestine........	....	The sea retired several miles (?) from the coast, and then returned with great impetuosity.	Joppa, Sichem, and Rama were especially injured. The bed of the Jordan remained dry for two days (?).	Rivander, in suo promptu.
1548. Feb. 9. After 4 A.M.	Bâle........	A slight shock........	....	The shock awoke Lycosthenes, who says that he felt as if his bed were raised up by some other person.	Lycosthenes; Bertrand; Coll. Acad.
1549. Mar. 12.	Brussels	Two shocks	....	....	Communication of M. Quetelet to M. Perrey.
—— May 31.	In Calabria	....	....	....	G. Fiore, p. 287.
1550	In the kingdom of Naples.	Disastrous shocks ...	....	Ariano was swallowed up. The same year (possibly at the same time) there was an eruption of Vulcano in the Lipari Isles.	Philip. Bergomat., p. 368.
1551. Jan. 26.	At Naples	Several shocks........	....	....	Mém. de Chronol. t. ii. p. 915.
—— —— 28.	Lisbon........	....	....	200 houses thrown down. Preceded by a remarkable aurora borealis.	Lycosthenes; Frytschius.
—— May 25.	Rygate, Croydon, and Darkin, in Surrey; especially at Darkin.	Many shocks	....	Kitchen utensils and other moveables were thrown from their places.	Strype's Memor. Eccles. vol. ii. p. 272; Collec. Acad.
1552. Mar. 6.	The Saxon and Bohemian Erzgebirge; especially at Freiberg, Joachimsthal, Eger, Bucha, and in Lusace.	Several shocks........	....	....	Fincelius and Rivander.
—— April 20. At twilight.	In the chain of the Sudetes, as at Meissen and Freiberg.	....	....	....	Lycosthenes.

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1552. Sept. 16. 6 P.M.	Bâle and the Valais. Also felt in Hungary, according to the Mém. de Chronol.	Slight	....	....	Lycosthenes; Bertrand; Collection Académique.
1553. Aug. 17. Between 7 and 8 P.M.	In the basin of the Elbe; principally at Meissen in Saxony.	....	....	Ruined some buildings	Lycosthenes; Eberus; J. Aug. de Thou, Hist. t. i. p. 409 (fol. edit.).
1554. Mar. 21. Midnight.	Belgium. (The author who reports this lived at Louvain.)	One violent shock ...	....	Accompanied by a subterranean noise like bellowing, and a brazen sound (æneus clangor) like the noise of many chariots in rapid motion. Vessels placed in elevated positions were thrown down.	Cornelius Gemma, De Nat. Div. Caract. lib. ii. p. 23.
—— —— 22. 4 P.M.	Ditto	Two violent shocks...	....	....	Ditto.
—— Apr. 30. 5 P.M.	Ditto	Three consecutive shocks.	....	....	Ditto.
1555. (In the second month of the Chinese calendar.)	In the provinces of Chan-si and Honan in China.	....	....	....	De Mailla, Hist. gén. de la Chine.
1556. Jan. 15.	Strasburg........	....	....	....	Pauli Eberi calendarium historicum.
—— —— 24.	Bavaria, Austria, in the Windischmark, Hungary, Croatia, Dalmatia, and Moravia.	The shocks lasted for four days.	....	Twenty-six townships (Ortschaften) were ruined	Ditto.
—— April 1. 11 P.M.	Province of Chan-si in China.	Lasted two hours. Extremely violent.	....	According to v. Hoff, a piece of ground of sixty leagues in circumference was sunk by this earthquake, and a lake produced in its stead. Very many people lost their lives.	De Mailla, Hist. gén. de la Chine, t. x. p. 321.
—— —— ...	The town of Rossana (Rossana Astropiæ), and the country round for a distance of thirty miles.	Very violent shocks	....	All the fortifications of the town were ruined. v. Hoff, quoting Bernherz, places this event in May, in connexion with the following account.	Lycosthenes.
—— May 10. 2 hours before dawn.	Constantinople	Very violent	....	Frytschius gives the date 10th March, and says that it lasted three days, doing great damage to houses, &c.	Eberi calendarium historicum.
——	Japan	....	....	....	Kämpfer, v. Dohm, t. i. p. 120.
1557. Apr. 24.	Zurich and Winterthur. Also in the Canton de Vaud, at Yverdun.	Several shocks........	....	Accompanied by much noise, but little damage.	Bertrand; Collection Académique; Scheuchzer.

1557.	In the neighbourhood of the volcano Tungura-gua, province of Quito.	....	....	Perhaps attended by an eruption of the volcano.	Bouguer, de la figure de la terre, p. 108, Hist. Gén. des Voyages, t. xx. p. 96.
1558. Apr. 13.	Sienna, Florence, and other parts of Tuscany.	Very violent	....	The water (fountain?) of Fontebranda rose three times to the height of more than two fathoms.	Libro di Mem. delle Monache del Santuccio.
—— May 17.	Thuringia.........	....	....	Followed by disastrous inundations	Frytschius.
1559. Aug. 25.	Val di Diano (Calabria?)	Very violent	....	Did considerable damage	G. Fiore, *loc. cit.* p. 287.
——	Cattaro, not far from Ragusa.	....	....	....	Doglioni, p. 655.
1560. Dec. 13.	Vienna.........	....	....	Accompanied by a violent storm, with thunder and lightning, and by a noise like that of a carriage in motion.	Epit. rer. gest. sub Ferdin. 1, imper. Rer. German. S. Schard, t. iii. p. 2168.
—— —— 27. Midnight.	Zurich	A feeble shock	....	Followed, the same night, by an aurora borealis of great brilliancy, seen not only at Zurich, but all over Germany. The evening before, in the Duchy of Wurtemburg, a piece of land of twenty feet square suddenly sank to the depth of thirty-six feet, and water then rose at the bottom to the height of nine feet.	Scheuchzer, p. 74.
1561.	In the kingdom of Naples.	Several violent shocks	....	Many buildings thrown down, and the courses of streams altered.	Frytschius.
1563. Jan. 17.	In Belgium, probably at Louvain.	....	....	Accompanied by thunder and wind, and followed by great rains.	Corn. Gemma, *loc. cit.* p. 41.
—— June 13. About noon.	Cattaro, not far from Ragusa, and the villages round.	....	....	Did great damage both to this town and others.	S. Schard, t. iii. p. 2201; P. Justiniani Hist. Venet. p. 310; v. Hoff.
——	In Illyria.........	Violent	....	Probably simultaneous with the last.........	J. Aug. de Thou, Hist. t. ii. p. 381.
1564. July ...	At Nice, and in Provence	....	....	Accompanied by loud claps of thunder. Seven villages were destroyed.	Gazette de France of the 24th Jan. 1772; Mém. de Chron. t. ii. p. 915; Mém. de Turin, t. xix. p. 158.
1565. Feb. Night between 7 and 8.	In Hundsrücken, on the Moselle, and on the Rhine.	Several shocks.........	....	....	Chron. Univers.
——	Bâle.........	Violent shocks.........	....	....	H. C. Wieland's MS. Chronik, 1684.
——	Neighbourhood of Nice	....	....	Some hamlets were swallowed up by the earth	Nigrin's continuation of Richter's Chronik, Frankfort, 1598.
——	Guatimala, especially in the neighbourhood of the volcano Paraya.	....	....	Accompanied by an eruption of the volcano ...	v. Humboldt in der Hertha, Bd. vi. S. 138; v. Buch, Descrip. des îles Canaries, p. 510.

1.	2.	3.	4.	5.	6.
1568. July 26. At night.	At Meissen				Georg. Fabricius.
1569. Apr. 16. 9 o'clock (A.M. or P.M.?).	Berne	A slight shock			Benedict Martin.
—— May 14. Midnight.	Louvain	Two hours and forty minutes later, there were two other shocks felt consecutively, of which the latter lasted three or four minutes.		Accompanied by a hoarse noise. Gemma says of the first shock, "ferebant tùm temporis et spectra rursùs in aëre pervagata." And of the second, "colores tum in aëre vidi varios, inusta specie, valdè terribiles."	Corn. Gemma, *loc. cit.* p. 64; Coll. Acad.; v. Zach, Corresp. astron.
—— Aug. 6.	Bâle	A slight shock			Wieland's Chronik.
—— Dec. Night between 13 and 14.	Constantinople	Violent shocks, but lasting a very short time.			Coll. Acad.
——	In different places, principally in the island of Cyprus.			Probably simultaneous with the last	P. Justinian, *loc. cit.* p. 326.
1570. Nov. 17 to 30. Beginning at $9^h 45^m$ (A.M. or P.M.?).	Venice, Ferrara, Florence, Modena, Reggio, and all the adjacent country; especially at Ferrara.	Daily shocks for the time mentioned, and recurring at intervals for a whole year. In the first three days there were 84, of which 36 were very violent.		Great damage done to buildings at Ferrara	S. Schard, t. iii. p. 2462; P. Justin. Hist. Venet. p. 336; J. Aug. de Thou, Hist. t. ii. p. 777.
—— Dec. 6.	Strasburg, and Spires	Several shocks		Inundations of the Rhine and Rhone	J. Aug. de Thou, Hist. t. iii. p. 36.
——	In the Grecian Archipelago.				Acta Eruditorum, an. 1688, p. 517.
——	St. Jago in Chili, extending over a very large tract of country.		The sea retreated some leagues (?) from the coast.	Great landslips took place from the mountains.	Coll. Acad.; v. Hoff quotes Molina.
1571. Feb. 17. 6 P.M.	Kinnaston, near Marcle hill, Herefordshire. Also in Belgium.			A vast landslip took place, *the motion continuing* from the time mentioned (on Saturday) until the Monday evening following. The piece of ground moved was 400 perches long by 160 wide (containing twenty-six acres), and about thirty feet deep. It moved about forty paces.	Baker's English Chronicle, p. 419; De Larrey, Hist. d'Angl. t. iii. pp. 218 and 378; J. Aug. de Thou, Hist. t. iii. p. 85; Coll. Acad.; Phil. Trans. 1750.

1571. Feb. 19. Between 8 and 9 A.M.	Bale, Strasburg, and all through Alsace.	Violent shocks	....	The season was early, the winter cold, and the summer very hot. On the 12th, 13th, 14th, and 15th, auroræ boreales. Scheuchzer gives the date 1572.	Bertrand; Merian; Coll. Acad.
—— Mar. 5.	Constantinople, and the country for four miles round.	....	....	....	Huot, Géol.; Hondorff, Theatrum historicum.
—— Nov. 1.	Inspruck	....	The same day, a disastrous inundation on the coasts of Holland.	....	Beuther.
——	Tuscany and Lombardy.	Continuation of the shocks of the year before.	....	....	Collection Académique.
——	Island of St. Michel, Azores.	....	....	Threw down a mountain in the island	Prevost, Hist. gén. des Voyages, t. i. p. 325; Raspe, De nov. insulis, p. 111.
1572. Jan. 6. 9 P.M.	In Prussia	....	....	Accompanied by the fall of aërolites..............	Rer. German., S. Schard, t. iii. p. 2509.
—— —— 28. 7 A.M.	Inspruck. Also, about the same time, at Munich and Augsburg.	Shocks lasting three days at Inspruck. Those at the other places were less violent.	....	Caused some damage to buildings. v. Hoff gives as date the 22nd Jan.	Ditto and Franck. p. 968.
——	In Switzerland; especially at Lausanne, Aigle, and the Haut-Valais.	Many slight shocks...	....	....	Bertrand; Scheuchzer; Coll. Acad.
1573. Sept. 20.	Zurich and the adjacent country.	....	....	....	Bertrand; Coll. Acad.
—— Dec. 20.	Ditto	....	....	....	Scheuchzer.
—— —— 21.	The whole of the canton of Glaris.	....	....	Accompanied by subterranean noise, and followed by some damage to houses, &c.	Bertrand; Collection Académique.
1574. Feb. 26. Between 5 and 6 P.M.	York, Worcester, Gloucester, Bristol, Hereford, and the neighbouring counties.	Very violent	....	At Tewkesbury and some other places plates and books were thrown from their places. The people who were on their knees in the chapel of Norton, were almost all thrown down. A part of Ruthen Castle was ruined, and the bell in the market house of Denbigh sounded two strokes.	Stow's Chronicle, p. 679; Coll. Acad.; Rév. du Globe.
—— May 3.	Geneva and the neighbourhood.	Several shocks	....	The town gate of Cornevin was thrown into the fosse.	Spon, Hist. de Genève, t. i. p. 521; Bertrand; Coll. Acad.
—— June 30.	Zurich and the neighbourhood.	Many shocks	....	....	Bertrand; Scheuchzer.

1.	2.	3.	4.	5.	6.
1574. July 30.	Bâle	One shock			Wieland's Chronik.
——	Offenburg. (In Baden, or in Transylvania?)			The walls of the town were much cracked	Beuther.
1575. April 24.	Geneva				Spon, Hist. de Genève, t. i. p. 521; Bertrand; Coll. Acad.
—— July 27.	Lisbon	Violent		Caused no injury to buildings	Tavares, in Balbi, Essai sur le Portug. t. i. p. 102.
——	Laybach in Carinthia				Collection Académique.
——	The Thames at London		The tide ebbed and flowed twice within an hour.		Baker's English Chronicle, p. 420.
——	The district of San Salvador in Mexico.	Disastrous earthquake			Ennery et Hirth, Dict. de Géogr. t. iv. p. 508.
1576. Oct.	Bâle	Several shocks			Ryffische Chronik (1514–1584).
—— Nov. 20, 21 and 22.	Ditto	More shocks			Ditto, and Wurstisen's Chronik; Bertrand; Coll. Acad.
—— Dec. 20 and 21.	Ditto	Ditto		Accompanied by very intense cold	Bertrand; Coll. Acad.
1577. Feb. 27.	Ditto. Also felt at Geneva, and in the Pays de Vaud.	One shock			Ragor.
—— Sept. 22. Between 2 and 3 A.M., at 5 P.M., and during the night.	Bâle, and all through Switzerland, especially in the Pays de Vaud, at Aigle.	Three shocks at the times mentioned; the second less violent than the first, and the third, according to one of M. Perrey's memoirs, more violent, and according to another, less so, than the second.		All through the course of this year many shocks were felt in different places in Switzerland.	Bertrand; Stumpf's Schweizer Chronik.
—— —— 23.	Ditto				Ragor.
—— —— 24.	Ditto				Ditto.
—— —— 29.	Ditto				Ditto.
—— Oct. 5.	Bâle				Ragor; Wieland's Chronik.
—— —— 18.	Ditto				Ditto.
—— Nov. 30.	In Mexico (lat. 13° 32′ N.)	"A very remarkable earthquake."			v. Humboldt, *loc. cit.* t. ii. p. 297.
——	Strasburg, Hagenau, and the neighbouring places.	Several shocks		Probably simultaneous with some of the earthquakes at Bâle.	Beuther.

1577	Island of Cyprus	Very violent shocks...	....	The people were driven to live in the open country.	Tarcagnota, *loc. cit.* t. v. p. 297; Sleidanus, t. iii. p. 63.
1578. (May 18? Whitsunday) 10 P.M.	Ofen in Hungary.........	....	....	During a storm of thunder and lightning.........	Bernherz.
—— June 17.	Peru, especially at Lima	....	....	....	Ulloa, Hist. gén. des Voyages, t. xx. p.31; v.Humboldt,Voyage, t.i. p.317.
—— Sept. 28.	Throughout Switzerlaud. Most violent at Zurich.	....	....	....	Bertrand.
——	Town of Sciacca in Sicily.	....	....	The town was ruined. This same year, or the following, an eruption of Etna.	Ferrara, Campi flegrei.
——	Java........................	....	....	....	Hist. gén. des Voyages, t. ii. p. 401; Raffles's History of Java, t. ii. p. 234 and Append.; John Prior's Voyages in the Indian Ocean.
1579. Jan. 26.	Tours, Orleans, and Chartres.	....	....	....	Mém. de Chronol. t. ii. p. 915.
1580. April 6. 6 P.M.	Throughout England, especially at London, Dover, and the whole of Kent. Also in France at Boulogne, Calais, Paris, &c., in Belgium at Brussels, Malines, Cologne, &c., in Zealand, and Holland. Most violent in England.	At London and the environs, the earthquake lasted about one minute. Two other slighter shocks were felt all through Kent, namely, at 9 and 11 P.M.	At Sandwich the sea was so much agitated that the vessels in harbour were dashed against one another. The same happened at Dover.	The great bells at Westminster and other places were made to sound. Portions of several buildings, and very many chimneys were thrown down in London. The heavens were serene, and the air quite tranquil.	Camden, Hist. of Elizabeth, p. 314; De Larrey, *loc. cit.* pp. 330 and 368; Phil. Trans. vol. xlvi. p. 660; Stow's Chron.; De l'Estoile, Journ. de Henri III. t. i. p. 198; J. Aug. de Thou, Hist. t. iii. p. 766.
—— May 1. Midnight.	County of Kent, especially at Ashford. Also in the Netherlands, as far as Cologne.	Very considerable ...	....	....	Camden, *loc. cit.*; J. Aug. de Thou, *loc. cit.*, and p. 784; Coll. Acad.
——	In Spain, the Pyrenees, and as far as Bordeaux.	....	....	....	Mémorial de Chronologie, t. ii. p. 915.
—— or 1581.	In Iceland	Very violent	....	An eruption of the volcano Katlegiaa took place about the same time, but whether it was exactly simultaneous with the earthquake or not, is doubtful.	v. Hoff.
1582. May 1.	Naples and Pozzuoli ...	....	....	Some buildings were thrown down	Vivenzio, p. 11.
——	In Peru, especially at Arequipa. Also felt at Lima.	Ditto	....	Arequipa was ruined. v. Hoff mentions an earthquake in this year, in the district of Angoango, Peru, which he thinks may be a distinct one.	Collection Académique.

1.	2.	3.	4.	5.	6.
1583. Jan. 13.	Blackmore, Armitage, in Dorsetshire, England.	....	....	Accompanied by a landslip of more than three acres, which moved about 900 feet. Possibly not a true earthquake.	De Larrey, *loc. cit.*, p. 378; Camden, *loc. cit.*, p. 366; Stow's Chronicle.
—— May 5.	Mans (in France?)	....	....	Accompanied by thunder and lightning, which set fire to the church of Saint-Julien.	De l'Estoile, Journal de Henri III. t. i. p. 259.
1584. Mar. 1. Afternoon.	Throughout Switzerland, Burgundy, Dauphiny, and Piedmont. The town and lake of Gryffensee, two leagues from Zurich, were very violently shaken.	At Geneva the shocks lasted ten to twelve min. They recurred all through the districts here mentioned for at least ten days, there being a violent shock, felt especially at Bâle, on the 10th.	The waters of the lake of Geneva were much agitated and raised more than twenty paces above their usual level.	The weather was very fine and serene. Many chimneys, buildings, &c. were thrown down.	Spon, Hist. de Genève, t. i. p. 325; Bertrand; Coll. Acad.; Mém. de Chronol., t. ii. p. 916.
——	Japan	....	....	....	v. Hoff.
1586. July 9.	In Peru, extending 170 leagues along the coast, and 50 leagues into the interior. Most violent at and about Lima.	Several violent shocks	The sea came in fourteen fathoms high immediately after the shocks, and inundated the country for two leagues from the shore.	....	v. Hoff quotes Bouguer; Coll. Acad.
—— Sept. ...	Japan	Very violent	The sea inundated the country, carrying away houses with their inhabitants.	The town of Nangasuma was completely ruined. Hills were thrown down, and clefts opened in the earth of such a size, that a musket shot would not reach from one end to the other; and out of these there came an insupportable smell of sulphur.	Kämpfer, v. Dohm, t. i. p. 236; Pater Hay de rebus Japonicis.
——	Guatimala	....	....	The city of Guatimala was ruined. An eruption of the volcano of Fuego in Guatimala took place at the same time. There were also eruptions in this year in Java and Banda.	v. Humboldt in Hertha, Bd. vi. p. 138; v. Buch; Coll. Acad.
1588. Mar. 25. A little before noon.	From Nantes to Saumur in France. Also, less violently, in some parts of Normandy.	....	....	The houses shook, and the waters of the Loire appeared to boil. In Normandy accompanied by a sort of smoke which tinged the air yellowish for an hour.	Mézerai, Hist. de France, t. iii. p. 478; De Larrey, Hist. d'Angl., t. iii. p. 529; J. Aug. de Thou, Hist. t. iv. p. 558.
—— Nov. ...	Saalfeld in Thuringia ...	....	....	A cleft opened during this earthquake in the mountain Culon or Culm of 10 feet wide and 100 deep.	Coll. Acad.

	France.			under 25th March.	
1590. June 29. Between 5 and 6 P.M.	In Austria, the country both above and below the Ens.	Slight shocks	....	....	Beuther; J. Hedericus; Coll. Acad.; Chr. Matthias, Theat. Hist. p. 822; Bresserus Millenarius, t. vi. p. 522; Hist. Germaniæ (edit. Elzevir), t. i. p. 414; J. Aug. de Thou, Hist. t. v. p. 13; Funccius, &c.
—— Sept. 15. Between 5 and 6 P.M.	Ditto, especially at Vienna, and at Maurbach, Tuln, &c. in a line about four miles long, north-west of Vienna, and parallel to the Danube. Also in Hungary, Moravia, Silesia, Bohemia, Lusatia, Saxony, and the Alps.	Two violent shocks at the time mentioned, followed by another, still more violent, at midnight. The shocks recurred until Christmas.	....	Vienna, Prague, and many other places, suffered considerably in buildings, &c.	Ditto.
1591. Feb. 17.	Ferrara........	Many shocks, recurring continually for 7 or 8 months.	....	....	Mém. de Chron. t. ii. p. 917.
—— July 26.	The Azores, especially St. Michel; and the sea for twenty leagues round.	The shocks recurred four times at Terceira and Fayal, but at St. Michel they were perpetual for fifteen days, and did not cease entirely for some time after.	The sea was greatly agitated, and all vessels within 20 leagues of the islands were much injured.	The surface of the islands was completely changed; plains were raised into hills, and hills levelled to plains. Numbers of buildings were absolutely ruined. In one place a stream of clear water burst forth from the earth, continued running for four days, and then suddenly dried up.	Lindschoten in Prevost, Hist. gén. des Voyages, t. i. p. 325; Raspe de nov. insulis, p. 111.
—— Sept. 3.	Bâle........	....	....	....	Wieland's Chronik.
1592	Faenza in Italy	....	....	....	Collection Académique.
1593. Jan. 9.	Geneva........	Several shocks........	....	....	Bertrand; Coll. Acad.
—— May 30.	Tuscany	Great earthquakes ...	....	Accompanied by an eclipse of the sun	Istoria di Chiusi in Toscana, Muratori, t. xxvi. p. 1114.
—— Nov. 5.	Neufchatel and the neighbourhood.	....	....	Large masses of rock were cleft from top to bottom.	Bertrand; Coll. Acad.; Huot.
——	District of San Salvador, Mexico.	Disastrous	....	....	Ennery et Hirth, *loc. cit.*
1594. (On St. Martin's day.)	In the Canton of Glaris	....	....	Followed by the fall of a mountain near, which did some damage.	Bertrand; Coll. Acad.; Scheuchzer.

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1594	Naples and Pozzuoli. Also, according to v. Hoff, in the Canton du Vaud.	Violent shocks.........	The sea retired 200 paces from the shore.	....	Kircher, Mund subter., lib. iv. s. 2. c. 10; Coll. Acad.
1595. Aug. 6.	The town of Meaco in Japan.	....	....	The town was ruined by the earthquake. Kämpfer gives the date 1594.	Dan. Bart., Asia, p. 2. l. ii.; Kämpfer v. Dohm.
1596. July 22.	Japan	....	The sea rose above its ordinary level.	Preceded by a rain of ashes. The towns of Ochinofama, Famaoqui, Ecuro, Finco, and Cascicanoro were ruined.	Zappell, Hist. dell' Incendio, c. 9; Coll. Acad.
——	Calabria	Three violent shocks	....	Caused no injury.	G. Fiore, *loc. cit.*
1597. Jan. 29. From the 22nd hour to the 1st hour of the night.	Luciana, and the hills about Pisa.	Five shocks	....	....	"Notizia estratta da una vecchia chronaca di un Parrocco di Luciana."
—— July 23.	Perth, and other parts of Scotland.	....	....	....	Thomson's Annals of Philosophy, vol. viii. p. 365.
—— —— 28.	Lisbon	....	....	The houses of three entire streets were thrown down, and the hill of St. Katharine was cleft in two.	Mém. de Chronol. t. ii. p. 915; Balbi, Essai sur le Portug. t. i. p. 102.
1598. July 22.	Ditto	....	....	People walking in the streets were thrown to the ground.	Balbi, *loc. cit.*
——	Japan	Many shocks during a whole month, some very violent.	....	A volcanic eruption in the isle of Banda took place this year.	Kämpfer v. Dohm, t. i. p. 237.
1599. Nov. 8, 12, 13, and 14.	In Calabria	Very violent shocks...	....	Preceded in October by unusually heavy and continuous rains, which caused most disastrous inundations.	G. Fiore, *loc. cit.*
1600. Sept. 16.	Upper part of the lake of Geneva.	....	....	The ground beneath the lake where the Rhone flows out from it, was raised and sunk so as to make the waters of the lake appear to ebb and flow three or four times.	Spon, Hist. de Genève, t. i. p. 417; Bertrand; Coll. Acad.
——	Norcia and Florence ...	Several shocks	....	Some houses thrown down	Ch. Mathias, Theat. Hist. p. 623.
——	Arequipa in Peru	....	....	Accompanied by darkness as of clouds, and a thick rain of ashes for twenty days.	Collection Académique.
——	The island of Bornholm in the Baltic Sea.	....	....	....	v. Hoff.
1601. Feb. 8.	Frankfort on the Maine.	Violent.....................	....	Did no damage	Lerner's Chronik; Kriegk.
—— Aug. 10.	In the kingdom of	Very great	....	....	Vivenzio, p. 11.

1601. Sept. 8. Between 1 and 2 A.M.	Throughout almost all Europe, especially in Germany; and part of Asia. Most violent in Switzerland, Austria, Bohemia, Bavaria, Swabia, Alsace, and part of the Netherlands	In almost all of these places, several shocks were felt.	The lake of Geneva was agitated, although the atmosphere was quite calm.	Morges, Lausanne, Yverdun, Orbe, Aigle, Lucerne, Zurich, Bâle, and Berne were much shaken. At Lucerne the course of the Reuss was stopped. Followed in Switzerland by heavy rains, and consequent inundations. It was felt at Haguenau, Strasburg, Spires, Frankfort, and Cologne, and in Wurtemburg, and Hesse. At Gotha, a steeple was thrown down.	Spon, Hist. de Genève, t. i. p. 417; Bertrand; Coll. Acad.; Scheuchzer; Joh. Gross, Basler Chronik; Beuther; Lerner; Kriegk., &c.
—— Dec. 24.	London	....	....	....	Camden, *loc. cit.* p. 831.
1602. June 28. 6 A.M.	Zurich and the neighbourhood.	Several shocks............	....	....	Bertrand; Scheuchzer; Coll. Acad.
—— Dec. At the end of the month.	In Calabria	Several tremblings ...	....	....	Pilla, Istoria del tremuoto, &c. p. 202.
1603. Jan 25.	Sienna	Terrible earthquakes.	....	....	Archivio del regio Scrittojo, quoted by Signor Pilla.
—— Aug. or Sept.	District of Waradin in Croatia.	Very violent	....	....	Claude Malingre, dit de St. Lazare, Remarques d'Estat. et d'Hist. de 1600 à 1632, p. 57.
——	In the country situated between the Carpathians and the Eastern Alps.	....	....	Probably the same with the last	v. Hoff.
1604. Apr. 14. Between 9 and 10 o'clock (A.M. or P.M.?)	Bâle	....	....	....	Bertrand; Basler Chronik; Coll. Acad.
—— Sept. 16.	In Italy	Very great	....	Caused no damage	G. Fiore, *loc. cit.*; Huot.
—— Nov. 26.	Arequipa in Peru	....	....	v. Hoff suggests that this may be only the same with that of 1600, wrongly reported as to date.	Frezier, Reise in die Südsee in den Jahren 1712–14.
1606	Japan	....	....	During this earthquake a mountain was raised from the sea in one night, near the rocky island Fatsisio.	Kämpfer v. Dohm, t. i. p. 237.
1607. April 2.	Throughout the Canton du Vaud, especially at Yverdun. Also felt at the same time in several other parts of Europe.	....	....	Followed by numerous storms	Bertrand.
—— July 15.	At Ebertzlingen, near Würzburg.	....	....	Threw down a portion of a mountain, and discovered various subterranean abysses, &c.	Claude Malingre, *loc. cit.* p. 125; Sleidanus, t. iii. p. 1308.
1608. Nov. 8. 9 P.M.	Aberdeen	....	....	....	Thomson's Annals of Philosophy, vol. viii. p. 365.

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1609. Jan. 19.	In the Thames	No shock mentioned	An extraordinary flux and reflux of the tide twice within an hour.		De Larrey, *loc. cit.* p. 673.
—— June 8. 14th hour.	In the kingdom of Naples.	Slight			Vivenzio, p. 11.
—— July 20.	Nicastro in Italy			Caused some damage	Fiore, *loc. cit.* p. 289.
—— Nov. 27.	Lima and Arequipa in Peru.				Coll. Acad.; v. Hoff.
1610. Nov. 29.	Bâle			Threw down a part of the walls of the town, and was attended with a subterranean murmuring noise.	Bertrand; Basler Chronik; Scheuchzer; Coll. Acad.
1611. Jan. 15.	In the valleys of Switzerland and Piedmont.	One of the most violent shocks ever heard of here.			Vassali—Eandi, Rapport, &c., p. 126, quotes Gilleo, Hist. des Églises Vaudoises, c. 52. p. 385.
——	Constantinople				Edinburgh Encyclopædia, Article Chronology.
1612. Jan. 31.	Nice and the environs. According to the Coll. Acad., in several places in the Mediterranean.			This year was remarkable for tempests	Mém. de Turin, t. xix. p. 158; Coll. Acad.
—— Feb. 29.	Bâle			Without damage	Bertrand; Basler Chronik; Scheuchzer; Coll. Acad.
—— May. Night between 15 and 16.	Bergen in Norway	Violent			MS. Hist. of Bergen, by Edvard Edvardsen.
—— Nov. 8 to Dec. 7.	Westphalia, and other parts of Germany, especially at Bielefeld, and the castle of Sparemberg. Also felt in the island of Candia, and several places in the Mediterranean.	At Bielefeld and Sparemberg the shocks occurred almost daily during the whole time.		The trees appeared agitated, as if by a high wind, although the air was unusually calm. In Candia many buildings were thrown down, and ships sunk.	Coll. Acad.; v. Hoff; Mercure Français adj. à l'an 1612, p. 3.
1614. Feb. 14.	Waradin in Transylvania, and the neighbourhood.	Very violent		Men and other animals could not remain standing.	Mercure Français, 1614, p. 571.
—— —— 17. At night.	Bâle			Accompanied by a great noise	Bertrand; Scheuchzer; Basler Chronik; Coll. Acad.

	vania, and the country round.	at the same place.			
—— May 4.	Island of Terceira in the Azores.			Ruined the towns Praya and d'Angra	Coll. Acad.; Buffon, Hist. Nat. t. ii. p. 312 (edit. of 1750).
—— Sept. 24. After midnight.	Bâle	Several shocks		Accompanied by subterranean noises as before.	Bertrand; Basler Chronik; Scheuchzer; Coll. Acad.
—— Nov. 24. 4th hour of the night.	Calabria	A terrible earthquake.			Fiore, p. 289.
1615. Beginning of January.	Neuhäusel in Hungary				Bernherz.
—— Feb. 20. Between 3 and 4 A.M.	In Austria, Bohemia, and Hungary; especially at Prague.	Lasted but a short time.		Accompanied by great subterranean noises, but without causing any damage.	Ditto.
——	Japan	Violent			Kämpfer v. Dohm, t. i. p. 238.
1616. Jan. 12. 4 P.M.	Naples	A slight shock			Vivenzio, p. 11.
—— March. Beginning of the month.	Different parts of Switzerland.			Many buildings, &c. thrown down	Claude Malingre, *loc. cit.* p. 251.
—— July 28.	At sea, at the entrance of the Straits of Le-Maire.		Felt by Le-Maire, the discoverer of these Straits.		Hist. gén. des Voyages, t. xvi. pp. 73 and 107.
—— Aug. 2.	Aleppo	Very violent		The walls were shaken like the leaves of a tree.	Pietro della Valle, Voyage en Syrie, t. ii. p. 152.
—— Sept. 7.	Naples	Slight			Vivenzio, p. 11.
——	Japan	Very destructive			Montanus, Japanische Gesandtschaft, p. 205.
1617. July 5.	Freiburg in the Brisgau.			During this earthquake a great mass of rock fell upon a house and ruined it.	Bertrand; Scheuchzer; Coll. Acad.
——	Aix in Provence				Basler Chronik; Coll. Acad.
1618. June 4.	Sardinia; especially at Cagliari.			According to the Journal Encyclopédique of the 15th Sept. 1771, the date of this event should be 1610.	Le Chev. Albert de Marmora, Voyage en Sardaigne de 1819 à 1825, p. 141.
—— July 3. Between 5 and 6, or between 6 and 7 A.M.	In Bearn, at the foot of the Pyrenees.	Two violent shocks		Steeples were shaken, and the bells made to toll.	Palassou, Mém. sur les Pyrénées, p. 261.

1.	2.	3.	4.	5.	6.
1618. Aug. 25. At night.	Throughout Switzerland, in the Pays de Vaud, the Valteline, &c.	....	....	In the Grisons a mountain called Conto fell, and ruined a village; 1200 persons losing their lives. Neufchatel was considerably injured. Igneous meteors were seen soon afterwards.	Bertrand; Scheuchzer; Coll. Acad. Also the treatises of Barthol. Anhornius and J. Gross on this particular event.
1619. Jan. 5.	In Calabria	Very violent	....	Did much damage in various places	Fiore, *loc. cit.* p. 289.
—— —— 19. Between 6 and 7 A.M.	To the west of Frankfort on the Maine, at Königsberg, Kronberg, Reiffenberg, as far as Boppart, St. Goar, and Ober-Wesel. Also at Neufchatel.	....	....	The little river Nidda, not far from Frankfort, ceased flowing. The Coll. Acad. gives the date Jan. 26 for the first-named places, and Jan. 29 for Neufchatel.	Sleidanus, p. 564; Lerner; Kriegk.; Bertrand.
—— Feb. 4. Shortly before noon.	In Peru, for a space of 160 miles long (and how wide?); especially at Truxillo.	The shocks lasted fifteen days.	....	....	Montanus, Japanische Gesandtschaft, p. 77.
—— July...	Iceland	Shocks continuing until September.	....	An eruption of Hecla at the same time.	v. Hoff.
1620. Jan....	Canton of Berne, especially at Frutingen, and extending as far as Geneva.	....	....	....	Bertrand; Collection Académique.
—— Dec. ...	Geneva........	....	....	....	Ditto.
——	Austria........	....	....	....	v. Hoff.
1621. May 20. Dur^g the evening sermon.	At Bâle and Neufchatel, in the Canton du Vaud, at Geneva, and in Savoy.	Several shocks	....	At Neufchatel several chimneys were thrown down.	Spon, Hist. de Genève, t. i. p. 486; Basler Chronik; Bertrand; Coll. Acad.
——	Laybach in Carinthia ...	....	....	....	Collection Académique.
——	Gonahpee in the island of Banda.	....	....	Accompanied by a volcanic eruption.	Purchas, Pilgrimes, 5. 1. p. 697.
1622. In March.	Upper and Lower Engadine (in the Grisons).	....	....	Followed by some thunder and lightning........	Bertrand; Coll. Acad.
——	Laybach in Carinthia ...	....	....	....	Collection Académique.
——	Province of Siounie in the Caucasus.	....	....	....	Chakathouno quotes Aroquel of Tauris, Hist. c. 21 and 22.
1623. Feb. 20 to 25.	Throughout the Valteline, especially in the commune of Pergell in the Grisons; and at Clèves (probably Cle-	Many shocks each night for the time mentioned.	....	The mountains Septimer and Major were so shaken, that pieces of rock were detached from them, and rolled down. During the summer red rain was remarked at many places in Germany and Switzerland.	Bertrand; Scheuchzer; Coll. Acad.

1623. Mar. 24.	Norway	More violent than any former earthquakes then remembered in Norway.			[illegible] p. 173.
—— Nov. 29.	In the Palatinate			Probably only the same with that mentioned the following year, on the same day and month.	v. Hoff.
1624. Feb. 3. About the 15th hour.	In Calabria	Very violent. Lasted the time of saying one *Ave Maria*.			Fiore, *loc. cit.* p. 289.
—— Mar. 21.	Argenta, near Ferrara			Three churches and more than 130 houses were thrown down. The Dresdner gelehrte Anzeiger, 1756, No. 2, places this event in the year 1625.	Mercure Français, an. 1624, p. 185; Huot; Coll. Acad.
—— Beginning of summer.	Rome			Caused no ruins	Mercure Français, *loc. cit.*; Coll. Acad.
—— Nov. 29.	In the Palatinate	Several shocks			Dresdner gelehrte Anzeiger, 1756, No. 2.
——	St. Michel in the Azores			A new island, of a league and a half long, was raised during this earthquake near St. Michel.	Collection Académique.
1625. Feb. 22. 11 A.M.	Different parts of Switzerland. Also, according to v. Hoff, in Budjadingerland. (In Sweden?)	Very sensible			Bertrand; Collection Académique; v. Hoff.
——	District of San Salvador in Mexico.	Disastrous			Ennery et Hirth, *loc. cit.*
1626. Jan.	Worms				v. Hoff.
—— Feb. 22.	Elbermannstadt in the district of Bamberg, duchy of Oldenburg. Also felt the same day at Sirifalco in Calabria, which town was ruined.			Probably the same with the earthquake in Switzerland of the preceding year. v. Hoff gives it in that year, without, however, specifying the month or day.	Huot, Cours de Géol. t. i. p. 110.
—— Mar. 27. 19th hour.	In Calabria	Moderate			Fiore, *loc. cit.*, p. 289.
—— —— 30.	Ditto	Three shocks			Ditto.

1.	2.	3.	4.	5.	6.
1626. April 4.	In Calabria	Very violent shock. Lasted the time of saying an *Ave Maria*. Followed by 15 other shocks on the same day, and by others at intervals until October.		Catanzaro in particular was much injured	Fiore, *loc. cit.*, p. 289.
—— May ...	Ditto	Many violent shocks, lasting altogether forty days.	....	The towns of Girifalco and Catanzaro were ruined. Many clefts opened in the earth. Vulcano in the Lipari isles was in eruption.	Vivenzio, p. 11; Terra tremens.
—— July 30. Noon.	In the provinces of the Capitanata and La Puglia, and in the city of Naples. Also extended as far as Ragusa and Smyrna.	The shocks lasted five hours. The places most injured lay in a line running N. and S., from the eastern side of the Apennines at Bovino to the Adriatic Sea, at the mouth of the river Fortore. The shocks continued at intervals up to the 7th August.	At Fortore and San Nicandro the sea retired more than two miles from the coast, and then returned again, inundating the country.	Thirty towns and villages are mentioned as having been ruined more or less by this earthquake, and 17,000 persons lost their lives. Clefts opened in the ground, lakes were dried up, mountains cleft, forests overthrown, and jets of water and mud thrown out of the wells. The shocks were accompanied by subterranean noises, and a smell of sulphur. v. Hoff, Huot, and Gaultier give the date 1627.	Coll. Acad.; Mém. de Chronol.; Langlois, Dict. de Géogr. t. i. p. lxvi.; Anton. Foglia, Istorico discorso del gran terremoto, &c., Napoli, 1627; and Vera relazione, &c.; Theatrum Europæum, t. i. p. 1054.
—— Aug. 7. 22nd hour.	Ditto, with the exception of Smyrna and Ragusa, which are not mentioned.	....	....	....	Ditto.
—— —— 8. 5th hour of the night.	Ditto	Lasted a quarter of an hour. Very violent shocks.	....	....	Ditto.
—— —— 24.	Ditto	Slight	....	....	Ditto.
—— Sept. 6.	Ditto	Very violent	....	Followed by a storm of thunder, lightning, rain, and hail.	Ditto.
——	Laybach in Carinthia ...	....	....	Followed by a pestilence in Lower Carinthia ...	Collection Académique.
1627	Luzon, one of the Philippine Isles.	....	....	Levelled a mountain in the province of Cagayan.	Collection Académique.
1628. June 16.	Island of St. Michel in the Azores.	....	....	Raised an island of more than a league and a half long, in 150 fathoms water, near St. Michel. Hence probably confounded with that before mentioned in 1624.	Coll. Acad.; Bertrand; Raspe.

1628. Dec.	In the Duchy of Mecklenburg.			Buildings were thrown down. Followed by a violent thunder-storm.	Coll. Acad.; Mercure Français, an 1628, p. 167.
——	China				Giac. Calderio, Tab. Geograph., &c.
1629	In La Puglia. Also in Africa.			7000 persons perished in La Puglia	Collection Académique.
1630. July 5. At night.	Bâle	One shock		The weather was unusually cold	Bertrand; Coll. Acad.; Merian quotes the Chronicle of Joh. Jac. Scherer.
—— ——	Mecca (Medina?)			Threw down many houses, and the mosque where Mahomet was interred.	Gaultier, Table Chronog. p. 869; Lettres Hist. et Polit. t. xiv. p. 262.
—— Sept. 2. Two hours after midnight.	St. Michel in the Azores.			Followed by a volcanic eruption, and rain of ashes.	Gaultier, *loc. cit.*; Coll. Acad.; Mercure Français, an 1630, p. 506, et suiv.
—— Nov. 27.	Lima in Peru				Coll. Acad.; v. Hoff.
—— Dec. 25.	Bâle	Violent shock			Bertrand; Coll. Acad.; Wieland's Chronik.
——, or 1631.	Banda-Nera in the Moluccas.		The sea overflowed its shores.	The earth opened in different places	Collection Académique.
1631. Aug. 24.	Sicily; especially the town Naso.				Ferrara, Campi flegrei della Sicilia.
—— Dec. 16. During the night.	In and around Naples, and all the country near Mount Vesuvius.	About twenty shocks on the day mentioned.		Followed by the greatest eruption of Vesuvius since the year 79. Brusoni and Sansovino give the date 1630.	Della Torre, pp. 62–66; Mercure Français, an 1631, p. 67; Gaultier, *loc. cit.*, p. 870; Dulac, t. iv. p. 390; Coll. Acad.; and several treatises on this particular event, quoted by v. Hoff.
—— —— 20.	Ditto	Five more shocks. From this day until the 15th January following they were almost continuous.			Ditto.
1632. Middle of February.	Ditto	Many more shocks		Accompanied by a fresh outburst of Vesuvius	Ditto.
—— Sept. 19. During the saying of the catechism(!)	Bergen in Norway, and the environs.			The church trembled, and those present felt themselves raised into the air.	Hist. de Bergen, by Edvard Edvardsen.
1633. Feb. Night between 21 and 22.	Village of Nicolosi at the foot of Etna.	A very violent shock		Destroyed a great part of the village. Followed the year after by a great eruption at the same side of the mountain.	Ferrara, Campi flegrei; Mascolo; Carrera.

1.	2.	3.	4.	5.	6.
1633. July 30.	Constantinople and the adjacent country.	....	....	....	Mercure Français, an 1633, p. 752.
—— Nov. 5.	Mantua	One shock	....	....	Magnati, pp. 207 and 230.
——	Naples	Several more shocks	....	....	Coll. Acad.
——	In the Haut Valais	....	....	....	Bertrand; Coll. Acad.
——	Chili	....	....	....	Relacion del Cile de Alfonso di Ovaglia, lib. vii. c. 22.
——	Egypt	Several shocks	....	v. Hoff mentions an eruption of a mountain in Ethiopia this year, on the authority of Gassendi, Vita Peirescii, ed. tert. lib. v. p. 168.	Collection Académique.
1634. Middle of December.	All the country on the south side of Etna.	Many shocks	....	Accompanied by subterranean noise like thunder. An extremely violent eruption of Etna now began, which continued with unabated vigour until 1636, and did not entirely cease until 1638.	Ferrara, Campi flegrei; Carrera, &c.
——	Laybach in Carinthia ...	....	....	The harvest was very abundant this year	Collection Académique.
——	In the valley of Mexico	Numerous and violent shocks.	....	The earth opened in many places	v. Humboldt, Neu-Spanien, t. ii. p. 102.
1635. Aug....	Catania and Messina ...	A slight shock only at Catania.	....	At Messina houses were ruined. Mount Etna was in violent eruption.	Ferrara quotes Carrera.
——	Island of Rhodes	Violent	....	....	Hadschi Chalifa.
1636. Jan. 25.	St. Michel in the Azores.	Lasted eight days ...	....	Accompanied by a submarine eruption, and the upheaval of a new island, which in a fortnight was 5 Italian miles long.	Collection Académique.
—— Sept. 30. From 9 P.M. to midnight.	Island of Zante	Several shocks	....	Did great damage, the effects of the earthquake extending about 12 miles.	Ferrante Pallvicini, Successi del Mondo ad ann. 1636; Dresdner gelehrte Anzeiger, 1756, No. 5.
—— Oct. 1. In the evening.	Ditto	More shocks	....	....	Ditto.
—— —— 2.	Ditto	Ditto	....	....	Ditto.
——	Schlettstadt in Lower Alsace.	Violent shocks for 8 days, daily, at the following hours, 7 P.M., midnt., 7 A.M., & noon	....	Accompanied by subterranean noise, but did no damage.	Dresdner gel. Anz. *loc. cit.*
——	Venice	....	....	....	v. Hoff.
1638. Jan. 18 to the end of March.	Calabria	Some slight shocks ...	....	....	Fiore, *loc. cit.*; Ferrara; Kircher, Mund. subter. t. i. p. 240; Mercure Français, an 1638, p. 482; Gaultier; Richard; Labbe, &c.

1638. Mar. 27. 21st hour.	In the two Calabrias, and the adjacent part of Sicily. The earthquake extended over a line of about 25 geogr. miles long, from Reggio to Terranova, running about S.W. and N.E.	One of the most violent earthquakes ever experienced here. Several shocks.	At Pizzo the sea retired 2 miles from the coast.	Accompanied by subterranean noise. 180 towns and villages were more or less ruined. The earth opened in many places, and at Vibona flames came forth. The direction was nearly parallel to that of the earthquake of 1626.	Ditto.
—— —— ...	Canton of Uri, at Bellinzona (Tesin), and some other places near.	Several shocks........	....	....	Bertrand; Coll. Acad.
—— April ...	Calabria and Sicily......	Several slight shocks.	....	....	Fiore; Ferrara, &c. before quoted.
—— —— ...	Sienna	Violent shocks, recurring for eight days.	....	Some other shocks were felt here during the spring and autumn.	Mem. del Macchi scrittore dello Spedale.
—— May 3.	Calabria and Sicily	Slight	....	....	Fiore; Ferrara, &c. as before.
—— June 2.	New England	Violent vibratory shock. Direction N.W. to S.E. Followed by a slighter one in less than half an hour.	....	Preceded by a noise like prolonged thunder. Houses were thrown down, and people were unable to keep their feet.	Phil. Trans. for 1757, pt. i. p. 9.
—— —— 8.	Calabria and Sicily	Several more shocks.	....	Did a good deal of damage at several villages ...	G. Fiore, and the other authors before quoted.
—— End of the year.	Chichester in England.	Several shocks........	....	Did great damage. Accompanied by the smell of pitch and sulphur. The atmosphere was obscured as if by a cloud.	Dresdner gelehr. Anz. *loc. cit.*
——	In the markgravate of Brandenburg.	....	....	....	Berlinische Nachrichten von Staats, und gelehrten Sachen, 1838, No. 19.
1639. In autumn.	Calabria, at the same places affected the year before.	Several shocks........	....	....	Agatio di Somma.
——	Smyrna	....	....	....	Phil. Trans. t. xlviii. p. 820.
——	Ragusa....................	....	....	....	Partsch, Detonations-Phänomen. v. Meleda, p. 88.
1640. April 4. 3h 15m A.M.	France, Belgium, and Holland; especially at Brussels, Antwerp, Mechlin, and Namur. Also at Frankfort, and in parts of Westphalia and Lorraine; altogether a space of about 360 leagues	Three very violent shocks.	The ships in the ports of Holland were very much agitated, although it was quite calm.	Followed at night by luminous meteors	Dresdner gelehrte Anz. *loc. cit.*; Opera van Helmont., art. terræ tremor, p. 90; Coll. Acad.; Mém. de Chronol.; Brachelii Hist. parti. p. 387.

1.	2.	3.	4.	5.	6.
1640. June 19 to July 18.	Calabria	Many shocks		A place called Vadulato was ruined by a shock at dawn on the 19th June.	Agatio di Somma.
——	Tabriz, and at the same time at Damascus.	Very violent		Houses thrown down	Hadschi Chalifa.
1641. March	In Calabria	A feeble shock			Agatio di Somma.
—— May. Towards the end of the month.	Constantinople				Comitis Bissaicioni Vita Sultani Ibrahim.
—— July 23 to Aug. 11.	In the Abruzzo			During this earthquake a mountain called Cayre, in the Abruzzo, gave out a quantity of water.	Physicalische Betrachtungen über das Erdbeben zu Lissabon, Vorrede.
——	Laybach in Carinthia			Followed by inundations, and a flood in the river Laybach.	Collection Académique.
——	Caraccas and La Guayra				v. Humboldt, Voyage aux régions équinoxiales, t. v. p. 5.
——	In Persia. Also felt at Bagdad.	Lasted altogether three days.		In the province Aziron the towns Rikan and Riangasan were ruined.	Physical. Betracht. über das Erdb. zu Lissabon.
1642. Some weeks before Easter. (Easter fell this year on the 20th April.)	In Holland	Several shocks		Possibly only the event of 1640, wrongly reported.	Dresdn. gel. Anz. 1756. No. 8.
—— March, April and May.	In Lombardy and Piedmont.	Ditto			Ditto.
—— April 5. In the evening.	At Leghorn	A violent trembling		Probably simultaneous with some of the last-mentioned shocks.	Magri, Origine di Livorno, p. 153.
—— Nov. 18.	Spires, Worms, Mayence, Frankfort, and Cologne.	Many shocks			Dresdn. gel. Anz. *loc. cit.*; Lerner; Kriegk.
—— —— 22. At night.	In the Canton of Neufchatel.	Three shocks			Bertrand; Coll. Acad.
1643. April 12. At night.	At sea in 3° 46′ S. latitude and 167° longitude (according to Berghaus E. longitude, reckoning from the Peak of Teneriffe), in the bay of the Cape of Good Hope in New Guinea.	Several shocks, the first being the most violent.		Narrated by Abel Tasman	Collection Académique.

1643. Dec....	In Sicily			The cold was very intense. Eruptions of Etna, Vesuvius, and Volcanillo.	Toaldo, Essai Météorol. p. 250.
——	Laybach in Carinthia...			Followed by an abundant harvest	Collection Académique.
1644. Feb. 16.	Geneva and the neighbourhood.	Several shocks			Bertrand; Collection Académique.
—— April 21.	Bâle	One shock			Wieland's Chronik; Brombach's Diarium.
—— June 3 or 13. 5 A.M.	Geneva	More shocks			Bertrand; Coll. Acad.
——	Gap in Dauphiny	A terrible earthquake			v. Zach, Corresp. Astron. t. vi. p. 46.
——	Nice				Ditto.
——	Poitiers	Several shocks			Dresdn. gel. Anz. 1756. No. 8.
——	Luçon, one of the Philippine Islands.				Collection Académique.
1646. April 5. 22⅔ hour.	Leghorn and the adjacent country. Also, at the same time, at Constantinople.	Lasted, at Leghorn, the time of chanting a *credo* (!). It appeared to come from the coast. Slight shocks from this up to the 17th, when there was another rather violent, at the same hour.	At Constantinople the sea rushed in so violently that it threw 136 ships up on the strand.	Chimneys were thrown down. Accompanied by a noise like that of a carriage rolling rapidly along.	"Notizia estratta da carte manoscritte del dott. Vivoli"; Huot, Cours de Géol.; v. Hoff.
—— May 31.	In La Puglia, along the Adriatic, to the north-east of the region shaken in 1626.	Many and violent shocks.		Viesti, Rodi, Cagnano, Pieschici, S. Giovanni, and other places at the foot of Mte. Gargano were much injured, and many of their inhabitants killed.	Vivenzio, 1783, p. 23, and 1788, p. 13.
——	In Denmark				Dresdner gel. Anz. 1756. No. 8.
1647. May 4.	Bâle				Wieland's Chronik; Brombach's Diarium.
—— —— 13.	In Chili			Mountains were in part thrown down	Kircher, Mund. subter. lib. ii. c. 12. sec. 1; Molina, Essai sur l'Hist. Natur. du Chili, trad. de l'Italien (Paris 1789), p. 20; Suppl. Encyc. Britan.; Coll. Acad.
——	Island of Santorin, and in the Levantine Archipelago.				Acta Eruditorum, 1688. p. 517.
1648. Nov. 23.	Yverdun and the Canton of Neufchatel.	Several shocks		Accompanied by high wind. The following winter was very wet.	Terra tremens; Bertrand; Coll. Acad.

1.	2.	3.	4.	5.	6.
1648.	Zeng in Dalmatia			Threw down a portion of the town walls. Followed by very high wind.	Terra tremens.
—	Luçon, one of the Philippine Isles.				v. Hoff.
1649. Beginning of the year.	Messina		Almost all the vessels in the port were much injured by being dashed against one another.		Huot, *loc. cit.*; Dresdner gelehrte Anz. *loc. cit.*; v. Hoff.
— Mar. 4. A little after midnight.	Bergen in Norway	Violent			Edvardsen's Hist. of Bergen.
— Nov.	At Naples				Terra tremens.
—	Rieti in the States of the Church.				Ditto.
—	Island of Santorin in the Archipelago.	Several violent shocks			Expédit. Scientif. en Morée, part. Géol. p. 272; L'Abbé L., Hist. de Vénise, t. xi. p. 422; Raspe de novis insulis, pp. 29 and 47.
1650. Jan. 10.	Canton of Berne, Neufchatel, and as far as Morges in the basin of the Rhone.				Bertrand; Scheuchzer; Coll. Acad.; v. Hoff quotes Merian.
— Feb. 15.	Bâle				Ditto.
— Mar. 15.	Ditto				Ditto.
— — Beginning of the month.	Island of Santorin	Two violent shocks		A great number of houses injured, and rocks rolled into the sea.	Expéd. Scientif. en Morée, &c. before quoted.
— May 2.	Bâle	More shocks			Bertrand; Scheuchzer; Coll. Acad.; v. Hoff quotes Merian.
— — 6.	Ditto				Ditto.
— — 7.	Ditto				Ditto.
— — 16. At noon.	Ditto				Ditto.
— July 11. 4 A.M.	Ditto				Ditto.
— — 26.	Ditto	Several shocks			Ditto.
— Sept. 10.	Berne and the shores of the lake of Geneva, Lausanne, Morges, Vevey, &c.	Very violent		Preceded, the day before, by a furious tempest, which did great damage.	Ditto.

4 A.M.	[illegible]	The most violent felt at Bâle during the whole year.	....	Yet did no damage	Ditto.
—— —— 12.	Bâle	....	....	....	Ditto.
—— —— 16.	Ditto	....	....	....	Ditto.
—— —— 19.	Ditto	....	....	....	Ditto.
—— —— 24. to Oct. 9.	Island of Santorin. Also felt in Candia.	Numerous and violent shocks, increasing in intensity until the 27th and 29th, when the most violent occurred.	Accompanied by a submarine eruption a little to the west of the island, which threw up a large bank of sand, not quite reaching to the level of the water. The vessels in the port of Candia were dashed against one another.	Accompanied by very loud subterranean noises like bellowing.	Expéd. Scientif. en Morée, &c. before quoted.
—— Oct. 9.	Bâle	Slight shocks	....	....	Bertrand; Scheuchzer; Coll. Acad.; Merian.
—— —— 10.	Ditto	Ditto	....	....	Ditto.
—— —— 13.	Ditto	Ditto	....	....	Ditto.
—— —— 16.	Ditto	Ditto	....	....	Ditto.
—— —— 18.	Ditto	Ditto	....	....	Ditto.
—— —— 20.	Ditto	Ditto	....	....	Ditto.
—— Nov. 6.	Ditto, and throughout the Canton.	Ditto	....	....	Ditto.
—— —— 9.	Ditto	Ditto	....	....	Ditto.
—— —— 10.	Ditto	Ditto	....	....	Ditto.
—— —— 13.	Ditto	Ditto	....	....	Ditto.
—— —— 16.	Ditto	Ditto	....	....	Ditto.
—— —— 20.	Ditto	Ditto	....	....	Ditto.
——	The seigneurie of Hohensau in the canton of Zurich.	Experienced eighteen earthquakes during the year.	....	The year was very rainy	Ditto.
1651. Jan. 8.	Bâle	Several shocks	....	....	Wieland and Brombach.
—— —— 18.	Ditto	Ditto	....	....	Ditto.
—— Feb. 12.	Ditto	....	....	....	Ditto.
—— —— ...	At and around Etna ...	Violent shocks	....	Accompanied by an eruption of the volcano ...	Ferrara, Descrizione, &c. p. 100.
—— June 8.	In Engadine, in the Grisons.	Several shocks	....	....	Keferstein, Zeitung für Geognosie, &c. S. 297.

1.	2.	3.	4.	5.	6.
1651. June 25.	In Engadine, in the Grisons.	Several shocks			Keferstein, Zeitung für Geognosie, &c. S. 297.
— Aug. 3.	Ditto	Ditto			Ditto.
— Oct. 29.	Geneva	Ditto			Ditto.
— Dec. 7. Between 4 and 5 P.M.	Ditto	Ditto			Spon, Hist. de Genève, t. i. p. 512; Bertrand; Coll. Acad.
—	Chili and Peru				Dresd. gel. Anz. *l. c.*; Terra tremens.
1652. Feb. 4.	In the canton of Zurich, Bâle and Schaffhausen.	Very violent			Bertrand; Scheuchzer; Coll. Acad.; Ephém. de Manheim, 1783, p. 685.
— Aug. 1.	Bâle			Merian considers this account as doubtful	Merian.
— Dec. 10.	Canton of Neufchatel			Followed by a great abundance of snow	Bertrand; Coll. Acad.
—	Canton of Berne	Several shocks during the year.			Bertrand.
—	Sciacca in Sicily	Shocks lasting for two weeks.			Ferrara, Campi flegrei.
—	Island of Palma (18 leagues from Teneriffe) and all through the Canaries.			Followed by a volcanic eruption in the island of Palma. [There was also a similar phenomenon this year in the island St. Michel, Azores.] The Coll. Acad. gives the date 1655.	Langlois, Dict. de Géogr. t. i. p. 60; Prévost, Hist. gén. des Voyages, t. ii. p. 243; Malte Brun.
1653. Jan. 9.	Frankfort on the Maine.				Lerner's Chronik; Kriegk.
— — 14. Ab^t midnight.	Bâle	A violent trembling.			Bertrand; Wieland; Schorer, Discours von den Erdbewegungen.
— Aug. 23.	Ditto				Wieland's Chronik.
— Sept. 27.	Cesena and Faenza in Italy.	Shocks lasting for several days.		Did great damage to buildings	Dresdn. gel. Anz. *loc. cit.*
—	Smyrna	Lasted two days		2000 or 3000 people killed	Ditto, Huot, *loc. cit.*
1654. Mar. 17.	Canton of Glaris, and different other parts of Switzerland.	In the canton of Glaris fifteen shocks were felt.		Frequent tempests this year and the following.	Bertrand; Scheuchzer; Coll. Acad.
— May 22.	Smyrna and many other places in Asia Minor.				v. Hoff.
— July 8.	Vienna				Ditto.
— — 23.	Terra di Lavoro, kingdom of Naples. In a line from the south to the north, a little east; from Pontecorvo to Alvito. Also felt at Rome.	Extremely violent. The shocks continued until the 12th August.		Many villages were ruined, and numbers of people lost their lives.	Huot; Bertrand; Coll. Acad.; Vivenzio; Terra tremens; Dresdner gel. Anz. *loc. cit.*

1655. End of March.	Strasburg. Also in Wurtemburg.	....	....	....	Terra tremens; Dresd. gel. Anz. *loc. cit.*
—— July 3	Frankfort on the Maine.	....	....	....	Lerner's Chronik; Kriegk.
—— Nov. 13	Lima in Peru	....	....	Injured the city very much. The Dresdn. gel. Anz. gives the date 1656.	Ulloa in Hist. gén. des Voyages, t. xx. p. 31.
1656. Feb. 23. At night.	Bâle. Also felt at Neufchatel and other parts of Switzerland.	Three shocks	....	....	Terra tremens; Bertrand; Wieland's Chronik; Scheuchzer; Coll. Acad.
—— May 16. Between 3 and 4 A.M.	Bâle........	One shock	....	....	Ditto.
—— Aug. ...	Ditto	Ditto	....	During cold and wet weather, which soon after became warm.	Ditto.
——	In Syria	....	....	Overthrew Tripolis. Keferstein places this event in February, the Dresd. gel. Anz. at the end of the year.	Huot, *loc. cit.*; v. Hoff; Keferstein; Dresd. gel. Anz. *loc. cit.*
——	District of San Salvador in Mexico.	Disastrous	....	....	Ennery et Hirth, *loc. cit.*
1657. Jan. 29.	Naples and Calabria ...	Lasted but a short time.	....	200 houses were ruined, and several thousand people killed, according to Huot, who, however, does not give the date of day or month.	Dresdn. gel. Anz. *loc. cit.*; Huot, *loc. cit.*
—— Feb. 15. 3 P.M.	St. Maure, not far from Tours (Indre et Loire), and the environs for 6 miles round.	....	....	Threw down some buildings. Accompanied by a subterranean noise like thunder.	Ditto; Theatrum Europæum. cont. p. 1093.
—— Mar. 15.	St. Jago in Chili	Very violent	....	....	Coll. Acad.; v. Hoff.
—— April 24. 11^h 45^m A.M.	In southern Norway; especially at Christiania. Extended from Osterdal to Bohus in the direction N. to S. 40 Norwegian miles, and from the Swedish frontier to Cape Lindesnäs in the direction E. to W.	Violent........	....	Accompanied by a noise like thunder. The houses trembled, and articles of furniture were shaken from their places.	Geologica Norvegica of Michel Pedersön Escholt; Phil. Trans. vol. ii. p. 210.
—— —— 25. Between 3 and 4 A.M.	Ditto	Less violent than the last.	....	Followed, twenty-four hours after, by a violent whirlwind at Christiania.	Ditto.
—— July 8.	Parish of Bickly (Beccles?) in England.	....	....	Preceded by a noise like a clap of thunder, the sky being quite serene at the time.	Collection Académique.

1.	2.	3.	4.	5.	6.
1657. Aug. 9.	Bâle				Communication of M. Ch. Martins to M. Perrey.
——	Southern part of Iceland				Voyage en Islande, p. 313; v. Hoff.
1658. Feb. 18.	Malta	Shocks which were repeated up to the 13th March.			Terra tremens; Dresd. gel. Anz. *loc. cit.*; Keferstein; v. Hoff.
—— April 4.	Messina	One shock			Ditto; Theatrum Europæum, t. viii. p. 1017.
——	Island of Cephalonia	Violent		Two places (names not mentioned) in the island were completely ruined. According to Keferstein this event took place on the same day with the earthquake at Messina.	Ditto.
——	New England	Ditto			Phil. Trans. vol. l. p. 9.
——	Concepcion in Chili				Theatrum Europæum, t. viii. p. 1018.
1659. Nov. 5. At night.	In Calabria, extending from Pizzo to Mileto, on the west of the Apennines, in the centre of the district shaken in 1638.	Very violent		More than thirty villages are mentioned as having been more or less ruined. Catanzaro was the only place injured not lying to the west of the Apennines.	Vincenzo d'Amato, Mem. Istor. di Catanzaro; Annales Mundi, t. vii. p. 538; Labbe, t. v. p. 905; Coll. Acad.
——	Constantinople	Violent		Buildings were thrown down	Nani, Hist. di Vinegia, t. ii. p. 493.
1660. Jan. 31.	New England	Ditto			Phil. Trans. vol. l. p. 9.
—— June 9.	In Spain and the coast of France on the Atlantic side.	Several shocks		Possibly only the same with the next	v. Hoff.
—— —— 21. 4 A.M.	At both sides of the Pyrenees, through the whole of the country from Bordeaux to Narbonne on the French side, and at St. Sebastian, &c. on the Spanish.	Violent		Near Bigorre a mountain sank, leaving a lake in its place, and a hot spring became suddenly cold.	Annales Mundi, t. vii. p. 543; Mém. de Chronol. t. ii. p. 919; Labbe, t. v. p. 906; Coll. Acad.; Kircher; Palassou, p. 262; Dresd. gel. Anz. *loc. cit.*
—— Oct.	Island of Rhodes				Dresd. gel. Anz. *loc. cit.*
—— Nov. 1 to Dec. 5.	Neufchatel	Six shocks during the time mentioned.			Bertrand; Coll. Acad.
—— Nov. 30. Between 9	Tyrnau in Hungary				Dresd. gel. Anz. 1756. No. 11.

10 and 11 P.M.	of Glaris.			January 9 at 11 P.M.	
—— —— 15.	Bâle	......	......	......	Communication of M. Ch. Martins to M. Perrey
—— —— 17. 6th hour.	Duchy of Milan	......	......	......	Collection Académique.
—— —— 25.	Neufchatel	Slight shocks	......	......	Bertrand; Coll. Acad.
—— —— ...	Island of Formosa	The shocks lasted six weeks.	The sea was violently agitated, and the ships dashed about.	Threw down several buildings at the capital Tajovan and part of the fortifications of Fort Zeland. This island is said to be subject to earthquakes.	Collection Académique.
—— Feb. 24.	Ravenna and twenty-four places adjacent.	......	......	......	Dresdn. gel. Anz. *loc. cit.*
—— Mar. 22. 20ʰ 56ᵐ.	Central Italy; principally in Modena, Tuscany, and the States of the Church.	......	......	Modena, Florence, Faenza, Forli, and twenty other places are mentioned as having suffered considerably by this earthquake. At Cassiano and Castro two clefts opened in the earth, from which there came forth a smell of sulphur.	Terra tremens; Coll. Acad.
—— —— 27.	Near Aigle in the Valais	......	......	Followed the day after by thunder, and hail of a large size.	Bertrand; Coll. Acad.
—— April 22.	At Venice. Also felt in the Romagna.	The direction of the vibrations at Venice was from E. to W., or according to others, from N.E. to S.W.	The water in the canals was raised, and ebbed and flowed like the sea.	......	Sansovino, *loc. cit.*, p. 85 and 753; Coll. Acad.
—— Dec. 3.	Bâle	......	......	......	Communication of M. Ch. Martins to M. Perrey.
—— —— 14.	Ditto	......	......	......	Ditto.
—— —— 24.	Ditto	......	......	......	Ditto.
—— —— 27.	Ditto	......	......	......	Ditto.
——	In Spain	......	......	......	v. Hoff.
——	England generally	......	......	......	Gentleman's Magazine for 1750, p. 56.
——	Island of Angle near Malta.	......	......	......	Dresdn. gel. Anz. *loc. cit.*
1662. Jan. 26. 6 P.M.	New England	A violent shock, followed by two others during the night and following morning.	......	The houses were shaken, and chimneys thrown down.	Phil. Trans. vol. l. p. 9.
—— Sept. ...	Rome	......	......	Followed by a thunder-storm	Dresdn. gel. Anz. *loc. cit.*
—— Nov. 6.	In Calabria	......	......	Threw down several buildings	Fiore, *loc. cit.* p. 289.

1.	2.	3.	4.	5.	6.
1662	Island of Candia	....	....	....	Dresdn. gel. Anz. *loc. cit.*; Huot, *loc. cit.*
——	Province of Oomi in Japan.	....	....	At the river Kazira a mountain sank entirely into the ground so as to leave no trace of elevation behind.	Kämpfer, v. Dohm, B. i. S. 190 and 241; Montanus, Gesandtschaft.
——	In New England	....	....	....	Phil. Trans. vol. l. p. 9.
1663. Jan. 5.	In the Canton of Berne, on the side of Aigle.	Slight	....	....	Bertrand; Coll. Acad.
—— —— — (or, according to others, Feb. 5).	A district of 400 leagues in circumference in Canada.	Very violent. The shocks recurred until the following July.	Ice of five or six feet thick was broken up.	Tabussac, Quebec, Sillery, &c. were injured by the shocks, which were accompanied by loud noise, and various atmospheric phenomena. For copious details see Perrey's memoir on earthquakes in the United States and Canada.	Terra tremens; Coll. Acad.; Macgregor's Travels in America, &c. &c.
—— June 10.	Canton of Berne, on the side of Aigle.	More shocks	....	....	Bertrand; Coll. Acad.
—— Sept. 10.	All the Alps of the canton of Glaris.	....	....	Accompanied by a subterranean murmuring noise, which appeared to frighten the cattle.	Ditto; Scheuchzer.
—— —— 13.	Ditto	Several more shocks .	....	Ditto	Ditto.
——	The southern side of Iceland, near Krisewik.	....	....	At the place mentioned there was a high mountain, at whose foot was a lake of great depth. The waters of the lake were completely swallowed up by this earthquake.	Collection Académique.
1664. Feb. 15.	Nice and Marseilles ...	....	....	In his memoirs on the earthquakes of the Italic peninsula and of France, Belgium, and Holland, M. Perrey gives the date 1664 for this event, but in that on the earthquakes of the basin of the Rhone he places it in 1663.	Statistique des Bouches-du-Rhône (communication of M. Aug. Bravais to M. Perrey).
——	Tabriz in Persia, and the country round.	Very violent	....	Did great damage in many places	Hadschi Chalifa.
——	Island of Zante	A rather violent shock	....	....	Montgomery Martin, Hist. of the British Colonies, vol. v. p. 431.
——	In the East Indies, at seven days' journey from Ducca.	The shocks recurred for thirty-two days.	....	....	Collection Académique.
1665. Jan. ...	In the island of Candia.	....	....	Threw down many buildings, and killed several people.	Girolamo Brusoni, Hist. d'Italia, p. 791; Brewer, Historica, sive Hist. Univ. t. x. p. 123.

	doussaque and La Malbaye in Canada.				remarquables aux missions des Pères de la Compagnie de Jésus en la Nouvelle France en 1664 et 1665. Par Jérome Lallemant, p. 115, et suiv.
—— March 1. 2 A.M.	The Alps of the Canton of Glaris.	....	....	....	Bertrand; Coll. Acad.; Scheuchzer.
—— —— —	In the kingdom of Naples.	....	....	At Nichino Casale near Aversa, about 3 miles from Naples the earth opened, and from a cleft of 350 feet long and 100 feet wide there came forth fire and smoke.	Terra tremens.
—— —— 31.	Neufchatel and the neighbourhood, principally in the mountains.	Several shocks........	....	....	Bertrand; Coll. Acad.
—— May ...	Ditto	Ditto	....	....	Ditto.
—— Oct. 15. 9 P.M.	Canada........	A violent earthquake, lasting about the time of a *Miserere*.		Preceded by a noise louder than that of 200 pieces of artillery.	Lallemant, Relation, &c. *loc. cit.*
——	In Japan	....	....	....	Montanus, Gesandtschaft.
——	On the banks of the Ganges.	....	....	....	Phil. Trans. for 1763, p. 251.
——, 1668, and 1669.	New England	Earthquakes in each of these years.	....	....	Phil. Trans. vol. l. p. 9.
1666. Jan. 18. 6 P.M.	Oxford, Belekington, Stanton, Coventry, Brill, &c. in England. Also, at the same time, in the district of Eisenthores, Temeswar, Hungary.	....	....	In Hungary rocks were cleft in pieces. The date of the month is not given for the earthquake at Coventry, but there is little doubt of its being simultaneous with that at the other places. v. Hoff gives the date 1665 for all.	Phil. Trans. vol. xlvi. p. 624; Révolutions du Globe; Dresdn. gel. Anz. *loc. cit.*
—— Feb....	At Kaminieck in Poland	Several shocks, lasting more than a quarter of an hour.	....	....	Dresdn. gel. Anz. *loc. cit.*
—— April 14. 7h 58m P.M.	Bologna	One shock	....	....	Collection Académique.
—— Sept. 1.	Arbon on the lake of Constance.	....	The waters of the lake advanced 25 or 30 feet on the shore, and then retired suddenly.	....	Bertrand; Coll. Acad.; Scheuchzer.

1.	2.	3.	4.	5.	6.
1666. Sept. 22.	In Syria, at Aleppo and forty-four other places around.	....	....	....	v. Hoff; Huot, *loc. cit.*; Brewer, *loc. cit.* p. 141.
—— Oct. 20.	Eglisau in Switzerland (Canton of Zurich).	Shocks of considerable violence.	....	....	Bertrand; Scheuchzer; Coll. Acad.
—— Nov. ...	In Assyria, at Mensal and the country around.	....	....	Five towns and forty-five villages were ruined, and four new mountains were raised.	Dresdn. gel. Anz. *loc. cit.*
—— —— ...	Island of Corfu	....	....	....	Ditto.
—— —— ...	Oporto in Portugal	....	....	v. Hoff mentions another earthquake at Oporto in December 1667, without, however, quoting any authority. It is probably confounded with the one here mentioned.	Ditto; Huot, *loc. cit.*
—— Dec. 2.	Eglisau in Switzerland (Canton of Zurich).	More shocks	....	Accompanied by subterranean noise	Bertrand; Scheuchzer; Coll. Acad.
—— —— 8.	Ditto	Ditto	....	Ditto	Ditto.
—— —— 11.	Bâle	One violent shock ...	....	....	Ditto.
—— —— 14.	Eglisau in the Canton of Zurich.	Several shocks	....	Accompanied by subterranean noise	Ditto.
——	In the kingdom of Naples, Basilicata, and Calabria.	Several slight shocks.	....	....	Vivenzio, 1783, p. 26; 1788, p. 14.
——	Java	....	....	Accompanied by an eruption of one of the volcanoes of the island.	Raffles's History of Java, vol. ii. p. 236.
—— or 1667.	In Arsendschan in Asia Minor.	....	....	Possibly this account and those of the 22nd Sept. and Nov. may only relate to one event.	Hadschi Chalifa.
1667. Mar. 5.	In Sicily	....	....	Followed, two days afterwards, by an eruption of Etna.	Mém. de Chronol. t. ii. p. 920.
—— April 6. Between 6 and 7 A.M.	Ragusa, and all Dalmatia, Albania, Venice, and the Italian coast of the Adriatic; and as far as Constantinople and Smyrna.	Extremely violent. The shocks continued for eight days. The first shock, which was the most violent, was instantaneous. Direction at Ragusa = E. to W.	At Ragusa, the sea retired four times, and submarine explosions were heard.	Ragusa was quite ruined, and 5000 persons perished. The little island of Mozzo near this city was greatly injured. The earthquake was attended by a violent wind at Ragusa.	Coll. Acad.; Huot, *loc. cit.*; Ann. de Chim. et Phys. t. xxx. p. 435; Gir. Brusoni, *loc. cit.* p. 847; Nani, *loc. cit.* p. 608; Brewer, *loc. cit.* pp. 123 and 141; Baglivi, p. 516; Andriasci; Partsch, &c.
—— —— 16. $18^h\ 22^m$.	Bologna	Several shocks	....	....	Collection Académique.
—— —— 17. $5^h\ 30^m$ A.M.	Florence	Three shocks, apparently from E. to W.	....	Preceded by calm and serene weather	Ditto.
—— June 27.	Ancona	Several shocks	....	....	Dresdn. gel. Anz. 1756, No. 12.

	Zurich, Innspruck, and Salzburg.				Ditto.
—— Nov. ...	At Venice, more violent at Constantinople, and still more so at Smyrna.	....	At Smyrna the sea as well as the land was affected.	....	Collection Académique.
——	At Schamaki	Lasted three months.	....	Buildings of all kinds were ruined. Mountains disappeared, and the earth opened in many places. The roads were so much injured that the caravans were obliged to adopt new routes. 80,000 persons perished.	Philosoph. Ergotzungen oder .... deutliche Erklärung der Erdbeben, Bremen, 1765; Palassou, *loc. cit.* p. 380; Jean de Struys, Voyages, Amsterdam, 1681, p. 235.
——	Jamaica	Several shocks	....	Several masses of rock, which had been detached from their places by the earthquake, formed a little hill of 59 feet high.	Langlois, Dict. de Géog. t. i. p. 66; Mém. de Chronol. t. ii. p. 920.
1668. Apr. 20. Between 3 and 4 P.M.	Canton of Glaris	....	....	Accompanied by loud subterranean noises, and followed by a great vapour or cloud.	Bertrand; Scheuchzer; Coll. Acad.
—— —— 26.	Bâle	....	....	....	Communication of M. Ch. Martins to M. Perrey.
—— May ...	At different places in the Ottoman Empire.	....	....	Produced great ruins	Terra tremens; v. Hoff.
—— July 3 to Sept. 13.	Different parts of Asia Minor.	Repeated shocks for the time mentioned.	....	At Angora the earth opened on two different days. At Castomme on the Black Sea houses were thrown down. Stammas, Maronoy, Sarduel, Conia, Cæsarea, and several other places were much injured. (The position of these places appears to be very difficult of determination at the present day.)	Dresdn. gel. Anz. *loc. cit.*
—— July 13.	Martinique	....	....	....	Terra tremens; v. Hoff.
—— Aug. 17.	Neustadt in Austria ...	....	....	Some buildings thrown down	Terra tremens; Dresdn. gel. Anz. *loc. cit.*
—— End of Oct.	Ragusa and Cattaro. Also felt in Asia Minor.	....	....	....	Dresdn. gel. Anz. *loc. cit.*
—— Nov. ...	Constantinople	Violent	....	....	Hadschi Chalifa.
—— Dec. 14. Between noon and 1 P.M.	Frankfort on the Maine.	Slight	....	....	Lerner's Chronik; Kriegk, *loc. cit.*
——	Sarrebourg in Lorraine.	One shock	....	....	Collection Académique.
——	The Antilles	....	....	The house belonging to the Jesuits at St. Christopher's was thrown down. Perhaps this event is only the same with that on the 13th July.	Hist. gén. des Voyages, t. xv. p. 456; Gazette de France, Nov. 3, 1668.

1.	2.	3.	4.	5.	6.
1668.	Province of Zantung in China.	....	....	....	Churchill's Voyages, vol. i. p. 101.
1669. Mar. 8. In the evening, and beginning of the night.	All the country round Etna.	Many shocks, continuing at intervals for some days.	....	Followed by one of the most memorable eruptions of Etna, which is described at length by v. Hoff.	Coll. Acad.; Raspe, de novis Insulis, p. 85. Also accounts of this particular eruption by J. Alf. Borelli and Tomaso Tedeschi. Also Ferrara, descrizione, &c. p. 101.
—— Aug. ...	Belgrade	One shock	....	....	Keferstein, *loc. cit.* p. 299.
—— Sept. 30. $3^h\ 30^m$ A.M.	Strasburg.........	Three shocks, of which the first was the most violent.	....	....	Dresdn. gel. Anz. *loc. cit.*
—— —— —	Bâle	....	....	....	Wieland's Chronik.
——	Laybach in Carinthia ...	....	....	....	Collection Académique.
——	Martinique, Guadaloupe, and St. Christopher's in the West Indies.	....	....	Possibly only the earthquake of the year before wrongly reported as to date.	Terra tremens; Dresdn. gel. Anz. *loc. cit.*
1670. Jan. 22.	Halle in Saxony	Several shocks.........	....	....	Keferstein, *loc. cit.* p. 300.
—— —— On the Sunday before the 28th.	4 miles from Pernau in Livonia.	....	....	....	Terra tremens.
—— July 6. 2 A.M.	Canton of Neufchatel ...	....	....	Very probably (allowing for the change of style) the same with the next. v. Hoff, however, gives them as different events.	Bertrand; Collection Académique.
—— —— 17. (7, O.S.) 3 A.M.	Hall and Innspruck in the Tyrol, and the adjacent country, and as far south as Venice. Towards the north, as far as Wildungen, Augsburg, Donauwörth and Nuremberg; and to the west, at the lake of Constance, and the Canton of Glaris.	These widely-extended shocks lasted for several days, and were most violent in and about Hall. Their direction there was from E. to W.	....	At Hall a church and several other buildings were thrown down. The earthquake began with the new moon.	Terra tremens; Bertrand; Coll. Acad.; Dresdn. gel. Anz. *loc. cit.*
—— Sept. 18. 10 A.M.	In the Canton of Glaris.	....	....	Accompanied by a murmuring noise in the air. The Dresd. gel. Anz. gives the date 17th Sept.	Bertrand; Scheuchzer; Coll. Acad.; Dresd. gel. Anz. *l. c.* Nos. 12 and 13.
——	Schamaki or Chamaki...	Many shocks during the year, there being sometimes as many as three in one day.	....	....	Jean de Struys, Voyages, p. 235.

1671. Jan. 1. (N.S.)	Ditto	In the morning there was only a moderate trembling, but towards evening it became very violent, ceased at night, and recommenced the following day with equal impetuosity.	....	Great numbers of buildings were crumbled down by the violent shaking motion, and many people lost their lives in the ruins. The earth opened in several places.	Ditto, p. 245.
—— Feb. 1. At night.	Ditto	Did not last long ...	....	Some buildings were thrown down, and people crushed to death.	Ditto, p. 249.
—— Mar. 31. Beginning of the night.	Ditto	....	....	Accompanied by much thunder and lightning, and a vast number of "balls of fire," which fell from the heavens, and terrified the inhabitants greatly.	Ditto, p. 256.
—— May 16.	Ditto	....	....	Did scarcely less damage than the preceding ...	Ditto, p. 261.
—— June 19. $22^h\ 41^m$.	Bologna	....	....	....	Collection Académique.
—— Aug. 18.	Schamaki.........................	....	....	Overthrew several houses. Followed by a violent wind, and much rain, which inundated half the town.	Jean de Struys, *loc. cit.* p. 261.
—— Sept. ...	On the coasts of the English Channel and German Ocean, at St. Malo, Havre, Calais, Dunkirk, and as far as Antwerp.	....	....	....	Dresdn. gel. Anz. 1756, No. 14.
—— Dec. 22.	Innspruck	One shock	....	Keferstein places this event at the end of October, without, however, giving any authority.	Ditto, No. 13.
——	In the archbishopric of Cologne.	....	....	Possibly simultaneous with that of September.	Brewer, Historica, sive Hist. Univ. t. x. p. 240.
——	Java.........................	....	....	This event is not mentioned by Sir Stamford Raffles.	Keferstein, *loc. cit.* p. 300.
1672. Jan. 9. 3 P.M.	Seigneurie of Hohensax in the Canton of Zurich, and the neighbourhood.	Two shocks.........................	....	The second shock was accompanied by a crackling noise, and did some damage.	Bertrand; Scheuchzer; Coll. Acad.
—— April 14. $4^h\ 48^m$ P.M.	Rimini; felt less violently at Fano, Pesaro, Ravenna, Ancona, and other places in Italy. Almost insensible at Bologna.	....	....	More than 1500 persons perished. Most damage was done at Rimini. v. Hoff gives the date 15th April, $4^h\ 38^m$ P.M.	Coll. Acad.; Girolamo Brusoni, *loc. cit.* p. 944; Mercure Hollandais, 1672, p. 79; Vinc. Magnati, p. 229. Dresdn. gel. Anz. *loc. cit.* No. 13.

1.	2.	3.	4.	5.	6.
1672. May 12. 11h 30m A.M.	Seigneurie of Hohensax in the Canton of Zurich, and the neighbourhood.	Another shock, more violent than that of the 9th January.	....	Accompanied by subterranean noise........	Bertrand; Scheuchzer; Coll. Acad.
—— June 8. 23rd hour.	Around Aquila in Italy, extending in a north and south line from Montereale to Amatrice, injuring both these places. This line is nearly the same with that of the earthquake of Pontecorvo, &c. in 1654.	Violent........	....	....	Vivenzio, 1783, p. 24; 1788, p. 14.
—— —— ...	At Rome and Castelnuovo.	....	....	Probably simultaneous with the last........	Dresd. gel. Anz. *loc. cit.* No. 14.
—— Aug. ...	Kingdom of Murcia in Spain.	Violent........	....	....	Ditto.
—— Dec. 2. 3 P.M.	Usler, Eglisau, Kybourg, and other places in the Canton of Zurich.	....	....	Accompanied by a feeble noise. The weather, which had been extremely cold, became warm and pleasant immediately afterwards.	Bertrand; Scheuchzer; Coll. Acad.
—— —— —	Bâle........	....	....	....	Wieland's Chronik; Communication of M. Ch. Martins to M. Perrey.
—— —— 10.	Zurich........	....	....	Probably confounded with that of the 2nd	Bertrand quotes J. J. Wagner; Coll. Acad.
——	Most of the Grecian Islands, especially Santorin and Stanichio.	Very violent	....	The island of Stanichio, 70 miles in circumference, is said to have been swallowed up with all its inhabitants.	Dresd. gel. Anz. *loc. cit.*; Huot, Cours de Géol.
1673. Feb. 13.	In the Canton of Glaris	Many other shocks were felt here during the year, but they were less violent.	....	Followed by a great fall of snow	Bertrand; Scheuchzer; Coll. Acad.
—— March	Dusseldorf	One shock	....	....	Dresd. gel. Anz. *loc. cit.*
—— March or April.	Island of Sanchio. (In the Levant, or an island of the same name near the coast of China?)	Very violent........	....	The whole island sank into the sea during the earthquake. Very probably this account is confounded with that of the earthquake at Stanichio the year before.	Collection Académique.
—— May 7.	Islands of Candia and Zante.	....	....	....	Dresdn. gel. Anz. *loc. cit.*

1673. May 9.	Island of Dominica in the West Indies.	....	....	....	Ditto.
—— 20.	Gilolo and Ternate in the Moluccas.	....	....	Accompanied by an eruption of a volcano at Gammacanore in Gilolo.	Hist. gén. des Voyages, t. xi. p. 25; Valentyn, t. i. pp. 2, 90, 94, 331.
—— Aug. ...	In Khorasan	....	....	The towns Metsched, Nishapour, and a third, the name of which is not given, were destroyed.	Collection Académique.
—— In the 7th month.	In China, at Pekin, and also at Songtschu, a place 4 leagues distant.	The shocks recurred for three months.	....	Others give the date 1679	De Mailla, Hist. gén. de la Chine, t. xi. p. 88; Du Halde, t. i. p. 476.
——	Italy	Violent earthquakes in this year.	....	....	Collection Académique.
——	In the Canaries	Several earthquakes.	....	Accompanied by subterranean noise, and showers of fire and stones. (Probably an eruption in some of the islands.)	Michele del Bono, Discorso sull' origine de' tremuoti, p. 45.
1674. Beginning of Feb.	Hitoe, the larger island of Amboyna.	Violent shocks	....	Followed, on the 17th, by an eruption of the volcano Wawani in this island.	Dresdn. gel. Anz. *loc. cit.* No. 15.
—— March.	At Yverdun	....	....	Preceded by an explosive noise in the air, and followed by a vapour spreading itself abroad.	Bertrand; Coll. Acad.
Dec. 6. During the morning service, it being Sunday.	Throughout almost all Switzerland, especially violent at Bâle, Colmar, the district of Hohensax in Zurich, and in the Canton of Glaris.	A violent shock	....	A short time afterwards, two igneous meteors or globes of fire fell from the heavens.	Wieland's Chronik; Brombach's Diarium; Bertrand; Scheuchzer; Coll. Acad.
1676. Mar. 26. (According to others, 22.)	In Hungary, especially at Erlau.	....	....	....	Dresdn. gel. Anz. 1756, No. 15.
—— End of March.	Some Turkish islands in the Adriatic, to the east of Faenza.	....	....	....	Collection Académique.
—— July 30. 10th hour.	Sienna	Two slight shocks, and one violent one.	....	They are said to have done no damage, but to have frightened the inhabitants much, *because they happened in summer*.	"Diario di un Anonymo contemporaneo." (Communicated by M. Pilla to M. Perrey.)
1677. Nov. 13.	Island of Palma in the Canaries. Particularly in the southern part of the island, at the hot springs, about 6 leagues from the capital.	Several shocks, which continued at intervals until the 17th.	....	Followed by a violent volcanic eruption, which did not entirely cease until the 21st January 1678.	v. Humboldt, Voyage, t. i. p. 177; v. Buch, Canar. Ins. p. 296, quotes Viera and a manuscript account preserved at Teneriffe.

1.	2.	3.	4.	5.	6.
1677.	Port Royal in Jamaica.				Hist. gén. des Voyages, t. ii. p. 246.
——	Wolverhampton in England.			Possibly only the same with the event at the same place the following year.	Gentleman's Magazine, vol. for 1750, p. 56.
1678. Jan. 5. (N.S.) 8 A.M.	Hanbury on the borders of Derbyshire.	Supposed direction from E. to W.			Coll. Acad.; Révolutions du Globe; Plott's History of Staffordshire, p. 142.
—— —— 11 P.M.	In Staffordshire, especially at Wittenhall near Wolverhampton.	A single shock, which lasted but a short time, and was in the direction S. to N.		Preceded by subterranean noise	Ditto.
—— Mar. 24. 17th hour, *i.e.* half an hour after noon.	Sienna	Rather violent		Did no damage	Diario, &c. (Communication of M. Pilla to M. Perrey).
—— April 22.	At Blois			The principal church sank considerably into the earth during this earthquake.	Dresdn. gel. Anz. *loc. cit.* No. 15.
—— —— ...	In the district of Zabagh in Caramania.	Violent			Ditto.
—— June 17.	Santa Fé to the north of Lima in Peru.		The sea receded, and, after 24 hours (?), returned with destructive violence.		Hist. gén. des Voyages, t. xx. p. 31; v. Humboldt, Voyage, t. i. p. 317.
—— July ...	In the Pyrenees			A high mountain sank into the earth, and its place was occupied by a lake.	Gauthier, Bibliothèque des Philosophes, t. ii. p. 402; Mém. de Chronol. t. ii. p. 920.
—— Sept. 2.	Avignon, Arles and Aix.	Three shocks		Did no damage	Collection Académique.
—— Oct. 20. 11 P.M.	In England, at the same places as on the 5th January.			Preceded by a loud noise like prolonged thunder.	Ditto.
—— Nov. 14. (N.S.) 11 P.M.	Ditto, especially at Brewood.	The shocks recurred three times before 2 A.M. the next morning.		Ditto	Ditto; Plott's History of Staffordshire.
—— —— 15. At night.	Ditto	Less violent than the last.		Ditto	Ditto.
1679. Jan. 25. Between 2 and 3 A.M.	In the Canton of Glaris.	Several shocks		A subterranean rumbling noise was heard before, during, and after the shocks.	Bertrand; Scheuchzer; Coll. Acad.
—— Mar. 4.	In Mexico. (Lat. 13° 32′ N.)	A remarkable earthquake.			v. Humboldt, *loc. cit.* t. ii. p. 297.

1679. Mar. 14.	Bâle	One shock			Wieland's Chronik; Suppl. to Brombach's Diarium.
—— June 4. (N.S.) 7 P.M.	The fort of Erivan, and all the country around, to the Ararat chain.	The shocks were most violent for nine days, and continued more or less until October, or, according to others, for a whole year.		Mosques, houses, and buildings of every kind were crumbled down by this violent earthquake. It appears to have been accompanied by slight volcanic eruption in some places, as it is said that flames and smoke issued from the ground. v. Hoff gives the date 1680.	Chakathouno, Description of Edchmiadsin.
—— Sept.	At Malaga	One shock			Keferstein.
—— Dec. 12. 2nd hour of the night.	In the neighbourhood of El-Tito in Calabria.	Violent		Did no damage	Fiore, *loc. cit.* p. 289.
1680. Jan. 4. 7 A.M.	Chedsey in Somersetshire, and the country for some miles round.			The air was very calm beforehand, but the shock was accompanied by a noise like a sudden gust of wind. The Gentleman's Magazine does not mention the day.	A pamphlet called The Theory and History of Earthquakes, p. 17; Gentleman's Magazine for 1750, p. 56.
—— July 24.	Many places in Switzerland, especially at Yverdun, Orbes, Bâle, and Neufchatel.	Many shocks		At Orbes followed by a rumbling noise which lasted some minutes, and by storms of thunder, hail, and rain, which produced great inundations, especially in the Pays de Vaud.	Bertrand; Scheuchzer; Coll. Acad.; Wieland's Chronik.
—— Aug.	In Spain; especially destructive at Malaga.				Dresdn. gel. Anz. *loc. cit.*
—— Oct. 9. (At Madrid, at 7 A.M.)	Throughout the whole of Spain, principally in the kingdom of Grenada.	Several shocks		At Madrid the shocks were slight, but at Malaga many houses were thrown down, and clefts opened in the earth, from which torrents of water came forth. Loud subterranean noises were also heard.	Coll. Acad.; Histoire d'Espagne (anonymous), t. viii. p. 249.
—— Dec. 11.	Bâle	One shock			Wieland's Chronik; Communication of M. Ch. Martins to M. Perrey.
——	In Italy				Collection Académique.
——	Poland				Mém. de Chronol. t. ii. p. 920; Coll. Acad.
——	Island of Celebes			Accompanied by an eruption of the volcano of Kemas in this island.	Phil. Trans. vol. v. p. 19. No. 7; Valentyn, t. i. pp. 2 and 64.
1681. Jan. 10 to 12.	Island of Candia	Shocks during the three days mentioned.			Dresdn. gel. Anz. *loc. cit.*
—— —— 27. Between 10 and 11 P.M.	Several places in Switzerland, especially in the Canton of Glaris. Also felt at Bâle and Neufchatel.	Several shocks		In various places in the Canton of Appenzel the tiles fell from the roofs. The weather was extremely cold.	Bertrand; Scheuchzer; Coll. Acad.

1.	2.	3.	4.	5.	6.
1681. Jan. On a Friday, between 4 and 5 (A.M. or P.M.?)	Mayence, Frankfort on the Maine, and Hanau.	....	....	The earthquake broke the ice on the river Maine, which had been so strong that laden waggons had crossed upon it. It, however, did no damage.	Dresd. gel. Anz. *loc. cit.*; Lerner's Chronik; Kriegk.
—— Aug. 19. 2 A.M.	Jassy in Moldavia	Lasted half a quarter of an hour. The oscillation was first from W. to E., then from E. to W., and finally from W. to E. again.	....	Preceded by a subterranean noise, which appeared to come from the West.	Collection Académique.
—— Nov. 16.	Ditto	....	....	....	Ditto.
—— —— 18.	Ditto	....	....	....	Ditto.
—— Dec. 27. 1½ hour before dawn.	Ditto	In the direction W. to E., which is the direction of Mont-Craplatz.	....	Preceded by a loud noise, apparently coming from the West.	Ditto.
1682. Jan. 16.	Trübenhausen in Hesse.	....	....	Accompanied by the fall of a mountain near.	Dresdn. gel. Anz. *loc. cit.* No. 18.
—— May 2. Between 2 and 3 A.M.	Throughout the whole of Savoy, Switzerland, Provence, Alsace, Burgundy, and as far north as Paris; and even in Thuringia in Germany.	Several shocks. At Remiremont they recurred constantly for some weeks.	....	Accompanied by loud subterranean noise, and agitation in the air. Flames came forth from the earth in various places, particularly at Remiremont on the Moselle. In Switzerland, Bâle, Neufchatel, Geneva, and the Canton of Glaris, were most violently affected. At Gotha the tower of the Rathhaus and the steeple of St. Margaret's church were made to oscillate very considerably. In France it was felt at Bar-le-Duc, Metz, Nancy, Troyes, Auxerre, Vesoul, Orleans, Paris, and several other places. The dates May 12 and 13 are also given, but they probably only refer to the same event.	Spon, Hist. de Genève. t. i. p. 555; Académie des Sciences, t. i. p. 341; Coll. Acad.; Bertrand; Richard, Hist. des Mét. t. viii. p. 495; Wieland's Chronik; Suppl. to Brombach's Diarium, &c.
—— —— 4. 7 P.M.	Frankfort on the Maine.	....	....	....	Lerner's Chronik; Kriegk.
—— —— 7.	In the Canton of Glaris.	....	....	Accompanied by a loud and sudden noise like the report of a large piece of ordnance, which made the windows rattle.	Scheuchzer; Coll. Acad.
—— June 1.	At Lyons	In the direction, according to some, of E. to W., and, according to others, of N. to S.	....	....	Collection Académique.

to 22.	try round.			Attended by an eruption	Maria della Torre, *loc. cit.* p. 66; N. M. Messina di Molfetta, Relazione dell' incendio, &c., Napoli.
1683. April 25. Between 8 and 9 P.M.	Wismar on the Baltic Sea.	....	....	....	Dresdn. gel. Anz. *loc. cit.*
—— Aug. 23.	In Basilicata, kingdom of Naples.	Two great earthquakes.	....	....	Gazette de France, 16 Oct. 1683.
—— Sept. 28. (N. S.). 7 A.M.	Oxford and the neighbourhood. Also felt at the same hour at Burford, Watlington, Brill, and other places in Berkshire; the noise extended to Dourton in Buckinghamshire, though the shock was there inappreciable. The earthquake appears to have extended as far as Burford on the north, Long Hanborough on the north-west, Brampton on the west, Abingdon on the south, and the Thames on the east; a circuit of about 70 miles.	Another shock is mentioned, on the same day, as having been felt at 4 A.M.; but this does not seem to be at all certain. The shock lasted six seconds, and consisted of alternate vibrations, succeeding one another more and more quickly.	A man who was fishing in the Cherwell, at Oxford, perceived the boat to tremble under him, and the little fish showed signs of alarm.	Accompanied by a low noise like prolonged thunder. The weather had been very wet up to the 20th, when it became fine until the evening of the 27th, when it was very cold, and even frosty though calm and serene. The barometer was higher than it had been for three years. The *ignis fatuus* had been often seen some days before the earthquake. The most violent effects mentioned were the throwing down a tin vessel, and setting in motion a bed upon castors.	Phil. Trans. t. ii. p. 208. (edit. of 1745) t. xlvi. p. 624; Coll. Acad.
—— Oct. 9. 11 P.M.	Oxford, and further north as far as Derbyshire, and *the country where the coal-mines are* (Staffordshire?).	Felt throughout at the same time. Very feeble at Oxford, but violent farther north.	....	....	Ditto.
—— Nov. 27.	Bâle	....	....	....	Wieland's Chronik.
——	Erivan, and on the frontiers of Persia and Turkey.	....	....	Did great damage	Ziehen, p. 13.
——	The island of Amboyna, and also the island Ceroewa, 40 miles off.	Violent shocks, lasting for several weeks.	....	....	Valentyn's Beschreibung v. Ostindien, B. iii. S. 17.

1.	2.	3.	4.	5.	6.
1684. Feb. 26. Between 8 and 9 P.M.	Different parts of Switzerland, especially in the Haut-Valais, and, perhaps, at Lausanne and Bâle.	One shock	....	Some houses were thrown down	Bertrand; Scheuchzer; Coll. Acad.
——	In Lorraine, Limousin, and Poitou.	Several shocks	....	....	v. Hoff.
——	Laybach in Carinthia	....	....	Followed by very severe cold	Collection Académique.
——	Surate (Surat?) in Further India.	....	....	....	Ditto.
1685. Feb. 26.	Bâle	....	....	Bertrand and the Collection Académique mention an earthquake in Switzerland as having happened on this day at between 8 and 9 P.M. It is in all probability the same with that of the year before.	Wieland's Chronik.
—— —— 28.	Ditto	....	....	....	Ditto.
—— April 25.	La Cava, Salerno, S. Severino, Vietri, and other adjacent places.	A violent shock	....	....	Vivenzio, 1783, p. 27; 1788, p. 14.
—— Sept. 9.	Canton of Glaris	One very violent shock. According to Scheuchzer, preceded by others for some days	....	The atmosphere was quite calm	Bertrand; Scheuchzer; Coll. Acad.
——	Smyrna	....	....	Felt by the traveller Dumont	Collection Académique.
1686. Jan. 1.	Linköping in Sweden	One shock	....	....	Dresd. gel. Anz. *loc. cit.*; Keferstein.
—— Sept. ...	Palermo and the country for 40 miles round.	....	....	....	Dresd. gel. Anz. *loc. cit.*
——	Laybach in Carinthia	....	....	....	Collection Académique.
——	Island of Ternate	....	....	Followed by a vast shower of ashes cast forth from a volcano on the island.	Hist. gén. des Voyages, t. ii. p. 4; Phil. Trans. No. 216, p. 42.
1687. Mar. 5.	Canton of Glaris	More very sensible shocks.	....	....	Bertrand; Scheuchzer; Coll. Acad.
—— ——. At night.	Naples	A slight shock	....	....	Baglivi, p. 538.
—— —— ...	Alexandria in Egypt	Shocks which recurred for ten to twelve days.	....	....	Dresd. gel. Anz. *loc. cit.*
—— April 23. 5h 30m A.M.	Naples	....	....	Most of the houses and churches thrown down. The inhabitants took shelter under tents in the open country.	Lettres hist. nov. 1694, p. 488.

Midnight.	of Amalfi; especially at Pasitano.	shocks were felt during the month.			
—— —— ...	The town of Machat on the borders of Persia and India.	....	....	The town was ruined	Dresd. gel. Anz. *loc. cit.*
—— May 19.	In Zealand	....	....	....	Ditto.
—— Sept....	In Calabria	....	....	At Tropæa some houses were thrown down......	Vivenzio, *loc. cit.*
—— Oct. 20. 4 A.M.	Lima, Callao, and an immense district along the sea coast of Peru. Also felt on board a vessel 150 hours distant from the coast.	Extremely violent ...	The sea retired, and then came back upon the coast with great violence.	The town and harbour of Callao were quite destroyed by the sea. *Tradition* also says that wheat never flourished since on the coast visited by this earthquake.	Hist. gén. des Voyages, t. xx. p. 31, quoting Ulloa; Phil. Trans. for 1694, p. 78, &c.
—— Dec. 18.	Smyrna	Slight	....	....	Hist. de l'Acad. des Sciences, t. ii. p. 37; Coll. Acad.
1688. Jan. ...	Province of Basilicata in the kingdom of Naples.	Violent shocks for three hours.	....	Pisticcio was ruined, and 2000 of its inhabitants killed.	Dresdn. gel. Anz. *loc. cit.*; Huot.
—— March 1. (N.S.)	Island of Jamaica	Three shocks in 1 minute. Felt through the whole island at the same time.	The ships in the harbour at Port Royal were much injured. A ship, also, at sea to the east of the island was greatly damaged by *a hurricane.*	Accompanied by a loud subterranean noise. The earth appeared to rise in waves like the sea, *apparently constantly advancing towards the North.* All the houses were much injured.	Coll. Acad.; Phil. Trans. vol. li. p. v. 572; v. Humboldt, Voyage, t. ii. p. 22.
—— April 1 to 11.	Venice	Several shocks........	....	....	Keferstein.
—— May 1. 10 A.M.	Genoa and a great part of the Genoese territory.	Ditto	....	....	Hist. de Gênes. (anonymous), t. iii. p. 428.
—— June 5 to 8.	At Naples and many other places along the Apennines as far as Matese to the north, and Mirabella and Benevento to the south. Also felt at the same time at some places in Romagna, at Venice, and even at Smyrna.	Many shocks. The first, which were very violent, occurred on the 5th at 21^h, and lasted a *Miserere.* They were very great at Benevento. The shocks did not entirely cease for 2 months.	....	Chasms opened in the ground in many places ...	Giannone, *loc. cit.* p. 845; Michele del Bono, *loc. cit.*; Coll. Acad.; Vinc. Magnati, p. 237; Vivenzio.

1.	2.	3.	4.	5.	6.
1688. July 10. 11h 45m A.M.	Smyrna	Began by a movement from W. to E., which lasted half a minute. Followed by five or six other shocks before night.	The ships near were much agitated.	A building situated on a little isthmus was thrown down, and the peninsula separated from the mainland by a channel of 100 paces wide. The town was ruined, and caught fire in many places. All the walls running E. and W. were thrown down, while those running N. and S. remained upright. The surface of the earth at the town was lowered by 2 feet. The earth opened in many places. 15,000 or 20,000 persons perished.	Coll. Acad.; Hist. de l'Acad. des Sciences, t. ii. p. 37; Kant, Géog. Fis. (Ital. Trans.) t. iv. p. 338.
—— —— 11 and 12.	Ditto	More shocks			Ditto.
—— Aug. 11. 8 A.M.	Ditto	Ditto		The weather was very cold, and the heavens obscured. New springs were remarked.	Ditto.
—— Sept. 10.	The islands of Metellino, Chio, and Satalin, and along the opposite coast of Asia Minor.			At Smyrna a strong smell of sulphur was perceived.	Ditto.
—— —— —— At night.	Constantinople				Ditto.
—— —— 16. 4 A.M.	Genoa				Hist. de Gênes, *loc. cit.*
—— Oct. 10.	Lima, and several other towns both of Peru and Mexico.				v. Humboldt, *loc. cit.* t. ii. p. 298; Dresd. gel. Anz. *loc. cit.*
——	Etna and the country round.	Shocks for seven days.		Accompanied by loud subterranean noises, and followed by an eruption of Etna.	Ferrara, Descrizione, &c. quotes Bottone.
——	Middle near Ellesmere, —— England.	An earthquake		An old castle said to have been destroyed. The fact seems doubtful.	Cook's Topography, Shropshire, p. 84.
1689. Feb. 12.	Mexico				v. Humboldt, *loc. cit.* t. ii. p. 298.
—— Mar. 14.	Etna and the neighbourhood.	A violent shock		Followed by an eruption of the volcano	Ferrara, Descrizione, &c. *loc. cit.*
—— June ...	Neufchatel and the environs.	Several shocks			Bertrand; Coll. Acad.
—— Sept. 21.	In Puglia and the Terra di Bari.	Apparent direction = S. to N.		Barletta, Andria, and some other places were ruined.	Vivenzio, 1783, p. 29; 1788, p. 15.
—— Oct. 9.	Genoa				Dresd. gel. Anz. *loc. cit.*
—— Dec. 11.	Innspruck and Augsburg.	Violent shocks.			Ditto; Coll. Acad.
—— —— 21.	Ditto	Ditto			Ditto.

[illegible]	Belgrade	Violent			Hadschi Chalifa.
1690. Jan. 13.	Smyrna				Dresd. gel. Anz. *loc. cit.*
—— —— 15.	Drontheim in Norway				Ditto.
—— —— 28.	Kingston in Ireland (?)				Ditto.
—— Feb. 19 to 21.	Laybach in Carinthia, and in Bohemia.				v. Hoff.
—— —— 26.	The islands of Antigua, Montserrat, Barbadoes, and St. Christopher's.			In St. Christopher's the earth opened	Dresd. gel. Anz. *loc. cit.* No. 19.
—— April 10.	Ditto, and at Martinique and St. Lucie.				Ditto.
—— Oct. 17. (N.S.)	Dublin and Kilkenny in Ireland.				Phil. Trans. 1750.
—— Dec. 5. (N.S.) 3 P.M.	In several places in Switzerland, and in Swabia, Austria, Prussia, Thuringia, and in fact almost all Germany; also in Poland (the date of the year only, however, being given for this last locality).	Apparent direction = S.W. to N.E. Followed by another shock at 7 P.M., but slighter.		Vienna, Strasburg, Heidelberg, Frankfort, Jena, Dresden, Meissen, and several other cities in Germany are mentioned as having experienced these shocks. Bells were made to ring. Preceded in Swabia by the sudden elevation of the water in a public cistern. In some places large masses of rock were detached from the mountains.	Dresd. gel. Anz. *loc. cit.*; Höpfner, das erschütterte und bebende Meissen; Lersner's Chronik; Kriegk; Coll. Acad.; Langlois, Dict. de Géogr. t. i. p. 66.
—— —— 18.	Cologne				v. Hoff.
—— Middle of the night.	In England and Scotland; in Bedford, Sutherland, &c.	Two shocks in Bedfordshire.			Dresd. gel. Anz. *loc. cit.*; Coll. Acad.
——	Constantinople				Hadschi Chalifa.
——	Lima in Peru	Three earthquakes during this year.			Coll. Acad.; Ulloa, Voyage au Pérou, t. i. p. 467.
1691. Jan. 1.	Ancona and Rimini	Several shocks			v. Hoff.
—— —— 4.	Bâle	One shock			Ditto.
—— —— 26. 6 A.M.	Ditto				Bertrand; Coll. Acad.; Philibert's Chronik.
—— Feb. 19, 20, and 21.	Carlstadt in Transylvania, Laybach in Carniola, Venice, Bâle, Metz (most violent at the three last places), Sarre-Louis, Mayence, Frankfort, and Hanau.	The first shock was the most violent. Direction = E. to W. (at what place?)		Trees were torn up by the roots, and clefts opened in the earth.	Lersner's Chronik; Coll. Acad.; Miscell. Acad. Nat. Curios. 1690, p. 423.

1.	2.	3.	4.	5.	6.
1691. Sept. 8. 2 P.M.	Deal, Canterbury, Sandwich, and Portsmouth.	Said to last six minutes.	....	....	A pamphlet called The Theory and History of Earthquakes, p. 18.
—— Oct. 14.	In Japan	Two shocks at Desima or Nangasaki.	....	....	Kämpfer, v. Dohm, t. ii. p. 323.
—— —— 17.	Aquila in Abruzzo	One shock	....	....	Keferstein.
—— —— 26.	Sienna	A slight trembling ...	....	....	Pirro Gabrielli, Mem. dei Fisiocritici, t. i.
—— Nov. 10. In the evening, and at night.	Japan	Several shocks	....	....	Kämpfer, v. Dohm, *loc. cit.*
——	The town of Azua in St. Domingo.	....	....	The town was ruined	Comptes Rendus de l'Acad. t. xvi. p. 1153.
——	St. Michel in the Azores	....	After violent earthquakes several little islands were raised above the sea near the coast of St. Michel.	....	v. Buch, *loc. cit.* p. 367.
1692. June 7. Between 11 A.M. and noon.	Jamaica	Extremely violent shocks, which did not entirely cease for two months.	A frigate was wrecked in the port.	The island rose in waves like the sea, and the people believed that it sank a little permanently. At Port Royal three-fourths of the houses were thrown down, and 3000 persons perished. A piece of land of about 1000 acres sank into the sea. Louis Gelday, an inhabitant of the island, was caught in one of the fissures of the earth, and thrown out again uninjured by a second shock. In this same month there was an eruption of a volcano at St. Kitt's, continuing several weeks.	Coll. Acad.; Phil. Trans. vol. li. p. 577; Hist. gén. des Voyages, t. xv. p. 581; Mercure Hist. et Polit. Sept. 1692, p. 344; Montg. Martin, vol. ii. p. 155; Preuss. Staats-Zeitung, 1826, No. 36, p. 147, &c.
—— Sept. 18. (N. S.) Between 2 and 3 P.M.	Very widely extended; the centre being probably in Brabant, and the earthquake extending to Paris, Normandy, England, Flanders, Holland, and as far east as Mayence, Frankfort, and the Valais.	Very violent. Lasted two minutes.	....	Brussels, Antwerp, Spa, Ipswich, Deal, Dover, Sheerness, and other places are mentioned as having experienced these shocks. It was observed that mountains, the coasts of the sea, and the banks of rivers were most affected. There was no wind at the time of the earthquake. Many persons felt their heads giddy after the shock. The Lettres Historiques give the date September 25.	Bertrand; Coll. Acad.; Phil. Trans. vol. xlvi. p. 624; Vivenzio; Lersner's Chronik; Kriegk, &c.; A History of Ipswich in the 19th century, by John Glyde, Jun., Ipswich, 1850, p. 13.
—— —— 20 or 21. Between 8 and 9 A.M.	Ditto	Less violent than the last.	....	....	Ditto.

1692. Oct. 15.	Schaffhausen				Keferstein.
—— —— 28.	Frankfort on the Maine.				Ditto.
—— —— 30.	Liège				Ditto.
——	Ile de Fer in the Atlantic, off the coast of Africa.	Many shocks		A violent volcanic eruption at the same time, which lasted six weeks.	Hist. gén. des Voyages quoting Atkins's Travels in Guinea, p. 30.
1693. Jan. 9.	Lausanne, Orbes, and Yverdun.			At Orbes the marshes filled very high at the time of the earthquake, and the lakes of the valley of Joux were also very high. The weather had been cold, but it now became suddenly warm, with gentle rain, and the ensuing season was an early one.	Bertrand; Coll. Acad.
—— —— —— 5 P.M.	Sicily and Calabria. Also at Malta, and several places in Switzerland, France, Germany, Flanders, Holland, and England, for a space of 2600 square miles.	Extremely violent shocks. The first lasted two minutes. Direction in Calabria = S.W. to N.E. Followed by other shocks on the 10th and 11th.		In Sicily the earth opened in many places. Catania was ruined by the first shock. Forty-nine towns, numerous villages, and 972 churches or convents were ruined in Calabria and Sicily, and 93,000 persons lost their lives. It does not seem certain that the shocks were simultaneous here and in the other parts of Europe mentioned. There was an eruption of Etna at the same time.	Ditto; Hamilton's Observations on Mt. Vesuvius, p. 59; Biblioteca Italiana, t. xi. p. 347; Phil. Trans.; Ferrara, &c. &c.
—— Feb. 13.	In the neighbourhood of Hecla in Iceland.		Also affected the sea near the coast.	Followed by a great eruption of Mount Hecla...	v. Hoff.
—— April 28.	Between Militello and Noto in Sicily.	Violent			Coll. Acad. and the other authorities quoted for the 9th January.
—— June 4.	The island Ceroewa in the Moluccas.			Followed by a violent volcanic eruption	Phil. Trans. vol. xix. p. 49; v. Buch, *loc. cit.* p. 366; v. Hoff.
—— July 6.	Venice, Padua, Mantua, and Avignon.	Slight shocks			Authorities just quoted under 9th January.
—— End of Sept.	Catania and the country round.	Many shocks		Moderate damage. The eruption of Etna still continuing.	Ditto.
—— Dec. 16 (O.S.) 1 P.M.	Frankfort on the Maine.				Lersner's Chronik; Kriegk.
——	At the Havanna			More than 1500 houses thrown down	Mercure Hist. et Polit. Mars et Avril, 1693, pp. 332 and 366.
——	Jamaica	Shocks lasting for some months.			v. Humboldt, *loc. cit.* t. v. p. 28; Phil. Trans. 1694, p. 99.
1694. March 1. 9 P.M.	The country around Mount Vesuvius.	One slight shock. Followed by several others up to the 12th.		On the 12th at 3 o'clock at night (Italian time) a violent eruption of Vesuvius. During the course of this month an eruption of Etna with some earthquake shocks.	Maria della Torre, *loc. cit.* p. 66; Coll. Acad.; Mercure Hist. et Polit. Mai, 1694, p. 462. A description of the succeeding eruption by Ant. Bulifone.

1.	2.	3.	4.	5.	6.
1694. April 4.	All the country about Vesuvius, and at Urbino, Castello, Borgo, San-Sepolcro, Naples, and even some places in Romagna.	Many shocks, continuing for some days.	....	Some buildings were thrown down. Accompanied by a great eruption of Vesuvius.	Maria della Torre, *loc. cit.* p. 66; Coll. Acad.; Mercure Hist. et Polit. Mai, 1694, p. 462. A description of the succeeding eruption by Ant. Bulifone.
—— July ...	In Sicily and the island of Negropont at the same time.	....	....	In Negropont a bastion was thrown down	Mercure Hist. et Polit. 1694, Aug. p. 125; Lettres Hist. 1694, Sept. p. 253.
—— Sept. 8. $9^h\ 45^m$ A.M.	In the kingdom of Naples; principally in the Terra di Lavoro, the two Calabrias, and Basilicata; in a line from S.E. to N.W., between the coast of the Tyrrhenian Sea and the south-west spur of the Apennines.	At Naples it lasted the time of repeating a *Credo*. At Tricarico (Basilicata) and Saracena (Calab. Cit.) the earthquake recommenced three times. During the course of this month and the following several other slight shocks were felt at Naples and Catania.	....	Naples, Sorrento, Castellamare, Vico, Ottajano, Nola, Sta. Maria, Aversa, and Capua were all violently shaken. At Naples the public buildings only were much injured. Etna threw out immense quantities of ashes.	Mercure Hist. et Polit. Oct. et Nov. 1694, pp. 359, 361, and 476; Lettres Hist. Nov. 1694, p. 489; Coll. Acad.
1695. Feb. 24. At night.	In the Venetian territories; especially in the district of Asolano (diocese of Treviso).	Followed by other violent shocks after sunrise the following morning, which often recurred for several months.	....	It was remarked that the sun even at noon was pale and dull, as if hidden by a mist. The same was observed in 1783. The following winter was extremely cold.	Codice Meteorico di Nicodemo Martellini. Venezia, 1700.
—— May 21. 2 P.M.	Island of Banda	Two shocks	....	....	Collection Académique.
—— June 10. 11 P.M.	Different parts of the States of the Church; especially at Bagnoreale, Bologna, Viterbo, Montefiascone, Celleno, Orvieto, Castiglione, &c.	Preceded by some rather slight shocks. The most violent (especially two of the shocks) were at the hour mentioned.	The lake of Bolsena was raised so as to overflow its shores and produce an inundation for 3 miles round, afterwards retiring, and leaving the shore covered with fish.	It was remarked that the Clitumnus (le Vene), which had lost much of its waters during the earthquake of 441 or 446, now in great measure recovered them.	Keferstein, *loc. cit.*; Coll. Acad.; Mercure Hist. et. Polit. 1695, Juil. p. 5; Août, p. 125; Sept. 247; Lettres Hist. 1695, Juil. p. 112; Août, p. 113.

1695. June 11. 3 A.M.	Ditto, and at Rome; and, with less violence, at Frascati, Tivoli, and the neighbourhood.	Almost continuous shocks. The most violent at the times here mentioned.	....	Did great damage in many places. In some localities the earth opened in chasms.	Ditto.
—— —— 7 P.M.	Ditto	Ditto	....	....	Ditto.
—— —— 12. 2 P.M.	Ditto	Ditto	....	....	Ditto.
1696	In Sicily	....	....	Several towns said to have been ruined. Possibly only the same with some of the earthquakes of the year or two before.	Histoire d'Espagne (anonymous).
——	Falmouth in England ...	....	....	....	Gentleman's Magazine for 1750, p. 56.
1697. Feb. 20. At night.	Various places in the Calabrias. Felt very violently at Naples.	Several shocks	....	Vesuvius was in a state of eruption. The houses at Naples were much shaken.	Mercure Hist. et Polit. 1697, Avril, p. 367.
—— Mar. 24. 10 P.M.	Mexico........	Shocks for two minutes. Followed, the next day, by others.	....	Acapulco was destroyed; while Pueblo Nuevo was not even injured. The shocks on the following day were accompanied by a loud noise like the firing of cannon.	Hist. gén. des Voyages, t. x. p. 528.
—— Probably in March.	Essek in the government of Waradin, Transylvania.	Several shocks........	....	Accompanied by thunder and lightning, but without doing any serious injury to buildings, &c.	Mercure Hist. et Polit. 1697, Avril, p. 367.
—— Sept. 20, 21, and 23.	Sienna	Seventy-four feeble shocks on the first two days. Many slight shocks from this time until the 19th March of the following year.	....	Very little damage done........	Ditto, Nov. p. 587; "Manoscritto presso il cav. Perfetti, citato da Soldani."
—— —— 29.	Lima in Peru	A very violent earthquake.	....	....	Coll. Acad.; Vivenzio; v. Hoff.
—— Oct. 2. Between 8 and 9 P.M.	Venice	Three shocks	....	....	Mercure Hist. et Polit. *loc. cit.* p. 587.
1698. June 2 to July 12.	All the country round Vesuvius.	Numerous and violent shocks.	....	Preceded by a great eruption of Vesuvius	Maria della Torre, *loc. cit.* p. 67; Ant. Bulifone, Compendio istorico, &c.
—— June 19.	The Andes about Quito.	Very violent	....	The summit of the volcano Carguairazo fell in, and from the broken part of the mountain came forth streams of mud and water, which did great damage. The towns Hambato and Llactacunga were ruined by the earthquake.	Bouguer de la figure de la terre, p. 71; v. Humboldt, Atlas Pittoresque, p. 106.

1.	2.	3.	4.	5.	6
1698.	Catania	....	....	Did great damage. Etna was in eruption at the time.	Mercure Hist. et Polit. Juil. 1698, p. 20.
1699. Jan. 5.	Islands of Java and Sumatra.	Extremely violent. In Java not less than 208 shocks were counted.	....	Accompanied by an eruption of the volcano Salak in Java. Great changes were produced in the surface of the islands, large landslips taking place, which in many places choked up the course of the rivers, &c.	Phil. Trans. 1700; Hooke's Posthumous Works, p. 487.
—— —— ...	In Switzerland; on the Rhine and Maine; and at Hamburg.	Several shocks	....	Great numbers of auroræ boreales were observed this year and the year before.	Keferstein.
—— July 14.	Lima in Peru	....	....	....	v. Hoff.
—— Oct. 27.	Lisbon	Very violent. Lasted, with many intervals, for three days.	....	....	Balbi, Essai sur le Royaume de Portug. &c. t. i. p. 102.
——	At Catania and in Malta. Also felt at the same time in France, Germany, and England.	Very violent shocks...	The sea near Catania retired more than 2000 yards from the shore.	Possibly only the same with that of last year ...	Mém. de Chronol. t. ii. p. 922.
1700. Feb. 6.	Sienna in Tuscany	....	....	....	Keferstein.
1701. Mar. 13 to 27.	In the Saxon Erzgebirge, and Voigtland; especially at Schneeberg.	Many shocks during the time mentioned.	....	....	Joh. Fr. Seyfart, Allgemeine Geschichte der Erdbeben, p. 94, quotes Ziegler's Schauplatz der Zeit. 1 Fortsetz, S. 1208.
—— April 5. About the 4th hour of the night.	Sienna	Moderate..............	....	On the 3rd there had been rain, and on the 4th and 5th a good deal of snow.	"Manoscritto presso il cav. Perfetti, citato da Soldani."
—— —— 8. Between 11 and 12 P.M.	Schneeberg	A violent trembling...	....	....	Seyfart, *loc. cit.*
—— —— 20 to 23.	In the Erzgebirge; especially at Johann Georgenstadt and Plauen.	Daily shocks	....	....	Ditto.
—— Aug. 17. 6 P.M.	In Saxony	....	....	....	Collection Académique.

1701, Aug. 19. (O.S.) Between 6 and 7 P.M.	In the Linththal, Canton of Glaris.	Three shocks	....	Accompanied by a loud noise in the air. From the 19th August of this year until the 30th January, 1702, the Canton of Glaris experienced thirty-seven, or according to others fifty (or even sixty) earthquakes, consisting of more or less shocks, often accompanied by subterranean murmurs, and sometimes loud noise. The list of thirty-seven noticed by Scheuchzer is here given.	Bertrand; Scheuchzer; Coll. Acad.
—— —— 30. 9 P.M.	Ditto	....	....	Probably only the same day as the last, allowing for change of style.	Ditto.
—— —— 31. 3 A.M.	Ditto	....	....	....	Ditto.
—— Sept. 1. 11 P.M.	Ditto	....	....	....	Ditto.
—— —— 2. 9 A.M.	Ditto	....	....	....	Ditto.
—— —— 4. 8 A.M.	Ditto	Probably two shocks.	....	The people in church heard the tongue (or lid) of the poor-box at the door strike twice as if struck with a stick.	Ditto.
—— —— —— 5 P.M.	Ditto	Two shocks, of which one was violent.	....	....	Ditto.
—— —— 5. 9 P.M.	Ditto	Violent	....	....	Ditto.
—— —— —— Between 11 P.M. and midnight.	Ditto	....	....	....	Ditto.
—— —— 6. 10 P.M.	Ditto	A violent shock	....	....	Ditto.
—— —— 7.	At Bettschwanden, and throughout the Linththal, as far as Æsch, to the beginning of the Schachenthal.	Very violent	....	Accompanied by different noises in the air. Bodies on the earth were much moved about.	Ditto.
—— —— 8. 1 A.M.	In the two valleys of the Linththal (Gross- and Klein-thal).	One violent shock	....	Sufficiently great to rock the people in their beds.	Ditto.
—— —— 10. 8 A.M.	Linththal and the country round.	....	....	....	Ditto.
—— —— 13. (N.S.) 10 A.M.	Ditto	....	....	....	Ditto.

1.	2.	3.	4.	5.	6.
1701. Sept. 18. 4 P.M.	Linththal and the country round.			Accompanied by noise	Bertrand; Scheuchzer; Coll. Acad.
—— —— 19. (N.S.) 8 A.M.	Ditto	A violent shock			Ditto.
—— —— —— (Hour not mentioned.)	Ditto (more violent in the Linththal than at Bettschwanden).	The most violent which had been felt.		Those in church heard a noise like the violent grinding of stone, and the building was greatly shaken.	Ditto.
—— —— 23. (N.S.) A little before 4 P.M.	Ditto	A short shock and then a slight trembling.		Accompanied by a hissing or humming noise, the weather however being fine, and the sun shining.	Ditto.
—— —— 29. (N.S.) 7 P.M.	Ditto (felt in both valleys).	Slight oscillation, without shocks.			Ditto.
—— Oct. 23. (N.S.) 6 A.M.	Ditto	One of the feeblest of these earthquakes.		The ground had been covered with snow for five days. This earthquake, though very slight, was remarked by very many people.	Ditto.
—— —— 26. (N.S.) $8^h\ 45^m$ P.M.	Ditto (in both valleys)	Moderate		Felt by many people. There had been a thick mist all day, which cleared away about midnight, and gave place to a fine starlight night.	Ditto.
—— Nov. 13. (N.S.) 7 A.M.	Ditto (on both sides of the Linth).	A feeble shock			Ditto.
—— Dec. 12. (N.S.) 8 P.M.	Ditto			During clear and cold weather. Two days before it had been very warm.	Ditto.
—— —— 19. (N.S.) $3^h\ 15^m$ A.M.	Ditto	One violent shock			Ditto.
—— —— 28. (N.S.) 6 A.M.	Throughout the whole of the Linththal.				Ditto.
—— —— 30. At night.	On both sides of the Linth.				Ditto.
1702. Jan. 4. (N.S.) 6 A.M.	In the two valleys	One of the most violent of these shocks.		The weather, which had been very cold for four days, became warm the day after.	Ditto.
—— Feb. 24. (N.S.) 9 P.M.	Ditto				Ditto.
—— March 8. About midnight.	Etna and the country round.	Several shocks		Followed by an eruption which lasted until the 8th May.	Ferrara, Descrizione, &c. p. 113.
—— June 17. (N.S.) A little before 10 A.M.	In the Linththal	A moderate shock			Bertrand; Scheuchzer; Coll. Acad.

mer.				Did great damage	Coll. Acad.; Baglivi, *loc. cit.*
—— Sept. ...	Martinique	Violent shocks	Also felt at sea off the coast.	Houses were thrown down	Labat, Voyage aux Iles, t. vii. p. 440.
—— Oct. 2. (N.S.) Before dawn in the morning.	In the Linththal	One shock		On the 4th very heavy hail at daybreak	Bertrand; Scheuchzer; Coll. Acad.
—— —— 18. 14th hour.	Rome and Norcia	A slight trembling		Followed by continual rain and a south wind for nearly four months.	Collection Académique.
—— Dec. 9. (N.S.) Before 5 A.M.	The whole of the Canton of Glaris, particularly Mollis.	Three very violent shocks, extending further than any of the preceding ones.		The people were not only rocked, but violently shaken in their beds.	Bertrand; Scheuchzer; Coll. Acad.
1703. Jan 14. 2 o'clock at night.	From Rome to Naples and Aquila, in a line running from N. a little W., to S. a little E. along the Apennines. Also felt slightly at Verona, Venice, and Trente.	Very violent. At Rome the first shock, which occurred at the hour mentioned, was vertical, very violent, and lasted nearly a minute.		The towns of Norcia, Cascia, Leonessa, &c., were ruined. At Rome the shock was preceded by a sudden gust of wind. The day there had been very windy, and very heavy rain had fallen. Some arches of churches in the same city were separated and afterwards closed again. The earth opened in many places, and fire, and water with an abominable smell of sulphur came forth.	J. G. Roserus de terræmotu qui Italiam nuper, primis anni 1703 mensibus afflixit, Stettin, 1703; Jac. Phil. Maraldi, Observations, &c. in Hist. de l'Acad. des Sciences de Paris, 1704, Hist. p. 8; Coll. Acad.; Huot; Baglivi; Lettres Historiques; Vivenzio; Keferstein.
—— —— 16. 21st hour.	Rome	A slight shock			Collection Académique.
—— —— 18.	In Abruzzo; especially at Aquila. Also felt at Mantua, Milan, and all the country at the foot of the Alps.	Slight tremblings		The weather remained wet from the 14th to the 25th, when it became fine, and remained so for fifteen days.	Roserus and Maraldi, *loc. cit.*
—— —— ...	Barcelona in Spain	A slight shock			Baglivi, p. 535.
—— Feb. 2. 18th hour.	Rome and all the country affected on the 14th January; especially Aquila.	Several shocks. Direction = N. to S.	At the mouth of the Tiber the sea retired.	Aquila was completely ruined, and 5000 people perished there. The earth opened in several places, and threw out stones, water, &c. Noises like the reports of a pistol were heard.	Maraldi and the other authors just quoted.
—— —— 3. 21st hour.	Rome	A slight shock, followed by two or three each day up to the 25th, during which period also more than 160 were felt at Aquila.			Ditto.

1.	2.	3.	4.	5.	6.
1703. Feb. 10. (N.S) 7½ A.M.	Valley of the Linth, Canton of Glaris.	Violent shocks	......	The houses were much shaken. Half an hour before, a great noise was heard in the air.	Bertrand; Scheuchzer; Coll. Acad.
——— 11. (Twenty-four hours later.)	Ditto (felt more violently at Bettschwanden than in the Linththal). N.B. Many of the shocks in this valley extended into the Grisons, for example to Dissentis.	Less violent than the last.	......	Several times during the last year or two the fountains gave out more water than usual without any shocks being felt at the time.	Ditto.
——— 25. About sunset.	Rome. Also felt at Eugubio (Duchy of Urbino), at Perugia and the neighbourhood, Spoleto, and S. Marino.	One shock at the time mentioned, three hours after a very violent one lasting fifteen secs., an hour after, another, at 5 o'clock (Italian) a short but very violent shock, at 6 two slight ones, at 9 two more, the ground being in continual agitation until daybreak.	......	The day was very wet at Rome, and there was much wind. The weather became calm about sunset, when the first shock took place. These shocks took place at Spoleto periodically at 9 o'clock (Italian time). The horses, oxen, dogs, birds, &c. showed the greatest uneasiness.	Maraldi and the other authorities quoted above.
— Mar. 14.	At Narni	A violent shock	......	......	Ditto.
——— 18.	Aquila	Terrible shocks	......	......	Ditto.
——— 27.	Ditto. Also at Rome, Foligno, and Spoleto.	Ditto	......	Between this earthquake and the last 5000 persons perished at Aquila.	Ditto.
——— 31. Before midday.	Rome and Aquila	Slight shocks	......	......	Ditto.
— April 1. 5h 30m P.M.	Ditto	Ditto	......	......	Ditto.
——— 2.	Ditto	Ditto	......	......	Ditto.
——— 8. Between 6 and 7 P.M.	Rome	Ditto	......	The wind was from the south during the spring, which was wet and rather cold.	Ditto.
——— 15.	Spoleto and many places in Umbria.	A violent shock	......	......	Ditto.
——— 18.	Rome	One shock	......	......	Ditto.
13th hour	[illegible]	[illegible]	[illegible]	[illegible]	

1703. May 6.	Frankfort on the Maine, and Hanau.	A slight earthquake...	....	....	Lersner's Chronik; Kriegk, *loc. cit.*
—— —— 13. 17th hour.	Genoa and Carmagnole in Piedmont.	One shock	....	....	Coll. Acad. &c. before quoted.
—— —— 15.	Aquila	....	....	....	Ditto.
—— —— 24. 9 P.M.	Aquila and Rome	....	....	....	Ditto.
—— —— 25. 5th hour.	Rome	Vertical	....	No more such were felt at Rome up to Jan. 1705.	Ditto.
—— June 29. 23rd hour.	In and about Spoleto ...	A violent shock	....	....	Ditto.
—— July 1 and 2.	Genoa and Carmagnole in Piedmont.	Two slight shocks. The direction of these and the numerous preceding shocks was generally from N. to S.	The sea fell 6 feet in the harbour of Genoa, and remained so for nearly a quarter of an hour. The sulphurous water on the road from Tivoli to Rome fell 2½ feet. The water of the lake l'Inferno also fell about 3 feet. Wells too were much disturbed.	This year was very abundant in Italy, but after the earthquakes diseases of various sorts were very prevalent.	Ditto.
—— Oct. ...	Norcia	A trembling........	....	....	Seyfart, *loc. cit.* p. 98.
—— Dec. 29. (In the night of the 28th.)	Asti in Piedmont. Also felt in France.	Shocks for half an hour.	....	....	Ditto.
—— —— ...	Terni, Spoleto, Narni, Norcia, &c. Also at Naples and Milan, though with less violence.	The shocks recommenced.	....	Great damage done........	Lettres Hist. 1704, Fév. p. 126.
——	La Guayra and Caraccas	....	....	....	v. Humboldt, *loc. cit.* t. v. p. 5.
——	Japan	....	....	The town of Jeddo was ruined, and 200,000 persons lost their lives there.	Kämpfer, v. Dohm, t. i. p. 120; Coll. Acad.
1704. Jan. 8. (N.S.) 5h, 3 or 4m P.M.	In England, at Hull; also at Beverley, South Dalton, &c. Most violent in the neighbourhood of Lincoln. Feeble at Selby and Navenby.	A sudden shock	....	Accompanied at Hull by a noise like the sighing of the wind, though the air was perfectly calm. Doors and furniture were set in motion, and chimneys thrown down. At Selby and Navenby a noise was heard like the rolling of carriages. Preceded by a violent tempest.	Phil. Trans. vol. xlvi. p. 624; of 1745, vol. iv. p. 287; Coll. Acad.

1.	2.	3.	4.	5.	6.
1704. Jan. 30. Between 6 and 7 P.M.	Frankfort on the Maine.	A trembling		Without damage	Lersner's Chronik; Kriegk, *loc. cit.*
—— May 20.	Duchy of Spoleto	Two vertical and violent shocks.		The feeble shocks had been almost continuous in the duchy up to this time. The same day an eruption of Vesuvius began, which lasted until July 23, 1706. v. Hoff gives the date May 30.	Baglivi, *loc. cit.*; Coll. Acad.
—— Nov. 4. Between 4 and 5 A.M.	At Zurich and the country round.	Two violent shocks		Preceded by a brilliant meteor in the air. At the same time there was a violent storm of thunder, lightning and wind at Bâle, where however no shock was felt.	Scheuchzer; Bertrand; Coll. Acad.
—— Nov. to the following Jan.	Island of S^ta^ Maura in the Archipelago.	Many shocks		Did great damage	Collection Académique.
—— About Dec. 7. At midnight.	Bologna and Florence				Ditto.
—— Dec. 24.	Island of Teneriffe	Violent shocks, succeeding one another so rapidly that twenty-nine were counted in three hours.			v. Buch, Canar. Inseln. p. 242; v. Humboldt, *loc. cit.* p. 392; Coll. Acad. &c.
—— —— 27.	Ditto	They became still more violent.		On the 31st an eruption near Guimar in Llano de los Infantes, on the side of the Peak. The eruption was very violent, and continued until the 26th February 1705.	Ditto.
1705. Jan. 20. 9 o'clock.	Rome	Slight		Between this and the 31st Naples was twice rather violently shaken, Spoleto and the neighbourhood, and Rimini several times.	Coll. Acad.; Baglivi, *loc. cit.*
—— Feb. 6 and 7.	Naples	Two slight tremblings		At several places shaken in 1703 the earth was not yet quite at rest.	Seyfart, *loc. cit.* p. 98; Baglivi, p. 566.
—— May 22.	Mollis and Näfels (Canton of Glaris).	A very sensible shock			Scheuchzer.
—— June 3.	Ditto	Ditto			Ditto.
—— Sept. 24. 10 A.M.	Eglisau, and slightly in the rest of the Canton of Zurich.		The Rhine was agitated.		Bertrand; Scheuchzer; Coll. Acad.

Between 3 and 4 P.M. (Scheuchzer says A.M.)	Ditto. Also felt in the Turgau, Toggenburg, a part of Swabia, &c.	Several shocks........	....	Accompanied in some places by loud noise. The snow had rapidly melted in the beginning of the month before a south wind, and caused disastrous inundations.	Ditto.
—— —— 17. 7 P.M.	Zurich and Eglisau......	More violent than the last.	....	....	Ditto.
—— —— 26.	Coast of Peru near Arequipa.	....	The sea was upheaved by the shock.	The village of Areca in the district of Arequipa was ruined.	Collection Académique.
1706. April 4.	Sicily and Calabria; especially at Aquila and Naples. Also felt at Rome.	....	....	....	Seyfart, *loc. cit.* p. 99.
—— May 5.	Teneriffe	....	....	Accompanied by an eruption in the same place as before.	v. Buch, Canar. Inseln. p. 243; v. Humboldt, *loc. cit.* t. i. p. 393.
—— Sept. 29.	In Sicily	....	....	Trapano del Vasto, 15 miles from Palermo, was ruined, and many people were killed. Huot gives as date the 30th October, and says that 1000 persons perished.	Seyfart, *loc. cit.* p. 100.
—— Oct. 28.	In Calabria	....	....	....	Ditto.
—— Nov. 3.	In Abruzzo	A violent earthquake	....	Thirty-six towns were ruined between Lanciano and Termoli on the coast of the Adriatic, amongst others Sulmona. 15,000 people perished. On the 18th November a black stinking vapour was perceived coming out from a chasm which had opened in the earth near Sulmona. This afterwards took fire, and burned for a short time.	Ditto; Huot, *loc. cit.*
—— —— ...	Rome	Two shocks	....	....	Journal Historique, Janv. 1707, p. 18.
——	Grimsnäs and Olves in Aarness-Syssel, Iceland.	....	....	....	Voyage en Islande, *loc. cit.*; v. Hoff.
1707. Feb. Night between 16 and 17.	Frankfort on the Maine	....	....	....	Lersner's Chronik; Kriegk, *loc. cit.*
—— In Spring	Iceland............	....	....	....	v. Hoff.
—— May 18, 21, and 24.	Island of Santorin	Many shocks, followed by others for some time.	The sea violently agitated by the eruption, and upheaval of the island.	Followed on the 23rd by the commencement of a submarine volcanic eruption, consequent on the raising of the island Nea-Kameny between Palaia and Micra-Kameny. This island was not entirely at rest until 1711, the volcanic action being particularly violent until May 1708.	Hist. de l'Acad. des Sciences de Paris, 1707, p. 11; 1708, p. 28; Phil. Trans. vol. xxvi. p. 69; vol. xxvii. p. 364; Roserus, Nouv. Mém. des Missions de la comp. de Jésus dans le Levant; Raspe de novis Insulis; Lettres édifiantes, &c.

1.	2.	3.	4.	5.	6.
1707. July 28. to Aug. 18.	Vesuvius and the neighbourhood.	Numerous shocks ...	....	The mountain was during this time in eruption.	Maria della Torre, *loc. cit.*; Sorrentino, Istoria del Vesuvio.
—— Sept. 18.	Island of Santorin	Slight	....	The new island increased considerably	Hist. de l'Acad. &c. just quoted.
—— —— 25.	Ditto	....	....	The doors of the houses opened of themselves. Accompanied by loud noise.	Ditto.
1708. Feb. Night between 9 and 10.	Ditto	Slight	....	The principal shocks are here mentioned, but slighter ones appear to have been almost continuous for a long time.	Ditto.
—— —— 10. About 8 A.M.	Ditto	....	....	....	Ditto.
—— March 3. At the hour of vespers.	Calabria; especially at Maratea, Tortona, and Baronal.	....	....	Many houses and some churches thrown down.	Journal Historique, 1708, Mai, p. 341.
—— —— 25.	Manosque (in the Basses Alpes).	Rather violent.........	....	....	Mémoires de Trévoux, 1708, p. 2096.
—— Aug. 14. A little after $6^h\ 15^m$ A.M.	Ditto. (Also extended to Toulon, Marseilles, Sisteron, and Hyères.)	A violent shock	The waters of the Durance were elevated 2 or 3 feet.	Accompanied by a noise which was variously compared to that produced by the breaking up of ice, to the discharge of artillery, bellowing, and rolling of vehicles. The earth opened on the river Largue, and flames came forth. Two whirlwinds did great damage at Manosque just at the same time as the earthquake.	Ditto; Seyfart.
—— —— — 8 o'clock.	Ditto	Another shock	....	....	Ditto.
—— —— — 10 o'clock.	Ditto	Ditto	....	....	Ditto.
—— —— 15. A little before midnight.	Ditto	Two shocks on this day, the principal at the time mentioned, the hour of the other not given.	....	....	Ditto.
—— —— 23. 3 A.M.	Ditto	Another shock	....	....	Ditto.
—— —— — $8^h\ 15^m$ P.M.	Ditto	Ditto	....	....	Ditto.
—— —— 26. 8 A.M.	Ditto	Slight trembling	....	....	Ditto.
—— —— —	Ditto	Ditto; more violent...	....	Preceded by subterranean noise	Ditto.

9^h 15^m P.M.					Ditto.
—— —— 27. 3^h 15^m A.M.	Ditto	Three more shocks ...	....	....	Ditto.
—— —— 28. At night.	Ditto	One shock	....	....	Ditto.
—— —— 29. 3^h 30^m A.M.	Ditto	Fresh trembling	....	....	Ditto.
—— —— —— Before 4 A.M.	Ditto	Ditto	....	....	Ditto.
—— —— 30. A little after 3^h 30^m A.M.	Ditto	Another shock.........	....	....	Ditto.
—— —— —— 6^h 45^m A.M.	Ditto	Ditto; rather violent	....	....	Ditto.
—— Sept. 1 to 15.	Ditto	Fourteen or fifteen slight shocks during this time.	....	Flames, water, &c. came forth from the clefts in the earth as before.	Ditto.
—— —— 15. After midnight.	Ditto	Another slight shock	....	....	Ditto.
—— —— 20. 3^h 30^m P.M.	Ditto	More sensible than the last.	....	Felt in the open country as well as in the town	Ditto.
—— —— 24 to 30. Every night.	Ditto	Several shocks, continuing during the first few nights of October.	....	....	Ditto.
—— Oct. 6 and 12; especially at midnight and 2 A.M.	Ditto	More violent shocks	....	....	Ditto.
1709. Jan. 8.	In the Canton of Glaris.	Several shocks	....	....	Keferstein.
—— Mar. 20. 2 A.M.	Lima in Peru	....	....	Preceded by explosive noises..........................	Collection Académique.
—— April 15 to Jan. 1, 1710.	In Peru	Fourteen earthquakes during the time mentioned.	....	Each of the earthquakes was attended with subterranean noises.	Ditto.
—— July ...	The country bordering on Hernösand.	....	....	....	Acad. des. Sciences de Stockholm, 1748, p. 155.
1710. Dec. 8.	Stein on the Rhine	Several shocks.........	....	....	Keferstein.

1.	2.	3.	4.	5.	6.
1710.	Island of Zante	A violent shock			Montgom. Martin, Hist. of the British Colonies, vol. v. p. 431.
1711. Jan. 7. Between 3 and 4 P.M.	Reggio in Calabria	Three shocks			Seyfart, *loc. cit.* p. 102.
—— —— 11.	In Abruzzo				Ditto, p. 103.
—— Feb. 9. Between 4 and 5 A.M.	Zurich and Bâle, extending as far as the Rhine.		The waters of the Rhine "bouillonnaient."		Coll. Acad. t. iii. p. 181; Acad. des Sciences de Paris, 1711, p. 4; Keferstein; Bachofen's Chronik.
—— May 10.	Venice				Seyfart, *loc. cit.*
—— —— 17.	Bergen-op-Zoom	Several shocks		During a storm of thunder, lightning, and hail.	Ditto.
—— —— 18.	In Sicily	Tremblings			Ditto.
—— Oct. 6.	Paris and the environs for 30 leagues round.				Coll. Acad. t. iii. p. 183; Acad. des Sciences de Paris, 1712, p. 7.
—— —— 25. About 7 P.M.	Leipzig and the country round.	A very violent earthquake.			Seyfart, *loc. cit.*
——	Constantinople				Hadschi Chalifa.
1712. Beginning of the year.	Rome	One shock		Threw down an arch of the Seminario Romano	Seyfart, *loc. cit.*
—— Jan. 23.	Leghorn	A violent shock		In February, March; April, October, and November of this year, Vesuvius was in eruption.	Ditto.
—— Feb. 2 to May 21.	Jaen in Andalusia	Sixteen shocks during this period.			Valentyn, lib. ii. p. 58; Hist. gén. des Voyages, t. xi. p. 20; Phil. Trans., &c.
—— April 10. Midday.	In and around Vienna; especially at Neustadt.			Did some damage	Seyfart, *loc. cit.*
—— Aug. 11. Between 11 P.M. and midnight.	Bea (Bex?) and the whole government of Aigle, and the Valais.	A very violent shock		Followed by a whistling sound in the air for some time. Some persons said that they had felt three shocks at the same places earlier in the month.	Bertrand; Coll. Acad.
——	Near Bosely in Shropshire.	One shock		Preceded, two days before, by a terrible hurricane, accompanied by a loud noise, and followed by outbursts of water and inflamed vapours.	Collection Académique.
——	Constantinople				Hadschi Chalifa.
1714. Jan. 13. 9 to 11 P.M.	Brabant, Hainhault, and Liège. Also felt at Brussels and Maestricht.	Slight shocks		Chimneys were thrown down at Maestricht and Brussels.	Coll. Acad.; Journ. Histor. 1714, Mars, p. 211.
[illegible]	Constantinople	Violent			Hadschi Chalifa.

	Vesuvius.	the 30th.		The mountain in a state of violent eruption	Maria della Torre, *loc. cit.* p. 68.
— July 27.	Patras			Several buildings either thrown down or much injured.	Pouqueville, Voyage en Grèce, t. v. p. 295.
— Aug. 28.	Island of Cephalonia	Much more terrible than the last.		280 houses were thrown down. The earth opened, and springs of hot water made their appearance.	Ditto.
— Sept. 3. Before 9 A.M.	In the Morea. Patras especially was much injured.			A portion of a church at Patras was thrown down.	Seyfart, *loc. cit.*
— Dec. 29. 7h 30m P.M.	District of Eglisau, Canton of Zurich.				Bertrand; Scheuchzer; Coll. Acad.
— — — 9 P.M.	Ditto				Ditto.
1715. Jan. 29.	Algiers	Repeated shocks, continuing six days.		v. Hoff, without quoting any authority, gives as date the 2nd February.	Seyfart, *loc. cit.*; Huot, Cours de Géol. t. i. p. 111.
— — —	In the Frioul, Italy	One shock			Ditto.
— Feb. 10.	In the Valais	Slight		The weather, which had been cold, became mild immediately after the shocks.	Bertrand; Coll. Acad.
— — 19.	Nantes	A trembling			v. Hoff.
— April 11.	Geneva	Three shocks			Bertrand; Coll. Acad.
— May 1.	District of Teschen in Silesia.	Oscillations for six and thirty hours.			Seyfart, p. 105.
— June 12.	At Delitzsch in Saxony, and also the village of Klebitz.			During a storm of thunder and hail	Ditto.
—	Probably in the Morea			Preceded the invasion of the Morea and Island of Sta Maura by the Turks.	Pouqueville, Voyage en Grèce, t. v. p. 295.
1716. Jan. 2.	In the Canton of Zurich	One shock			Keferstein.
— — 29 to Feb. 3.	"Bei Görz im Kloster Constantia." (In Illyria?)	Repeated shocks			Seyfart, *loc. cit.*
— Feb. 3. 2 A.M.	Algiers	Violent		Many houses thrown down	Journal Historique, Avril, 1716, p. 269.
— — 4.	Ditto	Frequent shocks			Ditto.
— — 5.	Ditto	Ditto			Ditto.
— — 6 to 8.	In Peru			Lima and Arequipa were greatly injured	v. Humboldt, Voyage, t. i. p. 317.
— April 5. 7h 30m P.M.	Eglisau, Canton of Zurich.				Bertrand; Scheuchzer; Coll. Acad.

1.	2.	3.	4.	5.	6.
1716. May and June.	Algiers. Also felt, though with less violence, at Catania and Syracuse.	Violent earthquakes	....	At Algiers 20,000 persons perished. Shaw, in his Travels in Barbary, gives this event without the date of the month, but it doubtless is the same. He adds that great landslips took place from the sides of the hills near El Kadarah and at other places.	Collection Académique.
—— June 25.	Geneva, Nion (Sion ?), and Morges.	Several shocks........	....	....	Bertrand; Coll. Acad.
—— —— 29. Between 10 and 11 P.M.	Geneva........	Ditto	....	....	Ditto.
—— Nov. 26. 3 P.M.	Neufchatel and the environs.	....	....	On the 20th at 2 P.M. a noise had been heard in the Val-de-Ruz in this Canton, supposed by some to proceed from the air, by others from the earth.	Ditto.
—— Dec. 1. 4 A.M.	Messina and Catania. Most violent at the latter place.	....	....	Houses were thrown down at Catania	Seyfart, *loc. cit.*
——	In central Asia, through the whole of the district Dzoungarie, between the lakes Balkhache and Dsaisang.	Very violent	....	The town Aksu, to the south-west of the volcano of Pechan, was almost wholly ruined.	Falk, Beiträge zur Topographie der Russischen Reichs. (St. Petersburg, 1785), t. i. p. 380.
1717. April 22.	The Lipari Isles, especially Vulcano; and in the north of Sicily, most violent at Milazzo, Pozzodigotto, and Castrocale.	Violent	....	....	Keferstein.
—— June 15 to 17.	Syracuse and Messina...	Several shocks	....	Did some mischief	Collection Académique.
—— —— 27 and 28.	Catania	Ditto; violent........	....	Preceded by loud subterranean explosions. Vesuvius was in full eruption during this month.	Ditto.
—— July 1.	Smyrna	Two little shocks ...	....	....	Ditto.
—— —— 6. 4 P.M.	Eglisau	....	....	....	Ditto; Bertrand; Scheuchzer.
—— Aug. 5. Shortly before midnight.	Algiers........	A very considerable earthquake.	....	Did much damage	Collection Académique.

[illegible]	[illegible] canton of same name.			The spring had been extremely cold	Ditto; Scheuchzer; Bertrand.
—— Sept. 27.	In Mexico				v. Humboldt, t. ii. p. 298; Sonneschmidt, Bergw.—Reviere von Mexico, p. 323.
—— Dec. 18. 8 P.M.	Eglisau				Bertrand; Scheuchzer; Coll. Acad.
—— —— 27. At noon.	Ditto				Ditto.
——	Cæsarea in Asia Minor			Much damage done to the city	Hadschi Chalifa.
1718. Feb. 1.	Fayal in the Azores	Lasted a whole day		Accompanied by a dreadful noise. Followed by a volcanic eruption which lasted some time. v. Hoff speaks of an eruption in another of these islands, El Pico, on the same day, but only mentions this earthquake in a note.	Collection Académique.
—— —— 25.	Leipzig			The wind was violent. Not mentioned by any of the other authorities but the Coll. Acad.	Ditto.
—— March. Night between 6 and 7.	Island of St. Vincent in the West Indies. Also at Martinique.	Very violent	Near Martinique a piece of land rose from the sea with a terrible noise and then sank again.	In St. Vincent accompanied by a furious hurricane, and an eruption of the volcano Morne-Garou.	Eyriès, Abrégé des Voyages; v. Humboldt, t. ii. p. 295; Mém. de Chron. t. ii. p. 923.
—— March. About 18.	Catania	More shocks		Houses were thrown down. The eruption of Vesuvius still continued.	Collection Académique.
—— May or June.	Ile de Feu, île Brave, île Sans-Fond, île Cores, and île Canarie—Canary Isles.			The earth opened in many places, forming fissures of great depth.	Ditto.
—— June. Night between 15 and 16.	Neustadt (8 miles from Vienna), and the neighbourhood.	Several violent shocks		Buildings were thrown down	Collection Académique.
—— —— 19. 3 A.M.	Sin-gan-San or Sin-Sou-Sou, the capital of the Chinese province Xansi, and the country all round.	Very violent. To the north of the city of Tong-ouei the earth rose and fell in waves like the sea, to the height of 6 fathoms. At Tin-min-chin the earth shook from 3 to 11 A.M.		The surface of the earth was greatly altered. Huge chasms opened in many places, and great landslips took place from the mountains.	Coll. Acad.; v. Hoff.
—— July 9.	Ditto	The shocks recurred			Ditto.

1.	2.	3.	4.	5.	6.
1718. July 17. Between 5 and 6 P.M.	Eglisau (and not in the Canton of Neufchatel).	....	....	....	Coll. Acad.; Bertrand; Scheuchzer.
—— —— ...	Canary Isles; principally in the île de Fer (Feu?), Forteventura, and Canarie properly so called. Also felt in the Azores.	Shocks for fifteen days	....	Chasms opened in the ground, and rocks were thrown from the hills.	Collection Académique.
—— Dec. (or May) 1.	Near Hernösand in Sweden.	The first trembling, which was violent and lasted about a quarter of an hour, was followed by twenty others of less importance.	....	Followed by the opening of fissures in the mountains.	Acad. des Sciences de Stockholm, 1748.
—— —— 10. Between 5 and 6 P.M.	Eglisau (and not in the Canton of Neufchatel).	Several shocks..........	....	....	Bertrand; Scheuchzer; Coll. Acad.
——	Island of Cyprus..........	....	....	The capital of the island was destroyed, and many persons lost their lives in the ruins.	Mercure de France, Déc. 1718 (sous la Rubrique de Gênes. 12 Déc. p. 179).
1719. Jan. 7. About 4 P.M.	Padua, Ferrara, Bologna, Venice and some of the neighbouring islands.	Several shocks..........	....	A chimney was thrown down at Venice, and some walls were cracked.	Coll. Acad.; Journal Historique, 1719, Mars, p. 227.
—— —— ...	Jamaica	....	....	....	Collection Académique.
—— March 5.	Constantinople	Violent shocks	....	....	Ditto; v. Hoff.
—— —— 6. (In Portugal a quarter of an hour before sunrise.)	Ditto. Also at Villanova in Algarbia, Portugal, and in many other parts of the same kingdom; and at several places in Champagne and Lorraine.	Lasted four minutes in Portugal. The movement was but slight in Champagne and Lorraine. At Constantinople the shocks did not cease for thirty days.	....	At Constantinople two mosques were ruined, and many people killed. In Champagne and Lorraine accompanied by thunder and lightning.	Ditto; Journal Histor. 1719, Juin, p. 405; Phil. Trans. vol. xlix. p. 116.
—— —— ...	Smyrna and Aleppo ...	Many shocks	....	At Aleppo three mosques and 200 houses were ruined.	Ditto.
—— March and beginning of April.	In Tuscany, at Piacenza, and as far as Perugia and Viterbo.	Rather violent shocks at intervals.	....	....	Ditto.

1719. May 25.	Syracuse	Several shocks, recurring for some days.	....	Several houses thrown down........	Journ. Hist. Sept. 1719, p. 185.
—— —— 25. About mid-day.	Constantinople, and in Natolia, forty miles from that city. Also between Scutari and the île des Princes, and at the town of Sevenit. Also at Nicomedia.	Very violent. At Constantinople the first shock lasted three minutes, followed, an hour after, by another of less violence, and at intervals by others for three days.	....	During the first motion a black powder was seen to rise from the town and suburb of Galata, beside the sea. Four or five villages were ruined, and about 1000 people killed or maimed. Great damage was done to the buildings of Constantinople itself. Nicomedia also was ruined.	Ditto; Hadschi Chalifa; Coll. Acad.; Phil. Trans. vol. xlix. p. 116; Mercure de France, Juillet, p. 113; Août, p. 103.
—— June 25.	Smyrna	A violent earthquake	....	No damage done........	Collection Académique.
—— —— 29.	Rome, Norcia, Chieti, Spoleto, and Foligno.	Less violent at Rome than at the other places mentioned.	....	....	Ditto.
—— July...	Sinigaglia and Nocera in Italy.	Slight trembling........	....	....	Ditto.
—— —— ...	Along the coast of Fez and Morocco.	Very violent	....	Many villages and a part of the city of Morocco were ruined. Probably simultaneous with the last.	Ditto.
—— —— ...	Juny in the north of China.	....	....	Very many buildings thrown down	Bell's Travels in Asia, in Pinkerton's Voyages and Travels, vol. vii. p. 377.
—— Dec. Towards the end of the month.	Terceira and St. Michel in the Azores.	Very violent	Followed on the 31st Dec. by the upheaval of a new island, of about nine miles in diameter, and which disappeared again in 1723	Accompanied by volcanic eruptions. The Collection Académique gives the date 1720.	v. Buch, *loc. cit.*; Phil. Trans. vol. xxvi. p. 69, xxvii. p. 353, xxxi. p. 100, xxxii.; Hist. de l'Acad. des Sciences, &c.
1720. Jan. 10.	Genoa and Leghorn ...	Slight trembling	....	....	Collection Académique.
—— Feb. 26. 7^h 30^m A.M.	Eglisau, Canton of Zurich.	....	....	....	Ditto; Bertrand; Scheuchzer.
—— April ...	Peru........	Shocks lasting for eight days.	....	The town of Guamanga was ruined	Collection Académique.
—— Beginning of June.	In Calabria. Violent at Barletta and Ascoli, less so at Salerno, Cava, Avellino, and Sarene. (These places are properly not in Calabria, but in Capitanata and Principato ultra, in a line passing through the Apennines from E. to W.)	....	....	....	Ditto.

1.	2.	3.	4.	5.	6.
1720. June 11.	Pekin in China	....	....	The city much injured. Probably this event is only the same with that in 1724.	Phil. Trans. 1769, p. 71.
—— —— 16.	In the Canton of Zurich.	....	....	....	Coll. Acad.; Bertrand; Scheuchzer.
—— —— 22.	Constantinople	A slight shock........	....	....	Collection Académique.
—— July 1. (At Leipzig at 5 P.M.)	In the Saxon Erzgebirge; especially at Freiberg and the neighbourhood. Also at Leipzig, Halle, Weimar, Meissen, and in Voigtland, in Thuringia, &c.	Violent in the Erzgebirge; at the other places mentioned, slight, but lasting some minutes.	....	Extended in the Erzgebirge seven or eight miles in length, and felt in the mines at the depth of 169 toises. A magnet let its keeper fall, but sustained it afterwards just as well as before. Accompanied here by thunder and hail. Two days before, the barometer descended suddenly and rapidly at Freiberg.	Ditto; Journ. Hist. Sept. 1720, p. 175.
—— Aug. 27.	In the kingdom of Naples.	....	....	Did some mischief at the monastery of Monte Cassino.	Collection Académique.
—— Sept. 9. 2 A.M.	Zurich. Also at Messina in Italy at the same time.	....	....	Did some damage at Messina....................	Ditto.
—— —— 12.	In Calabria; especially at Gerace on the Ionian Sea.	....	....	Gerace was ruined	Ditto.
—— Oct. 18. At night.	In the Canton of Neufchatel.	....	....	During a violent tempest	Ditto; Bertrand.
—— Nov. Night between 19 and 20.	Leghorn	A trembling..........	....	....	Coll. Acad.; Phil. Trans. t. li. p. 577.
—— Dec. 20. $5^h\ 30^m$ A.M.	Several parts of Switzerland, as St. Gall, Turgau, the borders of the lake of Constance, at Constance, Stein, Appenzell, Reinegg, Altstätten, and as far as Lindau in Bavaria. Also, though feebly, at Zurich.	Lasted about a minute	....	Accompanied by noise, and followed by a warm wind and sulphurous vapour. In some places houses were thrown down.	Bertrand; Scheuchzer; Coll. Acad.
—— —— —— 8 A.M.	St. Gall...	More shocks	....	At Zurich the barometer was at 26 in. $5\frac{1}{4}$ lines on the 19th, and on the 20th at 26 in. 3 lines.	Ditto.
About 1720—1730.	Neighbourhood of Hernösand.	....	....	Extended for 30 miles to the north and to the south.	Acad. des Sciences de Stockholm, 1748.
1721. Mar. 24.	Selva in the island of Majorca.	....	....	Accompanied by a subterranean noise and by inundations. Several houses were thrown down.	Journ. Hist. Juillet, 1721, p. 21.

1721. April 4.	In Hungary				Collection Académique.
—— —— 26.	Tabriz in Persia			The city was entirely ruined and more than 8000 persons lost their lives. Perrey says 9th or 26th April.	Vivenzio, 1783, p. 150; Malcolm's History of Persia, vol. i. p. 614; Journ. Hist. Oct. 1721, p. 276.
—— May 11.	Myrdalen in Iceland			Accompanied by an eruption of the volcano Katlegiaa.	v. Hoff.
—— July 3. 7h 45m A.M.	Throughout almost the whole of Switzerland; especially in the Canton of Bâle, at Wallenburg, at Porentrui, and at Mühlhausen. In the Canton of Berne along the Aar; slightly in Lucerne; more violently in Zurich. Extended as far as Strasburg.	In Bâle two shocks were distinguished acting horizontally backwards and forwards in the direction from E. to W. At Berne another slight shock was felt about 9 A.M.		At Bâle, where some walls and chimneys were thrown down, accompanied by a subterranean murmur, at Porentrui by a loud noise, and followed by a strong odour. The cold became extremely sharp for a short time immediately after the earthquake. Some days afterwards great storms, which did much mischief in Italy.	Bertrand; Scheuchzer; Coll. Acad.; Dan. Bachofen's Chronik.
—— Aug. 3.	Venice	A rather violent shock			Journ. Hist. Oct. 1721, p. 276.
1722. May 24.	St. Jago in Chili				Coll. Acad.; v. Hoff.
—— Nov. 29.	Algiers	Several shocks		Houses injured	Gazette de France, 20 Février, 1723.
—— Dec. 27. Between 5 and 6 P.M.	Portiman and Villanova in Portugal; and in fact all the south coast from Cape St. Vincent.	Shocks for from one to three minutes,	The sea was much agitated, and the river Accava was dry for some hours.	Houses were thrown down, and bells sounded of themselves. Rather violent at Albufeira, Loulé, Silves, Faro and Tavira, where it was accompanied by loud noises and great destruction of buildings. The latter of the two journals quoted gives the date 27th January 1723, but this is probably only a mistake.	Ditto; Journ. Hist. Avril, 1723, p. 268.
1723. April 13.	Eglisau	Slight trembling			Bertrand; Scheuchzer; Coll. Acad.
—— About Aug.	Faenza, Fiorenzuola, and in the Mugello.	Several shocks		On the 23rd June Vesuvius, and in the following November Etna, were in eruption.	Gazette de France, 1723, Sept. 25 and Oct. 2.
——	Barbary, about Algiers	Ditto			Shaw's Travels in Barbary, in Pinkerton's Voyages and Travels, vol. xv. p. 608.
1724. Jan. 13. 8 P.M.	In Bretagne	A slight trembling, not lasting more than a minute.		Preceded, some seconds before, by a loud noise	Coll. Acad. t. v. p. 64; Acad. des Scien. de Paris, 1725, p. 4.
—— May 17.	Thyngsore-Syssel in Iceland.	Very violent		Accompanied by the eruption of Krabla, a mountain not before known to be a volcano. This eruption continued at intervals until 1730.	v. Hoff.

1.	2.	3.	4.	5.	6.
1724. June 11. 9 A.M.	Pekin and many places in the province of Xansi in China.	The shocks lasted about four minutes.	....	Houses were thrown down, and about 1000 people killed.	Du Halde, Déscription de la Chine, t. i. p. 481.
——— Noon.	Ditto	More shocks	....	....	Ditto.
——— 7h 30m P.M.	Ditto	Ditto	....	....	Ditto.
—— Oct. 12.	Lisbon	Two very violent shocks, with an interval of some hours.	....	Many walls were cracked	Balbi, Essai Pol. sur le royaume de Portug. t. i. p. 102; Journ. Hist. Jan. 1725, p. 40.
—— Dec. ...	Sienna	Many shocks, lasting altogether ten hours.	The Arno was disturbed in its course.	M. Pilla gives the date December 11, 1 P.M.	Gazette de France, 20 et 27 Janv. 1725; Journ. Hist. Mars, 1725, p. 203.
——	Sciacca in Sicily	Shocks during some months.	....	....	Ferrara, Campi flegrei della Sicilia.
——	Forty leagues to the west of Lisbon.	....	Though not expressly stated, of course this was felt at sea.	....	Collection Académique.
——	Constantinople	Violent........	....	....	Hadschi Chalifa.
——	In Barbary; principally at Algiers. Extended from Miliana to Bona.	At sea three shocks were felt.	Also felt on board an Algerine vessel, at sea, 5 leagues S. of the Seven Capes, north coast of Africa (no ground with a line of 200 fathoms). It appeared as if a weight of several tons had been let fall on the ballast.	The barometer very high, and the air calm and serene. No immediate change of either after the earthquake.	Shaw's Travels in Barbary, in Pinkerton's Voyages and Travels, vol. xv. p. 608.
——	In Denmark	....	....	....	Edinburgh Encyclopædia, Article Chronology.
1725. Jan. 8.	Lima and Arequipa in Peru.	....	....	....	Vivenzio; v. Hoff.
——— 15.	Antigua	Violent. Lasted three minutes.	....	....	Gazette de France, 19 Mai, 1725.
——— 21. (O.S.?) 7 P.M.	Tchitinsck in the neighbourhood of Baikal.	A very violent shock.	....	Enormous fissures were produced both in the land and ice. Everything which was suspended in the houses was set in motion. The weather was calm.	Pallas, Voyage, t. iv. p. 396.

1725. April 17.	Florence	Rather violent			Gazette de France, 19 Mai, 1725.
—— —— 20.	Ditto	Ditto			Ditto.
—— June 17. About 11 A.M.	Venice	Two slight shocks			Ditto, 13 Octobre.
—— —— 30.	Naples	Violent			Ditto, 4 Août.
—— July 1.	Ditto	Ditto		For eight days Vesuvius had been throwing out ashes, flames, and smoke.	Ditto.
—— Aug. 3. 2 P.M.	District of Eglisau. Both banks of the Rhine were shaken.			Preceded by a loud noise like a clap of thunder or the discharge of a piece of ordnance, which appeared to come from the mountain of Hohen-Egg.	Bertrand; Coll. Acad.; Scheuchzer.
—— Sept. 17. 17th hour.	Padua			At full moon	Toaldo, Essai Météor. p. 270.
—— Oct. At the latter end of the month.	Mola, Forli, Fontana, Casola, &c.	Several slight shocks.		During inundations	Journ. Hist. Fév. 1726, p. 109.
—— Nov. 4.	Faenza in Romagna	Some rather violent shocks.			Gazette de France, 8 Déc. 1725.
—— —— 28.	Ditto	Ditto		Some buildings were injured	Ditto, 15 Déc.
——	Constantinople				Hadschi Chalifa.
1726. At the beginning of the year.	At Leghorn and Florence				Gazette de France, 25 Mai, 1726.
—— Feb. 6 to 8.	All the eastern side of Sicily; principally at Palermo.	Very violent		3000 persons perished	Huot, Cours de Géol.
—— —— 16.	District of Eglisau				Bertrand; Scheuchzer; Coll. Acad.
—— April 9. About the 4th hour of the night.	Sienna and the neighbourhood.	One very violent shock, followed by two other slighter ones.		Did great damage to the houses both of the town and neighbourhood.	"Manoscritto presso il cav. Perfetti."
—— —— 15. $0^h\ 15^m$ P.M.	Aleppo. Also felt at Alexandretta at the same hour.	Three rather violent shocks from E. to W. in two minutes.		Some old walls were thrown down	Mercure de France, 1726, Oct. p. 2349.
—— May to Oct.	Sciacca in Sicily	Numerous shocks			Michele del Bono, *loc. cit.*
—— July 7. 7 A.M.	Eglisau, Hiltenberg, Glattfelden, Berne, some parts of the Pays de Vaud, Frütingen, and the neighbourhood, and throughout the Sibenthal.		The springs were troubled.		Bertrand; Scheuchzer; Coll. Acad.

1.	2.	3.	4.	5.	6.
1726. Sept. 1. Between 10 and 11 P.M.	Palermo	The first shocks were comparatively slight, but they increased rapidly in violence, and continued for twenty-four or twenty-five minutes.	....	A quarter of the town was completely ruined. Four churches, ten palaces, and 1600 houses were thrown down, and from 3000 to 6000 persons perished. The earth opened in one street, and threw out burning sulphur and red-hot stones, which reduced the houses of that quarter to ashes in less than half an hour. During the earthquake the atmosphere appeared as if on fire. Half an hour before a loud noise had been heard in the air. According to v. Hoff, there was another earthquake a few days after at Noto. Ferrara gives the date for the event at Palermo, November 1.	Coll. Acad.; Gazette de France, Oct. 11 et 19; Borouski, *loc. cit.*; Journ. Hist. Déc. 1725, p. 420.
—— Oct. 17. About 7 P.M.	Naples	Two shocks, followed by a third an hour afterwards.	....	....	Gazette de France, 30 Nov., 1726; Journ. Hist. Janv. 1727, p. 46.
—— —— 31. Between 10 and 11 P.M.	Ditto	A slight shock, and an hour afterwards another rather more violent.	....	....	Gazette de France, 6 Déc. 1726.
—— Nov. 6. About 6 A.M.	Ivelcelster (Ilchester?) in England.	A rather violent shock.	....	....	Ditto, Nov. 30.
——	In the northern part of Iceland.	Several shocks........	....	Accompanied by an eruption of the volcano Krabla. Both this year and the next were marked by several volcanic eruptions in Iceland, most of which are said to have been preceded by subterranean commotions.	De Kerguélen Trémarec, Voyage dans la Mer du Nord, p. 37; Hist. gén. des Voyages, t. xviii. p. 11; Coll. Acad.
1727. Jan. Night between 5 and 6.	Palermo	Five consecutive shocks.	....	....	Journ. Hist. Mai, 1727, p. 349.
—— —— 6.	Ditto, and extending over all Sicily.	Two more shocks ...	....	The town of Noto was much injured. (v. Hoff gives as date for this the 5th January.)	Ditto.
—— —— 7. At midnight.	Palermo	Another shock........	....	....	Ditto.
—— —— 8.	Ditto. (Several of these shocks were felt at Malta.)	Another, as violent as those of Jan. 11, 1693.	....	Many houses damaged	Ditto.
—— May 12. 6 A.M.	Frankfort on the Maine.	....	....	Did some damage to buildings	Lersner's Chronik; Kriegk.

[illegible] Aug. [illegible]	Sutton and Dartford in Kent.	Several shocks......	....	The ground sank in one place in a meadow, and on the 2nd of this month fire broke out from the ground at 10 or 11 miles from Canterbury, continuing so for some days.	Phil. Trans. 1727, p. 305.
—— Oct. 4.	Naples. Extended also to Swabia and England.	....	....	....	Huot, *loc. cit.*
—— Nov. 9. (N.S.). Between 10 and 11 P.M.	New England	One very violent shock followed by five or six slighter ones, in the direction N.E. to S.W.	....	Accompanied by loud subterranean explosions. Preceded by an extraordinary calm; the stars sparkling brilliantly. The earth opened at Newbury, 40 leagues (or English miles?) N.E. of Boston, and threw out fine sand with ashes and pieces of sulphur.	Phil. Trans. vol. xxxv. pp. 33, 63, and 124, vol. l. p. 9; Coll. Acad.
—— —— 7 to 27.	Martinique	Shocks each day, some lasting more than three minutes (?).	....	Walls were cracked vertically, and one horizontally; many being thrown down. A considerable piece of land sank into the earth.	Journ. Histor. Mars, 1728, p. 229; Huot, Cours de Géol. t. i. p. 112.
—— —— 18. 11 (A.M.?)	Newbury in New England.	Another shock, followed by three to six more every day and night up to the 23rd.	....	Preceded by a loud noise	Phil. Trans. *loc. cit.*
——	Tabriz in Persia	....	....	The city was ruined, and 77,000 people perished.	Huot, *loc. cit.*; Hadschi Chalifa.
1728. Jan. 30. 2 P.M.	New England	There were repeated slight shocks felt in this region from the 9th November 1727, to the 2nd August 1728. For details see Phil. Trans. *loc. cit.*	....	....	Phil. Trans. vol. l. p. 13.
—— Feb. ...	Epstein, three miles from Wiesbaden.	Several shocks........	....	....	v. Hoff.
—— Aug. 3. Between 4 and 5 P.M.	In Alsace, Switzerland, and part of Germany; especially at Berne, Zurich, Eglisau, Bâle, Strasburg, Mannheim, and all the country between Worms, Mayence, Frankfort, Offenbach, Hanau, and Aschaffenburg. Also at Geneva.	The earthquake recurred at Bâle during the night, and at Strasburg there were five shocks on the 3rd at $10^h\ 30^m$ A.M., 4 P.M. (the most violent), $4^h\ 30^m$ P.M., 9 P.M. and midnight; and two on the 4th, at $2^h\ 15^m$ A.M. (very violent), & $3^h 45^m$ (slight).	The Rhine was much swollen.	The bell of the great clock at Berne sounded five times, and at the same place they had had the day before a violent tempest with thunder. At Strasburg the earthquake extended 30 leagues east and west. Perrey says, without however quoting any authority, that an earthquake was felt this day at dawn at Newbury in New England; and that shocks had been experienced there every month this year except April.	Journ. Hist. Oct. 1728, p. 287; Bertrand; Coll. Acad.; France Pittor. art. Strasburg; Bachofen's Chronik; Lersner's Chronik; Kriegk.

1.	2.	3.	4.	5.	6.
1728. Sept.	China	......	......	......	Edinburgh Encyclopædia, Article Chronology.
—— Nov. 28.	Luçon in the Philippine Islands, especially at Manilla.	......	......	Great devastation at Manilla	Don Ildefonso de Aragon, Descripcion Geogr. y Topogr. de la Ysla de Luzon, Manilla (1819), t. i. p. 8.
1729. Jan. 13. Between 10 and 11 P.M.	A great part of Switzerland; especially at Berne, more violently on the lakes of Thun and Brienz, at Interlachen, Spiez, Zurich, Frütingen (most violently of all), Rettingen, Constance, Bâle, Lausanne, Geneva, Vevey, and generally through the Canton du Vaud.	At Zurich there were three shocks, the first at the hour mentioned, the second at 2, and the third at 5 the next morning. At Frütingen the shocks recurred periodically for eight nights, beginning at 10 at night and ending at 7 the next morning. At Rettingen also the earthquake lasted several days.	The boats upon the lakes of Thun and Brienz were violently driven on shore.	Cracks were produced in the castle of Interlachen; that of Spiez was much shaken. Lightning was observed some days before at Zurich. The night was fine but very cold, and a slight wind had been blowing from noon. From time to time this wind would become stronger, and then cease, and at the moment of its ceasing the shocks would recur. The walls of the church and castle of Rykenbach were cracked. The earth opened at a short distance from the Sibenthal. Some damage was done at Constance.	Bertrand; Coll. Acad.; Bachofen's Chronik.
—— —— 18. 9h 15m P.M.	Geneva and Bâle	Another shock	......	......	Ditto.
—— Mar. 25.	Newbury in New England.	Repeated slight shocks from this date until 1741.	......	For details of these numerous slight shocks see Phil. Trans. *loc. cit.*	Phil. Trans. vols. xxxv. and l.
—— June 1. 2nd hour of the night.	Sienna	A violent shock	......	......	Macchi, nelle sue Memor.
—— —— —— 5th hour.	Ditto	A slight shock	......	......	Ditto.
—— —— 2. In the morning.	Ditto	Ditto	......	......	Ditto
—— —— —— About noon.	Ditto	Ditto	......	......	Ditto.
—— —— Night between 22 and 23.	Florence, and the country for at least six or seven leagues round.	Very violent for ten minutes.	......	Some houses were ruined	Journ. Hist. Sept. 1729, p. 195.
—— —— ... Some time after the last.	Velletri	......	......	Bertrand says for this year—Sundry earthquakes in Italy.	Ditto.

1729.	Constantinople				Hadschi Chalifa.
—	Sweden	Several earthquakes			Bertrand; Coll. Acad.
—	Japan			The city of Meaco was destroyed. A volcanic eruption took place soon after. According to the Journal de Physique, t. xiv. p. 111, this event should be placed in the year 1730.	v. Hoff.
1730. Mar. 28.	Genoa	One shock		No damage done.	Journ. Hist. 1730.
— — In the course of the month.	Different points in Italy; especially at Massa-di-Carrara.	Several shocks		Houses were thrown down at Massa-di-Carrara, and many people perished in the ruins.	Ditto.
— May 12. About 10 P.M.	Rome, Tivoli, Aquila, Norcia, Cascia, Virsa, Matrica, Monteleone, &c. Sulmona also suffered much.	At Rome but one shock was felt, which lasted nearly six minutes (?). At the other places three shocks were experienced, of which the last was the most violent at Norcia. The shocks continued almost every day up to the 28th, when there was another violent one.		At Tivoli some walls were cracked; at Norcia the shock was so violent that almost all the houses were thrown down. More than 500 persons perished there.	Ditto.
— June 12.	In Abruzzo. Also slightly at Messina.	Several slight shocks at Messina.		Leonessa was almost entirely destroyed	Ditto.
— July 8. 8 A.M.	Concepçion in Chili	Several shocks	Accompanied by a violent agitation of the ocean, which, at the first shocks, suddenly retired, and then on returning inundated the city and adjoining country.	The city terribly injured	Hist, gén. des Voyages, t. xix. pp. 415 and 419.
— — 9.	Ditto	More shocks, recurring at intervals for many months.		Completed the destruction of the city	Ditto.
— — ... Night between 24 and 25.	In Helsingland	Rather violent			Observ. Bromann.; Acta Litt. et Scientif. Sueciæ, III. A. p. 105.
— Nov. 30.	Island of Graciosa, in the Canaries.	Two violent shocks		Followed by a volcanic eruption	Journ. Hist. Mai, 1731, p. 350.

1.	2.	3.	4.	5.	6.
1730. Dec. 6.	At the western point of Teneriffe.	....	....	The earth opened, and a little hill sank into the fissure.	Journ. Hist. Mai, 1731, p. 350.
——	Kieff in Russia	....	....	....	Nova Acta Acad. Petropol. t. xv.; Hist. p. 71.
1731. Beginning of the year	China	....	....	Four provinces were much injured by earthquakes.	Gentleman's Magazine, vol. i. p. 309.
—— Mar. 20. (N.S.) 4 A.M.	At Naples and in La Puglia.	Very violent. First there was a trembling, then a pulsation, and finally a rocking motion like that of a ship, lasting altogether three min. and some secs.	At Siponto and Barletta the fishermen perceived a sudden rising of the sea which nearly wrecked their boats, although there was no wind.	The heavens were obscured by heavy clouds, which afterwards cleared away before a gentle breeze from the North. Water was thrown out from wells of 30 or 40 feet deep.	Phil. Trans. (edit. 1745) t. ix. p. 398; Journ. Hist. Juin, 1731, p. 411; Seyfart, p. 111; v. Hoff.
—— —— 21. 8 A.M.	Ditto	Shorter and less violent than the last.	....	The heavens were clear, but the sun appeared pale as if obscured by thin vapour. Before this earthquake the inhabitants of the Terra-di-Bari perceived around Monte Gargano a sort of flame like sudden lightning, which vanished in smoke. In the neighbourhood of Foggia this and the other earthquakes of April, October, and November, were observed to be preceded in general by violent wind from the north-east. Sometimes however it was quite calm. These aërial phænomena were accompanied by terrible noises in the open country. Foggia was greatly injured. It was supposed to be the centre of the shocks, and that they diminished in the ratio of the square of the distances of the places at which they were felt from it. About 600 persons perished. A spring of hot water made its appearance.	Ditto.
—— April 17.	Foggia and its environs	Fifty shocks during the day.	....	3600 persons perished	Journ. Hist. 1731, Juillet, p. 46.
—— June 4.	The island of Lancerote, one of the Canaries.	Violent shocks........	....	Accompanying a very violent and most remarkable volcanic eruption, which began on the 1st September 1730, was extremely violent for two years, and did not entirely cease until the 16th April 1736.	v. Buch quotes the account of Don Andr. Lorenz. Curbato, the curé of Yaisa in the island.

1731. June 15. Between 10 and 11 P.M.	Cavaillon in the department of Vaucluse.	Violent	....	The dome of the Porte de la Couronne fell	Acad. des Sciences de Paris, 1731, Hist. p. 19; Coll. Acad. t. vii. p. 100.
—— Sept. 20.	In the Abruzzo	Very violent. Many other slighter shocks during the month.	....	Several buildings thrown down. It was remarked that this earthquake and that of the 20th March were each just two days before the equinox.	Journ. Hist. 1731, Déc. p. 413.
—— Oct. 17.	At Naples, and in Puglia and Abruzzo.	One very violent shock, followed by others less so.	....	Many buildings were thrown down at Canosa...	Ditto, 1732, Janv. p. 42.
—— —— 19. (N.S.) 3 A.M.	Aynho in Northamptonshire.	....	....	Accompanied by a noise like distant thunder. The Journal Historique places this event in the middle of November.	Phil. Trans. (edit. 1745) vol. x. p. 249; Coll. Acad.
—— —— 21. (N.S.) 4 A.M.	Ditto, and in the neighbourhood, at Bloxham (4 miles S.W.), Barford (5 miles off), Banbury (4 miles W.), Adderbury (1 mile W.), Croughton (1 mile E.), and Charlton (1 mile N.); but it does not appear to have extended to the south or south-east.	Another shock, lasting one minute, or, according to some, even two.	....	The windows were shaken violently. Followed, one minute after, by brilliant lightning at Aynho. The day after, the sky appeared the colour of earth.	Ditto.
—— Nov. 30. Shortly before 11 A.M.	In China; in and around Pekin.	Extremely violent. After the first and greatest shock there followed in less than twenty-four hours twenty-three other slighter ones.	....	The first shock was so violent that buildings were instantaneously thrown down, and in less than a minute 100,000 persons in the city of Pekin alone were buried in the ruins, and still more in the surrounding country, where whole districts were ruined. The earthquake was not everywhere of equal violence in the line of its course, so that some places therein escaped comparatively well, though between others which were ruined.	Du Halde, Description de la Chine, t. i. p. 486; Bertholon in the Journal de Physique, t. xiv. p. 111.
—— Dec. 9. About 5 P.M.	Florence	A slight shock........	....	The same day a luminous cloud was seen, driven with some violence from E. to W., where it disappeared below the horizon. This phenomenon is said to have been quite different from an aurora borealis.	Journ. Hist. Fév. 1732, p. 118.

1.	2.	3.	4.	5.	6.
1731. Dec. 23.	Island of Lanzerote, one of the Canaries.	The most violent earthquake which had been felt in that island during the two preceding years of eruption.	....	On the 28th the eruption was renewed, having ceased for about a month. This earthquake and that of June 4, before quoted, are the only ones particularized, but it seems probable, from the account of the eruption, that slight shocks were frequently felt before or during its outbursts.	v. Buch, quoting Don Andr. Lorenz. Curbeto, curé of Yaisa in this island.
——	The town of St. Croix in Morocco.	....	....	The town was ruined	Verneur, Journal des Voyages, t. xv. p. 50.
1731 or 1732. At 6 P.M.	Felt at Bâle. It is said to have extended from Poland to the Pyrenees.	....	....	Bernoulli only says as to date, in a letter of 19th June 1737, "circiter ante quinque vel sex annos, hora sexta pomeridiana."	Jean Bernoulli, Œuvres complètes, t. iv. p. 515; Coll. Acad.
1732. Jan. 10. Between 8 and 9 A.M.	Seville in Spain	A slight shock, which lasted nearly a minute. Half an hour after, a more violent one.	....	The second shock threw down some old walls...	Journ. Hist. Mars, 1732, p. 203.
—— Feb. 25.	Acapulco	Very violent	Accompanied by an extraordinary flux and reflux movement of the sea. It rose 2 or 3 mètres above the level of high water, then retired, after being a moment stationary.	Destroyed a large number of the houses	Abel du Petit-Thouars, Voyage de la Vénus, t. ii. p. 212.
—— May 21. In the afternoon.	At Leghorn, in Tuscany, and as far as Genoa.	Six shocks	....	The same day a disastrous tempest at Leghorn...	Journ. Hist. Août, 1732, p. 111.
—— Aug. Night between 9 and 10.	Imola, Forli, and Faenza	Three shocks	....	Some damage done	Ditto, Nov. p. 341.
—— Sept. 5. Noon.	Canada. Also felt slightly at Boston, in Pennsylvania, and at Annapolis in Maryland.	A violent earthquake	....	Some mischief was done at Montreal. At Annapolis a clock was stopped at 11 A.M.	Phil. Trans. vol. l. p. 13.
—— Nov. 1.	Naples	One slight shock	....	....	Vivenzio quotes "Relazione del tremuoto ..... nel di 29 Novembre 1732."

1732. Nov. 29. $13\frac{1}{2}$ hour.	In the kingdom of Naples, the Terra di Lavoro, and the two Calabrias. The centre appears to have been about Vesuvius, and from it the earthquake seems to have radiated in eight different directions, particularized by v. Hoff. At Rome also a slight shock was felt.	A very violent earthquake. Another shock was felt at Rome the night following.	....	Buildings were thrown down at Naples. Ariano was almost entirely destroyed. Laurino also was much injured. 1940 persons are said to have been killed and 1455 wounded. On the 9th December Etna was in eruption.	Ditto; Huot, *loc. cit.*; Coll. Acad.; Della Torre; Journ. Hist.
—— Dec. 1.	Gallipoli on the west coast of the southern part of the province of Otranto.	....	....	....	Seyfart, p. 113.
——	Island of Corfu	Rather violent	On the side of Fort the sea appeared to rise up.	Accompanied by a loud noise from the side where the sea seemed to rise up. Followed by disastrous rains.	Mercure de France, Mars, p. 549.
——	Strontian in Argyleshire, and all along the western coast of Scotland, though to no great breadth.	....	....	....	Gentleman's Magazine, 1750, p. 56.
1733. Jan. Middle of the month.	Benevento and Naples .	Shocks which were very violent at Benevento, and slight at Naples.	....	About the same time Etna was in eruption	Journ. Hist. Avril, 1733, p. 265.
—— —— 29.	In Puglia and Basilicata.	One shock, followed by other slight ones for some time.	....	Accompanied at Matera by a loud noise in the air.	Ditto.
—— March. Night between 21 and 22.	Naples. Also felt at Ariano.	More slight shocks ...	....	Ariano suffered considerably	Ditto, Juin, 1733, p. 399.
—— May 18. 2 P.M.	Frankfort, Offenbach, Hanau, Giessen, Butzbach, Darmstadt, and Mayence; and all the district enclosed by these places.	Three shocks	....	Stones were thrown from the walls, and at Mayence a bell was made to sound.	Seyfart, p. 113.
—— June 14.	Annapolis in Maryland, North America.	....	....	The day and month of this event do not seem fixed with certainty as the 14th June.	Collection Académique.
—— —— 23.	Pardines in Auvergne...	Several shocks.........	....	....	v. Hoff.

1.	2.	3.	4.	5.	6.
1734. Nov. 5. (N.S.) Between 3 and 4 A.M. (At Chichester at 3^h 30 or 45^m.)	In Sussex; especially at Havant, Arundel, Goreing, Tarning, Shoreham, Goodwood, &c. Also felt at Portsmouth, and Chichester; and in France at Havre and as far as the other side of the Seine.	At Havant two shocks were felt, each lasting 2 or 3 secs. and with a short interval between. Some supposed the direction to be E. to W., while others thought it to be N. to S.	....	The atmosphere was quite calm. The weather became suddenly cold just before. All moveables were much shaken. The barometer was about 30 in. Horses were observed to be much frightened, and to endeavour to make good their footing.	Phil. Trans. (edit. 1745) vol. x. p. 247; Acad. des Sciences de Paris, 1734, p. 4; Coll. Acad. t. vi. p. 617, and t. vii. p. 103
——	The whole of the district of Sunnlendinga in Iceland.	Violent........	....	....	Voyage en Islande, *loc. cit.*; Huot; v. Hoff.
——	Lima in Peru	Shocks were felt here 3 times during the year.	....	....	v. Hoff.
1735. Aug. 7.	Frankfort on the Maine, Mayence, and Cologne.	Several shocks........	....	....	Ditto.
—— Oct. 1 to 4.	Etna and the country for 30 miles round.	Repeated shocks	....	Accompanied by subterranean noises, and followed by an eruption of Etna, which did not end until July 1736.	Ferrara, Descrizione, &c. p. 114.
1736. Apr. 23.	Fontcouverte (Maurienne).	Very considerable trembling.	....	....	Mgr Alexis Billiet, Notice sur les tremblemens de terre de Maurienne, Mém. de Turin, 2e série, t. ii.
—— May 1. 1 A.M.	Ochil Hills in Scotland	Two shocks	....	Accompanied by subterranean noises	Gentleman's Magazine, vol. vi. p. 289.
—— June 12. A little before 8 P.M.	Throughout the whole of Switzerland, & the country round. Felt at Bâle.	Rather considerable...	....	Some walls were cracked, and chimneys thrown down.	Bertrand; Coll. Acad.; Jean Bernoulli, t. iv. p. 515.
—— —— 13. 6^h 12^m A.M.	Geneva........	A single shock	....	....	Ditto.
—— Dec. Beginning of the month.	Province of Quito; especially the town of Llactacunga.	....	....	Llactacunga was much injured. Flames came forth from a lake near to it.	Bouguer, De la Figure de la terre, p. 74.
—— (According to Keferstein, in May.)	All the northern part of Sicily; especially Ciminna, Palermo, and Naso.	....	....	....	Huot, *loc. cit.*
——	Island of Cyprus	....	....	....	v. Hoff.
——	Island of Cephalonia ...	Very violent	....	Did great damage in the northern part of the island. Probably simultaneous with the earthquake at Cyprus.	Montgom. Martin, History of the British Colonies, vol. v. p. 415.

1737. Feb. 6. 4h 30m P.M.	Boston in North America.	One shock	....	....	Phil. Trans. vol. l. p. 13.
—— —— 12.	The Bas Valais, and a part of the Pays de Vaud.	Several shocks........	....	....	Bertrand.
—— March 3.	Constantinople	....	....	....	Gentleman's Magazine, vol. vii. p. 319.
—— —— 5.	Smyrna	Lasted two minutes...	....	....	Ditto.
—— May 11.	Bâle........	....	....	....	Jean Bernoulli, *loc. cit.*
—— —— 12.	Ditto	....	....	....	Ditto.
—— —— 11. 3h 45m A.M.	Carlswich (Carlsruhe ?) in Swabia.	A considerable shock. Another sudden shock at 2h 30m P.M., lasting about two minutes, and felt with still more violence at Radstadt. At Bâle a very slight one at 3 P.M. Other shocks at Carlsruhe at 10 P.M., and midnight.	....	Accompanied by a noise like distant thunder or the rolling of vehicles. The second shock was the most violent; buildings being much shaken and tables and vessels thrown down. The weather was extremely hot, but the sky was calm and clear.	Jean Bernoulli, t. iv. p. 304; Coll. Acad.
—— —— 12. 3h 45m A.M.	Ditto	A violent shock at the time mentioned, and slight tremblings all day. At Bâle a very slight shock at 5 A.M.	....	Attended with noise	Ditto.
—— —— 13. 1h 15m P.M.	Ditto	One violent shock. Another at between 3 and 4 P.M., and again at 5 P.M.	....	The first shock accompanied by a loud subterranean noise coming from the West. A storm about 3 P.M.	Ditto.
—— —— 14. 2 A.M.	Ditto	A violent shock	....	Walls were cracked. An extremely violent eruption of Vesuvius began this day, & lasted until the 23rd.	Ditto.
—— —— 15. About 3h 45m A.M.	Ditto	Another violent shock at 5h 45m A.M. followed by oscillations for three minutes. Two more at 6h 46 and 47m A.M. Another at 8h 20m A.M., followed by tremblings for eight minutes. At 10 A.M. a violent shock, followed by slight tremblings all day.	....	Many of the shocks were attended with subterranean noise.	Ditto.

1.	2.	3.	4.	5.	6.
1737. May 16. 5 to 6^h 15^m A.M.	Carlswich (Carlsruhe?) in Swabia.	5 or 6 violent shocks, principally at 5^h 37 and 46^m. Again at a little after 4 and at 5 P.M. numerous and violent shocks and tremblings.	....	The walls trembled much	Jean Bernoulli, t. iv. p. 304; Coll. Acad.
—— 17. 5 to 6 A.M.	Ditto	Many shocks and tremblings as before. Again at 8 A.M. and 8^h 5^m to 8^h 20^m.	....	The sky, which had hitherto been clear (the wind at S.W.), became obscured; the barometer went down about 4 P.M., and three thunder clouds formed in the W., S.W. and S., about 8 P.M. The sky then cleared again, and at night lightning was seen in the W., and W.S.W.	Ditto.
—— 18. 5 to 6 A.M.	Ditto	Several shocks, recurring at 9 A.M. At 9^h45^m P.M. a terrible earthquake lasting 3^m or 4^m. Again at between 10 and 11 P.M. (one at 10^h 45^m was vertical) and at 11^h 45^m P.M.	....	These shocks did some damage. Almost all were accompanied by loud subterranean noises. The heavens were a little cloudy; thunder and rain from 8 to 9 P.M. At 9^h 45^m P.M. an igneous meteor was seen.	Ditto.
—— 19. The whole of the first hour (from midnight of the 18th).	Ditto	Many shocks, but less violent than the former. About 3 A.M. a violent trembling. Some minutes before 4 A.M., two vertical shocks. At 6^h & rather more than 40^m 2 terrible shocks, followed, 1^m after, by a third, and continuous tremblings. Between noon and 1 P.M., two more vertical shocks. At 1 P.M. a violent shock from the S.E. At 1^h 30^m another from the S. At 2^h 15^m one from S.E., at 3^h and some minutes, another.	....	Most of these shocks attended as before with loud subterranean noises. The weather variable, and the wind shifting. At about 4 A.M., an aurora borealis, visible notwithstanding the clouds which then obscured the heavens.	Ditto.

1737. May 20. From 1 A.M. to noon.	Ditto	Many shocks; especially one at 7 A.M.; another a little before 10, some minutes past 10, at $10^h\ 45^m$ A.M.; & also at $10^h\ 30^m$ P.M.		Aurora borealis seen. The barometer had gone down. At night clouds, rain, and lightning.	Ditto.	
—— 21. 2 A.M.	Ditto	Trembling		The barometer very low. Thunder, clouds, and rain.	Ditto.	
—— 22. 1 to 3 (A.M. or P.M.?).	Ditto	Four shocks. At 10^h 40 and some minutes P.M. shocks for four minutes.		The barometer still very low. The weather wet, windy, and cold.	Ditto.	
—— 23. At noon.	Ditto	Other moderate shocks at 3 and 5 P.M.		The rain almost continuous. Winds variable ...	Ditto.	
—— 24. 2 A.M.	Ditto			Attended with a loud noise. The winds variable and the weather tempestuous. The barometer went up again.	Ditto.	
—— 25. About $6^h\ 45^m$ A.M.	Ditto	A violent vertical shock, followed by oscillations for four minutes. Some minutes after, another shock. At 8 great trembling; at $9^h\ 15^m$ A.M., another shock, soon repeated. At $4^h\ 30^m$ P.M., another with oscillations; and at 6 P.M., one more shock.		Heavy rain with wind during the night. The sky cloudy. Vortices in the air.	Ditto.	
—— 26. $1^h\ 30^m$ A.M.	Ditto	One shock with trembling. At 7 A.M., another similar one. At 6 P.M., a vertical shock; at 8, another, and again, half a minute afterwards, one rather more feeble.		During the first shock a whirlwind which agitated the air until daybreak. Also an aurora borealis. At 7 A.M. the barometer had gone up a little. The mountains were covered with fog, and it rained. At 6 P.M. the barometer was much higher. Some lightning was seen. All the shocks of this day were attended with noise.	Ditto.	
—— 27. 2 P.M.	Ditto	Vertical with trembling.		Rain all day and night. The mountains were covered with an extraordinary fog. They absolutely seemed to smoke.	Ditto.	

1.	2.	3.	4.	5.	6.
1737. May 28. 2 A.M.	Carlswich (Carlsruhe ?) in Swabia.	Tremblings for eight or ten minutes.	....	The weather was hotter than on the preceding days. The barometer went up in an extraordinary way. Rain at intervals. Amongst these shocks at Carlsruhe, 3 (namely, those on May 11, at 2^h 30^m P.M., May 18, at 9^h 45^m P.M., and 11^h 45^m P.M.) were extremely violent, 14 others were rather violent, and the rest were comparatively slight. Throughout the whole time there appears to have been a continuous slight trembling motion going on. During the shocks cocks and hens crowed repeatedly, and appeared much alarmed. On holding one's ear to the ground a noise like that of a vast mass of water in ebullition might be perceived. The earth was warm, and retained its heat even after the weather had become cold. The mountains were covered with thick mists, through which traces of a dim light might be perceived. Globes of fire were seen in the air on the side of Landau on the 18th; they had also been seen there three weeks before. At the same time with these shocks, slight ones were felt at Ulm, where tempests and lightning were almost continuous.	Jean Bernoulli, t. iv. p. 304; Coll. Acad.
—— Latter end of May or beginning of June. (The authority says "depuis peu.")	Constantinople	Several violent shocks	....	A castle was thrown down. At one place the earth opened, and such a quantity of water came forth as to inundate several villages.	Mercure de France, Juin, 1737, p. 1175.
—— Sept. ...	Near Lopatka in Kamtschatka.	....	....	Preceded by an eruption of Awatschinskaja or Gorälaja lasting twenty-four hours.	Mém. de l'Acad. de St. Pétersbourg, 1833, ii. p. 11.
—— Oct. 6.	Kamtschatka, and the Kurile Islands.	Extremely violent ...	The sea was greatly agitated, overflowed the land to an extraordinary height, and then retired so far that the bottom was visible between the first and second of the Kurile Islands.	Followed by a terrible eruption of Klutschewskaja, which lasted eight days. Great changes were produced on the surface of the country; many level places were raised into hills, and others sunk into chasms. Near the sea lakes and bays were produced.	v. Hoff; Lyell's Principles of Geology, quoting Chappe d'Auteroche, p. 337.

1737. Oct....	Zeitoun in Greece	......	......	Fissures opened in the earth of six inches width.	Pocock's Travels in the East, in Pinkerton's Voyages and Travels, vol. x. p. 745.
—— Dec. 7. (O.S.) Shortly before 11 P.M.	Boston and New York in North America.	At New York three shocks were felt during the night.	......	At New York some chimneys were thrown down.	Phil. Trans. vol. l. p. 13.
1738. Jan. 9. (N.S.)	Scarborough in Yorkshire and Taunton (in Somersetshire?).	......	......	Accompanied by the rising and falling of the ground near a mineral spring which disappeared, but reappeared soon after.	Ditto, 1741, p. 804; and 1748, p. 398.
—— Oct. 18. $4^h\ 30^m$ P.M.	Carpentras (department of Vaucluse) in France.	Lasted two minutes...	......	Accompanied by a noise like 100 *twenty-four pounders* being fired at once. The acorns of some oaks fell as thickly as if there had been hail. Two minutes afterwards a rain of earth as if a mine had been sprung. The earth opened. Some chimneys were thrown down.	Hist. de l'Acad. des Sciences de Paris, 1738, Hist. p. 37.
—— Oct. or Nov.	Boston in North America	......	......	......	Phil. Trans. vol. xlix. part i. p. 443.
—— Nov. 25. 8th hour.	Padua	Several shocks......	......	......	Toaldo, *loc. cit.*
—— Dec. 30.	Halifax and other places in the West Riding of Yorkshire.	......	......	Appeared as if the earth were suddenly moved in a horizontal direction, and then returned to its former place. Accompanied by vibratory motions, and ending with a kind of hissing noise. Possibly this may only be the same as that of the 9th Jan. wrongly reported as to year, as that event happened on the 29th Dec. 1737 (O.S.). "The Theory and History of Earthquakes" gives the date 30th Dec. 1739.	Gentleman's Magazine, vol. ix. p. 45.
—— —— ...	Kamtschatka	Violent......	......	......	v. Hoff quotes Kracheninikow.
——	Japan	Ditto	......	The city of Meaco much injured	Vivenzio, 1783, p. 34.
1739. Feb. 13.	Foggia in Capitanata. Also felt at Benevento.	Three violent shocks.	......	Did some damage at Foggia	Journ. Hist. 1739, Mai, p. 360.
—— —— 27. About 6 A.M.	Naples	A slight shock......	......	......	Ditto.
—— Mar. 24. (O.S.)	Smyrna	Shocks which lasted for a month, but continually decreasing in violence. The motion was horizontal from S. to N., but zigzag like flashes of lightning.	......	An island lying at the entrance of the harbour suddenly sank, leaving only a sandbank.	Phil. Trans. 1750, p. 700; Chandler's Travels in Asia Minor, p. 76; Hobhouse's Journey through Albania, p. 614.

1.	2.	3.	4.	5.	6
1739. April 24.	Different parts of Puglia	One shock			Journ. Hist. 1739, Juillet, p. 39.
—— May 4.	Valdemone in Sicily	The shocks recurred for some days (fifteen according to Michele del Bono). There were altogether 60 or even 100 of them.		The town of Naso was almost entirely ruined. The earth opened and closed again. An eruption of Vulcano in the Lipari islands at the same time. It was remarked that each shock was followed by the noise proceeding from the volcano.	Ferrara, Campi flegrei; Breislak, Institut Géol. (German translation) t. iii. p. 516; Dolomieu, Voyage aux îles Lipari, p. 27.
—— —— 21.	Ditto	More shocks			Ditto.
—— June 9.	Ditto	Ditto			Ditto.
—— —— 22, or 29.	Ditto	Ditto			Ditto.
—— July 23.	Batavia in Java	A trembling			H. Vogel, Beschreibung seiner Seereisen (Leipzig, 1797), B. ii. S. 137.
——	Pekin in China				Vivenzio, 1783, p. 34; v. Hoff.
1740. Jan. 24. 7 P.M. to 9 the next morning.	Janina in Epirus	Ten violent shocks			Pouqueville, Voyage en Grèce, t. v. p. 306.
—— —— 30. Between 11 A.M. and noon.	Annonay (Vivarais) in France, one of the extinct volcanic localities.	A trembling, lasting three or four seconds.			Acad. des Sciences de Paris, 1740, p. 2; Coll. Acad. t. viii. p. 64.
—— Feb. 15. 2 A.M.	Ditto	Less violent than the last.			Ditto.
—— —— 21. 3h 30m A.M.	Ditto	More violent than the last, less so than the first. All these shocks began towards the south.		Preceded and followed by a noise like that of thunder. This noise lasted half a minute, and went from octave to octave (!).	Ditto.
—— March 6. In the morning.	Milan, Leghorn, Pisa, Lucca, Massa-Carrara, and as far as Genoa.	A violent shock			Journ. Hist. Mai, 1740, p. 379.
—— —— —— 12¼ hour.	Barga (Tuscany). Also at Fornacetta and Bugliano.	A terrible shock which lasted the space of one *Ave Maria*. The days following, other shocks, but slight and short.		Great damage was done to buildings at Fornacetta and Bugliano, where three persons perished in the ruins. Probably simultaneous with the last.	"Notizia inedita," M. Pilla.
—— —— 22.	Sciacca in Sicily	Several shocks, recurring up to February 1741.			Journ. Hist. Oct. 1740, p. 137.

1740. May 22.	Palermo...	One shock	...	...	Ditto.
—— June. Beginning of the month.	Viterbo and Montefalco	Many shocks	...	...	Ditto.
—— —— ...	Sciacca in Sicily	More than 100 shocks (v. Hoff says twenty-two) in some days. The most violent on the 25th, which was also felt at Palermo.	...	It was remarked that, contrary to the general belief in Sicily, these shocks did not recur after twenty-four or forty hours.	Michele del Bono, *loc. cit.*; Ferrara, Campi flegrei.
—— Dec. About the beginning of the month.	At Naples	A violent shock	...	...	Journ. Hist. Mars, 1741, p. 200.
1741. Jan. 29.	In the Val-Demone and Val-di-Noto.	Violent trembling	...	...	Michele del Bono, *loc. cit.*
—— Feb. Night between 7 and 8.	Genoa	A violent shock	...	...	Journ. Hist. Avril, 1741, p. 278.
—— April 23. $11^h\,30^m$ (Ital.)	Padua	One shock	...	...	Toaldo, *loc. cit.*
—— Oct. 1. 7 A.M.	Sienna	Two violent shocks, followed, during the morning, by eighteen less so.	...	Attended with noise. Some damage done to buildings; arches, &c. being thrown down.	Diario del Sig. Silvestro Castinelli.
—— Dec. 6. 8 A.M.	Boston, Roxbury, Dedham, and Walpole in New England.	A slight shock	...	...	Silliman's Journal, vol. xl. p. 204.
1742. Jan. 10.	Leghorn	One slight shock	...	...	Phil. Trans. 1742; Journ. Hist. 1742, Avril, p. 273; Seyfart, p. 114; Coll. Acad.; communication of M. Pilla to M. Perrey.
—— —— 16. A little after 24th hour, Italian time (?)	Ditto. Also felt at Pisa.	Ditto. A quarter of an hour after, one from W. to E. About 4 o'clock more shocks in the same direction. At $10^h\,30^m$, two others.	...	The weather was very warm in the morning, but became cold in the evening. Extraordinary clouds were remarked. The following day, fine rain ending in snow.	Ditto.
—— —— 18.	Leghorn	Slight undulations, scarcely perceptible.	...	...	Ditto.

1.	2.	3.	4.	5.	6.
1742. Jan. 19. $12^h 30^m$ noon.	Leghorn. Also at Pisa...	Several shocks, all from W. to E.	The shocks at noon were felt by the captain of a Dutch vessel between capes Corse and Mele. Extraordinary motions were observed off the coast.	Vapours of an extraordinary character were seen at dawn, and remained until two hours before the shocks. The heat then became excessive, and the shocks began with a loud noise. The water in some wells was increased before the shocks.	Phil. Trans. 1742; Journ. Hist. 1742, Avril, p. 273; Seyfart, p. 114; Coll. Acad.; communication of M. Pilla to M. Perrey.
—— —— 20.	Ditto	Several shocks during the day. A violent one at $5^h 25^m$, from (or to?) the S.E., and lasting 10 or 12 secs. More of considerable violence up to the 20th hour of the 21st.	....	The weather, at the time of the principal shock, was rainy. At night a strange light, which is ill described, was seen; probably an aurora borealis.	Ditto.
—— —— 25. From the 20th to the 23rd hour.	Leghorn	The ground was in continual agitation during the time mentioned.	....	....	Ditto.
—— —— 26.	Ditto	Slight but very numerous shocks.	....	....	Ditto.
—— —— 27. 1 P.M.	Ditto, at Pisa, Genoa, and as far as Lastra near Florence. (According to M. Pilla, from Genoa to Cecina.)	Three terrible shocks, lasting 30 or 32 secs., and ending with a violent gyratory motion. Followed occasionally, up to the 18th March, by slight shocks.	....	Accompanied by a horrible subterranean noise. The atmosphere brilliant and the air calm. The weather became now very cold. Some buildings were thrown down, and many walls cracked. (Amongst these shocks M. Pilla distinguishes four as having been much more violent than the rest, namely, those of the 16th at $3\frac{3}{4}^h$, of the 19th at noon, of the 20th at $5\frac{1}{4}^h$, and of the 27th at $18\frac{2}{3}^h$. The hours here do not perfectly agree with those given by the other authorities here quoted.)	Ditto.
—— May 9. $9^h 45^m$ A.M.	Lima and Arequipa in Peru.	Lasted nearly a minute. Followed by numerous slight shocks up to the 19th.	....	....	Ulloa's Travels in South America, in Pinkerton's Voyages and Travels, vol. xiv. p. 590.

1742. May 19. Midnight.	Ditto	Lasted about the same time as the last.			Ditto.
—— 27. 3h 35m P.M.	Ditto	One violent shock, lasting nearly two minutes, and ending with slight tremblings.			Ditto.
—— June 12. 5h 45m A.M.	Ditto	Lasted one minute		On the 15th June Cotopaxi burst into eruption for the first time since 1533.	Ditto.
—— Aug. Night between 17 and 18.	Naples	One shock			Journ. Hist. Nov. 1742, p. 355.
—— Oct. 14. 9 P.M.	Lima and Arequipa in Peru.	Lasted one minute			Ulloa, *loc. cit.*
—— Nov.	Poromusir, one of the Kurile islands.				Kracheninikow in Chappe d'Auteroche, p. 337.
——	In Abruzzo			The situations of several springs were changed.	Collection Académique.
——	Malta	"A subterranean commotion."		The cupola of the cathedral was opened	Gazette de France, 12 Avril, 1776.
——	Zante	One violent shock			Montgomery Martin, Hist. of the Brit. Col. vol. v. p. 431.
1743. Feb. 20. 23rd hour.	Padua	One shock			Toaldo, *loc. cit.*
—— March. Beginning of the month.	Province of Otranto; especially at Nardo.	Very violent shocks		Houses were thrown down	Journ. Hist. 1743, Mai, p. 353; Juin, p. 436.
—— —— 7. 9h 15m P.M.	Toulouse, Bordeaux, Moissac, Castel-Sarrezin, and all along the Garonne.	Two shocks with an interval of six minutes.			Mém. des Savants Étrang. t. iv. p. 118.
—— Oct. 8.	Bâle	One shock			Busspredigt des Pfarrers, A. J. Buxtorf (Basel, 1755, 4to).
—— Nov. 8. Between 8 and 9 A.M.	Ditto	A very sensible shock		Accompanied by a subterranean humming noise. Probably only the same with the last, the month being mistaken.	Bertrand; Coll. Acad.
——	Cephalonia			Did some damage in the northern part of the island.	Montg. Martin, *loc. cit.* vol. v. p. 415.
——	Lima and Tarqui in Peru.	Tremblings at these places three times during the year.			Collection Académique.
1744. Jan. 1.	Near Hernösand	A slight earthquake			Acad. des Scien. de Stockholm, 1748.

1.	2.	3.	4.	5.	6.
1744. Feb. 22.	In the kingdom of Naples; especially at Lecce.	....	....	....	Seyfart, p. 114, quotes Genealog. Nachrichten, Th. 59, S. 1015.
—— May 16. Betwⁿ 11 P.M. and midnight.	Quebec in Canada	A considerable vibration.	....	Furniture was sensibly agitated........	Mém. de l'Acad. des Sc. 1745, p. 218.
—— June 3. $10^h\ 15^m$ A.M.	Cambridge in New England, North America.	The shock was not violent.	....	The subterranean bellowing noise was very great. The day was bright and hot; the wind (which was light) in the morning W.S.W., in the afternoon N.N.W. The barometer fell on the morning of the earthquake about two lines. The weather was very hot and dry both in the preceding and succeeding parts of the month. There had been no rain since the 23rd May. During the latter part of the month much lightning was observed.	Phil. Trans. vol. l. p. 14.
—— —— 13.	In Sicily	....	....	Attendant on the commencement of an eruption of Etna which lasted until the following year.	Seyfart, p. 114, quotes Genealog. Nachrichten, Th. 59, S. 1015.
1745. Feb. 7. About 9 A.M.	Christiansand in Norway, and the country round. It extended as far as the sea, and even to the Hellesand Isles. It was felt at Aaserald, and Staden, near Christiansand, and the same day at Copenhagen.	A trembling which lasted two or three minutes.	....	Accompanied by a loud noise. The houses were shaken, but it was not perceived by persons on foot in the open country or out of the house. It had been very cold on the 5th and 6th, but on the 7th the thaw suddenly came, contrary to all expectation. According to some authorities it appeared to advance 16 leagues per hour, and according to the Acad. de Stockholm it passed from Aaserald to Christiansand (8 or 10 miles) in thirty minutes, and from a place distant 4 miles from Staden to Staden in fifteen minutes.	Coll. Acad. t. ix. p. 63; Acad. des Sciences de Paris, 1745, p. 15; Richard, Hist. des Météores, t. viii. p. 498; Acad. des Sciences de Stockholm, 1747, p. 233.
—— Mar. 18 to June 20.	Smyrna	Twenty slight shocks, of which four were felt between March 18 at 4 P.M. and the following day.	....	The most of these shocks were felt at night; especially towards morning. They were more violent in the lower than the upper town, and experienced both during complete calms and when the wind was blowing freshly. The writer says that shocks here are more frequent at the equinoxes than at other times, especially during the spring one.	Mercure de France, Mars, 1746, p. 80.
—— July 9. 3 or 4 A.M.	Beziers (department of Hérault) in France.	Slight trembling......	....	Accompanied by a loud noise	Acad. des Sciences de Paris, 1745, p. 15; Coll. Acad. t. ix. p. 63.
——	Corfu	One shock	....	The government-house, the bishop's palace, and many other houses thrown down.	Montg. Martin, Hist. of the Brit. Col. vol. v. p. 327.

1746. Jan. 6. 1 P.M.	Around Hernösand in Angermannland.	....	....	....	v. Hoff; Acad. des Sciences de Stockholm, 1748, p. 156.
—— Feb. 2. Between 9 and 10 P.M.	Boston in New England.	A slight shock........	....	....	Silliman's Journal, vol. xl. p. 206.
—— July 9.	Barga in Tuscany	Some slight shocks...	....	....	Relazione giornaliera del tremuoto seguito in Barga l'anno 1746; nel mese di Giuglio, compilata dal dott. F. Tallinuci.
—— —— 10.	Ditto	Ditto	....	....	Ditto.
—— —— 11. 18th hour.	Ditto	One very violent shock	....	....	Ditto.
—— —— —— 21st hour.	Ditto	Ditto. Followed by numerous other slight shocks, gradually becoming less violent up to the 23rd.	....	....	Ditto.
—— —— 23. 22¾ hour.	Ditto	An extremely violent shock. The agitation of the ground ceased the next day.	....	During these shocks the water in the wells was troubled and of a leaden colour. The paleness of the sun was remarked *as usual*, the uneasiness of animals, &c. Many fish died. The weather was very bad on the 19th; a south wind rendering breathing difficult. Some rocks were shaken down on the 23rd.	Ditto.
—— Oct. 28. $10^h\ 30^m$ P.M.	Lima and Callao in Peru, and all the country near along the coast.	The first shock at the hour mentioned, followed by 200 more in twenty-four hours. The shocks continued at intervals up to the 24th Feb. 1747, during which period 451 were counted.	Callao was ruined by the sea twice retreating, and returning with overwhelming violence, during which it rose 80 feet above its ordinary level. A portion of the coast sank near this, producing a bay. Four other harbours, viz. Cavallos, Guannape, Changay, and Gaura, met with the same fate as Callao.	The valleys of Baranca, Supe and Patavilca suffered greatly. Near Lucannas a mountain opened, and water came forth. The same happened with three mountains of the chain of Convensiones de Caxa Marquillo.	Hist. de l'Acad. des Sciences de Paris, 1746, Hist. p. 24; Bouguer, de la Figure de la Terre, p. 73; Hist. gén. des Voyages, t. xix. p. 311; t. xx. p. 31; v. Humboldt, Voyage, t. i. p. 319.
—— —— ——	In the Haut-Valais	More violent than any shock before felt that year.	....	....	Bertrand; Coll. Acad.

1.	2.	3.	4.	5.	6.
1747. May 21. $14^h 45^m$.	Padua	One shock			Toaldo, *loc. cit.*
—— July 25. 4 P.M.	Bygdea in Westerbottn; Sweden.	Tremulous, lasting two minutes, and apparently from S.W. to N.E.		In many places the roofs cracked, and the windows rattled. A clap of thunder was heard while the atmosphere was quite clear, and, an hour after, another like an explosion from a cannon.	Acad. des Sciences de Stockholm, 1750, p. 158.
—— Oct. 17.	At sea, on board the vessel *Le Prince*, Captain Bobriant, going to the West Indies, in lat. 1°35′S., long. 20°10′W.	One or two shocks were felt as if the vessel had touched the ground.			Daussy in the Comptes Rendus de l'Acad. t. vi. p. 514.
——	Foligno, Norcia, and some other adjoining towns.	A violent shock		Several houses thrown down	Journ. Hist. Juillet, 1747, p. 46.
——	Venice				Seyfart, p. 118; v. Hoff.
——	Toulouse				Ditto.
——	Transylvania				Ditto.
1748. Mar. 12. 11 A.M.	Along the coast of Hernösand for 10 miles.			Probably this date is according to Old Style, and therefore equivalent to the 23rd N.S. If so it would be simultaneous with the next.	Acad. des Sciences de Stockholm, 1748, p. 154.
—— —— 23. $6^h 45^m$ A.M.	In the kingdom of Valencia in Spain.	Tremulous. Lasted two minutes.		Preceded by a dreadful noise, and followed by a very violent west wind.	Journ. Hist. Juillet, 1748, p. 45.
—— April 2. $9^h 30^m$ P.M.	Ditto. Felt at Valencia, Alicant, Carthagena, Orihuela, San Philippe, Alzira, &c.	As violent as the last, but not so prolonged.		Did some damage at the places particularized	Ditto.
—— —— 18. Between 6 and 7 P.M.	In the neighbourhood of Vevey.	One shock, followed by another less violent, a quarter of an hour after			Bertrand; Coll. Acad.
—— July 12. (N.S.) Between 10 and 11 P.M.	Taunton in Somersetshire and the country from the English Channel to the Severn, and extending about the same distance East and West, being felt at the same time at Exeter and Crookhorn.	Direction = S.E. to N.W.		The shock appeared to come from a distance, and was accompanied by a noise like that of a waggon in motion. Those who were sitting felt their seats move under them, and those who were in bed were wakened by a sudden start. China and kitchen utensils were thrown about, and here and there bells were heard to ring. v. Hoff mentions two earthquakes at this place, viz. on the 1st July, 1747, and on the 1st or 11th June, 1748. Both dates appear to be erroneous.	Phil. Trans. vol. xlv. p. 398; vol. xlvi. p. 690.

[illegible]	Madeira	A violent earthquake.	....	....	Ditto, vol. xlix. p. 435.
1749. Apr. 22. (N.S.) 5 A.M.	Neufchatel and the neighbourhood.	Followed by several other slight shocks during the day.	....	The wells became muddy, and moveable utensils clattered against each other.	Gentleman's Magazine, vol. xix. p. 190.
—— June 8.	Vienna, and the environs.	A trembling for one minute.	....	....	Journ. Hist. Août, 1749, p. 128.
—— —— 9.	Ditto	Another on this day...	....	....	Ditto.
—— —— 12	Ditto	Ditto	....	These shocks were more violent in the country round than at Vienna itself. At Neustadt a convent was thrown down.	Ditto.
—— Oct. 11. 7 P.M.	In France, extending for 60 leagues, from Poitou beyond Luçon to the neighbourhood of Blois.	....	....	Accompanied by a noise like the rattling of waggons upon a pavement which lasted a minute and a half. The letter of Reaumur to the Royal Society describing this event is dated 1749, yet it appears almost certain that it should be 1750, and that the earthquake happened in that year. *Vid. infra.*	Phil. Trans. vol. xlvi. pp. 689, 691.
——	Olvesbygden in Aarness-Syssel; Iceland.	A very destructive earthquake.	....	On the 27th March (at night), 23rd Sept. and 25th Nov. according to the Memoirs of the Stockholm Academy, subterranean noises were heard at Bygdea in Sweden. v. Hoff, though quoting from the German translation of the same work, does not mention the last two dates, and says for the first, "Erschütterung zu Bidea in Westerbottn."	v. Hoff.
——	Country around the volcano of Colima in Guadalaxara, Mexico.	....	....	Ruined Zapotlan. Accompanied by an eruption of the volcano.	Sonneschmidt, Mineralogisch. Beschrieb. der vorzüglichsten Bergwerks Reviere in Mexico, p. 307.
1750. Jan. 28. 2 P.M.	Rome. Also at Frascati and Albano.	An hour after, another slighter shock, and during the night, a third of greater violence.	....	At Frascati and Albano some houses were injured.	Journ. Hist. Mai, 1750, p. 385.
—— Feb. 11.	Rome	Very sensible shocks	....	....	Kant, Géog. Phys. (Italian translation, Milan, 1809) t. iv. p. 312.
—— —— 19. (N.S.) About $12^h 30^m$ noon.	Eltham in Kent, eight miles S.S.E. from London Bridge.	Two shocks from E. to W.	....	The wind from the S.W., which had been high the night before and during the morning, had ceased, and for some time after it was quite calm. Some pigeons seemed much frightened. As the time was not minutely observed this event probably did not precede that in London by ten minutes.	Phil. Trans. vol. xlvi. Appendix.

1.	2.	3.	4.	5.	6.
1750. Feb. 19. $12^h 40^m$ noon.	London and the country for seven miles ronnd, at Tooting, Chelsea, &c.; especially violent on both sides of the Thames from Greenwich to Richmond. Also at the same time on the coasts of Normandy (at Hâvre and Boulogne), Picardy and Brittany.	A violent shock	Many vessels in the middle of the Thames felt a violent shock.	Some persons spoke of a former slight shock at London at 7 A.M., and also of one at Plymouth at 1 A.M. on the following day. Both appear to be very doubtful. v. Hoff has obviously copied incorrectly the shocks in England of this year.	Phil. Trans. vol. xlvi. Appendix.
—— Mar. 10.	Canstadt in Swabia ...	A trembling	....	Keferstein mentions an earthquake at Constance on the same day, but v. Hoff thinks this name is only mistaken for Canstadt.	v. Hoff.
—— —— 19. (N.S.) Midnt (of the 18th)	London and some other places in the neighbourhood.	A slight shock........	....	....	Phil. Trans. *loc. cit.*
—— —— 2 A.M.	Ditto	Ditto	....	....	Ditto.
—— —— 3 A.M.	Chelsea	Ditto	....	....	Ditto.
—— —— $5^h 40^m$ A.M.	London, Chesnut (Cheshunt?), Hertford, Copthall, Bromley, Croydon, Tooting, Chelsea, Fulham, Epsom and Turnham.	Three or four consecutive shocks in the space of 10 or 12 secs. (or, according to some, only 3 or 4). Direction at London said to be E. to W., in the neighbourhood from NE. to SW., or even from N.W. to S.E. Others believed they felt alternate vibrations from N.W. to S.E., and *vice versâ*. At Chelsea two figures of porcelain, which had been placed with their faces to the W., were found after the shock turned to N.E.	....	Preceded by a loud noise compared by some to thunder, by others to the roaring of the wind, and moving in the direction, according to some, of S.E. to N.W. or W.; according to others, of W. to E., N.W. to S.E., or *vice versâ*. This noise (compared there to that of a carriage in motion) was heard at one or two places where no shock was felt. A black cloud with continual and confused flashes of lightning had been visible, the latter ceasing a minute or two before the earthquake. Some chimneys were thrown down and houses injured. A girl was thrown from her bed and her arm broken. In St. James's Park and elsewhere the earth seemed to swell up, and to be ready to open three times. Dogs howled dismally, fishes threw themselves out of the water, and a horse that was brought to the watering-place, refused to drink. One person felt himself turned on his feet by the shock.	Ditto.

1750. Mar. 20. 2 A.M.	London and the neighbourhood.	A slight shock	....	....	Ditto.
— — 4 A.M.	Ditto	Ditto. Lasted *some minutes.* (Probably a mere trembling.)	....	....	Ditto.
— —	Frascati near Rome	A trembling	....	....	Kant, *loc. cit.*
— — 24.	In the South of France.	Several shocks	....	....	Acad. des Sciences de Paris, 1750, p. 36; Mém. des Sav. Étr. t. ii. p. 612; Coll. Acad. t. x. p. 178.
— — 25. (N.S.) Before 4 A.M.	East Molesey in Surrey.	A trembling	....	....	Phil. Trans. *loc. cit.*
— — 29. (N.S.) Betw[n] 3 and 4 A.M.	The Isle of Wight	....	....	....	Ditto.
— — 6 P.M.	Ditto, at Portsmouth, Bridport, Southampton, Bath, Northaw, Gubbins, Hatfield (not felt at Hertford), Hackney near London, &c. Also in Jersey and Guernsey.	Direction at Portsmouth (where the shock was but slight) E. to W. Lasted four or five seconds. At Hackney the direction was W. to E.	....	Accompanied at most of these places by a noise like thunder at a distance. At Hackney, however, no noise was heard. The weather had been alternately wet and fine for a week before; there had been rain before 6 o'clock on the 29th, and a stormy cloud was seen at the moment of the shock. The time given for Portsmouth is $5^h\ 45^m$ or 6^h.	Ditto.
— April 13. (N.S.) 10 P.M.	Extended from Lancaster to Wrexham in the direction N. to S. and from Flintshire to Stockport and Altringham in that of W. to E.	Rather violent at Chester and Manchester. Slighter at Liverpool, where the motion was undulatory from N.W. to S.E. and lasted two or three secs.	....	At Barnhill the houses were violently agitated; at Downing in Flintshire a bed upon castors was moved from its place. Accompanied by a noise compared to thunder, wind, &c. The heavens were obscured by a thick mist, in which red rays were observed converging towards a point near the zenith. This appearance lasted fifteen or twenty minutes (aurora borealis?).	Ditto.
— Before May 11.	Jamaica	Many shocks	....	....	Journ. Hist. 1750, Oct. p. 300 (quoting letters from Jamaica of May 11).
— May 12. (N.S.)	Cerigo	Lasted five minutes	....	....	Gentleman's Magazine, vol. xx. p. 282.
— — 13. 5 A.M.	Hammerdal in Jämtland; Sweden. Also in the parishes of Lit and Rödöen, extending 8 miles.	Apparent direction = N.E. to S.W. The shocks more to the South did not take place for half an hour afterwards.	....	....	Mém. de l'Acad. de Stockholm, 1750.

1.	2.	3.	4.	5.	6.
1750. May 15. (N.S.) 10 A.M.	Winbourn in Dorsetshire, and the country for 20 miles round.	One violent shock …	…………	Accompanied by a noise like the discharge of artillery.	Phil. Trans. *loc. cit.*
—— —— —	In Calabria …………	Several shocks ……	…………	…………	Kant, *loc. cit.*
—— —— 23.	Simultaneously in Calabria and at Florence.	Ditto, repeated on the 25th.	…………	Probably only the same with the last …………	v. Hoff.
—— —— Night between 24 and 25.	Several parts of the South of France, in and about the Pyrenees. Felt at Rodez, Montpellier, Narbonne, Toulouse, Medoc, Pons in Saintonge, Macaire in Guyenne, Bordeaux, and for 12 leagues to the West of this last place.	Many very violent shocks, renewed at some places all through the month of June. At Tarbes four shocks were felt from 10 at night to 5 the next morning, and on the 26th, three more.	…………	The shocks were most violent in the Pyrenees. Masses of rock were thrown down in the valley of Lavedan. Several houses also were thrown down, and at Tarbes an old tower. Preceded by subterranean murmurings.	Gazette de France, 1750, No. 28; Mém. de l'Acad. de Paris, 1750, p. 36; Mém. des Sav. Étr. t. ii. p. 612; Coll. Acad. t. x. p. 178.
—— June 7.	In the Morea and the island of Cerigo.	Very violent ………	…………	In the island of Cerigo the town was ruined and more than 2000 persons perished.	Journ. Hist. Sept. 1750, p. 217; Phil. Trans. *loc. cit.* p. 734.
—— —— 21 to 28.	Tarbes (Hautes Pyrénées.)	Several violent shocks, slight ones having been felt there from the 24th May.	…………	…………	Mém. de Toulouse, t. ii. H. p. 15.
—— —— 24.	Munich and Landshut.	Three shocks at Munich; the first in the evening, the second, more violent, at midnight, and the third at 1 A.M. the following morning.	…………	All the 25th a violent wind, which threw down houses in the open country, and a thunderstorm with hail. The Isar overflowed its banks.	Journ. Hist, Sept. 1750, p. 212; v. Hoff.
—— Aug. …	Gibraltar …………	One shock ………	…………	…………	v. Hoff.
—— Sept. 3. (N.S.) 6^h 45^m A.M.	In the counties of Lincoln and Nottingham. Felt at Spalding, Newark, Grantham, Stamford, and Milton near Peterborough.	Ditto ………	…………	Accompanied by noise. The air was quite calm. The same night an aurora borealis was seen at the same places.	Phil. Trans. *loc. cit.*
—— ——	In Jamaica …………	Ditto ………	…………	…………	v. Hoff.
—— Oct. 5.	A large tract on the north coast of Africa.	A trembling ………	…………	…………	Ditto.

1750. Oct. 11. (N.S.) Between 12 and 1 P.M.	In the counties of Northampton, Leicester, Suffolk, Nottingham, Rutland, and Lincoln, in England; extending W. to E. from Warwick to Bury in Suffolk, and N. to S. from Lincoln to Northampton.	Four rather violent shocks from W. to E. in the space of three or four, or, according to others, of twenty seconds.	According to Dr. Stukely, who ascribes the production of earthquakes to the agency of electricity, these shocks followed the course of the rivers and canals, which acted as conductors.	Coventry, Derby, Nottingham, Northampton, Okeham, Grantham, Lincoln, Peterborough, Ely, and many smaller towns are mentioned as having experienced these shocks. Accompanied by a loud noise from N.E. to S.W. or *vice versâ*. At Northampton the houses of a street running N. and S. were more shaken on the East side than on the West. Some chimneys were thrown down. The weather was calm and fine. Auroræ boreales had been frequently seen for some time before.	Phil. Trans. *loc. cit.*
— —. About noon.	In Brittany, extending from Cherbourg to Avranches, and as far as Bayeux.	A very slight shock...	....	Accompanied by a loud detonation. Obviously the same earthquake with that in England.	Acad. des Sciences de Paris, 1750, p. 36; Mém. des Sav. Étr. t. iv. p. 118; Coll. Acad. t. x. p. 178.
— —	At Naples, and in the Romagna.	Tremblings	....	....	Kant, Géog. Phys. *loc. cit.*; Keferstein.
— — 16.	In Lapland	One shock	....	....	Keferstein.
— — ...	In Romania; especially at Philippopoli.	....	The river Maritza quitted its bed, and inundated the surrounding villages.	Philippopoli was ruined. The Journal Historique does not give the month.	Gentleman's Magazine, vol. xx. p. 478; Journ. Hist. Déc. 1750, p. 466.
— Dec. 22.	Felt at Naples, Venice, and Schaffhausen.	A trembling..........	....	....	v. Hoff.
—	At St. Pölten in Austria.	One shock	....	....	Keferstein.
—	Lisbon	One violent shock ...	....	....	Phil. Trans. vol. xlix. pt. i. p. 410.
—	Luçon, one of the Philippine isles.	....	Accompanied by a volcanic eruption under a lake, which lasted three months, and by which seven new islands were produced in the lake.	....	Ditto, pt. ii. p. 458.
1751. Feb. 3.	Jamaica	....	....	....	Keferstein.
— — 15.	Nantes in Brittany......	A trembling motion...	....	....	v. Hoff.
— Mar. 30.	On the banks of the lower Loire.	Ditto	....	....	Ditto.
— April ...	Angers in the department of the Maine and Loire.	Ditto	....	....	Ditto.

1.	2.	3.	4.	5.	6.
1751. May 6. (N.S.)	Staffuanger in Norway.	Lasted one minute ...	....	....	Gentleman's Magazine, vol. xxi. p. 235.
—— —— 25. Between 12 and 1 at night.	St. Domingo	....	....	....	An account in ditto, same vol.
—— June 5.	In the neighbourhood of Naples; at Rome and Florence.	Several shocks........	....	....	v. Hoff, S. ii. B. 331.
—— July 11.	In Sicily	Ditto	....	....	Keferstein.
—— —— 19.	At Nocera and Gualdo in the Apennines.	....	....	....	v. Hoff, *loc. cit.*
—— —— 26. At night.	Ditto, and other places in Umbria. Also at Rome.	Reiterated violent shocks for two hours in Umbria.	....	The city of Gualdo especially injured	Journal Historique, Oct. 1751, p. 308; Kant, Géog. Phys. *loc. cit.*
—— Aug. ...	Gubbio, some other parts of Italy, and at Palermo.	Several shocks........	....	....	Kant, *loc. cit.*
—— Sept. 15. 10 P.M.	Among the Antilles, especially at St. Domingo.	Several shocks. At Martinique they lasted but a short time.	....	The afternoon had been wet. Lightning in the evening. A little after 11 o'clock the thunder began.	De Chamvallon, Voy. à la Martinique, p. 144–155; Acad. des Sciences, 1752, p. 16; Journ. Hist. Avril, 1752, p. 318.
—— —— 29.	St. Domingo	....	....	....	Ditto.
—— —— ...	In Umbria	....	....	....	Kant, *loc. cit.*
—— Oct. 1. 8h 30m A.M.	Martinique	A slight shock........	....	The weather fine with light clouds	De Chamvallon, and the other works just quoted.
—— —— 8.	St. Domingo	....	....	....	Gentleman's Magazine, vol. xxi.
—— —— 12. At noon.	Ditto	....	....	....	Ditto.
—— —— 18. 2 P.M.	Ditto	Two shocks with a very short interval; the motion lasting at least three minutes at each shock.	....	The weather very fine and perfectly calm; not a breath of wind in motion.	Ditto.
—— —— —— 3h 30m P.M.	Ditto; and at Martinique. Also probably at some of the other islands.	The earth trembled slightly for two or three seconds.	....	The barometer did not vary during the earthquake. The wind was moderate, and the sky clouded.	De Chamvallon, &c. *loc. cit.*
—— —— —— 5 P.M.	St. Domingo	....	....	....	Gentleman's Magazine, *loc. cit.*

1751. Oct. 23. $17\frac{1}{2}^h$ (Italian time).	In Naples and towards Massa di Somma.	Slight		Vesuvius was in eruption from the 19th of this month to the 9th November.	Della Torre, p. 126.
—— —— 27. 10 P.M.	In Finland			The houses trembled. A noise was heard in the air.	Collection Académique, t. xi. p. 14.
—— —— 29. 8 P.M.	St. Domingo				Gentleman's Magazine, *loc. cit.*
—— —— ...	Camerino in Italy	A trembling			Kant, *loc. cit.*
—— Nov. 5. 9 A.M.	In Finland			Shocks again accompanied by noise	Collection Académique, *loc. cit.*
—— —— 7.	Swansky in Finland			Possibly confounded with one of those given by the Collection Académique.	Keferstein quoted by v. Hoff.
—— —— 9. At night.	In Finland			Again accompanied by noise	Collection Académique, *loc. cit.*
—— —— 18. From 1 to 7 A.M.	Ditto			More shocks with noise	Ditto.
—— —— 19. $3^h 20^m$ P.M.	St. Domingo	A short but violent shock.		Slight tremblings had been felt almost every day since the 1st.	Gentleman's Magazine, *loc. cit.*
—— —— 21. 8 A.M. (Perrey gives the hour $7^h 50^m$.)	Ditto	A trembling motion lasting a minute, and then a violent shock of two minutes' duration.		Port-au-Prince was completely ruined. A portion of the coast, twenty leagues in length, sank into the sea. Horses, sheep, and oxen by their irregular motions and cries, showed their fear, and birds durst not alight on the ground.	Hist. de l'Acad. de Paris, &c. before quoted, and Gent's Mag. *loc. cit.*
—— —— —— 10 A.M.	Ditto	Another shock			Gentleman's Magazine, *loc. cit.*
—— —— —— 5 P.M.	Ditto	Ditto			Ditto.
—— —— ——	Genoa. (Also felt in the country about Milan.)	A violent shock	The sea was so much agitated that vessels were nearly wrecked.		Journ. Hist. Fév. 1752, p. 150; Kant, *loc. cit.*
—— —— 22. 4 and 6 A.M. and 3, 4, 8, and 11 P.M.	St. Domingo	The shock at 3 P.M. was particularly violent.			Gentleman's Magazine, *loc. cit.*
—— —— 23. $1\frac{1}{2}$ and 5 A.M. and $1^h 45^m$ and $3^h 20^m$ P.M.	Ditto		The shocks were felt on board ships more than 100 leagues from the island, the sensation being as if the ship had struck.		Ditto.

1.	2.	3.	4.	5.	6.
1751. Nov. 24. 6½, 7½, 10, and 11½ A.M.	St. Domingo	More shocks			Gentleman's Magazine, *loc. cit.*
—— 25. 6½, and 7½ A.M. and 2 and 3 P.M.	Ditto	Ditto			Ditto
—— 26. 4½, 7¾, and 8½ A.M.	Ditto	Ditto			Ditto.
—— 28. 8¾ A.M.	Ditto	Two very violent shocks.			Ditto.
—— 30. 8¾ A.M.	Ditto	One violent shock			Ditto.
—— Dec. 1. 7 P.M.	Ditto	Described as a quick strong tremor.			Ditto.
—— ——	Genoa	Less violent than the shock of the 21st of November.			Journ. Hist. Fév. 1752, p. 150.
—— 4.	Naples	A trembling			v. Hoff.
—— 5. 2 A.M.	St. Domingo				Gentleman's Magazine. *loc. cit.*
—— 11. 8 A.M.	In Finland	More tremblings		Accompanied by noise as before	Collection Académique, *loc. cit.*
—— 12. 7½ A.M.	St. Domingo	One slight shock		This is the last shock the date of which is distinctly specified, but the earth appears to have been trembling more or less from the 18th October. During some of the violent shocks before mentioned, the earth opened and threw out hot water, having a fœtid smell. Noises like the explosions of cannon were heard. The weather was generally fine and calm, but each shock was preceded by a rushing noise like a sudden gust of wind.	Gentleman's Magazine, *loc. cit.*
—— 14. 7 A.M.	In Finland			The same phænomena as before renewed	Collection Académique, *loc. cit.*
—— 19.	Province of Tra-los-Montes in Portugal.	Violent		Many houses were injured at Torre de Moncorvo. Followed by a terrible storm.	Journ. Hist. Mars, 1752, p. 227.
—— 25. 3 P.M.	In Finland			Attended with noise as before	Collection Académique, as before.

1751.	Gap in Dauphiny				Moniteur, 10 Avril, 1808.
——	At Venice	A trembling			v. Hoff.
——	St. Jago di Guatemala				Schlözer, Neue Erdbeschreibung von America, Th. ii. S. 700.
1752. Jan. 12. 0h 30m A.M.	Toulouse and in the Pyrenees.	Two shocks in two minutes.		A noise was heard like that of a forge blown by bellows. Much snow fell during the night.	Mém. des Sav. Étr. t. iv. p. 118.
—— ——	Frontello, not far from Mantua.	A trembling			v. Hoff; Keferstein.
—— ——	Torre de Moncorvo in the province of Tralos-Montes, Portugal.				Seyfart, p. 121.
—— ——	In Chili, at Conçepçion, and on the island of Juan Fernandez. Also, according to some accounts, felt at Port-au-Prince in St. Domingo.			Possibly confounded with the St. Domingo earthquake of the year before, though this does not seem probable.	Ditto, p. 125; v. Hoff.
—— Feb. 23.	Dartmoor in Devonshire, and the neighbourhood.				Mrs. Bray's "Borders of the Tamar and Tavy," vol. i. p. 310.
—— —— 26.	Some parts of Sweden, especially at Fahlun and in Dalarne.	A slight trembling, which did not last long.			Seyfart, p. 120.
—— Mar. 16. 11 P.M.	Stavanger in Norway	A considerable shaking motion.		An unusual light seen in the East	Ditto, p. 121.
—— —— 27.	At the mouths of the Mondego and Vouga, at Aveiro in Portugal.	A violent trembling		Houses were injured and thrown down	Ditto, p. 122.
—— —— 31. (N.S.) 11h 30m A.M.	Bristol and other places in Somersetshire.	A considerable shaking from S. to N.		This account is not found in the English collections of earthquakes.	Ditto, p. 121.
—— April 15. 4 P.M.	Stavanger in Norway	Several violent shocks, lasting several minutes.		The weather was remarkably fine until 2 o'clock, when a small cloud rising extended itself over the heavens, and the whole evening there was a violent storm of wind, hail, and thunder and lightning; followed during the night by the appearance of a strange star of an octagonal shape, which seemed to throw forth balls of fire from its angles (!). Keilhau gives the date the 16th.	Gazette de France, 10 Juin, 1752; Seyfart, p. 122.

1.	2.	3.	4.	5.	6.
1752. April 16.	In Somersetshire	....	....	....	Kant, Géog. Phys. t. iv. p. 313.
—— —— 28.	At Buarcos and Aveiro in Portugal.	Violent........	Attended with inundations.	....	Seyfart, p. 121; Gazette de France, 3 Juin.
—— May 13. Between 2 and 3 A.M.	Neusohl in Hungary ...	Ditto	....	Unaccompanied by damage	Seyfart, p. 122; v. Hoff.
—— —— 26. (N.S.) 5 P.M.	Constantinople and Adrianople.	Not very great	....	....	Phil. Trans. vol. xlix. Pt. i. p. 116; v. Hoff; Gazette de France.
—— —— ...	At Nocera in Umbria. Also at the same time in the Marches of Ancona.	More shocks. Those in the Marches of Ancona slight.	....	....	Gazette de France, 8 Juillet.
—— June. At the beginning of the month.	Zante	A violent earthquake, lasting two minutes.	....	Many of the principal streets of the capital were ruined, and one of the highest towers of the castle thrown down.	Seyfart, p. 123; v. Hoff.
—— —— 5. At night.	At Riccia, Albano and Genzano in the southern part of the States of the Church.	One shock	....	v. Hoff places at this time the shocks at Nocera, &c. just mentioned. Kant gives the date July for both.	Seyfart, p. 124.
—— —— 22.	At Leghorn........	Ditto	....	....	Ditto.
—— July 13. At night.	At Urbino, Gubbio, Gualdo, Foligno, and Fabriano.	Ditto	....	....	Gazette de France, 19 Août.
—— —— 21. 3 A.M.	Tivoli	Ditto	....	....	Ditto.
—— —— 29. (N.S.) 8 P.M.	Adrianople. Also at the same time at Constantinople and Smyrna.	Very violent at Adrianople and Constantinople, slight at Smyrna. At Constantinople there was a trembling in a perpendicular direction for several seconds, and then three or four regular horizontal shocks from N.W. to S.E., *i.e.* in the direction of Adrianople.	....	At Adrianople clefts opened in the earth from which there came out water smelling of sulphur. Mosques and houses were much injured. The wind at Constantinople was in the morning S., in the afternoon E.S.E. and very violent. It remained so during the earthquake.	Phil. Trans. *loc. cit.*; Gazette de France, 30 Sept., 6 Janv.; Huot, *loc. cit.*; Journ. Hist. 1753, Fév. p. 149; Kant, *loc. cit.*

1752. Aug. ...	Adrianople	Frequent shocks during the whole month.	....	....	Ditto.
—— —— ...	Spoleto	A trembling........	....	....	Keferstein.
—— Sept. 6.	Riom and Clermont in Auvergne, and the neighbourhood.	A shock, first from N. to S.; then from S. to N.	On the same day a storm at sea.	Accompanied by noise	Hist. de l'Acad. de Paris, 1752, p. 16; Coll. Acad. t. xi. p. 55; Gazette de France, 30 Sept. 1752.
—— —— 9.	Rampiz, a village on the Oder.	A trembling motion, lasting scarcely half a minute.	....	Attended by a storm of lightning and hail	Seyfart, p. 125.
—— —— 26. At night.	At Frasigli, Marino, Veletri, and also (though but slightly) at Rome.	A trembling...........	....	....	Ditto, p. 126.
—— —— ...	Adrianople	Frequent shocks during the month.	....	....	Phil. Trans. &c., quoted under July.
—— Oct. Beginning of the month.	In the duchy of Urbino	Repeated shocks, which lasted until the 9th of December following.	....	....	Gazette de France, 11 Nov., 6 Janv. suiv.
—— —— 16.	Salerno	Tremblings	....	....	Seyfart, p. 126.
—— —— 19. At night.	Veletri......................	Ditto	....	....	Ditto.
—— —— 23.	Herculaneum, Torre del Greco, and all along the coast at the foot of Vesuvius.	Ditto	....	....	Ditto; Gazette de France, 2 Déc.
—— —— 29.	Naples	A slight trembling ...	....	....	Seyfart, *loc. cit.*
—— Nov. 9. 5h 30m A.M.	Constantinople	Ditto. The same felt several times more in the course of the month.	....	The wind N.E. The weather hot	Phil. Trans. *loc. cit.*; Journ. Hist. *loc. cit.*
—— —— 10.	Hernösand in the Swedish province of Angermannland.	....	....	....	Seyfart, p. 127–8.
—— —— 17.	Ditto	A second shock	....	....	Ditto.
—— —— 21.	Ditto	....	....	....	Keilhau in his memoir on Norwegian earthquakes quotes Gissler.
—— —— 28. 7 P.M.	Ditto	Lasted one minute ...	....	Accompanied by a loud noise, brilliant light in the heavens, and an auroral arch.	Ditto.
—— Dec. Beginning of the month.	Sienna in Tuscany	Three shocks	....	....	Seyfart, *loc. cit.*

1.	2.	3.	4.	5.	6.
1752. Dec. 6. 4 to 5 A.M.	Angermannland as before.	....	....	Accompanied as before by a loud noise. A feeble streak of light appeared in the heavens extending from N.E. to S.W. in the direction of the shock, for 12 or 13 (Swedish ?) miles along the coast. Balls of fire seemed to come from it.	Keilhau, as before quoted.
—— —— 29. Between midnight and 1 A.M.	Ditto	....	....	These shocks were accompanied by subterranean and aërial noises. These latter were heard in some places where the shocks themselves were not felt. The Coll. Acad. mentions four shocks here in November, and others in December, at each time lasting one or two seconds. Direction, *as usual*, from S.W. to N.E. The author adds that earthquakes are more frequent in the North towards the end of winter.	Ditto.
—— ——. End of the month.	Around Urbino	Tremblings	....	....	Seyfart, *loc. cit.*
——	In the marches of Ancona, at Nocera, Santo-Gemini, Civitella, &c.	Fresh shocks	....	Probably coincident with some of the Italian earthquakes already mentioned for this year.	Journ. Hist. Août, 1752, p. 152.
——	Cephalonia	Violent shocks	....	Berghaus considers these shocks as having occurred at the same time with those in Zante, *i. e.* in the beginning of June.	Montgomery Martin, Hist. of the Brit. Col. vol. v. p. 415.
1753. Feb. Beginning of the month.	At Modena	One shock	....	A very thick wall was thrown down	Seyfart, p. 128.
—— March 9. 2^h 30^m P.M. (v. Hoff gives the hour 1^h 15^m P.M.)	In Piedmont, Savoy, and part of Switzerland—at Turin, Susa, Mont Cenis, the valleys of Lucerne and Perouse, Fenestrelles, Pignerol, Asti, and Geneva.	At Geneva it lasted two minutes.	....	A large opening appeared in Mont Cenis, from which torrents of water came. Similar ones were observed in the valleys of Lucerne and Perouse. In the mountains a noise like that of cannon was heard. At Geneva a bell sounded loudly.	Gazette de France, 24 Mars, 14 et 21 Avril; Journ. Hist., Mai, 1753, p. 387 et 465; Seyfart, *loc. cit.*
—— —— —— 4 P.M.	Turin	Slight tremblings ...	....	....	Seyfart, *loc. cit.*; v. Hoff.
—— —— 10. 2 A.M.	Ditto	Ditto. During this day and those following fourteen shocks were felt.	....	....	Ditto.

1753. Mar. 19. 2h 23m P.M.	Geneva	A trembling		In all probability the same with that of the 9th, the numbers being confounded	Bertrand; Coll. Acad.
—— April 22.	Pieve, near Perugia in the States of the Church.	Violent		Many buildings damaged	Seyfart, p. 130.
—— —— 26.	Santo Gemini	Several shocks			Gazette de France, 23 Juin.
—— May. In the middle of the month. About half an hour after midnight.	In some parts of England.	Trembling motions for three hours.		No account of this given by the English chroniclers.	Seyfart, *loc. cit.*
—— —— 22 to 28.	Civitella	Daily shocks in the morning and evening.			Gazette de France, 30 Juin.
—— —— 26.	Perugia, Todi, Aurelia, S. Gemini, in the States of the Church.	Another rather violent earthquake.			Seyfart, *loc. cit.*
—— June 8. Between 11 and 12 P.M.	Knotsford in Cheshire. Especially felt in the villages of Tabley, Tatton, Rostberra, Mobberly, Toft, and Peover.	A trembling lasting for twenty seconds.		Not mentioned in the Philosophical Transactions.	Ditto, p. 131.
—— —— 9.	Turin, extending also to Switzerland.			In Switzerland several wells dried up, and did not reappear until after the shocks of 1755.	Vassali-Eandi, Rapport, &c. as before quoted, pp. 27 and 114.
—— —— 15.	St. John in the Island of Antigua.				Seyfart, *loc. cit.*
—— —— 18 or 19.	Cagli near Urbino.	Five shocks		On the same or following day a storm accompanied by hail was experienced at the same place.	Ditto.
—— July ...	Naples				Kant, Géog. Phys. &c., as before, p. 314.
—— —— ...	In different parts of England.	Shocks			Ditto.
—— Sept. 26.	Riccioli in Tuscany	Two violent shocks			Seyfart, *loc. cit.*
—— —— ...	In different parts of England.	More shocks		Accompanied by a terrible noise	Kant, *loc. cit.*
—— Nov. 14.	Genoa	Three slight tremblings.			Seyfart, p. 132.
—— Dec. 8.	Brest in Bretagne	A trembling			v. Hoff.

1.	2.	3.	4.	5.	6.
1753.	In Sweden	Tremblings			Abh. d. Akad. zu Stockholm, 1753, S. 69.
——	St. Domingo			Shocks attended with subterranean noise	Mém. de l'Acad. de Dijon. an. 1783, 2e sémestre, p. 37.
1754. Jan. 12. $11^h 30^m$ P.M.	Vorreppe, 2 leagues from Grenoble.	Some shocks from N. to S.		Accompanied by a noise like that produced by the falling of masses of rock. In a neighbouring village some houses were thrown down.	Gazette de France, 9 Février; Seyfart; Keferstein.
—— Feb. 5. 5 P.M.	In 20′ S. lat., and 23° 10′ W. long.		The vessel La Silhouette, Capt. Pintaul, felt an extraordinary shock, as if caused by touching a bank.		Daussy's memoir, *loc. cit.*
—— April 19. 11 A.M.	York in England. Also felt at Foforth, Bishopthorpe, Huntington, and Hesslington, 2 or 3 miles from York.	A wave-like motion, lasting for three seconds.		Accompanied by a rattling noise like that of a laden waggon on a stone pavement.	Phil. Trans. vol. xlviii. part ii. p. 564.
—— June 7. At night.	Rome, Tivoli, Frascati, Valmontana, in la Palestrina, and la Riccia.	A violent shock			Gazette de France, 13 Juillet.
—— —— 12.	In the Morea, and island of Metelin. Also through a great portion of Central Italy and Sicily.			More violent in Greece than in Italy. v. Hoff gives the date 15th June.	Gazette de France, 30 Juillet; Huot, *loc. cit.*; v. Hoff; Seyfart.
—— —— 18. (N.S.) At night.	Rome and the neighbourhood.	Several shocks			Gentleman's Magazine, vol. xxiv. p. 336.
—— July. Beginning of the month.	Smyrna	A very violent earthquake.			Seyfart, p. 132.
—— Aug. 18. 4 P.M.	Island of Amboina	Eighty-five shocks followed between Aug. 18 and Sept. 22.		The earth opened in several places, and water gushed out.	Pinkerton's Collection of Voyages and Travels; Seyfart, p. 398.
—— —— 19.	Padua	One shock			Toaldo, Essai Météor. p. 270.
—— —— 30. (N.S.) Betw^n 8 and 9 A.M.	Venice				Gent's Mag. vol. xxiv. p. 432.

1754. Aug. 30. In the night.	Acapulco	....	Accompanied by an elevation of the sea, three or four mètres above the lowest tides.	The city was ruined	Dupetit Thouars, Voy. de la Vénus, t. ii. p. 213.
—— Sept. 2. (O.S.) 10 P.M.	Constantinople. Also felt at Adrianople, and still more violently in Asia Minor, especially in Diarbeckir and Armenia; all the country between suffering more or less. Also, according to Seyfart, felt at Alexandria and Cairo in Egypt.	At Constantinople a vertical shock followed by some horizontal oscillations, the whole occupying about thirty seconds. The direction nearly E. to W.	....	In Constantinople much damage was done to the buildings. The shock was there felt more violently in the upper than the lower stories. The city of Sivas was ruined, that of Nicomedia much injured. The earthquake was preceded by complete calms. The wind during the day on which it occurred was from E.N.E. to E.	Phil. Trans. vol. xlviii. part ii. p. 819, and vol. xlix. part i. p. 117.
—— —— —— At midnight.	Constantinople	More shocks	....	....	Ditto.
—— —— 3. 10 A.M., and at noon.	Ditto	Ditto	....	....	Ditto.
—— —— 4. 2 P.M. and $11^h 15^m$ P.M.	Ditto	Two rather more violent shocks.	....	....	Ditto.
—— —— 5. At dawn and at $9^h 40^m$ A.M.	Ditto	Two more shocks	....	....	Ditto.
—— —— 6. 4 A.M.	Ditto	Ditto	....	Followed in the evening at 8 o'clock by thunder, lightning, and hail.	Ditto.
—— —— 8. $4^h 30^m$ A.M. and 10 A.M.	Ditto	Ditto	....	....	Ditto.
—— —— 9. $7\frac{1}{2}$ and $8\frac{1}{2}$ P.M.	Tain in Dauphiny	Two shocks at the hours mentioned.	....	The Collection Académique gives the dates 9 and 10 November for these shocks, and the third at the same place mentioned below.	Gazette de France, 5 Oct.
—— —— —— Midnight.	Constantinople	Another shock	....	....	Phil. Trans. *loc. cit.*
—— —— 10. 4 A.M.	Ditto	Ditto	....	....	Ditto.
—— —— ——	Tain in Dauphiny	Ditto	....	Accompanied by a noise like thunder	Gazette de France, *loc. cit.*

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1754 Sept. 11. Half an hour after mid-night.	Constantinople	Another shock			Phil. Trans. *loc. cit.*
—— 12. A litle before dawn.	In the neighbourhood of Brieg in the Valais to Villeneuve; and at Sion and Bex.	Slight tremblings			Bertrand; Coll. Acad.
—— 13. 3 A.M.	Constantinople	Another shock		Many persons said they felt slight shocks all through the month. The first appears to have been the only very violent one.	Phil. Trans. *loc. cit.*
—— 4 P.M.	Neighbourhood of Brieg, as above.	Other slight motions			Bertrand; Coll. Acad.
—— 19. Between noon and 1 P.M.	Ditto	Alternate oscillations from S. to N.		The shocks were more felt in the mountains than in the plains. They were violent enough to damage the bishop's palace at Sion, and to throw down masses of rock in the government of Aigle. A noise like the discharge of numerous pieces of artillery was heard, coming as it were from the mountains.	Ditto.
—— Oct. 6. 8h 45m P.M.	Constantinople	Several undulatory shocks.		Unattended by any noise	Phil. Trans. *loc. cit.*
—— 7. At noon.	Ditto	A slight trembling			Ditto.
—— 22.	Ottajano near Vesuvius.	A rather violent shock			Dulac, Mél. d'Hist. Nat. t. iv. p. 392.
—— 29.	Naples and towards Massa-di-Somma.	A considerable trembling.		Vesuvius opened on the 25th, but there was no serious eruption until the 2nd December.	Ditto.
—— Nov. 4. 10h 19m P.M.	Constantinople	A shock which lasted but a short time.			Phil. Trans. *loc. cit.*
—— 19. 9h 45m P.M.	Ditto	Another quite perceptible shock.		v. Hoff calls attention to the fact that this earthquake, though the shocks continued so long, seems to have produced no atmospheric disturbance, the strength and direction of the wind, and height of the barometer continuing pretty constant throughout the whole period.	Ditto.
—— •	On the north side of Hecla in Iceland.			Accompanied by a slight eruption of Hecla	v. Hoff.
1755. Jan. 12. 7 P.M.	Hermannstadt	One shock			Gazette de France, 8 Mars.

1755. Jan. 20. 0h 34m P.M.	Constantinople	Three violent oscillations.			Phil. Trans. *loc. cit.*
—— 23. 10h 30m A.M.	Ditto	Another shock		All the dates of these shocks at Constantinople are according to *Old* style. The Gazette de France mentions other shocks on the 14th September, 1754, the 26th September to 2nd October, and the 4th October. These seem doubtful.	Ditto.
— Feb. ...	The island of Metellino in the Archipelago.	A trembling felt during this month.		In March Etna was in eruption	Keferstein.
— Mar. 25.	York			A subterranean noise heard, unaccompanied however by any sensible shock. This noise recurred on the two following days.	Kant, *loc. cit.* p. 314.
—— 27. Between 10 and 11 A.M.	Ditto	A violent trembling motion.		Large masses of rock were thrown down from the hills, completely shivered into small pieces, and thrown to a great distance. The surface of the ground also was much disturbed, elevations and depressions being formed.	Ditto.
—— ...	In Hertfordshire			No distinct shock mentioned. The hills were shaken, and masses thrown down.	Collection Académique.
— About Whitsuntide.	In Bretagne	Very sensible shocks			Ditto.
— April 7.	On the coast of Bothnia	A violent shock			Gazette de France, 24 Mai.
—— 28.	Quito				Edinburgh Encyclopædia, Article Chronology.
—— ...	Stepney in Middlesex. Also in Brabant, and at several places along the coast of the Mediterranean.	Shocks were felt at all these places during the month.			Keferstein.
— May. At night.	Viterbo in Italy	Three violent shocks		The shocks were so violent that processions were formed the same night in order to avert their continuance.	Gazette de France, 4 Juin.
— June 7.	In northern Persia (Irak), at Tabriz, Kaschan, Hann, Ispahan, and Tauris.	Very violent shocks		In Kaschan more than 600 houses were thrown down. Altogether 40,000 persons perished.	Gazette de France, 8 Nov.; Journ. Hist. Déc. p. 462; Seyfart; Ker Porter's Travels.
— Aug. 1.	Stamford in Northamptonshire.	One shock			v. Hoff.

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1755. Aug. 24. 3 A.M.	Orgaz and Mora in the district of Toledo, Spain. More violent at the latter place.	Several shocks	....	Accompanied by a noise like thunder	Collection Académique.
—— Sept. 2. 5 A.M.	Rome and the neighbourhood.	A slight earthquake...	....	....	Seyfart, p. 140.
—— —— 10. At night.	Nord-Syssel. (Perrey says this is in Denmark. Should it not be Iceland?)	A violent shock	....	....	Gazette de France, 10 Janv. 1756; Journ. Hist. Fév. 1756.
—— —— 11.	Ditto	Several more shocks..	....	The shock at 2 P.M. threw down several buildings. All the following day the water of a little river near was white like milk.	Ditto.
—— —— —— And during all the remainder of the month.	In various places in Iceland.	....	....	Keferstein says from the 5th to the 27th September.	v. Hoff.
—— Oct. 4. Between 10 and 11 A.M.	Orgaz and the neighbourhood.	Slight shocks	....	....	Collection Académique.
—— —— —— 4 P.M.	Mora in the same district of Toledo.	Another shock........	....	A great number of strange meteorological phænomena are recorded as having been observed during this month in Spain. Indeed, for some time before the great earthquake of Lisbon, the accounts of halos round the sun and moon, igneous meteors, alterations in well and river water, which generally acquired an offensive odour, besides thunder, lightning, and rain, are to be found from almost all parts of Europe. These phænomena were most remarkable in Spain, where the water in many of the wells was quite troubled, and rats and some species of reptiles came forth as if much terrified. Domestic animals also appeared frightened and uneasy.	Ditto.
—— —— In the first half of the month.	Lake Ontario in N. America.	....	No shock is mentioned, but the water repeatedly rose in an unusual way to the height of five feet.	....	Phil. Trans. vol. xlix. pt. 2. p. 544.

1755. Oct. 15. At noon.	Grenoble and Geneva. Also, more violently, at Chambéry.	Lasted two or three seconds. Apparently from N.E. to S.W.	....	Accompanied by a noise like that of carriages, which appeared to come from N.E. Bells sounded in the third story.	Toaldo, Essai Météor. p. 280.
—— —— 17.	Myrdalen in Iceland ...	A violent earthquake. Many other shocks were felt during the month.	....	On the 19th Katlegiaa burst into eruption, which continued until August 1756.	v. Hoff; Gazette de France, 3 Janv. 1756; Journ. Hist. Fév. 1756.
—— Nov. 1.	THE GREAT EARTHQUAKE OF LISBON. This earthquake, one of the most violent and widely extended on record, produced sensible effects over a space of the earth's surface included between Iceland on the north, Mogador in Morocco on the south, Töplitz in Bohemia on the east, and the West India islands on the west. Actual shocks however were not felt over the whole of this surface; in some places agitation of the water in lakes, canals, &c. being the only sensible effect produced. The centre of disturbance seems to have been situated beneath the Atlantic Ocean a little west of the coast of Portugal. In Portugal itself, and especially in Lisbon, the most terrible destruction took place, partly owing of course to its contiguity to the seat of volcanic action, and partly to the nature of the earth's surface at that place. In order to arrange all the voluminous notices of this earthquake from so many places, they are here taken merely geographically, the times being given just as recorded, without correcting them for longitude.				
Betw[n] $9^h\ 30^m$ and $9^h\ 40^m$ A.M. $9^h\ 30^m$......... $9^h\ 40^m$.........	Throughout *Portugal* about the same time. Oporto and Colares...... Lisbon	The shocks appear to have been from W. to E. The first shock was slight and lasted about one minute (v. Hoff says 6 secs.). The houses in Lisbon were however sensibly shaken by it. Half a minute afterwards, another shock took place much more violent than the former, which lasted eight or ten minutes (?), and two minutes afterwards the third and most violent shock, which appeared to consist of alternate movements in diametrically opposite directions. This was followed by several other much slighter shocks.	The sea came in three times to an extraordinary height (according to some 15, to others 40 feet higher than usual high tides), each wave succeeding a shock. It continued ebbing and flowing in great agitation the whole day, and next night. The whole of the new quay at Lisbon sank into 100 fathom water. The waters of the Tagus, the Guadiana, the Douro, and the Minho rose high above their ordinary level, and inundated the country.	The difference in time from the various places in Portugal may only arise, v. Hoff thinks, from inaccuracy of the clocks. Before the first shock a noise was heard like the rolling of waggons, but which soon increased to the loudness of thunder. Besides Lisbon, which was utterly ruined, with the loss of 12,000 houses, Faro, Setuval, and Cascaez were very much injured, Colares not so much, and Oporto scarcely at all. The town of Compostella also suffered but little. Most of the towns and villages of Portugal experienced more or less damage. The mountains of Estrella, Arrabida, Marvao, and Monte Junio, were much shaken. Clefts opened in the earth in some places. Near Colares the sea bottom between the land and some rocks in the sea, rose so much as to make the place impassable for small vessels, which it had not been before. In another place also rising of the land was observed.	Phil. Trans. vol. xlix. pp. 35, 398, 402, 408, 411, &c.; Coll. Acad. t. vi.; Lyell's Principles of Geology; v. Humboldt, vol. i. and ii.; Poggendorff's Annalen, B. 19. S. 449; Gazette de France, 22 Nov., 13 Déc. 1755, and 17 Janv. 1756; Journal Historique, Déc. 1755, p. 470, Janv. et Fév. 1756, pp. 39, 44, 132. Also many special narratives of this celebrated event.
	In *Spain* the earthquake	At Gibraltar a violent	The sea rose at Gibral-	Seville, St. Lucar, and Xeres were greatly injured.	

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10h 10m ...... 10h .... 10h 5m, or 10h 18m. 9h 45m......... 10h 10m ...... 9h 50m......... 10h	was very violent at Gibraltar. The shock was strongly felt at Cadiz. At Madrid the shock was not quite so great. At Grenada, at the Escurial, at Cordova, at Seville, and throughout all the rest of Spain, with the exception of Barcelona and all Catalonia, as also certain districts in the kingdoms of Valencia and Arragon, the shocks were felt with more or less violence.	trembling for 23 (or 30) secs., and then a weaker lasting three minutes with wave-like oscillations. At Cadiz the shock lasted three minutes with violence, and continued, though decreasing, for six or seven minutes. At Madrid two slight shocks were first felt, and then several violent ones. Their direction appeared to be from S. to N., and they lasted altogether five minutes. At Cordova the motion lasted nine minutes with violence; the second shock lasted 24 secs. At Seville they lasted eight minutes.	tar 7 feet higher than usual, and a quarter of an hour after fell extraordinarily low. This ebbing and flowing lasted from one quarter of an hour to another, but constantly becoming weaker, until the following morning. At Cadiz the sea came in with overwhelming violence at 11^h 10^m, inundating the town, and causing considerable loss of life. It tore away the rampart for 100 toises in length. The sea came in again at 11^h 30^m—11^h 50^m—12^h 30^m—1^h 10^m—1^h 50^m; constantly decreasing in force.	Conil was completely destroyed. The town of Compostella in Galicia suffered but little. At Cadiz only three or four old houses were thrown down. At Madrid the water in the wells rose several fathoms a little after the shocks. The houses there were much shaken, but nothing fell but two crosses from the summits of the churches. A cleft opened in one place in a mountain, from which an exhalation destructive to cattle issued. Rota, Malaga, Chiclana, Medina, &c. &c. were more or less injured. Birds and quadrupeds exhibited decided symptoms of fear. Numerous meteors and other unusual atmospheric phænomena are stated to have been observed about this time in Spain and Portugal.	
About 10^h ... 10h 10m	In *Africa* the north-western portion experienced the shock with nearly as much force as Portugal. At Ceuta the shocks continued for some days. At Algiers also they were very violent.	At Tetuan three shocks were felt in seven or eight minutes. In Tangier they lasted longer. At Ceuta the first shock lasted about 30 secs. It was followed by slighter ones for three minutes.	At Tangier the sea ebbed and flowed eighteen times (some said to a height of 50 feet) before 6 P.M., and the wells for half a league from the coast were dry until evening. At Saffé the sea inundated the town. At Ceuta and Oran similar phænomena took place.	At Tetuan the water of the river Chico was coloured red. In Fez houses and part of a neighbouring hill were thrown down. Water was also coloured red here, probably by ochreous mud. At Salle many houses fell. So also at Mequinez, Saffé, and Morocco. Near the latter place a mountain opened, and swallowed up a village with 8000 or 10,000 people. Opposite the port of Mogador, some rocks sank suddenly, so that the water, before shallow, became twenty fathoms deep. At Ceuta the points of a mountain appeared to rise and fall.	

	The south and west of *France* experienced these shocks, and even in Poitou, Bretagne, and Normandy they were felt. At Caen they were violent.	At Bordeaux there was but a slight trembling for some minutes.	The water of the Garonne was greatly agitated at Bordeaux.	Toulouse, Anduse in Languedoc, Angoulême, Cognac en Saintonge, and Bordeaux are mentioned as places where the shock was felt. The waters appeared to boil, and changed colour. This was also observed in Provence, at Cuers, Vaucluse, Gémenox, and St. Auban. At Angoulême subterranean noises were heard, and a cleft opened in the earth.	
About 10^h.... About 10^h....	In *Switzerland* some shocks were felt in the Valais, especially at Brieg and the neighbourhood. Also near Visp (Viége). The neighbourhood of Neufchatel, as indeed almost all Switzerland, was more or less shaken.	The shocks here do not seem to have been so distinct as further west, but that the earth was sensibly shaken there can be no doubt. Between 3 and 4 P.M. shocks were felt at Bâle, and during the night two shocks at Locle.	Between 9 and 10 the Lake of Geneva retired three times from its eastern shore, while at the western nothing unusual was perceived. A vessel upon it appeared struck suddenly. Very many wells in different places were troubled and rose to unusual heights. The lakes of Thun, Brienz, Neufchatel, Etaliere, Constance, and Zurich, were also disturbed. The last rose from 6 to 10 and up to 12 feet. The course of the river Aar appeared for a moment retarded. A sulphurous and bituminous well near Kilchberg flowed in greater quantity than usual, and was troubled. The Rhine near Constance appeared to stop and rise for some moments.	In the subterranean mill near Locle, which lies nearly 300 feet deep, a terrific underground noise was heard. At the lake of Zurich a low noise was heard, as also at the little lake of Seedorf, where the noise appeared not merely in the air, but under the water. The *maximum* height of the barometer at Berne for this day was 26 in. 11 lines; the *minimum* at the same place was 25 in. 5 lines. At Bâle it was as low as 26 in. 2 lines, the mean being 27 in. The thermometer at Berne was at 6 A.M. 2°·5 below zero of Reaumur; towards evening it rose to 2° above zero.	
	In *Germany* the shocks	The shocks were not	On the lake at Salzun-	At Augsburg magnets let the weights suspended	

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	were felt in many places in Swabia, as at Canstadt, Augsburg, and Donauwörth. At Töplitz in Bohemia a smart shock.	very violent in Central Europe; the effects of the earthquake being principally manifested on the lakes and other pieces of water.	gen at the S.W. extremity of the Thüringer Wald, extraordinary movements were observed, during the night preceding the earthquake (v. Hoff thinks this account doubtful). In the lakes of Templin, Netza, Mühlgast, Roddelin, and Libezee, and those of the Markgravate of Brandenburg disturbances were also observed. So also at the lakes of Salzburg, and the Walchensee. The Elbe was agitated at Hamburg at 1 P.M., at Glückstadt between 11 and 12 noon.	to them fall, and there, as at many other places, the magnetic needle was disturbed. At Donauwörth some walls were shattered. At Ingolstadt the wells dried up, and afterwards gave forth turbid water for some minutes. At Töplitz in Bohemia the principal spring suddenly threw forth such a quantity of water that in half an hour the baths overflowed. Half an hour before this the water was very muddy. It then remained quite dry for nearly a minute, and then burst forth with great violence, carrying with it a great quantity of red ochre. It then became quiet as usual, but afterwards yielded more water than before. At Hamburg the chandeliers were seen to move in the churches.	
$11^h\ 30^m$ (Milan time).	Milan in *Italy* was slightly shaken. At Abbiategrasso 8 leagues N.N.W. of Turin the shock was also slightly felt. Central and Southern Italy experienced nothing.	The actual shocks were slight, and are only mentioned as having been felt at these two places.	The waters of the Lago Maggiore rose and sank suddenly.	At Milan the lamps swung of their own accord in the churches, the water was thrown out from the canals upon the banks, and vessels full of liquid flowed over. At Abbiategrasso the doors and windows opened and shut with violence, and the water of a canal returned towards its source, and then resumed its course with impetuosity. The smoke which had been coming from Vesuvius for some time before, at the moment of the earthquake, sank back into the crater, and disappeared.	
	In *Holland* actual shocks were felt at the Hague and Rotterdam.	....	At the Hague the water was seen suddenly agitated in a remarkable manner, the air	At the Hague and Rotterdam bodies which were suspended were seen to oscillate. The canals were affected far inland.	

			being quite calm. This occurred simultaneously at the Hague, Leyden, Haarlem, Amsterdam, Gouda, Utrecht, Rotterdam, and Bois-le-Duc. The motion appears to have been least violent at the Hague. According to one account this took place at 11 o'clock. Another letter mentions $10\frac{1}{2}$ and 11, as if it occurred twice. All along the coasts of Holland and Friesland the sea was much agitated. Vessels were dashed together by it, and moorings broken.		
	Tremblings were felt in *Denmark* at Ransburg, Elmshorn, Bramstedt, Kellinghausen, and Meldorf.	Several shocks were felt at these places.	In this country the waters appeared to boil in many places. They were also agitated and a bellowing noise heard at Albingsabs, Wenersborg, on the lake of Miörn near Gottenburg, and in some rivers, especially the Eider and Sturh.	The wells and springs rose so as nearly to inundate the land in some places.	
	In *Sweden and Norway* this earthquake was distinctly perceived. In *Iceland* and *Greenland* it is stated to have been felt, on the authority of	At Christiansand the shock was felt at 4 A.M. (This must either be a mistake as to time, or the shock must have been	The shock was violently felt on board a ship 17 miles south of Cape Lindesnaës, everything appearing calm again in a few	At Christiansand a noise was heard like that of a great wave, and then a shock felt which shook the furniture of the houses. In Gotha-Ebene large trees were uprooted and thrown down. At the lakes of Frixem and Stora Leed the earth sank suddenly and then rose again	

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	the Collection Académique. v. Hoff thinks the accounts from both these places doubtful.	a different one from that at Lisbon.) In Iceland, according to the Collection Académique, the shocks continued for three days in the district of Myrdahl.	minutes. The lake of Dybeyand, 3 miles from Christiansand, was swollen with a loud noise, and inundated its banks. The lake Tarevand did so likewise, and threw out wood which had been imbedded in its bottom. The lake Orevand, the waters at Skie and Laurvig in Tellemarken, and the lake Fœmundsöe were much agitated. The lake Wener, and those near Gothenburg, in Dalecarlia and Wermeland, suffered similar disturbances. At the lakes of Frixem and Stora Leed the water rose suddenly.	with a loud noise. In Iceland many houses are said to have been thrown down. The volcano of Katlegiaa was in violent eruption at the time.	
9 A.M. About 11.	In the *British Isles* actually sensible shocks were felt in but few places, the earthquake being principally remarkable from its effects upon the sea round the coast, the lakes, and ponds. Only four places are mentioned as localities where the earth actually shook, viz. Cork in Ireland, Eyam-Edge	At Cork a strong shock was felt at the time mentioned. At Eyam-Edge four violent shocks were felt in a space of 20 minutes. Near Reading the earth shook for 50 seconds. At Caversham it lasted 1 minute.	At Cork the sea was much agitated. At 10 o'clock, the sea rose 12 to 18 inches at various places on the Frith of Forth, in the neighbourhood of Leith in three or four minutes. At Yarmouth the sea rose to the height of 6 feet a little before noon. At Gainsbo-	At Eyam-Edge the shocks were felt in the Derbyshire mines at a depth of 60 fathoms, and at the surface. They were accompanied by a loud noise in the interior of the earth. Pieces of rock were detached and fell in the galleries of the mines. Some days after a long fissure was observed in the ground in this locality. The waters of a pond near Reading appeared to boil, and were raised over their banks to the extent of 20 inches above their usual level. At Caversham a noise was heard as if the house were falling, and a vine trained against the building was broken. Two trees also were	

Same time ... Same time ...	in Derbyshire, a place near Reading in Berkshire, and Caversham in Oxfordshire, one mile from Reading. At Cranbrook in Kent also some people *believed* that they felt the earth tremble.		rough it attained the same height and recovered its level in 1 or 2 minutes. The same thing was observed at the same time at Hull. At Hunston several people were in great danger from the rapidity of the motion of the water. At 10^h 35^m at Portsmouth the agitation of the sea was so great that 70 and 86 gun-ships rolled to the extent of 3 feet. The water rose, after 9 o'clock at Dartmouth, above the level of the highest tides, and retained this height for three-quarters of an hour. At Plymouth about 4 P.M. (the time of high water) the sea retired and then came back in 8 minutes, in each case to the extent of 6 feet. The ebbing and flowing continued for some time. At Mount's Bay the flux and reflux, which began about 2 P.M., was very violent and of about the same height. It lasted five hours. At Penzance	injured. At Cranbrook in Kent the water in some fish-ponds rose upon one bank, then retired, and rose on the opposite bank. At Busbridge, near Godalming in Surrey, at 10^h 30^m, the water rose 20 inches above its former level in a canal (running from W. to E.) of 700 feet long by 58 feet wide and 3 to 10 feet deep. The fluctuations lasted about a quarter of an hour, and were attended by a loud noise, sand also being thrown up in great quantity from the bottom. The channel which fed this canal rose towards its source, leaving 36 feet of ground dry. At Lee in the parish of Whitley, at Cobham near Guildford (where at 10 o'clock oscillations of the water from S. to N. and then from N. to S. were very distinct), at Medhurst in Sussex, at Tunbridge Town and Eaton Bridge, two places near Chevening in Kent, in the Thames at Rotherhithe (at between 11 and 12), near London at Peerless Pool (between 10 and 11), at Rochford in Essex (at the same time as the shock at Lisbon), at Earley Court near Reading, at Shireburn Castle in Oxfordshire, at four places in Hertfordshire, near Durham, on Windermere and others of the Cumberland lakes, on Lochs Lomond, Ness, Long, and Katrine in Scotland, and other pieces of water throughout the two kingdoms, similar phænomena were observed. See the more minute account of them in the Philosophical Transactions.	

1.	2.	3.	4.	5.	6.
			it began at $2^h\ 45^m$, lasted but 3 hours, and attained the height of 8 feet. At Newlyn and Mousehole, on the same coast, the phenomena were almost identical. This strange tide was also remarked at St. Ives, Hayle, and Swansea, at the last place about $6^h 45^m$. At Kinsale in Ireland the water came over the quay with such violence as to throw many people down.		
$9\frac{1}{2}$ A.M. (Funchal time = about 10 A.M. Lisbon time).	Over the surface of the *Atlantic Ocean* the disturbance seems to have extended widely, as far as the necessarily limited observations go. At Funchal in the south of Madeira, the shock was strongly felt.	At Funchal the shock was violent, from E. to W., and consisted of two epochs of undulation, the first being much the more violent. The whole lasted 1 minute.	At $9^h\ 45^m$ a Dutch vessel, a league and a half off Monte Zizambre (6 or 7 leagues from Setuval) experienced a violent shock. Some more shocks were felt on board the same vessel towards sunset. v. Hoff mentions the shock as felt by a ship 50 leagues west of Lisbon. Several other vessels appear to have experienced it in various regions of the Atlantic. At $11^h\ 45^m$ at the island of Madeira the sea suddenly retired	The crew of the Dutch vessel mentioned saw the effect of the shock on Monte Zizambre itself, large masses of rock being detached and rolled into the sea. Towards night a mass of smoke (observed also at Colares) was seen in the E.N.E., 7 or 8 leagues from where they were, and afterwards a fire, the light of which was seen all night. (This probably proceeded from one of the towns ruined and on fire.) At Funchal the shock was preceded by a dull noise like that of carriages, which lasted some seconds after the shocks. The doors and windows vibrated quickly.	

	Less than ten hours after the earthquake in Lisbon, its effects were remarked in the *West Indies* by the motion of the waters of the ocean. v. Humboldt (Voyage, t. v. p. 12) says that the shock was *felt* at Martinique.		(though the weather was perfectly calm) to the extent of 100 paces, and then as suddenly returned to the height of 15 feet above the highest tides, inundating Funchal, and doing a great deal of damage on the north and east coast of the island, on the west scarcely anything being perceived. This ebbing and flowing occurred four or five times more, to a less height each time. On the coasts of Antigua, Barbadoes, Martinique, and Sabia, about 3 P.M. (true time there, = about 7 P.M. Lisbon time), the waters of the Atlantic were much disturbed. At Martinique the water rose like a wave to the upper stories of the houses, and in ebbing again left an English mile of ground dry. At Barbadoes it rose 5 or 6 feet, and ebbed and flowed every 5 minutes for three hours, the water being as black as ink (probably from mud).		

1.	2.	3.	4.	5.	6.
			The movement recurred 64 times from 2 to 10 P.M.		
1755. Nov. 2.	Lisbon. Also on the same day at Bâle.	The shocks of the day before continued at Lisbon. One shock felt at Bâle.	The Tagus became dry for some time.		Authors quoted above for the Lisbon earthquake. For that at Bâle, a communication from M. Ch. Martius to M. Perrey (see the memoir of the latter on earthquakes in the basin of the Rhine).
—— 3.	At Lisbon again	At Lisbon the shocks continued.	....	....	Phil. Trans.; Coll. Acad. &c. &c., as above.
7 A.M.	At Gibraltar	At Gibraltar a rather violent shock of from 5 to 6 secs.			
Ditto	At Ceuta in Africa.	At Ceuta ditto; lasted a very short time.			
—— ——	In the island of Sumatra, at Manna, fifty English miles south of Fort Marlborough.	A violent shock on this day, followed by twelve others between this and the 3rd December. Still later (mentioned in a letter dated 12th January 1758, but the time not given more accurately) many more shocks.	....	The shocks mentioned as occurring later than the 3rd December injured Cumberland House, Salop House, Layo, and Manna. Near the mouth of the river at Bencoolen the earth opened, and threw out sulphurous water. Poblo Point and many villages around Manna were destroyed.	Phil. Trans. vol. 1. pt. 2. p. 491.
—— 4. 10h 30m A.M.	Madrid, the Escurial, in Andalusia, and almost the whole of Spain, Catalonia excepted.	Lasted five or six minutes at the Escurial. It was more violent at Madrid, and most of all in Andalusia.	....	....	Collection Académique.
2 P.M.	At Gibraltar.	At Gibraltar the shock at 2 P.M. was slight. The shocks were feebler at Lisbon.			
—— 5. 8h 15m P.M.	Gibraltar. The shocks also continued on this	At Gibraltar this shock was more violent	At 11 P.M. of this day the sea rose a yard	From the 6th to the 16th the shocks were almost insensible about Gibraltar.	Ditto.

	day in Lisbon, but were feeble.	than those which preceded it.	higher than had ever been known before at Saltholm near Hartlepool in Durham, and caused some mischief. No shock is mentioned as having been felt.		
1755. Nov. 7. 10 P.M.	Clermont in Auvergne and the neighbourhood.	Two rather smart shocks.	....	....	Ditto.
—— —— 8. $5^h 30^m$ A.M.	Lisbon .... The same day at Seville.	At Lisbon the shock lasted but a short time. There and at Seville the shock was violent.	On this day a shock is said to have been felt at sea, 60 leagues from the coast of Portugal, as great as that of the 1st.	At Lisbon some houses which had resisted the former shocks were thrown down. At Seville also the cathedral was shaken, and some other buildings injured. From the 8th to the 16th no shocks are mentioned as felt at Lisbon.	Ditto; Phil. Trans.; Journ. Hist. &c. &c.
—— —— 14. 3 P.M.	Brieg in the Valais	A trembling lasting one minute.	....	An opening appeared in a mountain near, from which water came out in large quantity.	Phil. Trans. vol. xlix. p. 511.
—— —— 16. $3^h 30^m$ P.M.	Lisbon	Renewed disturbance.	The sea rose prodigiously.	The earth seemed to rise and fall like a ship ...	Collection Académique, p. 632.
—— —— 17. In the morning.	At Gibraltar	At Irton in Cumberland violent shocks.	....	In Herefordshire houses are said to have been thrown down.	Coll. Acad.; v. Hoff.
In the evening.	At Whitehaven in Cumberland. Also on this day at Irton in Cumberland, and in Herefordshire.				
—— —— 18. $4^h 15^m$ A.M.	In New England, especially in the provinces of Massachusetts and New Hampshire. It was slighter towards the S.W. and N.E., and was felt in New York, Philadelphia, Chesapeake Bay in Maryland, at Annapolis Royal, in New Scotland, at Halifax, at Lake St. George to the west. Its total exten-	Two violent undulatory shocks, of which the second was the slighter, followed rapidly upon each other. A tree of 30 feet high bent 10 feet from its former position. Immediately after came another and more violent shock with redoubled noise, consisting of a quick trembling mo-	A ship in the Atlantic Ocean 70 leagues east of Cape Anne experienced this earthquake. A remarkable ebbing and flowing of the sea at St. Martin's Harbour in the West Indies was supposed to be connected with this disturbance. The water was much agitated	Preceded by about a minute by explosions like distant thunder. At Boston the windows and furniture were much agitated. About 100 chimneys were thrown down. An eruption was reported to have taken place at Scituate 20 or 30 miles south of Boston. At Annapolis some chimneys were also thrown down.	Phil. Trans. vol. xlix. pp. 439–443; vol. l. pp. 1–18; Coll. Acad. p. 634; Gazette de France; Journ. Hist.; Mercure de France.

1.	2.	3.	4.	5.	6.
	sion seems to have been about 800 miles from N.E. to S.W., by 550 from E. to W., the centre being in 43° N. lat.	tion gradually decreasing for two min. (The whole three lasted four min.) At $5^h 29^m$ another slight trembling was felt. The direction of the motion was from N.W. to S.E. (At New York W. to E.)	in the harbours of North America, and quantities of dead fish were observed.		
1755. Nov. 18. In the morning.	At Fez and Mequinez in Morocco.	At Fez and Mequinez the shocks were very violent, and continued until the following day.	....	....	Phil. Trans. vol. xlix. pp. 421 and 429; Coll. Acad. p. 634.
——— ———. Hour not mentioned.	At Lisbon. Also at Aquapendente and della Grotta near Rome; and on the borders of the Rhine and in the Brisgau. At Glossom also in Herefordshire, and at Aix in Savoy.	At Lisbon shocks equal to those of the 8th. At Aquapendente and della Grotta, one shock. Along the Rhine slight shocks. At Aix they were also inconsiderable.	....	At Lisbon twenty-two shocks were counted from the 1st to the 18th.	Ditto; Gazette de France; v. Hoff.
——— ———. About 10 P.M.	Tangier and Tetuan on the North coast of Africa.	Violent shocks for four minutes.	....	Both places were much injured........................	Phil. Trans. *loc. cit.*
——— ——— 19. $10^h 30^m$ A.M.	Gibraltar	A very strong shock .	....	Accompanied by a tempest. But little damage done.	Ditto, and the Coll. Acad. and other authorities quoted above.
Hour not given.	Mequinez in Morocco. Along the Rhine, in the Brisgau, and at Aix in Savoy the slight shocks continued.	Exceedingly violent .	....	Mequinez was completely ruined with two Arab encampments of 25,000 or 30,000 persons.	Ditto.
——— ——— 20. 2 A.M.	Tangier and Tetuan ...	More shocks. They recurred several times during the day, especially at 5 and 9 A.M., and at noon, but feebler than before.	....	....	Ditto.

1755. Nov. 21. 9 A.M.	Colares near Lisbon ...	Two shocks	....	....	Phil. Trans. vol. xlix. p. 413.
—— 22. $8^h\ 27\frac{1}{2}^m$ A.M.	Boston in New England.	Another shock	....	....	Silliman's Journal, vol. xl. p. 206.
—— 25. From midnight of the 24th till morning.	Colares again	Five shocks felt in the time mentioned.	....	On the 24th the same meteorological indications were observed as on the 31st of October, the day before the great earthquake.	Phil. Trans. &c. as before.
—— 26, and 27.	Sédan, Mézières, Charleville, Liège, and many other localities in Belgium.	Several slight shocks.	....	....	Ditto.
—— 27.	Cordova, and apparently all along the south coast of Spain.	....	....	....	Ditto.
—— 29.	At Malaga	....	About this time unusual movements of the waters of the ocean were still observed.	v. Hoff gives as date the 27th, and does not mention Cordova as shaken on that day. During the whole of this, and indeed the next month, slight shocks appear to have occurred almost daily in Spain, Portugal, Switzerland, and on the North coast of Africa.	Ditto.
— Dec. 9.	At Lisbon	The most violent shock which had been felt at Lisbon since the 1st of November.	....	Though the hour of this earthquake is not given, it was in all probability close to that at which the one in Switzerland, &c. took place.	Ditto.
—— —— About 2 P.M. $2^h\ 30^m$ P.M. $2–2\frac{1}{4}$ and $2\frac{1}{2}$	Throughout Switzerland and parts of France, Bavaria, Swabia, the Tyrol, the Italian Alps, and even north of Bavaria. Amongst the places where this earthquake was felt were Turin, Milan, through Piedmont, and Savoy, and as far as Naples, Brieg in the Valais, throughout the whole chain of the Alps and of Jura, at Chiavenna,	At Turin one shock lasting from 4 to 6 seconds, in the direction S. to N., and some minutes after a slighter shake of 2 seconds' duration in the same direction. At Brieg at 2 o'clock a subterranean explosion was heard, and soon after slight movements were perceived, at $2\frac{1}{4}$ a stronger, and at $2\frac{1}{2}$	Many of the small lakes of Switzerland were agitated, though not nearly so much as on the 1st November. The Rhine also was ruffled as by a moderate wind. The lakes, rivers, and springs were most unusually full and swollen, so that terrible inundations were the consequence in several	At Milan the water came in larger quantity than usual from the wells. Some damage was also done to buildings. At Brieg and throughout the Valais chimneys were thrown down, and all the buildings much shaken. The arches of some churches fell. The earth too opened here in many places in the direction S. to N. (that of the shock); some of these fissures threw out water to the distance of several feet, and others closed again themselves. Springs also dried up. Brieg, Glisa, and Natria were much injured. On a mountain, $2\frac{1}{2}$ miles from Brieg, the earth sank 1 inch daily from this date till the 26th February 1756. From the 9th until the 21st December slight shocks were	Ditto.

1.	2.	3.	4.	5.	6
$2^h\ 32^m$ $2^h\ 32^m$ $2^h\ 45^m$ $2^h\ 45^m$ 3^h	at Aigle, on the banks of the lake of Geneva, in the Cantons of Freiburg, Berne, Lucerne, Aarau, Zug, Zürich, Schwyz, Glarus, Appenzel, Thurgau, Schaffhausen, Basel, Neufchatel, and in Franche Comté. Also at Mulhousė, Besançon, Bourg, and in the Lyonnais. In the Tyrol, and at Munich, Ingolstadt, Donauwörth, Augsburg and Nestembach.	a very violent earthquake, which was felt all through the Valais. These shocks recurred at intervals of half an hour, but with diminished intensity. Three principal shocks were everywhere felt. At Berne these lasted altogether one-third or half a minute. At Lucerne a slight shock had been felt at $1^h\ 30^m$ P.M., and at Nestembach one at 8 A.M., followed by a second at 10 A.M., also felt at Donau-Eschingen. The violence of the shocks is reported very variously, even different people in the same room perceiving them differently.	provinces of France.	felt daily, always preceded by a little trembling some time before, the wind falling at the same time. At Vevey, Morges, Lausanne, and Nyon the shocks were violent. At Vevey they were most so in the streets running along the lake. The same was true at Geneva. The shocks were scarcely at all felt on elevated points. At almost all places they were accompanied by a loud noise. It was said that the Aar was covered in some places by a thick vapour and appeared to boil, a moment before the shocks. All through Switzerland bells were made to sound, doors and windows moved, and buildings were cracked and injured. At Chiavenna rocks were detached from the hills. At Zurich the people believed that they smelt an odour like sulphur after the shocks. Ice was cracked in some places. At Berne the barometer was at 27 in 7 lines, and at Bâle at 27 in $4\frac{1}{3}$ lines. At Morat a magnetic needle moved 0° 25′ to the west, about the moment of the shock. At Hohen Ems, a magnet suspended by a cord of 11 inches long swung more than 40° from the vertical (!).	
1755. Dec. 10.	Brieg in the Valais	More shocks. They recurred daily, though with decreasing violence, up to the 21st.	....	....	Phil. Trans. &c. as before.
—— —— 11.	Lisbon, Colares, Madrid, and Orleans in Spain and Portugal. At Brieg also the shocks recurred; and in the Electorate of Ingolstadt in Bavaria.	Several shocks. At Lisbon they were nearly as violent as those of the 8th and 18th November. At Ingolstadt another shock.	....	....	Ditto; Gazette de France, 10 Janv. 1756.

[To be continued.]

Twelfth Report of a Committee, consisting of H. E. Strickland, *Esq.*, Professor Daubeny, Professor Henslow, *and* Professor Lindley, *appointed to continue their Experiments on the Growth and Vitality of Seeds.*

The seeds set apart for this year's sowing were those collected in 1844, and it is the third time that the same kinds have been subjected to experiment.

There is a very evident decrease in the numbers which have vegetated when compared with those of previous sowings, as will be seen by reference to the annexed table.

It being still desirable for the continuation of these experiments that seeds of known date should be added to the Depôt at Oxford, more especially of families and genera not already there, we again beg to call the attention of the Members to the subject; and to guide them in the selection, we refer them to the List of Genera, the seeds of which are now in our possession, given in p. 32 of the Report of this Association for 1848.

Name and Date when gathered.	No. sown.	No. of Seeds of each Species which vegetated at			Time of vegetating in days at			Remarks.
		Oxford.	Cambridge.	Chiswick.	Oxford.	Cambridge.	Chiswick.	
1844.								
1. Ammobium alatum	200							
2. Asparagus officinalis	150							
3. Alstrœmeria aurantiă	100							
4. Argemone mexicana	100	27	....	26	25	....	15	Strong and healthy.
5. Bryonia dioica	100							
6. Carthamus tinctorius	100							
7. Carum Carui	200							
8. Catananche cœrulea	200							
9. Crambe maritima	100							
10. Chenopodium Botrys	200							
11. Eschscholtzia californica	200	......	....	3	......	....	7	Plants weak.
12. Helleborus fœtidus	150							
13. Linaria Prezii	200							
14. Scorzonera hispanica	200							
15. Saponaria annua	150							
16. Solanum ovigerum	200	......	....	12	......	....	13	Strong and healthy.
17. Sium Sisarum	200							
18. Sanvitalia procumbens	200							
19. Tragopogon porrifolium	200							
20. Vesicaria grandiflora	150							
21. Madia splendens	200	......	....	2	......	....	9	Plants weak.
22. Malva maritima	200	42	30	68	10	3	......	Strong and healthy.

Sown at Oxford on the 18th of June in pots and placed in a cold frame, at Cambridge on the 21st of June in the open border, and at Chiswick on June 10th in pots placed in slight heat.

Report on Observations of Luminous Meteors, 1851–52. *By* the Rev. Baden Powell, *M.A., F.R.S., F.R.A.S., F.G.S., Savilian Professor of Geometry in the University of Oxford.*

In submitting to the British Association a fifth report in continuation of former ones on observations of Luminous Meteors, I am bound to acknowledge the contributions (as heretofore) of Dr. Buist, the Rev. J. Slatter, Mr. J. King Watts, the Rev. T. Rankin and Mr. Birt, besides several other friends who have favoured me with occasional observations: to Mr. E. J. Lowe I am especially indebted for communicating, besides his own valuable series, those of Mr. Lawson, and the very exact observations of M. Bulard, and a series observed by the Rev. J. B. Reade and several friends.

These latter sets of observations have each been drawn up in such complete and distinct tabular forms that I have judged it better for the most part to retain them in the order in which they were communicated, than to attempt to reduce them to a more strict chronological arrangement.

I have also received a considerable series of *older* meteor-observations by T. W. Webb, Esq., of Ganarew, near Monmouth, extending over a period of upwards of thirty years prior to 1850. As it was found almost impossible to reduce these to the tabular form, they are given precisely as they were communicated: they in several instances afford points of comparison with former records, and supply deficiencies in them.

I. *Observations of Luminous Meteors, from* 1818 *to* 1850, *extracted from old diaries of natural phænomena. By* Thomas William Webb, Esq., *of Ganarew, Monmouth.*

1818. Jan. 5.—A meteor about $5^h 30^m$ P.M.; it passed from N.E. to S.W. across the zenith; its observed time was about 3 secs. (This is but an uncertain observation, from youth and inexperience.)

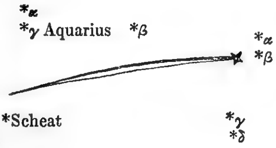
1820. Aug. 10.—My father, the Rev. John Webb, "informed me that as he was travelling about a quarter past 2 A.M., he saw a remarkable meteor. It was somewhere near Auriga, and had the appearance of a luminous line, with sparks issuing in great quantity from both sides of it. This soon disappeared gradually, and directly after, another, much less bright, was seen further on, which lasted only for a moment." He was also informed, that "one had been seen about 11 P.M., which was much brighter and lasted longer. Shooting stars were observed in surprising numbers all night."

1821. Aug. 23.—The same gentleman supposed that a meteor might have appeared about 9 P.M. "in the N.W. part of the sky, as he saw a light on the hedges before him (he was then going S.E.) such as would be produced by the sudden appearance of a candle, or the flash of a gun. It was accompanied by a noise like a rushing gale. The weather was hot, and the sky serene and cloudless, without a breath of wind. It should be observed that there was a thunder-storm on the evening of the 24th" (and therefore this observation is only so far valuable as it may be corroborated by others. It was in South Herefordshire).

1821. Sept. 9.—A meteor about 8^h P.M. at some height in the north. It had the appearance of a star, about as bright as Venus, and disappeared instantly without motion.

1822. Nov. 28.—About $9^h 45^m$ P.M. I saw a falling star which appeared, at first, quite as bright, if not brighter, than a star of the first magnitude, but very soon lost its splendour and gradually diminished till it became totally invisible. Its course was perpendicular, in the N.E., and about 30° in length. The full moon was shining at the same time with very great brightness. Its course was straight and performed with a medium rapidity.

1823. Sept. 7.—About 9^h 15^m P.M., a meteor was seen in the S.S.E., whose course may be thus delineated:



In its descent it made an angle of about 10° with the horizon: at first it appeared as bright as Athair, and it did not diminish until it had run about half its course, when it gradually became fainter and fainter. Its progress was not more rapid at first than that of a cloud driving with a high wind, but it became quicker whilst the angle of inclination to the horizon increased. It remained visible about 3 secs. (S. Herefordshire.)

1824. Aug. 29.—About 10^h P.M., my mother saw a meteor in the S.W., which from her description must have had when first seen 20° or 30° of altitude: it descended in a sloping westerly direction, till near the horizon, when it disappeared without diminution, either by extinction, or by passing behind trees. It was larger than Venus in her brightest state, but so blue as to be compared to a ball of quicksilver, and to appear quite unlike any planet or star. Its velocity was considerable, and it seemed as though projected with force. (South Herefordshire.)

1824. Aug. 31.—About 9^h 30^m P.M., the Swan being S. of the zenith, a falling star appeared in it, whose course was short and rapid, in a *S.E. direction.* It was of the second magnitude at one time, but very tremulous and variable. About three minutes after, another appeared just below it, in the N. part of Aquila, of the fourth magnitude, sailing in a W. direction, with a slow and equable movement, over a considerable space. (South Herefordshire.) The Diary adds, "this night there seemed to be many little startings and flashings in the heavens;" but on this I would not rely, as I am very near-sighted, and I think at that time did not wear a concave glass.

1825. April 13.—A servant at Gloucester saw a meteor at night in the S., which passed in a W. direction: it was quite red, larger than a falling star, and not like one. The night was quite cloudy, but the veil was unequal, and in some places occasionally thin.

1825. June 5.—About 8^h 45^m P.M., a light seemed to catch my eye for a moment in the N. at about 30° of elevation. If not a deception, which is very probable, it must have been twice as large as Venus.

1825. Aug. 10.—About 10^h 30^m P.M., a meteor equal to a star of the 3rd magnitude in brightness passed across the upper part of Pegasus in a straight line, tending somewhat downwards. Immediately on its disappearance another appeared just E. of the hand of Perseus, exactly in the course of the first, produced in the opposite direction: it seemed to come with a very short horizontal course from the N., then becoming stationary, blazed out as bright as Algenib for an instant, then diminished to the 4th magnitude, and quickly after vanished. Soon after another of the 3rd magnitude fell in the S.W., in a perpendicular line from Serpentarius downwards, with a swift course. After 11^h P.M. another meteor shot horizontally, rather descending, for the length of 2° or 3° by Scheat in Pegasus: it dissolved into a splendid broadish train of faint bluish light visible for some seconds. At the beginning of its course its apparent magnitude was about the 2nd. Just after this a very distant red reflexion of lightning was seen in the S. All these meteors came more or less from the N.E.

1825. Aug. 16.—About 9^h 30^m P.M., a shooting star of the 3rd magnitude was seen in the E. at an altitude of about 40°, which rose perpendicularly for 7° or 8°.

1825. Nov. 6.—At 9^h P.M., a meteor was seen 3° or 4° below Menkar in the E.S.E., as large or larger than Venus when at her greatest brightness. It did not seem to move, but vanished in an instant.

1826. May 12.—Great meteor, about 10^h 40^m P.M., which by the account of a person who was with me began to appear about two-thirds of the distance between the Pole and Lyra, but on a lower line, between Lyra and Cygnus. It was described to me to have begun "as if a star had shot," and then it broke out all at once in a great body, moving, with a moderate velocity, to the N.W.; at first, and for some parts of its course, horizontally, but at last deflecting downwards in a considerable curve; in which part of its course I first saw it, my attention being roused by the strange blue light it cast on the ground. As it was passing on beneath the Pole, it went out, as it were, but a red spark, half as large as Mars, passed on in the same direction for 3° or 4°, and had the same effect as a case that remains kindled after the extinction of a fire-work. This meteor had an intense bluish white light, and illuminated objects considerably which were not immediately in the moon's rays. When I saw it I thought it one-third as large as the moon, then about five days old. I do not think it left any train. I fancied the light on the ground was wavering and streaming, and diminished before I looked up, but I was informed that the meteor appeared uniform from beginning to end. An hour before, a falling star had been seen, with a course of 50° or 60° from the zenith to S.W., diminishing before it disappeared. (Gloucester.)

1826. Sept. 15.—I was informed that about 8^h P.M. (uncertain to half an hour), a meteor had been seen at some elevation S.E., which passed from N. to S., or from N.E. to S.W., for 30° or 40°, as large as a star of the 1st magnitude; its course was mostly horizontal, but descending towards the last. It had a very broad train, as long as two-thirds of its course, which lasted a short time.

1826. Dec. 21.—About 9^h 30^m P.M., while I was looking through a telescope, I perceived a falling star with the other eye: as soon as I could direct my attention to it, I ascertained that it was descending nearly in a straight line in the E., the point where I first saw it being between Ursa Major, Auriga, and Gemini: its course was perhaps 20°, pretty slow. It was of the 1st magnitude, as large, as bright, and nearly as red as Mars: at the extremity of its course it suddenly diminished to the 3rd or 4th magnitude, proceeded 2° or 3° in that state, and vanished. A few seconds after, another was seen, which first appearing very near the course of the former one, I think below Gemini, proceeded 8° or 10° in a direction to the S., perfectly at right angles to the course of the other. It was hardly so large as the 3rd magnitude.

1827. Dec. 6.—About 6^h or 7^h P.M., a very large shooting star was seen, whose course was nearly perpendicular, 8° or 10° long, passing through the tail of Ursa Major, and very slow: its commencement was not very accurately noted, but afterwards it exhibited two or three alternations of light, from a white star of the 2nd magnitude, to a brightness much exceeding α Lyræ, and of a splendid reddish yellow colour. It went out in a faint spark.

1828. Jan. 19.—About 5^h 45^m P.M., during light twilight a shooting star was observed to pass between two clouds in an open space of 2° or 3° in a direction sloping to the left. It seemed quite as bright as Venus.

1828. April 10.—About 9^h 30^m P.M., a meteor appeared at about 30° high, S.S.W. As I only saw it out of the corner of my eye, I cannot be particular as to its appearance, but it seemed a sudden short blaze or flash of bright red light, brighter I thought than Venus, then uncommonly brilliant. There had been a clap of thunder in a hail-storm during the day, which was showery; and there were a few clouds in the sky at the time, and a faint haze in the place where it appeared. It might, perhaps, be an electric spark; its instantaneous disappearance rendered this likely, but no report followed, nor did it, as far as I can judge, illuminate the haze in which it appeared.

1828. Aug. 22.—A beautiful shooting star as large as Venus passed in a long tract from S.E. to N.W. under Cassiopeia, about 9^h 10^m P.M. It seemed to become extinct by degrees.

1828. Aug. 28.—About 10^h 30^m a beautiful shooting star was seen, whose course was from S.E. to N.W., not less than 40° long, a little S. of the zenith. It was of the 1st magnitude. About the middle of its course it became duller, moved slower as I thought, and was perhaps a little deflected: it then resumed its first appearance: it seemed to leave a train on disappearing, but I could not tell, the moon being bright, and I not using an eye-glass.

1828. Sept. 29.—At 10^h 52^m a brilliant falling star appeared, which had a short course close to the horizon a little to the W. of the W. extremity of a fine auroral light in the N. horizon. It made an angle of 60° or 70° with the horizon (as a streamer might have been supposed to do in that situation), being deflected to the right as it advanced. It was gradually extinguished. It had a blue colour, as bright as Venus.

1828. Dec. 1.—(At the close of the memorandum of an aurora borealis, the following occurs):—Several falling stars were seen, whose courses were in opposite directions.

1830. June 25.—(The following is added to an account of a most tremendous thunder-storm.) The storm passed about two miles E. of Gloucester at 10^h P.M., and at some period between 10^h 20^m and 10^h 40^m, Mr. ——, who had a complete view of the whole, perceived a strange meteor in the W. or W.S.W., where the sky was cloudy, precisely like the moon behind clouds, of the same colour, and nearly as large, so that he thought for a moment it had been the moon. He called several other people, who all saw it. It lasted about three minutes as near as he could judge, and gradually disappeared as if obscured by clouds, or retiring in a straight line backwards, for it was quite stationary. He stated also that he saw another thing of the same kind, very much smaller, on the same night. But query, was it not the moon? [Supposing it to have been actually a meteor, and the observer, an educated and intelligent man, might not have been supposed liable to such a mistake, though the moon was, I believe, actually in that quarter, some light may be obtained from the following memorandum, which occurs under 1831, Feb. 6.] Mr. J. B——, an accurate observer of nature, told me that about the beginning of Sept. 1830 (a note states that there can be no doubt, from the account of another person, that the correct date was June 25) a thunder-storm came on towards night, the lightning of which was of a remarkable pale hue, and had not so much the appearance of flashing as of rolling from one cloud to another, and chiefly from N.E. to S.W. (This observation was made in the South of Herefordshire.) When it had passed off, and the sky was clear, about midnight, though it still lightened at a distance towards N.E., as he was returning home, a meteor suddenly broke out in the E. horizon, and passed rapidly across the sky till it disappeared in the W. horizon. He described it as a cloud of fire, of the deepest red, of surprising brilliancy, especially at its first breaking out; so that while it passed any minute thing might have been seen upon the ground. He described it as appearing as large as his garden, but tapering at the two ends: it produced no noise, and the whole appearance was over in a quarter of a minute.

1830. Nov. 11.—(After some streamers of an aurora in the N. about 9^h P.M.) Just afterwards a very large falling star was seen E.N.E.

1830. Dec. 10.—About $5^h\ 15^m$ P.M., a meteor was indistinctly seen at about 10° elevation N. by E. It was stationary, lasted a second or two, and appeared in colour and size much like Mars in opposition, as far as could be judged from a very imperfect view.

1830. Dec. 12.—(A description of a fine aurora, concluding thus):—After 8^h, when the streamers had ceased, a splendid and large green falling star was seen lowish in W.N.W. which left a train: another large one was also seen; and one also during the aurora of the night before.

1831. April 10.—There were faint streamers N. at night, and a beautiful and brilliant falling star N.E., and a light most clearly connected with a black cloud N.W.

1831. Dec. 8.—The morning being overcast with very low foggy clouds, and very dark (it was probably before 7^h), as I looked suddenly towards my window I saw a flashing or flickering effect of light, such as might have been produced by faint lightning or a fire *in the opposite quarter*. No light seemed to come into the room; the illumination was in the clouds or fog. As I instantly went towards the window, the light, after becoming rather brighter, faded and disappeared very suddenly. It occurred to me that it was probably the effect of some great meteor (for though the light was faint, the luminous body must have been considerable to have produced such an effect through such dense clouds); on the other hand, a boy was whistling not far off, who, had such been the case, would probably have been frightened. Such an effect from a lantern I never saw, nor believed it possible; it might have been best compared, as above, to faint lightning; perhaps a little ruddy. (South Herefordshire.) (The Hereford Journal of Dec. 21, contained a long extract, a copy of which I possess, from the Bath Journal, giving a long, though very unscientific account of this meteor, for such it was, which seems to have been visible over a great extent of country.)

1832. Oct. 20.—Four shooting stars were seen within half an hour about 10^h, three of which were large and beautiful, and sailed with a fine equable motion: all from E. or N.E. But one which proceeded from the latter quarter, at a considerable elevation, traversed 40° or 50° of the N. sky in a direction nearly straight and parallel to the earth, leaving behind it a fine white streak, which gradually spread wider and dispersed. As the star was equal to one of the 1st or 2nd magnitude, and as the streak was visible at once throughout so long a course, the effect was very striking and beautiful: what seemed remarkable was that the other three, though similar to this in their direction, left no visible train behind them. One night two or three months ago (I rather think on Sept. 18), I saw a bright star, which falling perpendicularly seemed to be partially quenched, but yet proceeded a short distance before it was totally extinct, in the form of a dull red spark. The appearance was just like that of a candle suddenly plunged into carbonic acid; the transition being apparently from a state of inflammation to that of simple ignition.

1832. Dec. 12.—A great meteor seems to have appeared between 7^h and 8^h P.M. M—— was then returning through the field behind her mother's house at ——, when a bright light shone round her, much brighter than moonlight, and more permanent than lightning.

1832. Dec. 13.—Another great meteor about 6^h P.M., described as a great body of fire passing across the sky from E. to W., and giving so strong a light that a pin might have been taken from the ground for a short time. Another account was that it passed two ways. No report seems to have succeeded it. The weather had latterly been electrical: it lightened on several nights at the end of last month, and I saw a strong distant flash on the evening of Dec. 2. (South Herefordshire.)

1833. Dec. 11.—At 10^h P.M., I saw a very beautiful meteor. It commenced somewhere near β and γ Ursæ Minoris, probably above and to the right of them, as a small shooting star, taking a left-hand direction, with an inclination of about 45° to the horizon. During a course of 8° or 10° it had increased gradually to a splendid globe, perhaps three times the size and brilliancy of Jupiter, and of a lovely colour, not easily described, probably nearest to a greenish blue. The remainder of its course was intercepted from my view by a building; but from the great illumination of the sky, I imagine its splendour still continued to increase. Its velocity was that of an ordinary falling star: it did not appear to leave any train. Frequent, though faint, flashes of lightning were seen in the E. horizon between 6^h and 7^h P.M., and a very strong one had been perceived on the preceding evening. The wind was N.W. with slight but very cold showers, indicating snow upon the mountains, which probably existed there at the time, and the next day was seen in considerable quantity. (South Herefordshire.)

1834. July 4.—A very beautiful meteor was seen at Tretire (South Herefordshire) at about 9^h 15^m P.M. When first noticed it was probably about 55° (or perhaps 60°) above the E.S.E. horizon, in the form of a very brilliant body of yellow or pale orange light, not apparently exactly circular, but a little irregular or angular in its outline. This appearance I think may have arisen from the preceding part being more brilliant than the rest, but my surprise at its sudden outbreaking, and the smallness of its diameter, which probably did not exceed 5′, prevent me from speaking with certainty. It descended with a very slow motion, vertically, for about 15°, and then broke into three balls, and became extinct: the lowermost ball was by far the largest and brightest, the other two were much smaller, one of them almost a point. They all became of a dull red before their disappearance, which took place when they were several minutes apart, one beneath the other, in a vertical line. This change of colour before extinction I have several times remarked, and it always gives me the idea of an entrance into a medium incapable of supporting combustion. The appearance of the present meteor was decidedly that of a ponderable body, probably fluid, in a state of ignition, perhaps fusion, actually, not apparently, descending, and upon disruption coalescing by the force of gravity into smaller globules, of which the heaviest preceded the rest. At any rate it had no resemblance to any electrical phænomenon which I ever witnessed. No report could be perceived; there was, however, a considerable noise of wind, and of the mill; at the time I am almost certain that the largest ball preserved its original brilliant colour longer than the others. I should estimate its splendour, before division, at 6 or 8 times greater than the maximum of Venus: such estimates, however, are apt to be very uncertain. The twilight was so strong, that α Aquilæ, which was a little below and to the left of the place of its disappearance, had not long been visible with the naked eye. Had it been in a dark winter's night the effect would have been surprising and magnificent. This meteor was also seen by young Mr. P——, then in the neighbourhood of Newport, Monmouthshire: he described it as having a tail, which very probably was at its first appearance, which I did not see. He says it was as large, or larger at first than at last; its disappearance was out of sight behind trees, but he thought it had fallen in the garden just at hand. Mr. P. informs me that two or three years ago, very early in the morning, there was so brilliant a meteor as to terrify such of his men as were out; the blaze seemed to surround them; and they might have picked a pin from the ground. (South Herefordshire.)

1834. Sept. 29.—About 7^h 15^m P.M., the twilight having already become very dusky, as I was walking along a lane among trees, I was startled by seeing the road before me suddenly illuminated by a beautiful blue light, much resembling the effect of lightning, and scarcely longer in its duration; such indeed for a moment I supposed it to be. I looked up, and saw, at a height of about 60° as I guessed, in the N.E., the luminous track of a meteor. The sky for a great extent in this quarter was overcast with a thin irregular veil, interspersed with darker masses; but a few stars were visible here and there, and as it soon became clear, I found that the phænomenon must have occurred in or near the Galaxy between Cassiopeia and the tail of Cygnus. The track was about 3° or 4° long, considerably bright and very narrow, if not interrupted in places. Its form and appearance were exactly that of the summit of a dense cloud illuminated from behind, which, indeed, for a moment I thought it had been; its light was reddish. It continued visible by estimation for 2 or 3 minutes, gradually decreasing in brightness and appearing more unconnected and like a series of insulated patches. The following may give a faint and inadequate idea of its form.

No report was heard.

1835. Aug. 4.—The forenoon had been very warm and nearly cloudless. Towards 3^h or 4^h clouds began to form in the W. horizon, which rapidly increased. Their great darkness indicated considerable density, but they exhibited no towering summits, or hard and defined edges, such as would lead to any apprehension of thunder. They gradually rose and spread to a considerable height, and it appeared likely that showers would ensue towards evening, which proved to be the case, but they did not seem dense enough for tempest. About 4^h 30^m, being in my bedroom at Tretire (in the South of Herefordshire), I was surprised by a distant explosion, dull and heavy, like that of a cannon, and by no means loud, yet causing a vibration in the house, which is very strongly built, and the window distinctly rattled from it. I should have supposed it a cannon fired at Goodrich Court (about 5 miles distant), or the blasting of a quarry, had it not been followed by a long low rumble of some duration. I immediately exclaimed almost involuntarily two or three times, that I never heard anything like it. A servant in the kitchen heard the cellar door so jar from it, that she thought some person had gone down there. Our man, who had the fairest opportunity of hearing it, being out of doors, was greatly surprised at it, and thought it had been the blasting of a quarry, only it seemed at some height in the air towards the E., and the succeeding rumble travelled towards the N. I also referred it to an E. direction. The sky on that side was nearly free from clouds, and of a fine serene appearance. My own impression decidedly was that it was not thunder, but the explosion of some meteor.

Extract from Hereford Journal, referring to the last notice:—

"On Tuesday the 4th inst. a most extraordinary concussion in the air was perceived by several persons in different parts of the kingdom, and at the same moment, about 40 minutes past 4 in the afternoon. It is described as a report as of heavy ordnance, and followed by a reverberating heavy sound for some seconds. A great peculiarity attending it, and most strongly showing the immensity of its distance, is the impression it made on all those who heard it, as if it was immediately in their own vicinity."

(I find here a reference to the Analyst, No. XIII., p. 175, which I am at present unable to verify.)

1835. Aug. 28.—About 9^h 15^m, a falling star, brighter than Venus, was seen at a moderate elevation in the E. descending with a straight course.

1836. March 8.—A beautiful falling star appeared in the S. to the left of

Sirius, about 7^h P.M., but was scarcely noticed time enough to be fairly seen. It seemed fully as brilliant as Jupiter, and of a greenish light.

1838. Oct. 15.—About 8^h 35^m, or 40^m P.M., the sky being for the most part covered with low dark dense clouds, driving with a strong wind, with an obvious degree of electrical light between them, in a part of the sky somewhat less obscured, and where several stars were plainly shining, a bluish light began to appear, which in two or three seconds became very brilliant, as much so as one-quarter or one-third of the full moon, and faded away again in about the same time. The luminous body itself was invisible behind a cloud, and nothing was seen but the reflexion. This exactly resembled distant lightning, but was less transient.

1838. Dec. 7.—A great number of falling stars were observed between 6^h and 7^h. In about half an hour forty were counted, sometimes by one, sometimes two, sometimes three observers, two at a medium. They were of all magnitudes up to the first: the larger dissolved into a train of light, but left no train [I presume this means no streak] behind them; the S. and W. quarters were chiefly observed, but their prevalence seemed to be universal: they all fell in nearly a vertical direction, but those in the N.W. and S.E. quarters inclined towards the S.W. The colour of the more conspicuous ones seemed to verge towards orange. Their courses were of no great length. There was at the same time a pale auroral light along the N. horizon from N.W. to N.E., apparently equally extended on each side of the true meridian. The meteors were not watched after 7^h, but about 11^h, upon looking out again, I saw one, the only one in several minutes, in the S.W.; but it had no longer a vertical direction, its course pointing now to the N.W. (South Herefordshire.)

(For an account of this phænomenon as observed by Mr. Maverly at Gosport, see 'Proceedings of the Meteorological Society during the Session 1838–39,' p. 9.)

[This shower of stars is not noticed by M. Coulvier-Gravier in his 'Etoiles Filantes.']

1840. June 30.—About 10^h 30^m, a beautiful falling star was seen in the S., nearly in the meridian, having a long straight course somewhat inclined to the E. Its commencement was small; it gradually attained considerable splendour, and after a period of obscuration, produced perhaps by a thin cloud, it attained the magnitude of Jupiter in quadrature before it disappeared. Its colour was orange. Streamers of the aurora borealis had previously been noticed, extending from N.E. towards S.W.

1841. Aug. 12.—In the early part of the night, from about 9^h to $10\frac{1}{2}^h$, many falling stars were seen. Being engaged myself with the telescope, I saw but very few; but two or three persons in the company were frequently exclaiming that they perceived them. I should imagine that there must have been three or four times the average number. I did not then recollect, what has since occurred to me, that the smaller periodical shower is about this time.

1841. Aug. 13.—On looking out of my window between 10^h and 11^h, I saw a large falling star, which induced me to go out to examine whether there was any repetition of the phænomenon of last night; I saw however nothing in the course of several minutes.

1841. Nov. 8.—The night seemed remarkably free from shooting stars. I was abroad from 6^h to 6^h 15^m, and from 9^h 30^m to 9^h 55^m, without noticing one. (South Herefordshire.)

1841. Nov. 9.—There appears to have been a considerable meteor this morning, from the following extract from a note from Miss H. (South Herefordshire):—"Last Tuesday morning, before 5 o'clock, one of our workmen saw an immense large substance, which he described to be like a ball of fire, coming down from the sky quite perpendicular till within fifteen yards of the earth, when it suddenly disappeared."

1841. Nov. 11.—One of our servants saw three falling stars in the course of milking, about 7^h P.M. She described them as passing from E. to W. in the N.W. quarter of the heavens, as being of the first magnitude, and leaving trains. (South Herefordshire.)

1841. Nov. 12.—The day had been rough and showery, with a high wind from W. or W.S.W., and a little hail in some places, but the evening twilight was very clear, during which, about the same hour and in the same quarter as last night, our servant saw two considerable falling stars with trains. About $6^h 30^m$ there was a faint light in the N. horizon, which I then thought indicated a slight tendency to an aurora, but I afterwards found it accompanied the edges of dark clouds in various parts of the sky. Until 9^h I was detained indoors at L. (South Herefordshire); from that time till $9^h 45^m$, I kept as sharp a look out as a speedy walk over a bad path permitted, but saw nothing until about $9^h 40^m$, when a meteor of an orange-colour appeared low in the S.E. to the right of Rigel, and about the size of that star; its course was short, rapid and flickering, descending gradually towards the S. I did not perceive any train. $10^h 30^m$ there was a fine meteor of the 1st magnitude, orange-coloured, with a train, in the E. quarter, shooting, as the former, in a line directed from Leo; it was not seen by me. Two smaller ones afterwards, one with a train, which one I did not see, had short courses from the same direction in the E. or S.E. quarter, in the space of the next 7^m or 8^m. But between $10^h 35^m$ and $10^h 40^m$, a small point was perceived towards the feet of the Great Bear, not far above the N.E. horizon, drawing a small train after it, and rapidly increasing in size as it rose with a steady course, in such a way as to prove that it was really drawing near from an incalculable distance in an apparently straight line. It grew brighter and brighter, as did its splendid and beautiful train, and it assumed an orange-yellow hue; it passed a few degrees N. of the zenith, but not quite so far N. as Cassiopeia, and still continued to increase as it descended towards the W. horizon, but it seemed to become fainter and to be extinguished before it reached it; but trees partially obscured this portion of its course. It was seen by three others besides myself, my father, Mr. T. and his son, and it appeared to all of us except my father, to be attended, when at its height, with a hissing sound, but a loud rushing wind prevented any certainty as to this point. Its appearance was like that of a magnificent rocket, and the impression of absolute height, speed, and projectile force, was truly sublime. Its size appeared to me greater than Venus, but not so vividly brilliant. The length of its course might be 5 or 6 seconds. At $11^h 5^m$ a stormy cloud in the N.E. horizon had a faint luminosity attendant upon its upper edge. A shower afterwards came on. At $11^h 45^m$, a storm, which had passed to the E.N.E. horizon, was followed by a similar light, which was very evident 5^m afterwards amongst dark patches of cloud. Our friends also saw what appeared like a light cloud somewhere towards the S.W. horizon, and wondered at it in the absence of the moon. 10^m after midnight the E. horizon continued light, though the clouds had left it. I watched the S.E. quarter pretty frequently from 11^h till $1^h 30^m$, Nov. 13, but no meteor was seen after the large one, nor could I see anything during a short examination at $3^h 30^m$ and $4^h 30^m$. The distinctness with which I saw the light of the Welsh furnaces [20 or more miles distant] upon my walk about $9^h 30^m$, though the sky was very clear, except low in the horizon, was very unusual indeed. The air was not favourable for delicate astronomical observations, the diameters of the stars, according to Sir W. Herschel's remark, appearing enlarged. Miss H. N., who watched from half-past 1^h till morning, informed me that she saw thirteen meteors; the finest, which ran a longer course, were between 5^h and 6^h. None of them, however, seem to have been remarkable either for brilliancy or trains.

1841. Dec. 10.—Eleven shooting stars were counted between 11^h and 12^h at night, by a person in Hampshire. "The greater part proceeded from a N.W. direction, some far less brilliant than others, and their light of a silvery whiteness."

1842. Aug. 9.—About 10^h (as near as I can judge) I looked out for two or three minutes for the periodical meteors, but saw nothing, though the sky was very clear: my father thought he perceived a flash of lightning in the S. horizon. But on looking out about $10^h 30^m$ (having been called by him upon the appearance of a falling star), I counted in about one-fourth of the heavens, or possibly one-third, 8 or 9 in as many minutes, two of which were brighter than any fixed star, and of an orange-colour; one left a beautiful train. I heard that two had been seen by a servant, between 9^h and 10^h, bright, and in immediate succession, but passing in different directions; and one of those 8 or 9 (which one I did not see) appeared to my father to deviate from the general direction of the others, which was towards the S. For about 15^m afterwards I saw no more, and gave up the observation. Nothing could be seen during a minute or two, about $1^h 30^m$ on the following morning, or again at $2^h 45^m$, except perhaps one meteor the latter time, but I am not sure. (South Herefordshire.)

The meteors on this night were seen by several persons in the neighbourhood.

1842. Aug. 10.—The night was cloudy and rainy. Aug. 11.—I was out much during the evening and early part of the night, but saw nothing.

1842. Aug. 13.—Extract of a letter from a correspondent in Hampshire. "The scene was truly magnificent. I saw thirteen shooting stars within the space of half-an-hour, between 11 and 12, and S. saw one shoot at the same time that I did not witness, making fourteen. Three of them had beautiful trains, two in the S.W., with trains something like the tail of the comet of 1818; colour of these two a silvery whiteness; one was of surpassing beauty and brilliancy; they both proceeded in a southerly direction. The third appeared near the Polar star, and proceeded towards the S.E. This was less brilliant than the two preceding ones, of the same colour, but had a curious flickering motion in the train; the streams of light radiated towards the centre of the train, something like this figure . It was very beautiful indeed, and what I had never before witnessed. The motion too was less rapid than that of the two preceding ones."

1842. Aug. 27.—A little before 9^h P.M., the sky being overcast with thin clouds, a glow of dusky red light appeared between me and a thick hedge beside which I was riding, and which was very dark; from its peculiarity of appearance, its being chiefly visible to one eye, and its duration (however short), I felt more inclined to refer it to (the reflexion of) a great meteor than to lightning, of which there was no appearance, though the weather was close and warm. The clouds were thin and foggy, and had no electrical appearance. (South Herefordshire.)

1842. Sept. 3.—Between 9^h and 10^h P.M., an unusual number of falling stars were seen, probably seven or eight in about 20^m.

1844. Aug. 9.—Several fine falling stars, more numerous than the average, were seen (at Gloucester). Mr. H. W., who was observing with me, told me that for some nights previously, but especially last night, they were still more numerous and brilliant at Minehead in Somersetshire, and that he saw one very curious appearance, resembling a serpentine train of sparks. He described them as generally visible towards the S.E. All those that we noticed tonight had a similar general direction from N.E. to S.W.

1844. Aug. 10.—A few falling stars were noticed (at Gloucester) moving in the same direction as last night, but one was observed which presented the singular appearance of a comparatively slow, and as it were difficult progress in the opposite direction.

1846. July 25.—A workwoman near Gloucester, returning home about 10^h P.M., saw a meteor of considerable magnitude. It was of the size and colour of the moon, and she compared its light to that of day. According to her account, it seemed as though it proceeded downwards from an opening cloud, and was instantly withdrawn into the cloud again; but probably this retrograde motion may have been a deception. It was in the N. or N.E. at a considerable altitude.

[This meteor was described in the 'Illustrated London News.']

1847. March 19.—Extract of a letter from a lady.

"On the evening of Friday, March 19, A. and I left Albion Road [Holloway] about half-past 8. Not any stars were then visible, but when we were in Highbury Place, A. called my attention to what we thought a fire-balloon ascending slowly. It was in the west, a little inclining to the south. As it passed on slowly to the west its intense brilliance convinced me that it was not an earthly thing. When it appeared to be over Hampstead (but as high in the heavens as the sun is at 6 o'clock in the evening when the days are longest), it shot forth several fiery coruscations, and whilst we were gazing at it, broke into an *intensely* radiant cloud. This cloud sailed on slowly, and we never took our eyes off it. At this time the stars were shining. When we were in the gravel path opposite to Highbury Terrace, the cloud was rather higher in the heavens, and more to the W. It cast a most brilliant light on the houses there, brighter than moonlight, and unlike any light I ever saw. It appeared of a blue tint on the bricks, but there was no *blue* light in the cloud itself. Suddenly over the radiant cloud appeared another cloud *still* more brilliant, but I now felt so awe-struck that I cannot say precisely how long they hung one over the other, before the most wonderful sight happened. Perhaps they remained so for two or three minutes, when from the upper cloud a small fiery ball (about the size that the largest planets appear to the naked eye) dropped into the lower cloud, and was instantly absorbed. Soon after another similar ball dropped from the upper to the lower cloud; and then a ball apparently four or five times the size of the two preceding fell from one cloud to the other in the same wonderful way. Shortly after this both clouds disappeared, apparently absorbed in the heavens, though I did see a few particles of the brilliant clouds floating about for a minute or so. Presently the moon appeared considerably to the northward of the place where the clouds had hung. We then saw the bright light across the heavens which you told me was zodiacal light, which lasted for more than an hour."

1847. Aug. 10.—A little after 10^h P.M., several large and beautiful falling stars, with fine trains, appeared to descend in the S. in pretty quick succession; and on the whole the meteors of this kind certainly much exceeded the average between 10^h and 11^h 30^m. Most of them fell in the above-mentioned direction, but the track of a small one, near the latest time of observation, pointed towards the N.W. Several of them were noticed two or three nights ago. [Reference is then made to an account of shooting stars in a letter in the 'Times,' dated Aug. 17, and this follows.] The Hereford Journal of Sept. 8, 1847, contains also the following:—"M. A. Frère, of Montizon, has stated that on the night of the 11th ult. he counted more than fifty shooting stars in the course of two hours, viz. from 11 to 1. Most of them were seen in the Milky Way, and a few towards its edges. The direction of all, however, was by the Milky Way, and towards the S.W. horizon."

1847. Sept. 14.—About 9^h 48^m P.M., as I was looking (or going to look) through a telescope towards the S., a light caught my left eye towards the E. horizon. I turned immediately, but only caught a glimpse of a meteor of a yellow or reddish colour, about the brightness of Jupiter or Venus, which had descended through the N. Fish, to the S. of Aries, in a course a little inclined towards the N., and had become invisible behind a building, leaving a narrow red streak, at first of considerable brightness, but fading very rapidly. Its course must have been of 20° or 30° in length, before hidden near the horizon. (Gloucester, I believe.)

1848. Nov. 17.—During a brilliant aurora witnessed by me at the extreme W. verge of Herefordshire, three falling stars of considerable magnitude were seen, one with a long course and fine train.

1850. Aug. 12.—A few minutes after 11^h (Greenwich time) a beautiful meteor shot across Cygnus, then at a great elevation in the meridian. I do not know whether I caught its first appearance; but its brilliancy drew the attention of my left eye, while the other was at the telescope. Its course was from W. to E. and not rapid, extending for perhaps 10° or 12° till I lost it behind the top of a tree. Its light was intense, much brighter than that of Venus, and of a beautiful clear blue colour: in the middle of its course it seemed to be extinguished, and then broke out again as bright as before. I think it left no train. Nearly an hour before I had noticed a much smaller one, falling in quite a different direction, low in the S.S.W. perpendicular to the horizon. This meteor was seen at Highfield near Nottingham, by Mr. Lowe, as appears by his letter in the 'Times.' He calls its colour, however, yellow. (South Herefordshire.)

1850. Aug. 24.—A little after 10^h P.M., a fine yellow meteor fell from near the zenith to α Aquilæ, as large as Venus.

1850. Oct. 5.—While looking with my $5\frac{1}{2}$ feet achromatic at a considerable star, probably of about 7 mag., I saw in the field a bright point of light, of nearly the same size and appearance, and at no great distance, which immediately vanished. It seems to have been a small and instantly extinguished meteor. It had I believe a reddish tinge.

1850. Nov. 29.—About 9^h, or from 9^h to 9^h 10^m P.M. Greenwich time, I caught an oblique sight of a very beautiful meteor of a yellowish colour and considerable size, which seemed to run a very short course at a great altitude, a few degrees W. of the zenith, and I believe among the stars of Gloire Frederici; but I did not exactly note the place, as finding it had left a bright and beautiful, though short train, I endeavoured to turn the telescope upon it; but before I could succeed, the train had disappeared, and I then could not exactly identify its place. [This meteor is mentioned in the 'Times,' in two letters, dated Barnstaple and Brixton Road.]

II. *Meteors observed by* Henry Lawson, Esq., *F.R.S.* (*assisted by* T. Cane, Esq., *and* H. Adams, Esq.), *at Hereford, during the November Epoch of* 1841. *Communicated by* E. J. Lowe, Esq.

Nov. 11. From h m

7 15 till 8^h 35^m none seen.

No. 253. 8 35 from Ursa Minor to Cygnus, with slight train.

254. 8 45 from Ursa Minor to Lyra.

255. 8 55 between Pleiades and Ursa Minor, with slight train.

256. 8 57 passing down through Ursa Major.

257. 9 4 near Polaris to the Great Bear. Soon became cloudy.

Nov. 12.

258. 7 0 from Cassiopeia towards Polaris. Very faint.

259. 7 29 near Pleiades.

260. 7 30 from Cassiopeia to Ursa Minor. Bright.

261. 8 15 from Polaris.

262. 8 30 from E. to W. Small.

263. 8 35 from W. to E.

264. 8 36 from W. to E. Alt. 90°.

265. 8 37 from E. to W. Alt. 25°.

266. 8 40 =1st mag. from E. to W. Alt. 45°. Train of light.

267. 8 44 from E. to W. Small. Alt. 40°.

268. 9 0 from W. to N. Alt. 40°.

269. 9 23 from E. to N. Alt. 30°.

270. 9 43 from E. to W. Alt. 30°.

271. 9 48 from zenith to N. Alt. 40°.

272. 9 54 from E. to N. Alt. 60°.

273. 10 0 from Cassiopeia to Polaris.

274. 10 1 from Ursa Minor to Ursa Major.

275. 10 2 from between Castor and Pollux to Ursa Major.

276. 10 5 as bright as Vega from meridian. Alt. 15° downwards to E.

277. 10 6 from near Pleiades to Castor.

278. 10 15 from E. to S. Alt. 10°.

279. 10 20 from W. to E. Alt. 20°.

280. 10 40 from zenith to Castor.

281. 10 44 from Rigel to Batelguex.

282. 10 45 from Pleiades to Castor.

283. 10 45 from E. to W. as large as Sirius. Of a bluish-green colour and with a train 70° long.

284. 10 48 from zenith to W.

285. 10 49 from W. to E. Alt. 20°.

286. 10 54 from W. to E. Alt. 80°.

287. 12 0 from Pleiades to Castor.

288. 12 1 from Castor to Procyon.

289. 12 2 from N.E. to S. Alt. 20°.

290. 12 15 alt. 20° in S.E. moved towards horizon.

291. 12 16 towards N.E. Alt. 25°.

292. 12 21 from Great Bear to horizon.

Nov. 12. From h m

293. 12 24 alt. 20° towards horizon in a S. direction.

294. 12 25 from Cassiopeia to Ursa Minor.

295. 12 50 alt. 90°.

296. 12 52=2nd mag. Between Castor and Great Bear.

297. 13 10 alt. 40°, from W. to S. Declining. Slight train.

298. 13 11 from zenith to Great Bear.

299. 13 33 alt. 70° from N. to S.

300. 13 34 train of light, from Ursa Major to S.

301. 13 45 from Castor, downwards.

302. 13 46 from Capella to N.W.

303. 14 0 from Cassiopeia to N.E.

304. 14 8 from W. to E. through the *Pointers*.

305. 14 17 from Great Bear towards W.

306. 14 32 8° towards N.

307. 14 40 from *Pointers* towards W.

308. 14 45 from N.E. to N.W. Alt. 30°.

309. 14 45 from N.W. to W. Alt. 12°.

310. 14 46, flashes in Ursa Major.

311. 15 1 from Orion downwards.

312. 15 2 from Orion downwards.

313. 15 3 from alt. 40° in East downwards.

314. 15 4 from E. to W. Alt. 30°.

315. 15 15 train of light. From Leo to Ursa Major.

316. 15 16 crossed Orion to W.

317. 15 17 from Ursa Major to W. horizon.

318. 15 17 from Ursa Major to W. horizon (following the path of the other).

319. 15 18 from Orion downwards.

320. 15 22 from Gemini, southwards.

321. 15 22 from E. to N. Alt. 20°. Train of light.

322. 15 25 from Leo downwards.

323. 15 27 through Orion downwards.

324. 15 29 from N. to S. through Ursa Major.

325. 15 30 from Orion to Sirius.

326. 15 32 to W. Alt. 70°.

327. 15 35 from Polaris, downwards, with train of light

328. 15 37 from E. to S. Alt. 10°.

329. 15 40 from zenith to Polaris.

330. 15 45 from Sirius to S.E. horizon.

331. 16 2 from Castor.

332. 16 6. Alt. 20°.

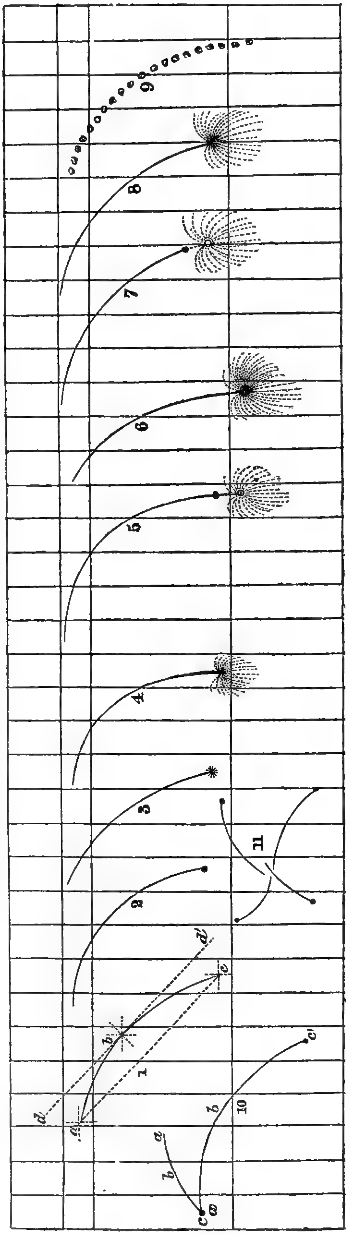
333. 16 10 from zenith to W. Train of light.

334. 16 10 from zenith to E.

335. 16 14 from Castor to E.

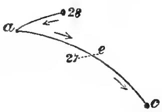
336. 16 30 due E. Downwards from an alt. of 20°.

III. *Observations of Luminous Meteors*, 1848–51. *By* M. BULARD, B.A.

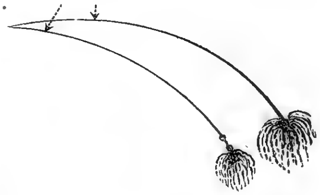


View of the most curious Meteors in Mr. Bulard's Catalogue.

No.	Date.	Hour. Greenwich Mean Time	Apparent Magnitude.	Bright-ness and Colour.	Velo-city or Dura-tion.	Mean places for 1840 of A. R.A.	Mean places for 1840 of A. Decl.	Mean places for 1840 of B. R.A.	Mean places for 1840 of B. Decl.
	1848.	h m s			s				
1	Feb. 22	9 21 25	Sirius × 12 ...	Blue......	4·0	61° 24′	14° 18′	56° 01′	9° 05′
	1849.								
2	April 24	11 34 53	α Pegasi	White ...	3·0	234 40	- 7 48	239 02	11 05
3	May 22	11 45 00	γ Orionis	White ...	2·0	247 00	−10 16	243 30	−11 25
4	July 5	11 38 00	α Orionis	White ...	3·0	343 36	28 20	334 17	20 00
5	6	11 34 00	α Orionis	White ...	4·0	281 35	33 46	266 28	32 28
6	Aug. 12	10 00 53	ε Geminorum	Blue......	1·0	352 56	28 27	344 00	24 36
7	12	10 7 00	Sirius × 3	Blue......	3·0	356 05	26 50	345 41	19 55
8	12	10 14 50	λ Orionis	Blue......	2·0	284 31	12 29	289 21	7 03
9	12	10 15 45	λ Arietis	Blue......	1·0	284 45	9 09	288 00	4 10
10	12	10 21 00	η Arietis	Blue......	0·5	282 00	3 50	284 26	− 3 07
11	12	10 43 00	α Arietis	Red	1·5	30 48	61 48	20 08	55 39
12	12	12 20 40	λ Arietis	White ...	0·5	274 35	38 52	281 03	34 35
13	12	12 24 00	π Arietis	White ...	0·5	336 47	28 28	334 17	20 16
14	12	12 14 50	Sirius × 6	Blue......	5·0	291 04	16 39	292 14	− 1 40
15	12	12 25 00	λ Pegasi	Blue......	0·5	1 35	25 11	358 35	14 28
16	12	12 38 00	Sirius × 8	Blue......	1·5	282 00	38 39	275 44	23 50
17	13	11 12 52	γ Pegasi	Blue......	2·0	5 25	23 24	354 32	20 16
18	13	12 53 00	Sirius − 0·1 ...	White ...	2·0	310 09	37 59	298 38	28 48
19	13	10 3 00	α Arietis	White ...	1·0	357 8	26 50	346 30	34 46
20	13	11 53 00	Sirius × 2·5 ...	Blue......	4·5	352 28	44 41	8 00	31 47
21	13	12 18 00	θ Pegasi	Blue......	2·0	25 20	29 56	20 44	28 12
22	13	12 23 00	λ Orionis	Blue......	0·5	23 32	19 29	16 21	16 09
23	15	12 18 00	β Orionis	Blue......	2·0	349 15	31 30	326 28	23 45
24	15	12 31 00	β Orionis	White ...	2·0	358 35	− 5 3	352 56	− 9 43
25	15	12 37 55	α Lyræ.........	White ...	5·0	341 58	27 2	340 33	14 27
26	15	12 45 00	β Pegasi	White ...	2·0	357 46	25 11	350 00	21 45
27	15	12 49 00	β Orionis	White ...	3·0	344 50	30 27	333 21	20 00
28	15	12 49 05	Aldebaran ...	Red	0·5	338 53	29 23	339 40	30 27
29	15	12 58 00	Sirius	Blue......	1·0	356 30	57 11	17 40	62 03
30	15	13 11 00	α Lyræ.........	White ...	2·0	20 38	14 29	12 10	6 43
31	16	10 15 00	λ Arietis	Blue......	0·5	38 19	39 01	45 3	38 13
32	19	10 27 00	ι Geminorum	Blue......	2·0	339 42	− 5 03	335 44	− 7 22
33	Sept. 7	9 30 00	Sirius	Blue......	3·0	309 00	20 39	301 43	16 37
34	7	9 33 00	a star, 3rd mag.	White ...	0·25	335 8·45	−10 45	334 41	−10 51
35	11	9 26 00	Sirius × 4	Blue......	2·0	11 58	10 07	8 8	5 59
36	11	10 21 00	Aldebaran ...	Blue......	2·0	348 3	4 40	340 30	0 54
37	11	10 22 00	Aldebaran ...	Crimson	3·0	348 3	4 40	340 30	0 54
38	22	9 48 00	α Lyræ.........	Blue......	2·0	66 21	40 56	59 39	36 26
39	24	11 53 00	Sirius	White ...	2·5	58 50	67 42	63 47	6 41
40	24	12 6 00	Sirius × 3	Blue......	2·0	49 42	10 00	52 00	− 9 6
41	Oct. 15	9 9 00	Sirius − 3	Blue......	1·5	42 47	8 16	40 9	5 19
42	15	10 17 04	Sirius	White ...	2·0	335 28	2 25	324 52	1 51
43	15	11 1 30	Lyræ............	Blue......	1·0	8 53	− 2 4	3 40	− 4 30
44	15	11 22 53	α Arietis	White ...	1·0	66 43	11 00	71 31	8 17
45	15	11 35 00	α Lyræ.........	White ...	1·5	28 27	− 6 32	22 3	−11 8
46	15	11 52 00	α Lyræ.........	White ...	1·75	32 26	1 7	26 19	− 2 1
47	Nov. 6	11 3 00	Aldebaran × 5	Orange...	1·5	80 57	24 1	69 22	20 00
48	10	6 34 00	α Lyræ.........	White ...	2·0	10 6	22 31	356 12	15 56
49	13	9 39 15	β Orionis	Blue......	0·5	332 25	− 2 55	335 45	− 7 20
50	14	10 50 00	Sirius	Blue......	2·0	75 00	− 3 33	66 39	7 54

Mean places for 1840 of C. R.A.	Decl.	Place of Observation. L. from G.	Lat.	Train or sparks. Remarks.	Observer.	Reference.
° ′	° ′	m s	° ′ ″			
50 30	3 45	+2 54·7	+50 59 46·6	A most splendid meteor, giving light all over the country. Explosion without noise. See fig. 4. 	C. Bulard, Esq.	Mr. Lowe's MS.
244 06	14 25	+2 54·7	+50 59 46·6			
239 00	−11 00	+2 54·7	+50 59 46·6			
324 50	1 57	−4 22·27	+49 26 29			
245 50	23 15	−4 22·27	49 26 29			
338 53	20 47	+2 54·7	+50 59 46·6			
335 28	7 58	+2 54·7	+50 59 46·6	With a train of light and nebulous ball.		
293 16	0 36	+2 54·7	+50 59 46·6			
289 35	0 01	+2 54·7	+50 59 46·6			
284 30	− 5 07	+2 54·7	+50 59 46·6			
13 31	50 00	+2 54·7	+50 59 46·6	Passing through a small Cirrocumulus. 		
82 14	27 49	+2 54·7	+50 59 46·6			
32 20	12 23	+2 54·7	+50 59 46·6			
90 35	−13 00	+2 54·7	+50 59 46·6	A very beautiful meteor, having a nebulous appearance, train of light. No. 16, alike. No. 14. See fig. 3 in Map. 		
52 23	5 59	+2 54·7	+50 59 46·6			
74 58	14 35	+2 54·7	+50 59 46·6			
48 00	12 09	+2 54·7	+50 59 46·6			
91 25	15 21	+2 54·7	+50 59 46·6			
38 22	37 38	+2 54·7	+50 59 46·6			
8 27	20 00	+2 54·7	+50 59 46·6	Rather a brilliant object.		
15 12	25 11	+2 54·7	+50 59 46·6			
11 51	10 00	+2 54·7	+50 59 46·6			
17 50	2 14	+2 54·7	+50 59 46·6			
48 3	−16 40	+2 54·7	+50 59 46·6			
43 56	−12 28	+2 54·7	+50 59 46·6			
46 30	15 33	+2 54·7	+50 59 46·6			
26 27	7 36	+2 54·7	+50 59 46·6			
44 55	30 02	+2 54·7	+50 59 46·6	Here a rather curious phenomenon took place. When No. 27 was in C, No. 28 vanished at C, fig. 10.		
38 19	56 58	+2 54·7	+50 59 46·6			
8 8	− 5 14	+2 54·7	+50 59 46·6			
48 14	34 14	+2 54·7	+50 59 46·6			
30 50	−12 21	+2 54·7	+50 59 46·6			
97 34	10 14	+2 54·7	+50 59 46·6	A beautiful meteor with train of light.		
34 12	−10 41	+2 54·7	+50 59 46·6	34. Seen in the field of telescope while observing Neptune. The given places are for 1800. 35. Train of light.		
6 2	0 00	+2 54·7	+50 59 46·6			
35 11	− 5 3	+2 54·7	+50 59 46·6			
35 11	− 5 3	+2 54·7	+50 59 46·6			
57 20	31 47	+2 54·7	+50 59 46·6	37. This meteor has not been observed except the light which emanated from it from the zenith and which was very brilliant indeed, and so intense was it that the observer thought it safer to take a shelter in-doors.		
69 22	5 20	+2 54·7	+50 59 46·6			
52 11	−11 33	+2 54·7	+50 59 46·6			
38 56	1 00	+2 54·7	+50 59 46·6			
14 7	− 6 31	+2 54·7	+50 59 46·6			
2 38	− 9 57	+2 54·7	+50 59 46·6			
73 3	3 29	+2 54·7	+50 59 46·6			
20 8	−16 30	+2 54·7	+50 59 46·6			
24 14	− 9 7	+2 54·7	+50 59 46·6			
61 1	13 32	+2 54·7	+50 59 46·6	This is the curious meteor of which a drawing is given in the Map. It showed a dark side, and then a bright one. See fig. 9.		
48 3	6 43	+2 54·7	+50 59 46·6			
36 47	−11 32	+2 54·7	+50 59 46·6			
64 52	−14 10	+2 54·7	+50 59 46·6			

No.	Date.	Hour. Greenwich Mean Time	Apparent Magnitude.	Brightness and colour.	Velocity or Duration.	Mean places for 1840 of A. R.A.	Mean places for 1840 of A. Decl.	Mean places for 1840 of B. R.A.	Mean places for 1840 of B. Decl.
		h m s			s	° ′	° ′	° ′	° ′
51	Nov. 16	7 37 00	Aldebaran ...	Blue......	2·0	15 12	34 46	26 9	24 15
52	16	7 37 37	Sirius	Blue......	3·0	45 37	19 00	38 45	21 53
53	16	8 43 00	Sirius×3.......	Blue......	5·0	79 51	45 00	99 44	59 36
54	Dec. 8	11 9 00	α Lyræ.........	White ...	1·0	64 59	12 43	58 40	8 29
55	8	11 13 00	Sirius	White ...	2·0	82 00	18 2	83 10	6 12
56	9	9 7 00	Sirius	White ...	0·5	324 21	23 45	332 6	14 3
	1850.								
57	Jan. 6	6 13 00	α Lyræ	White ...	4·0	359 45	28 12	15 35	30 34
58	Feb. 9	7 17 32	β Orionis	White ...	1·0	85 2	1 28	85 10	− 4 8
59	11	9 10 25	α Lyræ.........	Blue......	0·5	121 30	9 40	126 29	12 45
60	12	10 57 00	Sirius×5	Blue......	5·0	170 30	− 2 07	181 40	− 9 16
61	Mar. 6	8 22 00	Sirius—4	Blue......	1·0	195 00	71 7	212 17	70 11
62	15	9 42 00	β Orionis	Blue......	0·5	130 46	17 34	124 55	14 44
63	15	12 9 00	α Aldebaran...	Blue......	0·5	214 45	22 4	223 22	21 51
64	A 5	9 0 00	Lyra α	Blue......	1·0	193 33	10 18	189 23	6 00
65	5	9 16 00	Sirius×3......	Blue......	5·0	212 37	62 17	βθ Borealis.	δ Borea[illegible]
66	18	8 48 00	α Lyræ.........	White ...	2·0	168 13	8 12	172 11	4 29
67	May 9	13 10 00	β Orionis	Blue......	1·5	282 00	38 38	275 44	23 50
68	9	13 17 00	β Orionis	Blue......	1·0	281 3	33 49	274 51	28 50
69	30	11 55 00	Arcturus	Blue......	2·0	151 51	72 55	154 59	59 00
70	June 1	11 33 00	α Orionis	Blue......	1·0	237 16	3 02	231 47	1 38
71	1	11 42 53	α Arietis	Blue......	0·5	306 16	42 54	313 9	43 5[illegible]
72	1	13 47 00	α Arietis	Blue......	0·5	261 42	47 54	253 33	42 4[illegible]
73	Aug. 12	10 10 37	α Lyræ.........	Blue......	1·0	281 00	32 40	277 53	31 3[illegible]
74	12	10 23 30	α Lyræ.........	Blue......	1·5	295 00	7 10	290 20	1 3[illegible]
75	12	10 47 35	Sirius	Blue......	0·5	17 35	57 25	30 01	55 5[illegible]
76	12	10 49 37	Sirius	Blue......	0·5	20 44	55 39	13 31	49 5[illegible]
77	12	10 50 37	α Lyræ.........	Blue......	1·0	355 00	32 00	4 30	42 0[illegible]
78	30	11 15 00	α Lyræ.........	White ...	0·5	344 00	24 36	355 00	23 4[illegible]
79	Sept. 10	10 57 30	β Orionis	Blue......	0·5	358 00	18 44	357 45	14 4[illegible]
80	10	11 23 54	β Orionis	Blue......	0·5	22 47	27 13	20 44	20 4[illegible]
81	Oct. 10	10 15 00	α Pegasi	White ...	0·5	164 50	61 15	155 88	58 4[illegible]
82	10	11 6 00	Sirius	Blue......	2·0	28 8	− 9 20	19 05	−12 4[illegible]
83	11	10 33 50	β Orionis	Blue......	0·5	5 15	20 00	7 08	2 4[illegible]
84	Nov. 6	7 27 30	Sirius×3.......	Blue......	2·0	6 00	64 00	20 00	80 0[illegible]
85	6	9 56 00	β Pegasi	Blue......	0·5	31 05	14 00	23 17	4 4[illegible]
86	8	7 8 00	α Pegasi	Blue......	1·0	322 18	25 00	325 38	16 [illegible]
87	8	7 30 00	α Lyræ.........	Blue......	1·5	12 22	34 46	11 40	26 [illegible]
88	8	7 33 54	Sirius×5.......	Blue......	1·0	30 5	20 00	28 39	14 2[illegible]
89	8	8 21 30	σ Orionis	White ...	0·75	29 28	18 35	25 00	12 5[illegible]
90	8	8 39 24	β Orionis	Blue......	0·5	14 17	19 23	5 14	14 [illegible]
91	8	9 35 24	β Pegasi	Blue.. ...	0·5	53 04	33 27	51 00	26 [illegible]
92	23	7 35 00	β Pegasi	Blue......	0·5	15 00	2 46	17 54	− 3 [illegible]
93	25	5 58 00	α Lyræ.........	Blue......	1·0	197 00	9 30	195 00	7 [illegible]
	1851.								
94	Jan. 5	10 12 00	Mars×4	Red	1·5	166 28	15 45	160 00	12 [illegible]
95	27	10 42 00	α Lyræ.........	Blue......	0·5	65 24	10 00	69 30	11 [illegible]
96	27	10 48 00	α Lyræ.........	Blue......	1·0	81 25	23 56	72 02	23 [illegible]
97	Feb. 5	11 33 00	β Orionis	Blue......	0·75	149 56	0 24	149 00	0 [illegible]
98	5	11 34 50	Sirius	Blue......	1·5	186 00	15 47	196 30	14 [illegible]
99	5	11 45 00	β Orionis	Blue......	0·5	140 00	8 00	144 00	9 [illegible]
100	5	11 52 00	α Lyræ.........	Blue......	1·0	185 00	1 15	189 00	4 [illegible]
101	21	10 4 00	Sirius	Blue......	0·5	128 00	+ 4 30	119 30	+13 [illegible]
102	21	11 15 00	Arcturus	Red	0·5	92 00	+23 16	87 1	+25 [illegible]
103	21	12 16 00	Lyræ	White ...	0·2	191 53	+ 6 40	197 23	+ 6 [illegible]

Mean places for 1840 of C.		Place of Observation.		Train or sparks. Remarks.	Observer.	Reference.
R.A.	Decl.	L. from G.	Lat.			
° ′	° ′	m s	° ′ ″			
30 1	16 55	+2 54·7	+50 59 46·6		C. Bulard, Esq.	Mr. Lowe's MS.
37 48	22 00	+2 54·7	+50 59 46·6	Ascending slowly.		
129 37	62 33	+2 54·7	+50 59 46·6			
54 20	3 28	+2 54·7	+50 59 46·6			
85 2	− 2 42	+2 54·7	+50 59 46·6			
335 9	5 25	+2 54·7	+50 59 46·6			
30 1	17 23	+8 20·0	+50 30 00	Ascending slowly.		
83 10	9 44	+8 20·0	+50 30 00	A beautiful meteor with two successive fire-balls. Explosion without noise. See fig. 7, 10ʰ 57ᵐ 0ˢ. Fig. 8, 10ʰ 57ᵐ 4ˢ.		
128 45	18 00	+8 20·0	+50 30 00			
185 24	−15 37	+8 20·0	+50 30 00			
225 23	66 32	+8 20·0	+50 30 00			
121 40	10 39	+8 20·0	+50 30 00			
229 9	17 29	+2 54·7	+50 59 46·6			
188 32	0 35	+2 54·7	+50 59 46·6			
237 45	23 45	+2 54·7	+50 59 46·6	This meteor passed exactly over the following stars. 		
174 25	− 1 37	+2 54·7	+50 59 46·6			
276 8	14 35	+2 54·7	+50 59 46·6			
271 54	20 55	+2 54·7	+50 59 46·6			
150 30	47 47	+2 54·7	+50 59 46·6			
228 53	− 7 53	+2 54·7	+50 59 46·6			
318 41	44 53	+2 54·7	+50 59 46·6			
251 8	34 22	+2 54·7	+50 59 46·6			
275 1	28 48	−4 22·27	+49 26 29			
284 26	− 6 2	−4 22·27	+49 26 29			
39 45	52 50	−4 22·27	+49 26 29			
9 57	50 8	−4 22·27	+49 26 29			
15 00	46 23	−4 22·27	+49 26 29			
6 00	18 44	+2 54·7	+50 59 46			
357 30	7 36	+2 54·7	+50 59 46			
20 40	14 38	+2 54·7	+50 59 46			
148 29	54 45	+2 54·7	+50 59 46			
12 41	−16 49	+2 54·7	+50 59 46	A fine meteor with train of light.		
10 30	−11 15	+2 54·7	+50 59 46			
80 00	82 56	+2 54·7	+50 59 46			
20 27	− 5 41	+2 54·7	+50 59 46			
326 27	7 30	+2 54·7	+50 59 46			
13 40	16 05	+2 54·7	+50 59 46			
28 32	6 09	+2 54·7	+50 59 46	A beautiful meteor having the appearance of a blue ball.		
21 49	5 19	+2 54·7	+50 59 46			
1 15	10 00	+2 54·7	+50 59 46			
51 14	20 00	+2 54·7	+50 59 46			
19 00	− 9 58	+2 54·7	+50 59 46			
190 00	6 00	+2 54·7	+50 59 46			
156 38	8 00	+2 54·7	+50 59 46	A beautiful meteor, of a red colour, inclining towards orange, perhaps on account of its proximity to the horizon.		
72 30	10 00	+2 54·7	+50 59 46			
66 30	20 25	+2 54·7	+50 59 46			
148 58	− 0 54	+2 54·7	+50 59 46			
203 30	8 00	+2 54·7	+50 59 46			
145 00	8 15	+2 54·7	+50 59 46			
192 00	6 10	+2 54·7	+50 59 46			
101 24	+16 23	+2 54·7	+50 59 46			
81 25	+23 56	+2 54·7	+50 59 46			
201 40	+ 4 00	+2 54·7	+50 59 46			

No.	Date.	Hour. Greenwich Mean Time	Apparent Magnitude.	Brightness and Colour.	Velocity or Duration.	Mean places for 1840 of A.		Mean places for 1840 of B.	
						R.A.	Decl.	R.A.	Decl.
	1851.	h m s			s	° ′	° ′	° ′	° ′
104	Feb. 21	12 20 00	Lyra...........	Blue......	0·5	178 10	+ 7 30	170 00	+ 6 54
105	21	13 8 30	Virgo	White ...	0·5	144 00	+26 45	138 50	+26 52
106	21	13 30 30	Virgo	White ...	0·25	216 14	+31 4	219 00	+34 00
107	22	13 30 30	Sirius	Blue......	0·5	175 13	+15 28	163 27	+17 00
108	26	8 58 30	Aldebaran ...	Red	1·5	196 37	+41 00	191 40	+34 24
109	Mar. 24	13 56 30	Lyra...........	Blue......	0·5	15 33	+86 27	343 51	+83 29
110	Apr. 19	10 30 30	Arcturus	Blue......	2·0	214 00	+39 00	205 28	+20 00
111	19	9 45 30	Lyra...........	Blue......	1·0	128 54	+18 13	127 6	+10 12
112	22	10 47 30	Lyra...........	Blue......	0·5	227 6	− 8 30	230 00	− 8 5
113	28	9 40 30	Lyra...........	Blue......	0·5	180 00	+ 2 40	170 32	− 4 00
114	28	9 50 30	Regulus	White ...	0·25	185 24	−14 30	181 00	−15 00
115	28	9 55 30	Regulus	White ...	0·25	184 00	−16 00	180 00	−20 00
116	30	11 40 30	Lyra...........	Blue......	0·5	263 00	+ 4 40	259 00	− 0 00
117	July 21	10 40 30	Lyra...........	Blue......	0·5	3 1	+28 52	2 5	+21 37
118	21	11 23 46	Aldebaran ...	Red	1·0	353 8	+45 40	1 18	+50 12
119	21	11 28 40	Lyra...........	Blue......	0·5	348 14	+26 50	354 56	+31 30
120	21	11 46 40	γ Arietis	Blue......	0·25	357 44	+46 59	2 30	+42 20
121	21	11 49 10	γ Arietis	Blue......	0·25	10 15	+33 5	12 20	+28 5
122	21	11 56 25	γ Arietis	Blue......	0·25	28 30	+31 30	30 5	+25 11
123	30	10 53 10	γ Arietis	Blue......	0·25	20 44	+29 14	26 4	+28 50
124	30	11 0 2	Lyra...........	Blue......	1·5	349 21	+30 00	0 30	+45 11
125	30	11 19 40	Sirius	Blue......	0·25	340 25	+23 40	342 20	+20 00
126	30	11 23 10	γ Arietis	White ...	0·5	0 9	+53 38	359 10	+52 10
127	30	11 53 10	Lyra...........	Blue......	0·5	357 14	+45 11	9 58	+48 25
128	30	11 56 25	Lyra...........	Blue......	0·25	0 30	+29 00	2 34	+30 38
129	30	11 56 30	Sirius	Blue......	0·5	6 40	+59 15	350 15	+66 21
130	30	12 1 10	Lyra...........	Blue......	0·25	18 45	+59 17	15 35	+59 32
131	30	12 5 55	γ Pegasi	Blue......	0·25	358 26	+38 48	2 30	+39 49
132	30	12 12 10	Sirius × 2......	Blue......	1·0	24 45	+48 15	35 00	+52 18
133	Aug. 3	9 48 15	Lyra × 2	Blue......	0·5	333 40	+29 18	338 24	+25 00
134	3	10 27 45	Lyra × 2	Blue......	0·25	348 15	+22 46	348 40	+15 50
135	3	10 29 00	Lyra × 2	Blue......	0·25	22 3	+47 4	28 31	+41 34
136	3	10 33 45	Lyra × 2	Blue......	0·25	346 5	+29 18	351 35	+32 50
137	3	10 54 50	Lyra...........	Blue......	0·5	357 14	+ 4 34	20 53	58 24
138	3	11 2 50	Lyra...........	Blue......	0·25	359 8	+30 18	345 13	38 27
139	3	11 14 30	Lyra × 4	Blue......	0·5	10 00	− 3 25	0 32	− 8 5
140	3	11 22 20	Lyra × 4	Blue......	0·25	353 59	+23 41	348 41	15 56
141	3	12 8 20	Lyra × 4	Blue......	0·5	34 45	+ 7 35	27 15	3 20
142	3	12 12 40	Lyra × 4	White ...	0·5	5 36	−10 35	0 38	−15 17
143	3	12 16 10	Lyra − 0·25 ...	Blue......	0·25	31 8	+11 00	34 40	11 15
144	3	12 36 10	Lyra − 0·25 ...	Blue......	0·25	36 5	+39 31	40 25	34 24
145	3	12 46 10	Lyra − 0·25 ...	Blue......	0·25	4 2	−13 6	1 38	−18 24
146	3	12 56 30	Sirius	Blue......	0·5	30 57	+17 23	27 9	14 31
147	3	12 59 30	Lyra...........	Blue......	0·25	40 20	37 10	35 12	36 40
148	3	13 1 20	Lyra...........	Blue......	0·5	53 4	32 52	52 36	27 40
149	3	13 14 20	Lyra...........	Blue......	0·25	56 4	17 2	56 29	12 34
150	3	13 28 15	Lyra...........	Blue......	1·0	43 31	20 42	45 37	19 7
151	17	9 44 30	Lyra...........	Blue......	0·5	257 14	43 27	5 37	48 45
152	17	10 25 30	Lyra...........	Blue......	0·5	268 14	16 40	265 1	12 41
153	17	10 36 30	Lyra...........	Blue......	0·25	262 17	1 19	257 46	− 1 59
154	17	9 49 30	Lyra...........	Blue......	0·25	239 00	4 40	236 50	2 20
155	20	9 50 1	Lyra...........	Blue......	1·0	17 40	12 30	21 49	16 37
156	21	10 2 1	Lyra...........	Blue......	0·5	181 52	57 00	176 54	56 20
157	Sept. 3	13 26 30	Sirius × 3	Blue......	1·0	8 28	40 24	10 19	26 50

Mean places for 1840 of C.		Place of Observation.		Train or sparks. Remarks.	Observer.	Reference.
R.A.	Decl.	L. from G.	Lat.			
° ′	° ′	m s	° ′ ″			
163 4	+ 4 29	+2 54·7	+50 59 46		C. Bulard, Esq.	Mr. Lowe's MS.
133 20	+25 5	+2 54·7	+50 59 46			
224 11	+36 30	+2 54·7	+50 59 46			
150 00	+16 00	+2 54·7	+50 59 46	Train.		
190 58	+28 25	+2 54·7	+50 59 46			
350 13	+77 00	+2 54·7	+50 59 46			
195 00	+ 5 00	+2 54·7	+50 59 46			
123 43	− 1 37	+2 54·7	+50 59 46			
232 31	− 9 31	+2 54·7	+50 59 46			
163 00	−13 55	+2 54·7	+50 59 46			
178 00	−18 00	+2 54·7	+50 59 46			
178 00	−22 00	+2 54·7	+50 59 46			
257 00	− 7 00	+2 54·7	+50 59 46			
3 5	+16 00	+5 12	+50 45 25			
14 25	+49 41	+5 12	+50 45 25			
357 24	+34 46	+5 12	+50 45 25	Train of light.		
7 5	+38 42	+5 12	+50 45 25			
15 00	+25 11	+5 12	+50 45 25			
32 18	+22 35	+5 12	+50 45 25			
30 57	+27 1	+5 12	+50 45 25			
12 45	+50 00	+5 12	+50 45 25	Train of light.		
342 24	+14 27	+5 12	+50 45 25			
358 24	+48 25	+5 12	+50 45 25			
21 00	+47 55	+5 12	+50 45 25			
6 5	+32 40	+5 12	+50 45 25			
337 57	+71 33	+5 12	+50 45 25			
13 00	+59 47	+5 12	+50 45 25	Train of light.		
7 5	+33 40	+5 12	+50 45 25			
48 30	+53 15	+5 12	+50 45 25	Train of light.		
335 12	+20 10	+5 12	+50 45 25			
348 41	+19 57	+5 12	+50 45 25			
30 1	+34 14	+5 12	+50 45 25			
359 47	+34 46	+5 12	+50 45 25			
52 53	+60 38	+5 12	+50 45 25	Train of light.		
355 53	+45 30	+5 12	+50 45 25	Train of light.		
350 53	−15 55	+5 12	+50 45 25	Train of light.		
345 29	10 53	+5 12	+50 45 25	Train of light.		
22 45	− 2 12	+5 12	+50 45 25	Train of light.		
0 52	−22 35	+5 12	+50 45 25	Train of light.		
38 28	10 35	+5 12	+50 45 25	Train of light.		
44 1	29 30	+5 12	+50 45 25	Train of light.		
360 00	−22 40	+5 12	+50 45 25	Train of light.		
24 14	8 21	+5 12	+50 45 25	Train of light.		
31 48	34 14	+5 12	+50 45 25	Train of light.		
51 49	23 00	+5 12	+50 45 25	Train of light.		
57 57	8 29	+5 12	+50 45 25	Train of light.		
50 30	10 23	+5 12	+50 45 25	Train of light.		
17 31	53 1	+5 12	+50 45 25	Train of light.		
251 53	4 50	+5 12	+50 45 25	Train of light.		
255 18	− 5 50	+5 12	+50 45 25	Train of light.		
235 19	1 25	+5 12	+50 45 25	Train of light.		
25 10	18 30	+5 12	+50 45 25	Train of light.		
168 20	54 30	+5 12	+50 45 25	Train of light.		
11 32	18 19	+5 12	+50 45 25	Train of light.		

IV. *Observations of Luminous Meteors*, 1851–52. *Com-*

Date.	Hour.	Appearance or magnitude.	Brightness and colour.	Train or sparks.	Velocity or duration.
1851. July 4	h m 11 16 30s	=twice ♃	Orange - red, the separate balls blue, very bright, at last became more purple.	Small separate balls. 	3 secs., slowly; at last vanished suddenly.
20	11 5	=twice ♃	Red	Slight tail	$\frac{1}{2}$ sec. ....
	11 15	As a spark	Orange-red ...	Slight tail	0·2 sec. ....
29	10 36	Small, indistinct	Yellow	Separate sparks	0·5 sec. ....
	10 39	More than 1st mag....	Yellow. Less than 1st mag.	Separate sparks	$1\frac{1}{2}$ sec.; slowly ...
Aug. 5	10 39	....	= 1st mag. ...	Train 25° long	Passed 1° 30′ above γ, 2° below β, and just below ψ Ursæ Majoris.
7	9 3	Small	....	As a spark	Rapidly ....
10	8 23	Large	....	....	....
22	9 30	Large	....	Long tail	....
28	10 31	....	= 4th mag. ...	....	Passed midway between 2 Draconis and α Ursæ Majoris, through ξ Ursæ Majoris.
Sept. 3	11h to 13h	....	....	....	....
4	9 40	....	....	....	....
5	9 40	Small	....	....	....
	10 7	= 2nd mag.	Blue	Continuous streak	Rapid ....
	10 25	= to Saturn	Orange - red. Brighter than Saturn.	Giving out stars	Moved over 12° in 3 secs.
10	9 16	= 3 times Venus in opposition.	= 4 times Venus in opposition. Blue.	Long continuous blue stream of light.	3 secs. ....
14	9 15	Very small, = 7th mag.	Colourless ...	Continuous streak	Instantaneous ......

municated by E. J. Lowe, Esq., *F.R.A.S, F.G.S.*

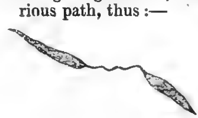
Direction or altitude.	General remarks.	Place.	Observer.	Reference.
From γ Lyræ through β Cygni, β Delphini to γ Equulei. The meteor always equally large and bright.	Well-defined circular disc. The small circular appendages kept vanishing quickly, never remaining visible a distance of twice the diameter of the object.	Highfield House	E. J. Lowe, Esq.	Mr. Lowe's MS.
From near No. 6 Cassiopeiæ to H. 1 Camelopardi. Commenced R.A. $23^h 51^m$, N.P.D. 29° 10′, ended at R.A. $1^h 15^m$, N.P.D. 25° 15′.	Increased from a point to 2 secs. ♃.	Ibid.	Id.	Ibid.
λ Cassiopeiæ to η Persei. Commenced AR. $0^h 12^m$, N.P.D. 40°, ended AR. $1^h 27^m$, N.P.D. 37° 30′.		Ibid.	Id.	Ibid.
From χ to λ Ophiuchi		Ibid.	Id.	Ibid.
From 41 Camelopardi to 39 Lyncis.	Well-defined disc...	Ibid.	Id.	Ibid.
2 secs.		Darlington, Durham.	J. Graham, Esq.	Ibid.
δ Cephei to ψ Andromedæ		Highfield House	E. J. Lowe, Esq.	Ibid.
ϵ Ursæ Majoris to 42 Coma Berenices.	Seen through haze.	Ibid.	Id.	Ibid.
From E. to W., passing 10° S.E. of zenith.		Nottingham	M. J. L. E. Durand.	Ibid.
Great velocity		Darlington, Durham.	J. Graham, Esq.	Ibid.
	Many falling stars .	Ibid.	Id.	Ibid.
In S.E.		Ibid.	Id.	Ibid.
From zenith perpendic. down in N.W.		Highfield House Observatory.	E. J. Lowe, Esq.	Ibid.
From under Atair perpendic. down.	Bright	Ibid.	Id.	Ibid.
Downwards =45°, passing 35′ above Saturn.	Increased from a point and disappeared at maximum brightness.	Ibid.	Id.	Ibid.
From midway between θ and η Aquilæ, passing above λ Aquilæ through η Serpentis, disappeared between γ and τ Ophiuchi a little above ζ Serpentis.	Circular, well-defined edge, intensely blue.	Observatory, Beeston.	Id.	Ibid.
Position when first seen R.A. $19^h 51^m$, N.P.D. 90° 20′; point of disappearance R.A. $17^h 41^m$, N.P.D. 92° 58′.	Very many small meteors.	Ibid	Id.	Ibid.
Through ϵ Lyræ, passing to N. horizontally.		Highfield House	Id.	Ibid.

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or duration.
1851. Sept. 14	h m 10 20	=3rd mag.		Continuous streak	Duration ½ sec.
18*	8 41	=3rd mag.	Colourless	Continuous streak	Duration 1 sec.
18*	8 55	= 1st mag.	Blue, brighter than 1st. mag.	Continuous streak	Duration 1·5 sec.
18*	8 59 30s	= 1st mag.	Blue	Stream	1·2 sec.
18*	9 40	=3rd mag.			Rapid
18*	9 41	= 3rd mag.	Blue	Stream	0·8 sec.
18					
20	9 50	Nearly ½ diam. ☾	Light blue	Long train, which vanished rapidly.	3 to 4 secs.
21					
	8 20	Small		Streak	
	8 24	Small		Streak	
	8 30	Small		Streak	
	8 30	Small		Streak	
	8 31	=2nd mag.		Streak	
28	7 40	=8th mag.			Instantaneous
	8 20	=6th mag.			Instantaneous
	8 30	=6th mag.	Blue		
	8 45	= 2nd mag.	Orange-yellow	Collection of sparks, thus: 	1 sec.
Oct. 1	8 20	=2nd mag.			
7					
	7 35	=2nd mag.	Bluish	As a spark	3 secs.
	8 0	=1st mag.	Blue		
16	9 15	=4·5 mag.			1 sec.
19	12 9	1st mag.		Train	
23	10 3	=3rd mag.	Yellowish		2 secs.
27	9 51	=3rd mag.	Blue		2·5 secs.
	9 54 30s	= ♃ at opposition	Faint blue		2 secs.
	10 3	Very small			1 sec.

* These five meteors gave a point of

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
From 10° S. (and same level as) α Lyræ towards S.	Appeared very distinct at $<45°$; rapid.	Highfield House	E. J. Lowe, Esq.	Mr. Lowe's MS.
From α Cassiopeiæ perpendic. down.	....	Observatory, Beeston.	Id.	Ibid.
From 39 through ξ Pegasi.......	Increased from a point, circular.	Ibid	Id.	Ibid.
From α Draconis through η Ursæ Majoris.	....	Ibid	Id.	Ibid.
Through ε Aquilæ perpendicularly down.	....	Ibid	Id.	Ibid.
From 6 Vulpeculæ perpendic. down through ϑ Serpentis.	....	Ibid...............	Id.	Ibid.
....	Several meteors ...	Highfield House	A. S. H. Lowe, [Esq.	Ibid.
Below χ Draconis over δ Ursæ Minoris, vanishing in the head of the Lynx near No. 14. First seen R.A. $18^h 8^m$, N.P.D. 15° 40′, disappeared R.A. $6^h 15^m$, N.P.D. 31°.	Almost as light as day.	Ibid...............	Id.	Ibid.
....	Several small meteors.	Ibid...............	Id.	Ibid.
Down through α Cassiopeiæ ...	....	Obser^y, Beeston	E. J. Lowe, Esq.	Ibid.
Through α Delphini, downwards	....	Ibid...............	Id.	Ibid.
Through α Cassiopeiæ	....	Ibid...............	Id.	Ibid.
Through Polaris	....	Ibid...............	Id.	Ibid.
From head of Draco towards Cygnus.	....	Ibid...............	Id.	Ibid.
Horizontal level but 2° E. of α Andromedæ, perpendicular down inclining to S.	....	Ibid...............	Id.	Ibid.
Below α Cassiopeiæ perpendic. down.	....	Ibid...............	Id.	Ibid.
Across from α Arietis under Pegasus, square at $<25°$.	....	Ibid...............	Id.	Ibid.
Moved horizontally from 3° N. and 3° lower than Saturn, moved towards N. Passed over 2° of space.	An assemblage of sparks, the whole mass being equal to a 2nd mag.*	Ibid...............	Id.	Ibid.
Moved down at $<25°$ towards N. from 1° above Cor. Caroli, passing 15′ to N. of that star.	Auroral glare and lightning.	Ibid...............	Id.	Ibid.
....	Many meteors	Ibid...............	Id.	Ibid.
From under Cassiopeia horizontally to β Ursæ Majoris.	Slow..................	Ibid...............	Id.	Ibid.
From S. downwards at $<$ of 40°, passed 2° below ☾.	....	Ibid...............	Id.	Ibid.
Immediately below α Pegasi, perpendic. down.	Space 4°	Castle Donington	W. H. Leeson, Esq.	Ibid.
Between α Pegasi and α Andromedæ down.	....	Highfield House	A. S. H. Lowe, Esq.	Ibid.
β Pegasi to α Andromedæ	....	Castle Donington	W. H. Leeson, Esq.	Ibid.
From β Cygni to μ Aquilæ......	....	Ibid...............	Id.	Ibid.
From μ Aquilæ, incurved direction towards ϑ Tauri Poniatowski.	Small at first, gradually increased to size ♃ at opposition.	Ibid...............	Id.	Ibid.
Near Scheat to near Markab (Pegasi).	....	Ibid...............	Id.	Ibid.

divergence about R.A. $23^h 15^m$, N.P.D. 30°.

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or duration.
1851.	h m s				
Oct. 27	10 11 30...	Small	Blue..........	....	1 sec. ....
29	8 58 30...	Very small	....	....	Almost instantaneous.
30	8 25	=to Saturn...........	Much brighter than Saturn; orange.	Long tail of sparks	2 secs. ....
	8 50	=2nd mag...........	=3rd mag., yellow.	Continuous streak	1 sec.; rapid ......
	9 4	=3rd mag.	Orange, =3·5 mag.	Composed of many separate sparks.	2 secs.; slowly ...
Nov. 3	5 32	6 times size of Saturn	Pale orange, and after 15° movement turned bluish.	Slight tail ....  The above is a sketch of it.	12 secs. ....
4	5 30	¼ size of ☾	Orange and prismatic.	No sparks	Several seconds ...
11	7 49 30...	Very bright...........	Much brighter than Vega.	Leaving bright train, curious path, thus :— 	3·5 secs. ....
	8 5 30...	Small	....	....	0·5 sec. ....
12	7 56	Very small	Blue..........	....	Less than 1 sec. ...
	9 4	=4·5 mag.	....	....	Less than 1 sec. ...
	10 10	=2nd mag...........	Brighter than 2nd mag.; orange-red.	Sparks	1 sec. ....
14	10 45	=2nd mag,...........	....	Train of light	....

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
Midway between Vega and Altair to below Delphinus.	....	Castle Donington	W. H. Leeson, Esq.	Mr. Lowe's MS.
From α to κ Draconis............	Aurora at the time.	Ibid...............	Id.	Ibid.
From near ϑ Draconis to about No. 76 Ursæ Majoris. First seen R.A. 12° 53′, N.P.D. 31°; disappeared R.A. 12^h 32^m, N.P.D. 26° 20′.	....	Obser^y, Beeston	Id.	Ibid.
From ζ Andromedæ to δ Piscium	....	Ibid...............	Id.	Ibid.
From No. 72 to ο Piscium	....	Ibid...............	Id.	Ibid.
From 13° S. of Marac; passed 3° S. of Arcturus; continued visible to near horizon; vanished suddenly.	Moved very slowly. Before starting increased from a point to 4 times the size of Saturn, moved 15°, and then increased to 6 times the size of Saturn.	Highfield House	E. J. Lowe, Esq. and A. S. H. Lowe, Esq.	Ibid.
From just N. of Jupiter fell downwards at an angle of 55° towards N. horizon; it disappeared very near the horizon in haze. The sun just set, a half ☾, and much glare in the sky at the time. When first seen was about ¼ size of ☾ and had confused edges, being a mass of prismatic light; after descending slowly for a time the confused light disappeared, and it assumed the form of a well-defined orange ball, twice the size of ♃, and intensely bright. The meteor disappeared in thick mist. (Probably the luminosity which surrounded it was rendered invisible owing to passing behind cirrous haze, which there was at the time.—E. J. L.)	....	½ mile W.N.W. of Bramcote.	R. Enfield, Esq.	Ibid.
From ε Pegasi to 3° below Altair, much brighter than Altair; it then became fainter, and moved 1° in horizontal direction somewhat zigzag, then shot off more rapidly towards ϑ Poniatowski, near which star it suddenly disappeared, leaving a bright train.	....	Castle Donington	W. H. Leeson, Esq.	Ibid.
1° above η Ursæ Majoris to 1° below that star.	....	Ibid...............	Id.	Ibid.
From α Pegasi to ζ Pegasi	....	Ibid...............	Id.	Ibid.
From midway between γ and β Cygni to near β Lyræ.	....	Ibid...............	Id.	Ibid.
From β Persei through the Pleiades.	....	Highfield House.	E. J. Lowe, Esq.	Ibid.
From Polaris to head of the Dragon.	....	Ibid...............	Id.	Ibid.

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Trains or sparks.	Velocity or duration.
1851. Nov. 15	h m 6 18	Small	Yellow	Slight tail	Instantaneous
	6 20	Small			Instantaneous
16	6 58	= ♃		Tail	2 secs.
	7 4	Small, thus:— 	White	Separate stars	$\frac{1}{4}$ sec.; rapid
	7 5	Small		No tail	Instantaneous
	7 36	Small			
	7 45	=to Saturn	Red	Continuous train left	3 secs.
17	10 50	=to Rigel	Coloured, brilliancy of Rigel.	Slight sparks	
18	10 8	=1st mag.	Red	No tail	
20	11 10	=3rd mag.	Orange	Sparks	1 sec.
	11 13	=3rd mag.	Orange	Sparks	1 sec.
30	6 26		=1st mag.		Passed midway be tween κ and χ Dra conis, and over ε Ur sæ Majoris.
Dec. 1	8 23 45s	=twice Saturn	Red and orange.	Separate sparks. The following figures will show its several appearances:— 	4 secs.
24	11 4	=3rd mag.	Orange	Train of light left	Rapid, being in stantaneous.
26	8 3	=2nd mag.	Orange	Tail	$\frac{1}{2}$ sec.
29	10 14	=2nd mag.	Yellow	Tail	$\frac{1}{2}$ sec.
	7 46	Orange, outshone Mars.		Without a train	In N.E. alt. 12°, an moved down to wards the extremit of an auroral arcl Its path formed a angle of about 6(with E. horizon. I vanished when 1½ above the uppe edge of the arcl near its E. extrem ty; at about 1m late a very great chang occurred in the au rora, it became ver active, very brilliar streamers occu ring for 15m.

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
From η Ursæ Majoris perpendic. down.	....	Highfield House	E. J. Lowe, Esq.	Mr. Lowe's MS.
From β Bootis perpendic. down	....	Ibid.	Id.	Ibid.
From 1° above Saturn horizontally towards S.	Moved over 20° of space.	Ibid.	Id.	Ibid.
From immed^y above α Andromedæ, moved towards Atair, and ended when half-way to that star.	Ibid.	Ibid.	Id.	Ibid.
From α Arietis to 2° E. of Saturn	....	Obser^y, Beeston.	Id.	Ibid.
Perpendic. down from midway between α and β Aurigæ.	....	Ibid.	Id.	Ibid.
Fell upwards through θ, η and ζ Draconis.	....	Ibid.	Id.	Ibid.
Perpendic. down from γ Pegasi.	Lightning and aurora borealis.	Ibid.	Id.	Ibid.
4° N. of α Cygni towards horizon, passing S. of Vega.	....	Ibid.	A.S.H. Lowe, Esq	Ibid.
Perpend. down from midway between η Ursæ Majoris & λ Bootis.	Moved over 2½° of space.	Ibid.	E. J. Lowe, Esq.	Ibid.
Perpendic. down from γ Ursæ Majoris.	Moved over 3° of space.	Ibid.	Id.	Ibid.
Rapid	....	Darlington, Durham.	J. Graham, Esq.	Ibid.
From α Ceti to ξ Eridani	First as a spark, then increased as a number of sparks, became less bright when passing near the star 35 Eridani, but increased again immediately; moved slowly.	Obser. Beeston .	E. J. Lowe, Esq.	Ibid.
5° S. and 5° lower than Mars; moved down in direction of S. at an angle of 45°.	....	Highfield House.	Id.	Ibid.
From 5° below Pleiades, perpendic. down.	....	Ibid.	Id.	Ibid.
From Polaris towards W. at an angle of 45°.	....	Ibid.	Id.	Ibid.
Very slow, moving over 3° in 5 secs.	....	Darlington, Durham.	J. Graham, Esq.	Ibid.

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or Duration.
1852.	h m				
Jan. 24	10 45	=3rd mag.	Colourless ...	Long streak................	Instantaneous ......
	10 45 15ˢ	=2nd mag...........	Colourless ...	Streak	Instantaneous ......
25	9 0	Larger than Mars ...	Yellow.........	Long train	2 secs. ....
	8 36	....	=1st mag. ...	....	Descended perpendic. down in W., passed between γ & α Pegasi, about 2° nearer the latter star.
	8 52	....	=1st mag. ...	....	Passed 5° above γ Pegasi, and moved obliquely northward, its path forming an angle of about 20° with horizon. It moved over 4° very slowly; it made a stop and partially disappeared before it finally vanished.
Feb. 1	10 13	Size of Mars	Orange.........	Continuous train...........	Slowly; duration 1 sec.
18	10 55	Small, =3rd mag. ...	....	....	Slowly ....
20	9 17	=2nd mag...........	Not so bright as 2nd mag.	No tail........................	Duration 1·5 sec. .
22	8 54	....	....	....	....
	8 50	....	....	....	....
April 8	10 19	Small	....	....	Rapid ....
9	9 39	Small	Blue............	Train	Rapid ....
12	10 40	Small	....	....	....
	10 55	Small	....	....	Rapid ....
	12 40	Small	....	....	....
13	13 12	=4th mag.	Blue............	Two sparks	Instantaneous ......
	13 18	=to ♂	Yellowish red. Brighter than ♂.	....	1 sec. ....
21	10 45	=2nd mag...........	Orange.........	Stream of light	Slowly ....
26	9 40	Small	....	....	....
	9 50	Small	....	....	....
	10 10	Small	....	....	....
May 10	11 0	Small	....	....	....

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
From ½ between γ and β Andromedæ perpendic. down.	....	Highfield House	E. J. Lowe, Esq.	Mr. Lowe's MS.
From γ Ursæ Majoris between η and ζ Ursæ Majoris, nearly perpendic. down.	....	Ibid.	Id.	Ibid.
From θ to η Ursæ Majoris	....	Ibid.	Id.	Ibid.
Passed over 15° in 3 secs.	....	Darlington, Durham.	J. Graham, Esq.	Ibid.
....	....	Ibid.	Id.	Ibid.
From midway between β and ψ Ursæ Majoris, fading away at about R.A. 13° 30′, N.P.D. 44°	....	Highfield House Observatory.	E. J. Lowe, Esq.	Ibid.
From 30° above S.S.W. horizon perpendic. down.	....	Ibid.	Id.	Ibid.
From λ Ursæ Majoris through ε Ursæ Minoris; moved slowly towards α Cephei, fading when 3° from that star.	....	Ibid.	Id.	Ibid.
Moved downwards, passing slightly E. of Procyon.	....	Ibid.	Id.	Ibid.
A very large meteor reported as being in N.; unluckily I was not observing at the moment. My brother saw the reflexion and registered it as a flash of lightning.	....	Ibid.	Id.	Ibid.
From δ Cephei towards Arcturus	....	Ibid.	Id.	Ibid.
From δ Hydræ perpendic. down	....	Ibid.	Id.	Ibid.
Down across α Leonis	....	Ibid.	Id.	Ibid.
Through Mars..................	....	Ibid.	Id.	Ibid.
Near Spica Virginis	....	Ibid.	Id.	Ibid.
From Caput Medusæ to ε Bootis	Two spark meteors side by side; moved very rapidly, apparently at no very great elevation.	Bath Observatory.	Id.	Ibid.
About 30′ above Mars; moved 1° towards Pollux.	Well-defined circular disc.	Mr. Lawson's Observatory, Bath.	Id.	Ibid.
From ϑ Cassiopeiæ towards W., a slight inclination.	....	Highfield House	Id.	Ibid.
Downwards from θ Virginis ...	....	Ibid.	Id.	Ibid.
Down from γ Leonis	....	Ibid.	Id.	Ibid.
Down from ε Lyræ..............	....	Ibid.	Id.	Ibid.
Perpendic. down in N.N.W. ...	....	Ibid.	A.S.H.Lowe, Esq.	Ibid.

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or Duration.
1852.	h m				
July 3	10 30 ……	6 times ♃, gradually diminished in size.	Pale blue……	Long streak………………	Slowly, 8 secs. …
12	10 47 30s	< ♃ at opp. ………	………………	Left a train ………………	2·5 secs. …………
13	10 47 ……	………………………	Small ………	………………………	Horizontally from τ through ϱ Serpentis.
	11 0 ……	………………………	Small ………	………………………	Through zenith from S.E. to N.W.
19	11 10 ……	………………………	Brilliant ……	Leaving a lengthened train	Fell parallel with milky way, passing near μ Cygni, moving to E.
	10 39 15s	=2nd mag.…………	Colourless …	Continuous streak ………	Slowly, 1·2 sec. …
	12 6 ……	=3rd mag. …………	Colourless …	Continuous streak ………	0·2 sec., rapid …
22	11 59 57s	=3rd mag. …………	Colourless …	Continuous train…………	0·2 sec. …………
	12 0 30…	=3rd mag. …………	Colourless …	Continuous train…………	0·2 sec. …………
23	11 45 ……	=3rd mag. …………	Colourless …	Continuous train…………	0·1 sec. …………
Aug. 5	10 32 p.m.	Bright ………………	Red …………	With train ………………	………………………
	10 43 ……	Small ………………	………………	Faint train ………………	Rapid …………
9	10 24 ……	Meteor………………	………………	………………………	………………………
	10 35 ……	Meteor………………	………………	………………………	………………………
10	11 5 ……	Meteor………………	………………	………………………	………………………
	11 5 ……	Meteor………………	………………	………………………	………………………
	11 5 ……	Meteor………………	………………	………………………	………………………
	11 5 ……	Meteor………………	………………	………………………	………………………
	11 10 ……	Meteor………………	………………	With train ………………	………………………
	11 14 ……	Meteor………………	………………	………………………	………………………
15	9 52 ……	Meteor………………	………………	………………………	………………………

V. *Observations of Luminous Meteors made at the Observatory, Stone*

1851.					
Aug. 19	………………	………………………	………………	………………………	………………………
19	………………	………………………	Blue…………	Train ………………	………………………
20	10 3 p.m.	Brighter than a star of the 1st mag.	Blue…………	A train as long as twice the distance from α Andromedæ to Markab.	Slow; visible during 4 secs.

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
Near ζ Ursæ Majoris, above χ Draconis through Polaris to ι Cephei. Ill-defined trembling mass of light.	....	Near Dreux (Eure & Loire), France	M. J. E. Durand	Mr. Lowe's MS. Ibid.
From γ Cygni to a point 2° below Deneb, it then changed its course and proceeded about 3° in horizontal direction, growing less and less bright, till at length scarcely visible. In an instant it changed its course a second time, became as brilliant as at its first appearance, fell in a direction nearly perpendic. to horizon and disappeared midway between Deneb & β Pegasi.	....	Castle Donington	W. H. Leeson, Esq.	Ibid.
....	....	Highfield House	A. S. H. Lowe, Esq.	Ibid.
....	....	Ibid.	Id.	Ibid.
....	....	Ibid.	Id.	Ibid.
From ο to φ Andromedæ	....	Beeston Observatory,	E. J. Lowe, Esq.	Ibid.
From λ through ε Ophiuchi	....	Ibid.	Id.	Ibid.
From γ through ε Ophiuchi	....	Ibid.	Id.	Ibid.
Moved across β and α Arietis towards N.	....	Ibid.	Id.	Ibid.
From ε Herculis to δ Coronæ Borealis.	....	Ibid.	Id.	Ibid.
From Cassiopeia to Andromeda.	....	Highfield House	A. S. H. Lowe...	Ibid.
S.E. of Milky Way	....	Ibid.	Id.	Ibid.
In S.W.	....	Ibid.	Id.	Ibid.
In N.E.	....	Ibid.	Id.	Ibid.
In S. In W. In zenith In S.S.W. In S. along Milky Way In W.	6 meteors in 9 minutes.	Ibid.	Id.	Ibid.
From 15° below Vega to S.	....	Ibid.	Id.	Ibid.

Vicarage, Aylesbury, Bucks. Lat. 51° 47′ 57″·03. Long. 0° 52′ 16″·35 W.

Two meteors from N. to S. under Cassiopeia.	....	Stone	Rev. J. B. Reade	Ibid.
Two meteors from E. to W., one under α Herculis, and the other under α Aquilæ.	....	Ibid.	Id.	Ibid.
From Cassiopeia, passing south of β Pegasi to β Aquarii; it disappeared in a cloud beyond Aquarius.	It appeared as a train of beads very well separated.	Ibid.	Rev. J. B. Reade and Vnt. Fasel, Esq.	Ibid.

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or Duration.
1851.	h m				
Aug. 20	11 0 p.m.	....	....	....	....
21	9 10 p.m.	....	....	Train	....
22	9 30	....	....	....	....
28	8 20 59ˢ	....	Red	Train	Very rapid ....
	8 23 58ˢ	2nd mag.	Red	Train	Rapid ....
	9 48	....	....	....	....
	9 55	About 5th mag.	....	....	Moderate........
	10 8	4th mag.	....	....	....
	10 9	3rd mag.	Yellow........	....	....
30	10 15	3rd mag.	White	....	....
	10 50	3rd mag.	....	....	....
	10 53	4th mag.	....	....	....
	10 54	5th mag.	....	....	....
	11 49	3rd mag.	Blue........	....	....
	11 52	2nd mag.	Red	Train	....
31	0 38 a.m.	5th mag.	....	....	....
Sept. 3	8 41 p.m.	2nd mag.	Blue........	Short train	Rapid ....
5	8 4 p.m.	2nd mag.	Red	Train-beaded	1 sec. duration
10	7 48 p.m.	3rd mag.	Blue........	....	Rapid ....
11	8 43 p.m.	1st mag.	Yellow........	....	Moderate........
13	10 45	3rd mag.	White	....	Rapid ....
14	8 44 p.m.	3rd mag.	White	....	Moderate........
15	8 55 p.m.	3rd mag.	Red	....	Rapid ....
17	7 35 p.m.	4th mag.	Red	Short train	Rapid ....
	7 45 p.m.	3rd mag.	White	....	Rapid ....
	8 4 p.m.	4th mag.	Blue........	....	Rapid ....
	8 31 p.m.	4th mag.	Yellow........	....	Rapid ....
	9 0 p.m.	4th mag.	Dull red	....	Moderate........
19	9 38 p.m.	2nd mag.	Light yellow .	....	Rapid ....
	9 45 p.m.	4th mag.	White	....	Rapid ....
	9 54 p.m.	3rd mag.	Light blue ...	....	Rapid ....
	10 8	5th mag.	White	....	Rapid ....
	11 45	4th mag.	Yellow........	....	Rapid ....
20	8 25	3rd mag., and as bright as a star of the 1st mag.	Yellowish........	Short train	Moderate........
	8 45	2nd mag.	White	....	Rapid ....
	9 17	4th mag.	Light blue ...	Long train	Moderate........
	9 18	2nd mag.	Yellow... ...	Train	Rapid ....
	10 28	3rd mag.	Orange... ...	Beaded train	Rapid ....

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
Went through the Pleiades ...	....	Stone	Rev. J. B. Reade	E. J. Lowe's MS.
From α Lyræ to α Coronæ Borealis.	....	Ibid..............	J.W. Eccles, Esq.	Ibid.
From below β Ursæ Minoris to 2° east of α Ursæ Majoris.	....	Ibid..............	Id.	Ibid.
From Cassiopeia to α Andromedæ.	....	Ibid..............	Rev. J. B. Reade	Ibid.
From Markab to a very short distance south.	Train red and continuous.	Ibid..............	Vnt. Fasel, Esq., & Rev. J. B. Reade.	Ibid.
From ε Urs. Maj. to Mizar......	....	Ibid..............	Rev. J. B. Reade	Ibid.
From α to β Cassiopeiæ	....	Ibid..............	O. J. Grace, Esq.	Ibid.
From Perseus to the Pleiades...	....	Ibid..............	H. Smith, Esq. .	Ibid.
From H Urs. Maj. to κ Bootis .	....	Ibid..............	O. J. Grace, Esq.	Ibid.
From Cassiopeia to Polaris......	....	Ibid..............	Id.	Ibid.
From the square of Pegasus; from east to west.	....	Ibid..............	Rev. J. B. Reade	Ibid.
Through Corona Borealis, from E. to W.	....	Ibid..............	Id.	Ibid.
Above ε Bootis from E. to W. .	....	Ibid..............	W. Whitbread, Esq.	Ibid.
Went through Aquarius due S.	....	Ibid..............	Rev. J. B. Reade	Ibid.
From ζ Urs. Maj. down to the horizon.	....	Ibid..............	Id.	Ibid.
1° below the Pleiades from E. to W.	....	Ibid..............	W. Whitbread, Esq.	Ibid.
From ζ Ursæ Majoris passing through γ, to 2° beyond it.	....	Ibid..............	Id.	Ibid.
From 4° below Corona borealis to ε Bootis.	....	Ibid..............	Rev. J. B. Reade	Ibid.
Through Lyra from E. to W....	....	Ibid..............	H. Smith, Esq. .	Ibid.
From β Urs. Min. to α Urs. Maj.	....	Ibid..............	W. Eccles, Esq. .	Ibid.
From 2° below α Serpentis, passing between ζ and ε Urs. Maj. to 2° below them.	....	Ibid..............	O. J. Grace, Esq.	Ibid.
From E. to W., passing by α Herculis.	....	Aylesbury	J. W. Eccles, Esq.	Ibid.
From Sheat to δ Cygni	....	Stone	Rev. J. B. Reade	Ibid.
From below Polaris to half-way between Polaris and Perseus.	....	Ibid..............	Id.	Ibid.
From a short distance west of ε Bootis to near Cor. Caroli.	....	Ibid..............	J. W. Eccles, Esq.	Ibid.
From ζ to λ Draconis............	....	Ibid..............	O. J. Grace, Esq.	Ibid.
From γ Cephei to 2° below it .	Bright	Ibid..............	Id.	Ibid.
From ε Pegasi to γ Aquarii ...	....	Ibid..............	J.W. Eccles, Esq.	Ibid.
From Cassiopeia to Capella ...	....	Ibid..............	Id.	Ibid.
Through Cassiopeia from N. to S.	....	Ibid..............	H. Smith, Esq. .	Ibid.
From β Cephei to β Urs. Min. .	....	Ibid..............	Id.	Ibid.
From Musca Borealis to the Hyades.	....	Ibid..............	J.W. Eccles, Esq.	Ibid.
Started half-way betwaen Aldebaran and the Pleiades, and travelled about 3° towards the Pleiades.	....	Ibid..............	Rev. J. B. Reade	Ibid.
From about ζ Andromeda to 2° below δ.	....	Observatory......	Vnt. Fasel, Esq.	Ibid.
From β to γ Andromedæ	....	Stone	J.W. Eccles, Esq.	Ibid.
From o Urs. Maj. to between the Pointers.	....	Ibid..............	Rev. C. Lowndes	Ibid.
From 4° above to β Aurigæ ...	....	Ibid..............	Rev. J. B. Reade	Ibid.
... from Capella to 6° due east.	....	Ibid..............	Id.	Ibid.

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or Duration.
1851.	h m				
Sept. 20	11 15	3rd mag.	Orange	Long train	3 secs. duration
	11 43 p.m.	4th mag.	Red		Rapid
21	7 27 p.m.	3rd mag.	White		Rapid
	7 27 p.m.	2nd mag.	Blue		Rapid
	7 53	4th mag.	White		Rapid
	9 18	3rd mag.	Yellowish	Train	Rapid
	9 25	4th mag.	Orange	Train	Rapid
24	7 56	As bright as α Aquilæ.	Light blue		Very rapid
29	7 31	4th mag.	White	Train	Moderate
	7 32	2nd mag.	Blue	Train	Rapid
	7 42 30ˢ	4th mag.	Blue		Rapid
	7 55 p.m.	3rd mag.	Yellow		Moderate
	9 5 p.m.	3rd mag.	Yellow		Rapid
	9 10 p.m.	3rd mag.	Yellow		Rapid
Oct. 2	8 15 p.m.	As bright as Capella.	White		Instantaneous
5	9 14 p.m.	Much larger and brighter than Capella.	Brilliant white		Slow
14	7 2 p.m.	3rd mag. when it began, and of the 6th when it ended.	Blue		Rapid
	7 53 p.m.	2nd mag.	Brilliant white	Beaded train	Rapid
15	8 8 p.m.		Blue	Short flash, no train	Rapid
	8 10 p.m.	1st mag.	Blue	Long train	Slow
	9 2 p.m.	3rd mag.	White		Moderate
16	6 47 p.m.	As bright as a star of the 1st mag.; it increased in size as it proceeded.	Bright orange.	Long train	Slow
	7 10 p.m.	3rd mag.	White		Rapid
	7 56 p.m.	4th mag.	Blue		Rapid
	8 6 p.m.			Instantaneous flash	
	9 7 p.m.	4th mag.	White		Moderate
	11 4 p.m.	3rd mag.	Blue		Moderate

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
From Capella, through Perseus, to Caput Medusæ.	The tail of the train was visible for several seconds after the meteor had disappeared.	Hartwell	Rev. C. Lowndes	E. J. Lowe's MS.
From Algenib to ε Piscium ...	....	Stone	Vnt. Fasel, Esq. .	Ibid.
From 47 Andromedæ to α Trianguli.	This meteor started a few seconds before the following one.	Ibid...............	H. Smith, Esq. .	Ibid.
From β Andromedæ to λ Arietis.	....	Ibid...............	Id.	Ibid.
From α Lyræ to ε Cygni.........	....	Ibid...............	J. W. Eccles, Esq.	Ibid.
From α Cassiopeiæ to γ Andromedæ.	....	Ibid...............	Rev. J. B. Reade	Ibid.
From α Andromedæ to α Cassiopeiæ.	....	Hartwell	Rev. C. Lowndes	Ibid.
From α Aquilæ to α Ophiuchi .	....	Stone	J. W. Eccles, Esq.	Ibid.
From χ Cephei to β Urs. Min..	....	Ibid...............	O. J. Grace, Esq.	Ibid.
Through Pegasus, in a south-eastern direction.	....	Ibid...............	W. Carter	Ibid.
From Polaris to α Urs. Maj. ...	....	Ibid...............	Rev. J. B. Reade	Ibid.
3° through Lacerta from N. to S.	....	Ibid...............	O. J. Grace, Esq.	Ibid.
From δ Aurigæ to α Urs. Maj. .	....	Hartwell	Rev. C. Lowndes	Ibid.
From δ Aurigæ to Castor	....	Ibid...............	Id.	Ibid.
In 7 Camelopardalis	It only broke out, and then vanished.	Stone	Rev. J. B. Reade	Ibid.
From 3° east of the moon, crossed the moon, and went about 7° west of it.	It appeared like the flame of a candle.	Ibid...............	J. W. Eccles, Esq.	Ibid.
From Cassiopeia to δ Cygni ...	....	Ibid...............	Id.	Ibid.
Through Aquarius from N. to S.	It was as bright as Jupiter when it ended.	Ibid...............	Id.	Ibid.
From ι Bootis to the horizon. It started a little to the E. of ι Bootis.	....	Aylesbury	Rev. J. B. Reade	Ibid.
From β Bootis down to the horizon.	....	Ibid...............	Id.	Ibid.
From α Arietis to β Andromedæ	....	Stone	J. W. Eccles, Esq.	Ibid.
From about 24 Lyncis, passed through 42 Urs. Maj., and between the Pointers; and vanished in the middle of the trapezium, about $5\frac{1}{2}$° from the little star above-named, 42.	The same meteor was seen at Hartwell by Rev. C. Lowndes; his account perfectly agrees with this.	Stone Observatory.	Vnt. Fasel, Esq. .	Ibid.
From α Arietis to S.E. horizon .	....	Stone	J. W. Eccles, Esq.	Ibid.
From between α and μ Aquilæ to the horizon.	It increased to 2nd mag.	Ibid...............	O. J. Grace, Esq.	Ibid.
At the cluster in the sword of Perseus.	....	Ibid...............	Rev. J. B. Reade	Ibid.
Started from Algol, passed between α and δ Persei, and vanished about 3° beyond ψ Persei.	....	Ibid...............	Vnt. Fasel, Esq. .	Ibid.
From α Andromedæ, and travelled about 8° towards χ Andromedæ.	....	Ibid...............	Id.	Ibid.

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or Duration.
1851.	h m				
Oct. 17	7 47 50s	1st mag.	Yellow	Train	Very rapid
	7 48 p.m.	3rd mag.	Yellow		Rapid
	7 50 p.m.	6th mag.	Red		Moderate
	7 54 p.m.	3rd mag.	White		Rapid
	8 0 p.m.	5th mag.	Red		Moderate
	8 17 p.m.	4th mag.	Yellow		Moderate
	8 21 30s	1st mag.	White		Moderate
	8 24 p.m.	4th mag.	Yellow		Rapid
	8 24 30s	2nd mag.	Blue		Very rapid
	8 26 p.m.	1st mag.	Red		Rapid
	8 27 30...	1st mag. and as bright as α Lyræ.	Blue	Train	Moderate
		After it parted, that of the 2nd mag. was	Bright orange.	Train	Moderate
		that of the 4th was	Blue	Train	Moderate
	8 35 p.m.	3rd mag.	Blue	Train	Moderate
	9 0 p.m.	3rd mag.	Light blue		Slow
	9 25 p.m.	3rd mag.	Blue		Rapid
Nov. 2	7 1 p.m.	2nd mag.	Blue		Moderate
	7 2 p.m.	2nd mag.	Blue		Rapid
	7 2 7s	2nd mag.	Blue	Red tail	Rapid
4	7 35 p.m.	3rd mag.	Red		Moderate
20	6 32 p.m.	3rd mag.	Blue	Train	Rapid
21	6 45 p.m.	As large as Mars, with a well-defined disc.	Of the same colour as Mars.		
22	8 22 p.m.	3rd mag.	Orange	Short train	Rapid

N.B. The above 89 meteors were observed within the space of three months and three days. From th
there have been many bright starry nights, on every one of which there has been a constant and caref

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or Duration.
1852.					
Aug. 3	9 30 p.m.	1st mag. and as bright as Jupiter.	Light yellow	Train	Rapid
5	10 0 p.m.	2nd mag.	Reddish	Train	Rapid
	10 18 p.m.	3rd mag.	Yellow	Train	Very rapid
15	9 10 p.m.	2nd mag.	Whitish	Train	Rapid
	9 15 p.m.	3rd mag.	Yellow	Train	Rapid

On the 10th August many meteors were seen between 9h an

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
From β Bootis, went 5°, passing between γ and δ Bootis.	....	Stone	W. Whitbread, Esq.	E. J. Lowe's MS.
From μ Herculis to β Bootis ...	....	Ibid...............	Id.	Ibid.
From β to δ Bootis	....	Ibid...............	Id.	Ibid.
From γ Lyræ, and went in circular form to ο Herculis.	....	Ibid...............	J. W. Eccles, Esq.	Ibid.
From α to β Lyræ	....	Ibid...............	W. Whitbread, [Esq.	Ibid.
From ε to ζ Pegasi..............	....	Ibid...............	Id.	Ibid.
From α Lyræ to γ Draconis ...	....	Ibid...............	H. Smith, Esq....	Ibid.
From η Herculis to δ Bootis ...	....	Ibid...............	Rev. J. B. Reade	Ibid.
From γ Pegasi to ζ Cygni	....	Ibid...............	Vnt. Fasel, Esq. .	Ibid.
It went 5°, running parallel with α and β Draconis.	....	Ibid...............	Rev. J. B. Reade	Ibid.
From about 15° east of the solstitial colure and 7° above α Lyræ; it went 4° towards N.W., then parted into two meteors, one of the 2nd and the other of the 4th magnitude; they took a different direction, each leaving a train. That of the 2nd mag. went to ι Herculis, and that of the 4th vanished at λ Herculis.	Rev. J. B. Reade saw the same meteor from a different place, and the two descriptions perfectly agree.	Ibid...............	Vnt. Fasel, Esq. .	Ibid.
From about α Cygni to α Lyræ.	It appeared low ...	Ibid...............	Rev. J. B. Reade	Ibid.
From 1° under Saturn, went about $1\frac{1}{2}$° from E. to W.	....	Ibid...............	J. W. Eccles, Esq.	Ibid.
From Polaris to δ Aurigæ	....	Ibid...............	Id.	Ibid.
Through Lacerta from S. to N.	....	Ibid...............	Vnt. Fasel, Esq. .	Ibid.
From β Cygni to near α Aquilæ	....	Ibid...............	J. W. Eccles, Esq.	Ibid.
Through π Herculis from east to west.	....	Ibid...............	Rev. J. B. Reade	Ibid.
From Saturn to β Ceti	....	Ibid...............	J. W. Eccles, Esq.	Ibid.
From a little below Polaris to ζ Urs. Maj.	....	Ibid...............	Rev. J. B. Reade	Ibid.
Passed up the field of the telescope, which is 1°, in a little less than half a second. It preceded υ Herculis of the 3rd mag., and its declination was the same as Brorsen's comet. Hence its R.A. = 15^h 55^m; its N.P.D. 43° 55′.	....	Ibid...............	Id.	Ibid.
From α to β Cygni	....	Ibid...............	Id.	Ibid.

atter end of November 1851 up to the beginning of August 1852, *very few meteors* were seen, although ook out.—VNT. FASEL.

From about 2° south of ρ Aquilæ, and travelled about 10° in a S.W. direction.	....	Stone	Vnt. Fasel, Esq. .	Ibid.
From δ Urs. Maj. to very near Cor. Caroli.	....	Ibid...............	Id.	Ibid.
From α Cassiopeiæ to half-way to Polaris.	....	Ibid...............	Id.	Ibid.
From about ε Delphini to η Aquilæ.	....	Ibid...............	Id.	Ibid.
From π Pegasi, and travelled about 13° in a southward direction.	....	Ibid...............	Id.	Ibid.

0^h p.m. immediately after a thunder-storm.

VI. *Observations of Luminous Meteors*, 1851–52. *Com-*

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or Duration.
1850. Sept. 4	h m From 9 30 a.m. to 3 30 p.m.	A vast number of luminous bodies seen through a telescope	Various magnitudes, from 2″ to 20″ with discs.	....	Various velocities, but uniform.
1851. May 2	10 0 p.m.	Circular illumination in the clouds, about 10° in diameter.	....	....	Did not change place, lasted about one minute.
22	10 15 p.m.	Large and brilliant meteor.	Somewhat increased in size&brightness, purple and green.	Tail or streak lasted two minutes.	....
23	....	Smaller and less bright	....	....	Fell and dissipated at 10° alt.
June 1	8 30 p.m.	Brilliant light = moon four days' old.	Became green just before disappearing	....	....
24	11 0	3rd mag.	Red	No train	Rapid ....
	11 0	3rd mag.	Red	No train	Rapid ....
July 30	10 0 p.m.	>Sirius	Bluish white .	No train	....
	10 9	1st mag.	....	No train	....
	11 35	3rd mag.	....	No train	....
Aug. 3	10 27	Gradually dying away and suddenly = 1st mag.	....	....	....
	10 28	2nd mag.	....	....	½ sec. ....
	10 30	2nd mag.	....	....	½ sec. ....
	10 43	2nd mag.	....	....	½ sec. ....
	10 45	4th mag.	....	....	½ sec. ....
	10 46 30s	3rd mag.	....	....	½ sec. ....
	10 48 40s	3rd mag.	....	....	½ sec. ....
	10 48 50s	4th mag.	....	....	½ sec. ....
	10 52	1st mag.	....	Fine sparks	1 sec. ....
	10 54	2nd mag.	....	....	½ sec. ....
	10 55 30s	4th mag.	....	Continuous line of light...	1 sec. ....
	11 26	4th mag.	....	....	½ sec. ....
	9 57 p.m.	4th mag.	White	....	Very rapid ....
5	10 16 p.m.	....	Reddish, brilliant.	....	Rapid ....
7	9 40 p.m.	2nd mag.	Blue, very brilliant.	Train of blue light, stopped several seconds in its progress, then proceeded	Slow............
11	From 10 0 p.m. to 11 0 p.m.	7 meteors............	....	....	....

municated by various Observers.

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
[In a continuous stream due E. and W. about 18° in breadth.	....	South Mimms ...	Rev. W. Read, M.A.	MS. See Appendix, No. 13.
[I]n S.E..............................	Entirely cloudy ...	Ennore, India, 11 miles N. of Madras.	Correspondent to Dr. Buist.	See Appendix, No. 3.
[U]nder a verandah, first seen at alt. 75°, fell perpendicular to horizon into the sea.	....	Ibid...............	Id.	Ibid.
[F]rom N.W. to S.E...............	....	Ibid.......... ...	Id.	Ibid.
[F]rom zenith to S.	....	Calcutta	Id.	See Appendix, No. 5.
.S.E. alt. 25° to 15° .... .S.E., alt. 25° to 45°...........	These two meteors were seen through hazy clouds, pursuing each other.	Rose Hill, near Oxford.	Rev. J. Slatter...	MS. communicated to Prof. Powell.
[i]n N.N.E., alt. 40°	Communicated to me by a friend staying in the house.	Ibid...............	Id.	Ibid.
[T]hrough Ursa Major below β...	....	Ibid...............	Id.	Ibid.
[T]hrough Sagittarius	....	Ibid...............	Id.	Ibid.
[D]own on right of Milky Way...	....	Ibid...............	Id.	Ibid.
° E. of ζ Aquarius..............	....	Ibid...............	Id.	Ibid.
[T]hrough Bootes	....	Ibid...............	Id.	Ibid.
[B]elow Delphin. through Antinous.	....	Ibid...............	Id.	Ibid.
[T]hrough Sagittarius	....	Ibid...............	Id.	Ibid.
[T]o α Capric.	....	Ibid...............	Id.	Ibid.
[A]bove Cassiopeia..............	....	Ibid...............	Id.	Ibid.
° E. of Polaris	....	Ibid...............	Id.	Ibid.
[Fr]om centre of Pegasus ⊥ to the rest.	....	Ibid...............	Id.	Ibid.
[B]elow Cassiopeia, ‖ to rest	....	Ibid...............	Id.	Ibid.
[Fr]om ε Pegasi, ⊥ to rest with great force.	....	Ibid...............	Id.	Ibid.
[Fr]om β Aquar. to between α and β Capric.	....	Ibid...............	Id.	Ibid.
[Fr]om Ursa Major	Passed downwards.	St. Ives, Hunts..	J. King Watts...	Ibid.
[B]elow Ursa Major	From N. to S.	Ibid...............	Id.	Ibid.
[N]ear Polaris	Passed to N.	Ibid...............	Id.	Ibid.
[V]arious directions, 5 generally towards S., 2 towards N.	Moon full; atmosphere hazy.	Haverhill.........	Mr. and Mrs. W. Boreham.	MS. communicated. See diagram, App. No. 7.

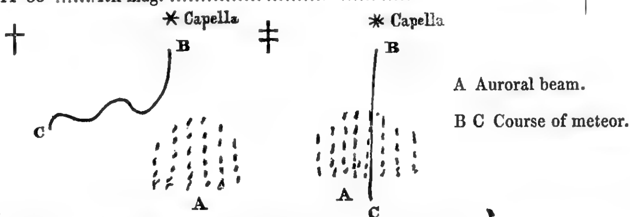
Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or Duration.
1851.	h m				
Aug. 13	8 45	3rd mag.	....	....	1 sec. ....
	9 40	3rd mag.	....	....	1 sec. ....
14	9 38	4th mag.	....	....	1 sec. ....
	9 38 30s	5th mag.	....	....	1 sec. ....
	9 43	2nd mag.	Red	....	1 sec. ....
	10 2	>Jupiter	Orange............	Coarse sparks	1½ sec. ....
*19	10 13	1st mag.	....	Train	....
18	9 52 p.m.	Small	White	....	Very rapid ....
19	9 8 p.m.	Large	Bluish	....	Slow............
20	10 25 p.m.	Large and brilliant ...	White	Beautiful sparks and bright	Slow............
21	9 23 p.m.	3rd mag.	White	....	Rapid ....
	9 27 p.m.	Large and bright......	Bluish	Train	Slow............
22	9 35 p.m.	Large and beautiful .	Very bright and white, increased until it disappeared in sparks.	Train continuous............	Slow............
23	10 35 p.m.	=4th mag.	....	....	....
28	9 50 p.m.	Large	White and brilliant.	....	Slow............
Sept. 2	7 30 p.m.	An ill-defined luminous patch or band, longer diameter, slightly-inclined.	Bright white, gradually increased in brightness, then decreased and disappeared.	....	Stationary, duratio[n] about 1 minute.
	A few secs. later.	A small shooting star nearly in the same place.	....	....	....
	7 30	Two-thirds of moon .	Dark red	....	....
	7 45	Sheet form	Lighter red ...	....	....
	10 0	Star of 1st mag.	....	....	....
3	1 0 a.m.	Larger than any star.	Yellow and violet.	Long train, which exploded	About 2 secs. ......
19	11 0 p.m.	Bright meteor, one-fifth full moon, star-shaped.	Illumination more than half moon, tinged with blue.	No explosion, disappeared suddenly, leaving no track, except a whitish trace at the upper part of its course.	About 5 secs ......
20	9 45 p.m.	Disc............	Bright blue ...	....	Rather slow, disa[p]peared witho[ut] explosion.
	9 50 p.m.	Very large	....	Iridescent sparks	....
25	Between 10&11 p.m.	A large ball of fire ...	....	....	Rapid ....
Oct. 5	7 52	= ♃............	....	....	....

* This day an immense meteor was

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
Beneath Polaris	....	Rose Hill, near Oxford.	Rev. J. Slatter...	MS. communicated to Prof. Powell.
Through Perseus downward ...	....	Ibid.	Id.	Ibid.
Through Ophiuchus above η ...	....	Ibid.	Id.	Ibid.
Through Aquila above γ	....	Ibid.	Id.	Ibid.
Through Capric., slanting down	....	Ibid.	Id.	Ibid.
Same as last, slightly curved ...	....	Ibid.	Id.	Ibid.
Through γ Cor. Bor. from under Polaris.	....	Ibid.	Id.	Ibid.
From Virgo	Passed S.	St. Ives, Hunts.	J. King Watts...	Ibid.
From Leo	Exploded with a brilliant light.	Ibid.	Id.	Ibid.
Below Virgo to west	....	Ibid.	Id.	Ibid.
Below Ursa Major to west	....	Ibid.	Id.	Ibid.
From Ursa Major to west	....	Ibid.	Id.	Ibid.
Passed the whole length of Ursa Major from south to north, and in its progress rendered some of his stars invisible.	....	Ibid.	Id.	Ibid.
°° below Cor. Bor. from near Polaris.	....	Rose Hill, Oxford.	Rev. J. Slatter...	Ibid.
From Lyra down to the west ...	....	St. Ives, Hunts.	J. King Watts...	Ibid.
In S.W., alt. 60°?	....	Garsington, near Oxford.	Rev. T. Masterman.	Verbal communication to Prof. Powell.
....	....	Ibid.	Id.	Ibid.
Upwards	Phosphoric meteor.	Huggate	Rev. T. Rankin.	MS. communicated to Prof. Powell.
Horizontal	....	Ibid.	Id.	Ibid.
....	....	Ibid.	Gamekeeper ...	Ibid.
Curved towards the earth	To the W. of Ursa Major.	Ibid.	Id.	Ibid.
From a little north of zenith down about 45° to S.W.	....	Calcutta	Correspondent to Dr. Buist.	Bombay Times, App. No. 4.
From near Polaris, passed Ursa Major (see sketch in Appendix).	....	Near Farnham, Surrey.	Mr. G. W. Hewitt	MS. communicated to Prof. Powell, see App. No. 8.
From N.N.W. to N.N.E., from alt. 25° to alt. 20°.	Altitudes taken from windows, also reported by Mr. Lowe.	Rose Hill, Oxford.	Seen by some of Mr. Slatter's family.	MS. communicated to Prof. Powell, from Rev. J. Slatter.
Fell perpendicularly down, apparently into the sea.	In a storm, accompanied by a rushing sound and a noise as if of a falling mass.	Several places near Bombay.	Several communicated to Dr. Buist.	Bombay Times. See App. No. 6.
Beneath the moon in S.W. ...	....	Rose Hill near Oxford.	Brother of Rev. J. Slatter.	MS. communicated to Prof. Powell.

seen at Naples from W. to E.—*Papers.*

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or Duration.
1851.	h m				
Nov. 4	5 0 p.m.	Brilliant	....	Fell slowly towards the W. in a curve concave to horizon.	....
	10 2 p.m.	Large	White	....	Rapid ....
24	10 15 p.m.	Large	Purplish, brilliant.	Sparkling............	Slow............
25	7 6 a.m.	2nd mag............	Pale yellow ...	....	About 1 sec. ......
1852.					
Mar. 12	9 28	Small	White	....	Slow............
	10 5	Large	White, brilliant.	Sparkling, and stopped twice in its progress.	Slow............
April 20	11 25	1st mag.	....	....	....
†	11 35	4th mag.	....	....	....



Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or Duration.
‡	11 35 5s ...	4th mag.	....	.... 	....
	12 25	=Jupiter............	White	Fine sparks	....
May 14	10 33 30s	=Vega	White	Fine sparks	....
July 12	About 9 59 p.m. G.T.	Apparent diameter little inferior to full moon.	Very bright, ruddy colour.	Noted shape  tail pointing to south.	Moved towards the N. very rapidly. Duration of visibility about 2 secs.
13	10 0 p.m. (London time.)	Larger than ♃. As it fell brilliancy increased; then seemed to decrease and again to increase till disappearance.	Bright orange-red, changing to nearly white, and then red again.	Disappeared without separation; no explosion.	About 2 secs. ......
29	9 45 p.m.	=2nd mag., but gradually decreased till =5th.	Bluish white .	....	....
Aug. 3	9 15 p.m. (G.M.T.)	At first like a small star, intensely bright	....	For about 15° gradually increased in magnitude, became brilliant, though white (as if inflamed), =2 diam. of ♀ when brightest, and continued through about 30°, when it suddenly resumed its first appearance (as if burnt out) and continued onward some distance further.	Train ....

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
Appeared first below and a little to the right of the moon, in S.E. alt. Estimated about 35°.	Perhaps the same as one seen in Nottingham; vide Mr. Lowe's Catal.	St. John's Lodge, Stone, near Aylesbury.	Miss G. R. Smyth	MS. communicated to Prof. Powell.
From Polaris running northward	....	St. Ives, Hunts...	J. King Watts...	Ibid.
Left of Ursa Major to north ...	....	Ibid..............	Id.	Ibid.
Perpendicular down	Below Leo Minor .	Huggate	Rev. T. Rankin .	Ibid.
From the Pleiades to the north	....	St. Ives, Hunts. .	J. King Watts...	Ibid.
From Polaris to the N.W.	....	Ibid..............	Id.	Ibid.
From Ursa Major to 2° N. of Mars.	During Aurora ...	Rose Hill, near Oxford.	Rev. J. Slatter...	Ibid.
From Capella				
	[The meteor † fell downwards till apparently near the auroral haze, and then started aside into a wavy course, as if repulsed. ‡ followed downwards uninterruptedly. It was as if ‡ had been repulsed by a similar electric force and exhausted it. See figure above.]			
From Capella	Ibid..................	Ibid..............	Id.	Ibid.
From 1° W. of Spica to Crater .	Ibid..................	Ibid..............	Id.	Ibid.
From Spica to Crater, curve curving upwards, intensely incandescent at the end of the curve.	Ibid..................	Ibid..............	Id.	Ibid.
Altitude about 30° above west point of horizon.	Seen at Glasgow, Helensburgh, Perth, &c.	Dunse, Lat. 55° 47′ N. Long. 2° 23′ W.	Wm. Stevenson .	Ibid.
Appeared in N.N.W. at alt. 20°, fell nearly vertically or a little to E.	....	Carlisle. Seen also 90 miles W. of Carlisle.	John Carrick Moore, Esq.	Communicated to Prof. Powell, through Mr. Faraday. See App. No. 9.
Path perpendicular to a line, joining Polaris and the Upper Pointer; greater part of course above that line, and thence down to horizon.	....	Victoria Park, London.	W. R. Birt, Esq.	MS. communicated to Prof. Powell.
From α Lyræ to past β Scorpionis.	About 2 secs., velocity uniform.	Oxford	Mr. G. A. Rowell.	Ibid.

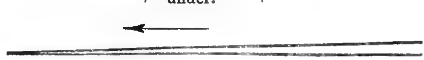
Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or Duration.
1852.	h m				
Aug. 5	9 40	=1st mag.	....	....	....
8	9 40 p.m.	Small	White	....	Slow..................
	9 42 p.m.	Small	White	....	Rapid ....
9	From 10 25 to 11 30	80 shooting stars ...	....	....	....
	10 58	1 brilliant	....	Path illuminated for 30 or 40 secs.	
	10 21 p.m.	Large	White	....	Rapid ....
	10 30 p.m. to 10 40 p.m.	Magnitudes full 1st down to 5th or 6th. No. counted in northern sky.. 9	Mostly stellar	Almost all left a luminous train.	Velocity as usually noticed. Duration 1′ to 5″ or 6″.
	10 50 p.m. to 11 5 p.m.	No. counted in southern sky.. 13			
	11 12 p.m. to 11 27 p.m.	No. counted in northern sky.. 12			
	11 30 p.m. to 11 45 p.m.	No. counted in southern sky.. 14			
	11 50 p.m. to 0 5 a.m.	No. counted in northern sky.. 12	* Night cloudy.		
10	0 20 a.m. to 0 35 a.m.*	No. counted in southern sky.. 18	—78		
	9 20 p.m.	Large	Whitish red...	Brilliant	....
	9 22 p.m.	Small	White	....	Slow..................
	9 47 p.m.	Large	Reddish	Many brilliant sparks, and a train similar to a rocket, thus : 	Slow..................
	9 53 p.m.	Small	White ...		Slow..................
	9 59 p.m.	Small	White ...		Rapid ....
	10 1 p.m.	Large	White	Brilliant	Slow..................
	10 1 p.m.*	Large	White	Brilliant	Slow..................
		* On this evening, which was very clear, many other meteors were visible besides the above, chiefly in the field between Polaris, Ursa Major and Lyra, five or six being visible at the same time, going in various directions.			
		Many the whole evening, 17 in 20 mins. (from $10^h 45^m$, to $11^h 5^m$.)	None particularly brilliant.	....	....

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
From near Cassiopeia towards N.N.E. Through 14°.	Velocity moderate, 2 secs.	Oxford	Mr. G. A. Rowell	MS. communicated to Prof. Powell.
N.W.	From Ursa Minor .	St. Ives, Huntingdonshire.	J. King Watts, Esq.	Ibid.
W.	....	Ibid..................	Id.	Ibid.
....	....	Haverhill.........	W. W. Boreham, Esq., and Mrs. W. W. Boreham.	MS. See App. No. 11.
N.W.	....	St. Ives, Huntingdonshire.	J. King Watts, Esq.	MS. communicated to Prof. Powell.
Nearly all moved to S. or S.S.W. In northern sky a few moved to N.W. and E.	The meteors were distributed over all parts of the sky; the place from which they proceeded appeared to be in the northern sky, somewhere between Perseus and the Pole, but this is uncertain.	Dunse	Wm. Stevenson	Ibid.
....	From α Cephei to the S., then became stationary several seconds and threw off some large sparks before it expired.	St. Ives, Huntingdonshire.	J. King Watts, Esq.	Ibid.
	From Ursa Major.	Ibid................	Id.	Ibid.
N.	From α Lyræ	Ibid................	Id.	Ibid.
....	through Cygnus to zenith.			
....	From zenith to W.	Ibid................	Id.	Ibid.
N......................................	From Ursa Major downwards.	Ibid................	Id.	Ibid.
S.W.	To Ursa Major ...	Ibid................	Id.	Ibid.
N.E....................................	From Cygnus*.			

* These two meteors crossed each other's path, and both shining at the same time, thus:

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
All from E. to W. Downwards at each 45°.	From a window facing S.E.	Oxford	Mr. G. A. Rowell	Communicated to Prof. Powell.

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or Duration.
1852. Aug. 10	h m From 9 57 to 10 57	23 shooting stars ...	....	....	....
	From 10 0 to 11 0	Numerous; one large star.	....	With long horizontal train	....
	9 2 p.m.	2nd mag.	White, increased rapidly in brilliancy until its extinction.	....	Obliquely across Cassiopeia, about half a degree N. of γ.
	9 8 p.m.	Between 2nd and 3rd mag.	....	....	Obliquely towards the horizon, a little to E of γ Pegasi:
	9 18 p.m.	2nd mag.	Bluish-white	Slight scintillations as it passed along.	Shot from midway between Cassiopeia and Ursa Major, towards α Ursæ Majoris, where it became extinguished.
	9 27 p.m.	Small; 3rd mag.......	....	....	From Cassiopeia to β Pegasi.
	9 27 30[s]	Between 2nd and 3rd mag.	....	Slight train, which quickly vanished.	From Cassiopeia towards α Ursæ Majoris, nearly parallel to the course of the star seen by Mr. Harding.
	9 28 p.m.	Nearly as large as 1st mag. star.	Commenced with considerable brilliancy, which gradually diminished as it proceeded, as if it were a long narrow cone of light, the base being first illuminated with great brilliancy, and the apex very dim, as under.	....	From Cassiopeia towards Ursa Major across f Cassiopeiæ.



			Colour brilliant white, with silver greyish tinge.		

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
....	....	Haverhill	W. W. Boreham, Esq.	MS. See Appendix, No. 11.
....	....	Derby and neighbourhood.	Correspondent to Derby Mercury	Ibid.
....	....	Victoria Park, London.	W. R. Birt, Esq.	See App., No. 10.
....	Globular	Ibid................	Id.	Ibid.
....	....	Ibid................	J. Harding, Esq.	Ibid.
....	....	Ibid................	W. R. Birt, Esq.	Ibid.
....	Extinguished when nearly under Polaris.	Ibid................	W. R. Birt, Esq., and J. Harding.	Ibid.
....	....	Ibid................	J. Harding, Esq.	Ibid.

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or Duration.
1852. Aug 10	h m 9 34 p.m.	Small	Bright	....	From below β & Ursæ Minoris t ζ Ursæ Majoris.
	9 37 p.m.	....	....	....	From Algæ oblique ly toward the ho rizon.
15	9 5 p.m.	Small, brilliant	....	....	....
	9 8	Small, globular	Bright bluish-white.	....	....
	Immediately after last.	Very similar	....	....	....
	9 14	Light, =2nd mag. ...	....	....	....
22	7 44 p.m.	Nearly=half moon...	Brilliant clear white light.	Left a train in its path ...	Slow; several seconds.

APPENDIX,

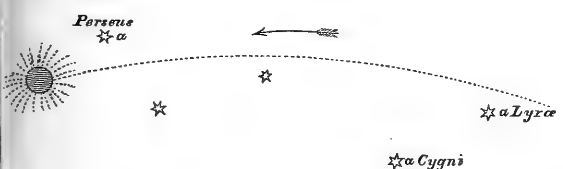
Containing original details of various observations of Meteors communicated by the respective observers to Prof. Powell.

No. 1.—It may be important for comparison to mention that in the Phil. Mag., Jan. 1839, will be found observations of 54 shooting stars, seen in the night of Nov. 12–13, 1838, at 109 York Street, Whitechapel, by W. R. Birt, Esq.

No. 2.—Further particulars of the Meteor shower, April 19–20, 1851. (See last Report, App., Nos. 23, 24, 25, 29.)

"*Meteors.*—We have been favoured with the following from Madras on the subject of the shower of meteors visible all over India on the 19th or 20th of April. By a blunder of our own we mistook the Bombay date, and made it Saturday the 19th, when it ought to been Sunday the 20th; and on this night accordingly the shower was seen here, at Poona, and at Cawnpore. With all these coincidences we came to the conclusion that our Kolapore correspondent, who gave an account of them, had also mistaken the date, and that there had been one shower only. As he makes no sign of recantation,

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
....	....	Victoria Park, London.	W. R. Birt, Esq.	See Appendix, No. 10.
....	....	Ibid................	Id.	Ibid.
Above β Cassiopeiæ to S.E. for above ½°.	....	Ibid................	Id.	Ibid. No. 12.
Through Pegasus' square	....	Ibid	Id.	Ibid.
Parallel, but to E.	....	Ibid................	Id.	Ibid.
½° N. of β Cassiopeiæ towards Pole.	....	Ibid................	Id.	Ibid.
From W. to E. with a slight curve, from near α Lyræ to beyond α Persei.	....	St. Ives, Huntingdonshire.	J. King Watts, Esq.	MS. Letter.



we now come to the conclusion that there were two showers on two successive nights, bearing a very close resemblance to each other. The following description is one of the most copious and clear that we have met with; it is from the pen of one of the oldest and ablest of our observers in India:—

"'On the evening of Saturday the 19th of April, I was sitting in a verandah of the Government House at Madras, facing to the eastward, from about ½ past 8 to ½ past 10. From the height of the verandah I could see the sky to about an altitude of 60° or 65°, and about one-fourth of the horizon between north-east and south-east. During the period above stated I counted not less than forty meteors, of different magnitudes and brightness. The flight of the whole was from north and north-east to south and south-west. Some of them commenced their flight at a point of the heavens invisible to my eye, whilst others came into sight whilst on their career, from my left-hand. Some burned out (if I may use the expression) whilst visible, and others disappeared whilst yet burning to my right-hand. I heard no explosions, though some of the largest left a bright streak or tail, the trace of which remained for several minutes. The greater part of the time it was brilliant moonlight, which detracted greatly from the effect of the meteors.

No. 3. (Continued from the same).—"'During the period between the

29th of April, 1851, and the 6th of May the atmosphere at Madras was completely overcast with dense clouds. On the night of the 2nd of May (Friday), at 10 o'clock, there was every symptom of the subsequent gale. At the hour I state, I observed in the south-east quarter a very extensive circular illumination of the clouds, which continued for above a minute. The space in the clouds so lighted up might, I estimated, be about 10° in diameter, but owing to the dense state of the atmosphere and the lowness of the clouds, I saw nothing of the meteor, which doubtless covered the circular illumination. I infer that the meteor was flying towards me, that is, from south-east to north-west, because the shape of the illumination in the clouds did not vary.

"'On the night of the 22nd of this month, I was sitting, as is my wont, under an awning on the terrace of my bungalow at Ennore (11 miles north of Madras): I could see in altitude about 75°. About $\frac{1}{4}$ past 10 o'clock, a very brilliant and large meteor came within the range of my sight, and fell apparently perpendicularly in the sea (Bay of Bengal). From the moment it became visible to me it rather increased into size and brilliancy than otherwise, and was in full blaze when it disappeared behind the sand-hills in front of my bungalow, which is not above a quarter of a mile from the sea-shore. The colour of this meteor, which seemed to be as large as an 84lb. shot (qu.), was bright purple and green mingled, and it left a luminous tail or streak, which did not wholly disappear for about two minutes.

"'Last night (the 23rd) I saw another meteor in the same quarter, but neither of the dimensions nor brilliancy of that of the preceding night. The flight was from north-west to south-east, and it burned out before it had got within 10° of the horizon.—Ennore, 24th of May, 1851.'

"Our correspondent mentions a very brilliant meteor seen from Madras some months since before sunset; it swept clean across the sky, and was so light and of such magnitude that it caused a glare over the landscape even at this early hour. This is the third meteor within the year that has been visible in daylight in India; that seen to explode on the 30th of November, 1850, near Bissunpore at 3 P.M.,—the stone was afterwards picked up;—and that seen near Beerbhoom at 9 P.M. on the 8th of January, 1851." [See last Report.]—*Bombay Times*, June 4, 1851.

No. 4.—"A correspondent of the *Bengal Hurkaru*, subscribing himself 'W. M.,' gives the following interesting account of a meteor which he had observed on the night of the 19th of September:—

"'A splendid meteor burst over Calcutta last night about 11 P.M., and I send this notice to you that it may serve as a record of the event. On the 13th, 14th, and 15th, the atmosphere was dry and its general movement from south-west, the lower clouds also moved from south to west, little wind and occasionally sultry and oppressive. On the 16th and 17th a storm or squall brewed in the south-east during the afternoon, but did not visit us. On the 18th of September the clouds and atmosphere during the forenoon moved from south-west; the weather dry and close. Between 3 and 5 P.M. nimbus clouds passed over quietly from north-west to east, with scarcely a breath of air. After 5 P.M. the aspect of the sky was again dry. The chirping of the crickets was unusually loud, and the weather close and sultry. About 11 P.M. the sky was clear, but the stars were not brilliant, and there was no wind, when a most splendid meteor lighted up in zenith or a little north of it, and shot down half-way to south a little west, illuminating the landscape as if the full or half-moon had suddenly appeared on high. The meteor was a bright ball of light appearing to be of a size equal to one-fifth the area of the full moon: it was star-shaped, its light brilliant with a faint tinge of blue, but its light reflected from surrounding objects had a green tinge even in the sky; and in its progress there was a curdling appearance in the sky, about ten or fifteen degrees in advance of it, as if cirrus or fleecy clouds, very gauzy and thin, were retreating from it and crowding on each other, or more like a very thin and watery solution of white paint brushed over a smooth and polished surface and then invaded by the finger. The white particles fly from the finger with the repelled liquid, and form a white fleecy circle at a little distance all round it. The meteor endured as long as a person would require to take five or six steps at a quick march and disappeared at once, from perfect brightness to nothing, leaving no apparent track where it was extinguished: but in the upper part of its course, a little south of zenith, there was a milky or phosphorescent line, its thickness that of the little finger, and tapering towards the south; and between its southern point and the spot where the meteor vanished, a clear space of some degrees without any evidence of a track. There was no appearance of an explosion, nor did I hear any sound. I am not quite certain of the hour, but I think the church clocks were chiming eleven a few minutes after the meteor disappeared. Shortly after a light southerly air sprung up, and during the night the temperature was low, approaching to cold.'"—*Bombay Times*, Oct. 3, 1851.

No. 5.—"On the 1st of June last, about $8\frac{1}{2}$ P.M., while there were clouds around, cirrostratus overhead, and moderate south-east wind blowing, a splendid meteor shot from zenith towards south: it gave a light like that of the moon when it is four days old, and turned to a green star just before it disappeared. This meteor was preceded by four days of dry and sultry weather."—*Ibid.*

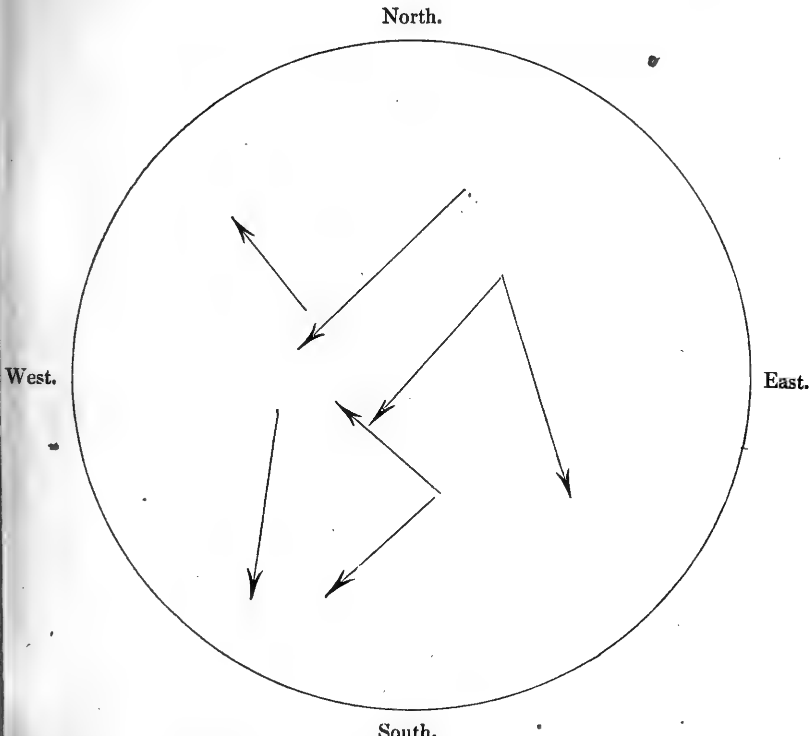
No. 6.—"Some singular phænomena occurred during the thunder-storm of Thursday evening, Sept. 25, 1851, which seem well-worthy of record. Exactly at a quarter past ten, when the thunder was at its loudest, the inhabitants of the northern end of the Fort were alarmed with the sound as if of a large mass of something rushing violently through the air, the noise resembling that of a huge cannon-shot passing close by; and immediately afterwards a tremendous crash was heard, as if the mass had impinged on the ground or penetrated some of the buildings; nothing however could yesterday morning be discovered in the neighbourhood. The whole closely resembled what is mentioned as having occurred in Ross-shire in August 1849, when a huge mass of ice was found to have fallen. The rain was at this time falling so furiously, the night was so dark in the intervals between the flashes of lightning, and these last so bright and frequent, that a meteor of any size might have "swept unheeded by;" yet appearances look very much as if something of this sort had fallen, and we should recommend observers to be on the outlook for the *corpus delicti*—more than likely at the same time to have dropped into the sea. A tumbler half-full of water, on the sideboard of a house near the Mint, fell in two about seven in the evening, immediately after a vivid flash of lightning! We have it now before us; it is cut almost as clean asunder as if cloven with a knife. The storm abated somewhat after eleven, having apparently gone round to the west and south-west: half an hour after midnight it again got round to east, and several loud peals of thunder were heard; the lightning throughout was almost continued. Shortly after one all was tranquil again."—*Bombay Times*, Sept. 27.

"*The Meteor.*—The writer of the following most interesting notice has our grateful thanks; we trust to hear further of the matter from the lighthouse, or those on board the outer light-vessel. We have no doubt whatever that this was a meteor or fire-ball of large dimensions which has fallen into the sea :— 'It may be of interest to you, with reference to the notice in to-day's paper of the storm on the night betwixt Thursday and Friday, to know that I was last evening informed by a seafaring friend of mine, who was, at the time the *Times* describes the *rushing sound* to have been heard, sitting on the deck of a vessel in harbour watching the storm, that he saw what appeared to be an immense mass or ball of electric fluid fall perpendicularly (as it were) into the sea, apparently near the outer light-vessel: the persons in charge of this craft may probably be able to afford further information.' "—*Ibid.* Sept. 29.

"Some further particulars of the fall of the meteor which occurred during the thunder-storm of Thursday evening noticed in our two last issues, have since then been received. The mighty rushing sound and violent concussion perceived by hundreds of persons in the Fort, was so in exactly the same manner in Colaba, a mile to the southward,—at Ambrolie, two and a half miles to the north-west,—as it was in the Roadstead, a mile to the eastward. All the parties between these two extremes of nearly four miles give exactly the same account of the matter. The sound was said to proceed from the northward as of that of a body passing right over head towards the south, and striking the ground at no great distance. As these phænomena are spoken of by all parties as nearly identical, the meteor must have passed when at its nearest at a distance of ten or twelve miles at least. We want more information on the subject; the smallest contributions will be acceptable: only one party who has communicated with us actually saw it rush through the air, and observed it fall near the outer light-ship."—*Ibid.* Sept. 30.

"*The Meteor of last Thursday.*—The following notice of the meteor of Thursday last, Sept. 25, closely corresponds with what has already reached us: had our correspondent been able to give us anything like an exact idea of the interval which elapsed betwixt the fire-ball being seen and the sound being heard, we might have formed an estimate of the distance of the falling body, if the hissing spoken of was in reality the same as the rushing through the air described by other observers. We shall be happy to receive the further communication our correspondent promises us. 'My wife and I had been watching the lightning for some time at the door of our bungalow, but feeling very much fatigued, being an invalid, I retired to the sofa, and had scarcely done so when my wife called out that she saw a ball of fire fall into the sea in the vicinity of the outer light-ship. The heavens appeared to open at one spot, from which it descended. This took place between the hours of ten and eleven P.M. Neither of us noticed at that time any peculiar noise, but at a later hour I said, Listen to the conflict going on amongst the elements: they seemed hissing one another for some moments. I recollect many years since, when residing at Sidmouth, on the coast of Devon, during a violent storm, a large ball of fire fell into the sea, illuminating the whole region; but in those years little or no notice was taken of these things.' "—*Ibid.* Oct. 2.

No. 7.—Meteors seen by Mr. and Mrs. W. W. Boreham, Aug. 11, 1851, from 10 to 11 o'clock. Right ascension of zenith $19^h\ 20^m$ to $20^h\ 20^m$.



No. 8.—Diagram of Mr. Hewitt's meteor, Sept. 20, 1851.

No. 9.—Extract of a note from John Carrick Moore, Esq., Corswall, Stranraer, N.B. Addressed to Mr. Faraday.

"On the evening of Tuesday, the 13th of July, 1852, I happened to observe a very brilliant meteor. I was walking on the bridge of Carlisle when it occurred. It resembled a large star, but certainly bigger than Jupiter, which was shining bright at the time. It was about N.W. or perhaps N.N.W., and seemed to fall vertically, or with a *very slight* inclination to the E. I guess the altitude when it first appeared to have been about 20° above the horizon. [I am aware that persons not in the habit of using instruments generally exaggerate altitudes; but still I do not think it could have been less.] The colour was a bright orange-red; as it fell, the brilliancy increased; it became nearly white, and then again a very bright red, and disappeared without dividing. The night was still, there were no clouds, and not the slightest sound was perceptible. I do not think it could have been two seconds visible. It had scarcely disappeared, when the clock of Carlisle, set to railway, that is London time, struck 10.

"I would mention a circumstance, which I *thought* I noticed, but in which, as the time was so short, I may be deceived. The meteor appeared after the brilliancy increased, suddenly *to become dim*, and then again to shine out in its greatest brightness, which was at the moment of its disappearance. It seemed so near, that I tried to mark the spot where it fell. Mr. Hyslop, the clergyman of Kirkcolm, tells me he also saw it on the shore of Loch Ryan, about 90 miles as the crow flies to the west; he expected it also to fall near him. Mr. H. tells me it seemed to him to fall with a considerable slope to the east. He did *not* observe the dimness after the first increase of brilliancy, which I have mentioned, and of which I feel rather confident; the more so, that I did not expect it, and never heard of such being observed before."

No. 10.—Extract of a letter to Prof. Powell from W. R. Birt, Esq.

"11A Wellington Street, Victoria Park, London, Aug. 11, 1852.

"My dear Sir,—I have the honour to transmit to you the enclosed observations of luminous meteors witnessed by myself and a friend, Mr. J. Harding, last evening in the Victoria Park. The two classes of shooting stars are very apparent, viz. those stars that *increase* in brilliancy during their progress, and those that *decrease* as they proceed. The first star seen by myself, at 9^h 2^m P.M., is an instance of the first class, and that seen by Mr. Harding, at 9^h 28^m P.M., is a fine instance of the second. The description by Mr. Harding appears to be very accurate: I regret I did not catch it, but the figure given well describes the appearance presented by the meteor seen on the evening of July 29th, an account of which I forwarded you. The paths of the whole of the stars now sent, if prolonged, meet in the constellation Camelopardalis, and may be regarded as confirmatory of the point of divergence being in this constellation at this period of the year.......The same feature which I noticed three years since was well brought out last evening, viz. the retrograde movement of the meteors towards the southern and eastern part of the heavens, and the direct movement of those in the northern and western,—confirmatory of the idea that the *real* movements of the meteors are of a planetary nature and opposed to the motion of the earth in its orbit, *unless they should be comparatively at rest as the earth passes through the group.*

"I have the honour to be, my dear Sir,

"Yours very respectfully,

"*Rev. Professor Powell.*" "W. R. BIRT."

No. 11.—Letter from Mr. W. W. Boreham to Prof. Powell, with diagrams of meteors.

"Haverhill, Aug. 13, 1852.

"Dear Sir,—I enclose three diagrams of the approximate paths of 80 on Aug. 9, and 23 on Aug. 10.

"On the former evening I was assisted by Mrs. Boreham; on the 10th I observed alone, looking westward.

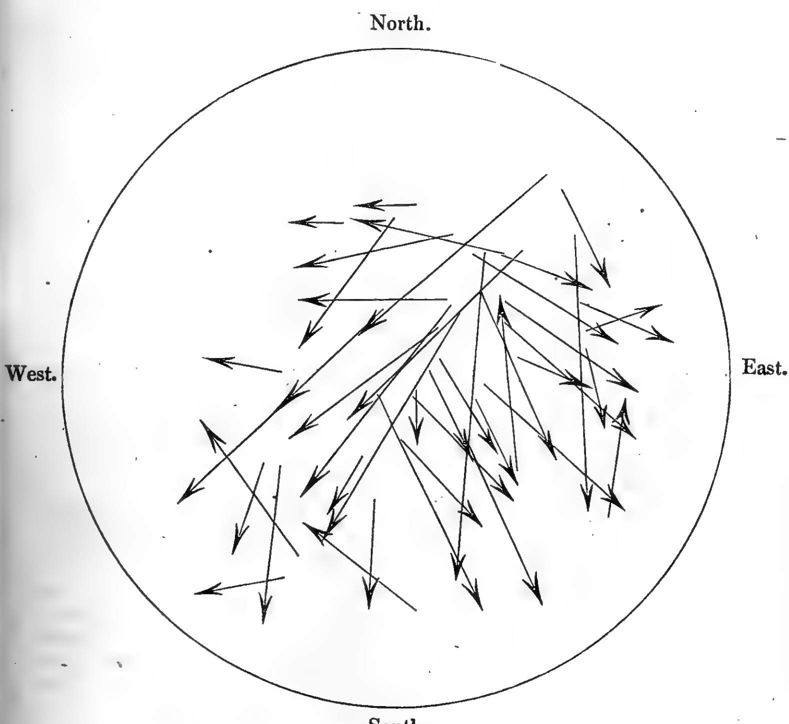
"There was one very remarkably brilliant meteor at 10^h 58^m on the 9th, the path of which was illuminated for 30 or 40 seconds (marked *).

"Trees interfered with my seeing it perfectly.

"I am, dear Sir, yours most truly,

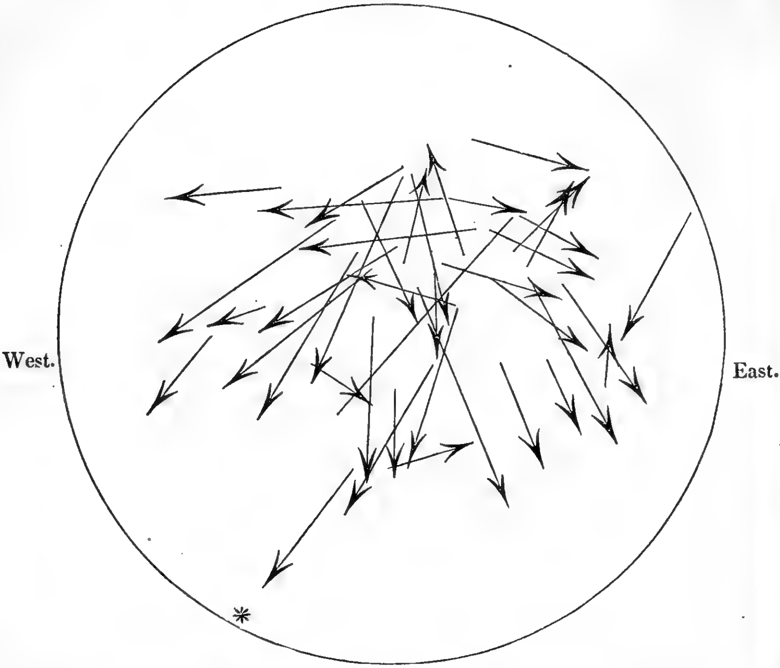
"*Rev. Prof. Powell.*" "Wm. W. Boreham."

Fig. 1.



Aug. 9, 1852, from 10^h 25^m to 10^h 55^m mean time. Right ascension of zenith 19^h 40^m to 20^h 10^m.

Fig. 2.



Aug. 9, 1852, from $10^h\ 55^m$ to $11^h\ 30^m$ mean time. Right ascension of zenith $20^h\ 10^m$ to $20^h\ 45^m$.

No. 12.—Note from W. R. Birt, Esq., to Prof Powell.

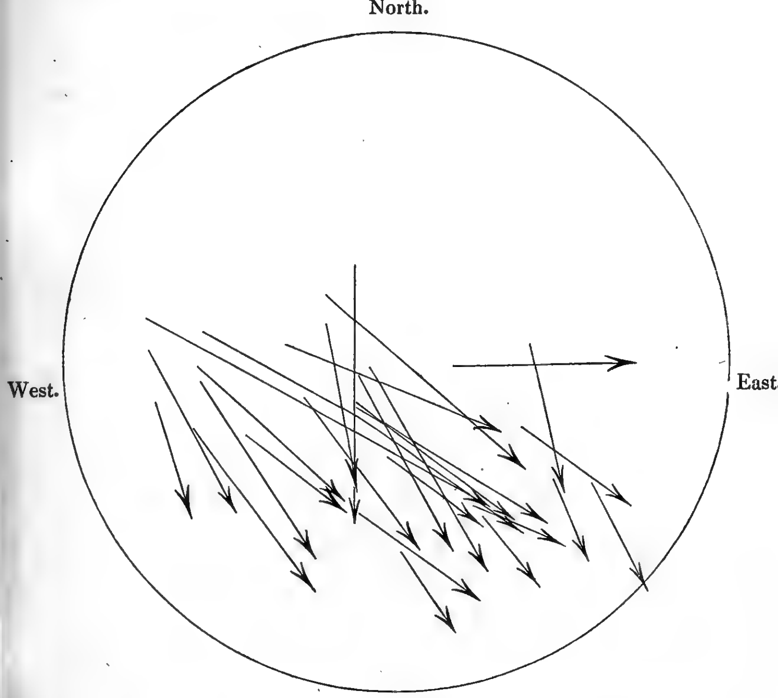
"Observations of Luminous Meteors seen at 11A Wellington Street, Victoria Park, London, by W. R. Birt.

"1852, Aug. 15, $9^h\ 5^m$ P.M.—A very small luminous meteor passed just above β Cassiopeiæ towards the south-east, its visible part less than half a degree; it was very brilliant for its size, which was less than a star of the third magnitude.

"1852, Aug. 15, $9^h\ 8^m$ P.M.—A small globular meteor, between second and third magnitude, passed about midway between α Andromedæ and β Pegasi; it appeared to describe a somewhat curved path, but very slightly so, within and nearly parallel to the sides of the square formed by α, β and γ Pegasi and α Andromedæ; its motion was from the line joining α Andromedæ and β Pegasi to that joining α and γ Pegasi.

"Immediately afterwards another very similar meteor described a very similar and nearly parallel path about the same distance, east of α Andromedæ and α Pegasi, as the former star was west of them: both these meteors very closely resembled the falling stars designated b, No. 4 and 5, observed on the

Fig. 3



Aug. 10, 1852, from 9h 57m to 10h 57m mean time. Right ascension of zenith 19h 15m to 20h 15m.

10th of August, 1849 (see Report, 1849, pp. 51, 52). The approximation of the parallelism of their paths clearly indicates them to have been two distinct bodies; colour a bright bluish white.

"Aug. 15, 9h 10m P.M.—A bright meteor fully of the second magnitude shot across the Milky Way about half a degree north of β Cassiopeiæ towards Polaris.

"Upon comparing the path of this star with that observed on August 10, 9h 2m P.M. (1852), it will be found that their paths cross at rather a considerable angle, the star of August 10 moving from Capella towards Cygnus, which would be slightly erratic from the general direction of movement witnessed on that evening. The direction of the star seen this evening at 9h 14m, is considerably at variance with the motion of the other three, indicating that the body was certainly moving (*i. e.* with its true motion) in a different direction."

No. 13.—Communication from the Rev. W. Read, M.A., to Professor Powell.

"Croydon, Surrey, Aug. 12, 1852.

"I have the honour to transmit an account of a singular phænomenon witnessed by myself and my family on the morning of the 4th of September, 1850.

"I was then residing at the Vicarage, South Mimms, Middlesex, in a situation peculiarly favourable for astronomical observation.

"I had been engaged for several consecutive days in observing the planet Mercury during his approach to the sun; partly to test the accuracy of my power of observation by the calculations of the Nautical Almanack, but chiefly to remark how nearly I could trace the planet in his course to the sun, before he should be wholly lost in his rays.

"For this purpose I used the most careful adjustments my instrument was capable of, and continued my observations without noticing anything peculiar.

"When, however, on the morning of the 4th of September I was preparing my equatoreal before it was fixed on the planet, I observed, passing through the field of view, in a continuous stream, a great number of luminous bodies; and I cannot more correctly describe the whole appearance, than by employing the same language which I used when I communicated the circumstance to the Royal Astronomical Society, in the Monthly Notices of Dec. 13, 1850, and Dec. 12th, 1851.

"When I first saw them I was filled with surprise, and endeavoured to account for the strange appearance by supposing that they were bodies floating in the atmosphere, such as the seeds of plants, as we are accustomed to witness them in the open country about this season; but nothing was visible to the naked eye.

"The sky was perfectly cloudless; and so serene was the atmosphere, that there was not a breath of wind through the day, even so much as to cause any perceptible tremor of the instrument; and I subjected the luminous bodies to examination by all the eye-pieces and coloured glasses that were needful; but they bore every such examination just as the planets Mercury and Venus did, both of which were frequently looked at by me, for the purpose of comparison, during the day; so that it was impossible I could resist the conclusion (much as I was early disposed to hesitate) that they were real celestial bodies moving in an orbit of their own, and far removed beyond the limits of our atmosphere.

"They continued passing, often in inconceivable numbers, from ½ past 9 A.M., when I first saw them, almost without intermission, till about ½ past 3 P.M., when they became fewer, passed at longer intervals, and then finally ceased.

"The bodies were all perfectly round, with about the brightness of Venus, as seen in the same field of view with them; and their light was white, or with a slight tinge of blue; and they appeared *self-luminous*, as though they did not cross the sun's disc; yet when seen near him they did not change their shape, or diminish in brightness.

"They passed with different velocities, some slowly, and others with great rapidity; and they were very various in size, some having a diameter, as nearly as I could estimate, about 2″, while others were approaching to 20″.

"I tried various powers upon them, and used both direct and diagonal eye-pieces; but with every one I employed they showed the same appearance, being as sharply defined as the planet Jupiter, without haze or spot, or inequality of brightness.

"I naturally anticipated some such appearance at night, but after ½ past 3 I saw nothing peculiar, though I waited till 11 P.M.; but have since been informed that at ½ past 11 (it is believed on the same night) a meteor of amazing brilliance and size, and passing in the same direction and about the same altitude, was observed by Mr. Ballan of Wrotham Park, in the immediate neighbourhood of South Mimms.

"I repeated my observations the following morning, and then saw *one* such single body pass in the same direction as those of the preceding day.

"They occupied a tolerably well-defined zone of about 18° in breadth; and, though with some exceptions, their direction was due east and west. Their motion was perfectly uniform, so far as I was able to follow them with the instrument at liberty; and they were observed continuously by myself and members of my family, accustomed to the use of instruments, both by day and night.

"The telescope I employed on this occasion is one of $3\frac{1}{2}$ feet focal length, and $2\frac{3}{4}$ inches aperture, by Mr. Dollond, of faultless performance and mounted equatoreally by Mr. Jones of Charing Cross, the circles divided by Mr. Rothwell of London, and reading off to *5″*.

"I understand that a similar phænomenon has been witnessed by Mr. Cooper of Markree Castle, County of Sligo, though I have not communicated with that gentleman on the subject; but I take the opportunity of subjoining a portion of the contents of a letter to me from Charles B. Chalmers, Esq., F.R.A.S., now residing at Jugon, Côtes du Nord, France.

"He thus writes:—'About the latter end of the year 1849, I witnessed a phænomenon similar to that which you saw in September 1850, in *every respect*, excepting that I thought some of the bodies were elongated, though certainly the majority were globular; and their brightness appeared to me about equal to that of Venus, as seen at the same time.

"'I was then residing at Weston-Super-Mare, in Somersetshire; and the instrument with which I saw them was a 5-feet telescope, equatoreally mounted, in a fixed observatory.

"'I was engaged similarly to yourself in observing the planet Mercury; about $\frac{1}{2}$ past 10 A.M. I was at first inclined to believe it must be the seed of some plants of the thistle nature floating in the air, but from my position that could not have been the case.

"'The wind on the day I observed the phænomenon was very slight; but such as it was it came from the sea. The bodies all appeared sharply defined, no feathery appearances that I could detect; and I did not observe any difference in their brightness during the time I observed them'.

"Mr. Chalmers, then, after offering some remarks on a communication made by Mr. Dawes to the Roy. Astron. Society's Notice in April 1852, says, 'My impression certainly is that the phænomena observed by Mr. Dawes and myself were not similar, and I trust that future observers may throw a clear light on the subject; for though Mr. Dawes is a very high authority, he is not infallible'.

"I feel it right, myself, to notice, that in the paper referred to by Mr. Chalmers, Mr. Dawes conceives an appearance which he saw to have been produced by seeds floating in the atmosphere.

"No one, I am sure, would doubt the correctness of his observations on such subjects; but, excepting in the season of the year, there is so little real similarity, that they cannot be parallel cases; and in his concluding observation that 'had such a dense shoal of bodies so brilliant as those described by me, as seen in September, passed in the night, they would have sufficed to turn darkness into day;' no doubt but that would have been the case, as it was in the phænomenon witnessed by Messrs. Olmsted and Palmer in America, as recorded by Capt. Smyth and Baron Humboldt.

"In conclusion, I may be permitted to say to the British Association, that I had been, at the time my family and myself witnessed what I now communicate, a careful observer with superior instruments for upwards of 28 years, but that I never saw such appearance before nor since that period.

"WILLIAM READ, M.A."

No. 14.—Letter from Dr. Buist to Prof. Baden Powell, Oxford.

"Bombay, July 24, 1852.

"Dear Sir,—I have done myself the pleasure of forwarding from time to time to your address copies of the 'Bombay Times,' containing notices of meteors seen on the coast of India in the course of the year. I regret to say that the list is a poor one; whether it be the want of reapers or the barrenness of the celestial field which has prevented more information being gathered, I shall not take upon myself to determine. I have been about as much out in the open air as usual, that is, I have driven home from office six miles every evening after dark, and so am likely to observe anything unusual in the skies: this season I have absolutely seen nothing.

"One of the most extraordinary circumstances hitherto observed, is the length of time through which they are occasionally visible in one spot, when they must either be approaching or retiring from the earth in a line with the observer's eye. Another adverted to by Olmsted is the almost equally surprising train of light they occasionally leave behind them; the most extraordinary case of which is that described in a recent number of the Journal of the Bengal Asiatic Society, by Professor Middleton. 'I was awakened,' says he, 'at four o'clock on the morning of the 4th of Sept., 1844, by my friend Mr. Williams, Head Master of the College, who remarked to me that something remarkable had occurred towards the north, when a truly beautiful object presented itself, namely a delicate white arch of light, extending from about four degrees from the horizon on the west, to about seven on the east, its crown rising up to near the Pole star. It looked as if an even and rigid rod coated with phosphorus had been made to arch the sky in the manner described. It was seen under very favourable circumstances, also in so far as no trace of cloud was anywhere visible, the sky being at the time of that peculiar depth and transparency which is to be witnessed here during a break in the rains. The account which he gave of its first appearance was this:—a servant rushed into the house in great fright, declaring that the sky had split. He first saw he said an immense ball of fire pass from east to west, which left behind it the rent which had terrified him so much. During the time which I was able to observe the arch, about twenty minutes, it increased in curvature near the crown, which besides moved slowly through about two degrees towards the east. The dawn was now setting in, and the arch diminishing in absolute brightness, though still as well-defined as at first, and before it had ceased to be distinguishable it had shortened by several degrees, rushing away from the ends upwards.'

"I sent to you last year an account of a meteor seen here on the 6th of November, 1850, a few minutes before seven o'clock. When first seen it was about 60° above the horizon, and was rushing towards the south. It traversed an arc of about 40°, when it exploded without noise, descending in a number of brilliant fragments towards the earth. It left a long stream of brilliant white light behind it, ten or twelve degrees in length, resembling the tail of a comet, and which was visible for full twenty minutes. Seen through a telescope it bore exactly the appearance of a comet, the nucleus, even after the explosion, and when nothing was visible to the naked eye, but the light appearing like a star of the second magnitude, surrounded by luminous vapour or cloud. Captain Shortrede describes a meteor seen by him from Churla on April 11, 1842; it was from ten to twenty degrees in length, equally bright throughout, except at the upper end, where it was rather faint. It continued of the same appearance and at the same place for two or three minutes, when it became fainter and fainter and then vanished. There are numberless instances in which similar things have been visible, but for shorter periods of time. I called your attention last year to the extraordinary shower of meteors seen on the 19th of March, 1851, at Shekarpoor, Bombay, Kholapoor, and Cawnpoor, over an area of nearly a thousand miles each way. I have now to bring to your notice the following remarkable facts in reference to fire-balls seen to fall during thunder-storms.

"I have scarcely any hope that this will reach you in time for the Meeting of the Association, as this is our season of slow mails. It was not in my power to despatch it sooner, and the facts may be worth preserving though at present useless to you.

"We have had three instances this season of what seems to have been the fall of an aërolite during thunder-storms. On the 25th of September a violent explosion occurred in the air at Bombay, followed by a wild rushing sound overhead, heard at various points over an area of thirty miles in length and eight in breadth, followed by a severe conucssion, as if a heavy body had fallen, just before the occurrence of which a large fire-ball was seen plunging into the sea. On the 18th of March, during a violent thunder-storm near Dhutmah in the north-west provinces, at seven P.M., a thunderbolt, as it was called, was seen to fall and strike the ground, giving out in the course of the concussion a clear ringing sound like the crack of a rifle; there was no echo or reverberation at all like thunder. It appeared 150 yards from Choki, and resembled in its descent a huge ball of red-hot iron with a band of fire estimated at about thirty feet in length. On the 30th of April, about midnight, a violent explosion was heard during a storm of wind and rain at Kurrachee, resembling the discharge of a vast artillery battery, and about half a minute afterwards a meteor, partially obscured by the rain, but still distinct and visible, was seen descending into the sea. It is now well-established that in India at all events earthquakes are almost always accompanied by furious storms of thunder, lightning, wind and rain: it is difficult to trace the cause of coincidences so remarkable in the commotions of the earth and air, still more so to imagine any connection whatever betwixt the perturbations within the limits of our atmosphere and the movements of solid bodies entering it from regions beyond its boundaries; yet it is surely possible to suppose a thunder-storm propitious to the precipitation on the surface of the ground of bodies which might otherwise have passed on in their career."

On the Influence of the Solar Radiations on the Vital Powers of Plants growing under different Atmospheric conditions. By J. H. GLADSTONE, *Ph.D.*

THERE are few subjects of experimental research in which such opposite statements have been made as on the mutual action of the atmosphere and the vegetable kingdom; even the apparently simple question as to whether plants increase or diminish the amount of oxygen in the air was long a matter of dispute. This arose partly from defective modes of analysing gases; partly from experiments upon plants being made under circumstances very unfavourable to their healthy development; and partly also from variations in light having a great influence in modifying the functions of the vegetable world. The history of these discussions, in which many of the greatest philosophers of the day took part, is too long and too well known to need further notice here. When it was fully conceded that carbonic acid really is decomposed by the plant, it was natural enough that those who observed the wonderful powers of the chemical rays of the solar spectrum in reducing salts of silver and other substances, should refer the chemical changes taking place within the vegetable tissues to the same occult agency. But Dr. Daubeny, in an admirable investigation, published in the Philosophical Transactions for the year 1836, has shown by indisputable evidence that it is the luminous, and not the chemical or the calorific rays, which cause the decomposition of carbonic acid with emission of oxygen from the leaves, the formation of chlorophyl, the irritability of the *Mimosa*, the evolution of water, and indirectly at least the absorption of it by the roots. The colours of flowers are supposed by this author to depend also on the luminous rays; sunshine was found to act far more energetically than diffused daylight; while no colouring effects were observed to be produced by any artificial illumination, not even by that afforded by incandescent lime.

That portion of the inquiry requested by the British Association which devolved upon me, embraced a question not included in the investigations of the Oxford Professor, nor in those of any other experimentalist, as far as I am aware: I refer to the influence of various atmospheric conditions in conjunction with light. This circumstance necessitated the employment of closed vessels under which the plants should be grown; and glass, from its transparency, was not only the best but almost the sole article which could be employed. Bell-shaped glasses were accordingly procured; and they were made of various colours, in order that the different properties of the spectrum might be to a considerable extent separated.

The blue glasses mentioned in this paper had each a capacity of about 690 cubic inches. A smaller bell-glass of 172 inches capacity was also employed in an experiment not described on the present occasion. The yellow glasses had a capacity of 650 cubic inches; the red of 558; and those made of colourless glass of 740 cubic inches. The darkened glasses mentioned below were made by partially covering bell-jars with brown paper, thus excluding the light except such as passed through about one-eighth of the surface of the glass, and that on the side turned away from the window. Their cubic contents were 500 inches. Small colourless and yellow glasses were also procured, each having a capacity of 177 cubic inches.

The blue glass employed is of so intense a colour, that it cuts off by far the greater portion of the luminous rays, but photographic paper showed that it admits the chemical rays freely; it may also be considered as interfering much with the transmission of heat. The red glass, on the contrary, freely admits the calorific influence, but stops the chemical, whilst, like the blue, it diminishes greatly the luminous. The yellow again scarcely decreases the illuminating power of light, but almost destroys its chemical action.

The place in which the experiments here described were conducted, was a room in a dwelling-house at Stockwell, in the neighbourhood of London. The glasses stood on a table close by the window, which had a S.S.E. aspect. No fire was ever lighted in the room, but it must have been a little warmer than the external atmosphere in the winter time on account of the vicinity of heated apartments.

As preliminary experiments, merely the effect of these coloured glasses in accelerating or retarding the growth of various kinds of plants was tried.

Hyacinths were chosen as samples of bulbous-rooted plants. They were all of the same description, purple in colour, as nearly as possible of the same size, healthy, and beginning to put forth a plumule and radicles. They were weighed, placed on the top of colourless glasses containing sufficient pure water just to touch the rootlets, and then covered with the large glass shades.

The experiments were started on Nov. 13th. In order to change the air, the shades were lifted off for a minute or two about every second night. Each plant grew healthily and flowered; yet some differences were observed of a character which might fairly be attributed to the quality of the light. First, as to the rootlets. Under the colourless glass they grew abundantly; under the blue glass they also grew abundantly and more rapidly; under the red glass scarcely any rootlets were produced, and what there were never attained any considerable length; while under the yellow glass they were few in number, but long. Secondly, as to the leaves and flower-stalk. Under the colourless glass they were put forth in process of time and grew healthily. No difference was noticeable under the blue; under the red long spreading leaves were put forth, that bent towards the light in a very marked manner, and the plant had an unhealthy appearance; while under the yellow glass short sturdy leaves and flower-stalks were produced.

As to the flower itself, it began to open at about the same period in each instance, namely,—

Under colourless glass,	on Feb.	11th,	or after	90 days.
Under blue	,,	10th,	,,	89 ,,
Under red	,,	8th,	,,	87 ,,
Under yellow	,,	10th,	,,	89 ,,

There was no observable difference in the colour of the four flowers, notwithstanding the variety of tint under which they had been formed. The flower under the red glass was long and thin. Latterly they all suffered for want of room.

On April 16th all the plants were removed from the water into which their rootlets dipped, dried in the air, and weighed.

	Primary weight of bulb.	Weight of fully developed plant.
Under colourless glass	1305 grs.	2118 grs.
Under blue ,,	1328 ,,	2026 ,,
Under red ,,	1135 ,,	1386 ,,
Under yellow ,,	1299 ,,	1704 ,,

showing an increase of—

Under colourless glass, as	1000	:	1623
Under blue ,,	1000	:	1525
Under red ,,	1000	:	1221
Under yellow ,,	1000	:	1312

The greatest growth therefore was in the plant exposed to all the influences of the solar ray.

Cereals were also grown under the various glasses, a comparative experiment being made under a darkened shade. Access of air was permitted to the plants by the glasses being placed upon boards which were perforated with holes close together, and were raised about one-third of an inch from the table. No direct rays of light could enter, especially as the space under the boards was blocked up on the side nearest the window, and any diffused light finding access by the perforations had to pass through several folds of tarlatane of the same colour as the glass shade itself.

On Sept. 12th three grains of white wheat, sown in garden mould, to which a little stable manure was added, were placed under the various glasses. The wheat began to grow in a few days in each instance, one seed only under the red glass proving unproductive. They were watered as occasion required. In a week or two the plants under the darkened shades attained a considerable height, turning in a very marked manner to that part where most light entered. No secondary leaves ever appeared, but each plant consisted of two long white leaves of about 9 inches in length, so thin and flaccid that they were unable to support themselves; and after thirty days they drooped entirely and became mouldy. The corn-plants under the other glasses grew more slowly, but put forth many leaves, attained a height of 10 or 12 inches, and remained healthy throughout the winter and spring. Those under the yellow glass were the most sturdy in their growth; and those under the blue alone appeared thin and unhealthy.

Mallow-seeds (*Malope trifida*) were sown in garden mould, and placed under the various glasses near the commencement of September, the arrangements being the same as in the preceding experiment. They began to grow after the lapse of a few weeks, first under the colourless glass, then under the blue, and afterwards under the red, yellow, and darkened glasses at about the same time, October 8th. Thin etiolated stalks, with only the first pair of leaves, and those badly developed, about 2 inches in length, were all that was produced under the darkened shade. In about a fortnight they died; and in the middle of March some other seeds sprouted in a precisely similar manner. The mallows under the other glasses grew more healthily and survived much longer, but in no instance did they arrive at maturity: the best plant was one that grew under the yellow light; it had sprouted in the early part of January and put forth many leaves, reaching the height of 5 inches. They grew worst perhaps under the blue glass. A self-sown *Stellaria* grew luxuriantly along with the mallows under the red, and a grass-plant under the yellow shade.

In a paper read by my brother and myself before the Association last year, and published in the Philosophical Magazine for September 1851, we remarked that plants kept in an unchanged atmosphere appear to enter into a sort of lethargic condition. An experiment was instituted for the purpose of ascertaining whether the alteration in light produced by coloured media made any marked variation in this matter; and as the pansy and *Poa annua* were the plants generally experimented on in our previous investigation, they were employed here likewise. Six pansies newly struck, which had taken good root and were vigorous, were planted in six flower-pots containing good garden mould; and with each was also placed a grass-plant in flower. They were all set in trays filled with water to the depth of an inch, or thereabouts; five were covered with the different descriptions of glass shades dipping into the water, so as to cut off all communication between the external and internal atmospheres; while one was freely exposed to all the changes of the surrounding air. The experiment was commenced on October 17th, and access of air was never permitted to the covered plants. The results under the glasses were very various, but how far they depended upon the character of the light or upon the peculiar atmospheric condition, could not be determined with any accuracy. One thing however was clear, that the plants survived much longer for being in an unchanged atmosphere. The pansy that was not covered by any shade was attacked with aphides eight weeks after the commencement of the experiment, and although these were washed off, it drooped before the end of December. The *Poa* also scarcely survived the winter. Under the colourless glass the plants remained healthy much longer; the pansy was attacked by the forementioned insects at the commencement of December, but although it was necessarily impossible to remove the aphides without disarranging the experiment, the plant lived till March. The grass-plant grew very luxuriantly. A curious phænomenon was observed. As the air within the glass shade was perfectly still, the ripe seeds of the *Poa* did not fall from the flower-stalk, and through the dampness of the atmosphere many of them which rested against the sides of the glass germinated and shot forth leaves, in some instances 3·5 inches long, and radicles of 1 inch in length. Under the blue shade the plants grew very tall. No aphides appeared, but mouldiness was observed. In March both plants were straggling and unhealthy; the grass-seeds never germinated; and any portion that died quickly suffered decomposition. The plants exposed to the red light were healthy at first, and the grass grew luxuriantly; but aphides appeared on the pansy in the middle of December, and at the commencement of the succeeding month it became sickly and drooped. The grass-plant also lost its healthy appearance during the spring: some of its seeds germinated. Under the yellow glass neither of the plants increased in size at first, but in the spring they grew, the grass attaining a very great length; they maintained a strong and healthy appearance; no insects showed themselves on the pansy, and the grass-seeds gave little indications of germinating. Some changes in the colour of the pansy's leaves were observed to take place, but the grass remained of its proper green tint. The plants under the darkened shade soon became sickly. On December 11th the grass was found to be dead; the pansy had grown tall, and turned decidedly towards the least darkened part of the shade; it was mouldy and ill-favoured, and on January 6th it drooped.

Researches connected with the growth of plants must necessarily stretch over a considerable space of time. My object in detailing these experiments now is not to draw any general conclusions from them; I regard them as far too few and uncertain for that; but offer them to the Association as a sample of my preliminary attempts in this inquiry,—attempts which may indicate a line of fruitful investigation in future seasons.

A Manual of Ethnological Inquiry; being a series of questions concerning the Human Race, prepared by a Sub-committee of the British Association for the Advancement of Science, appointed in 1851 (*consisting of* Dr. Hodgkin *and* Richard Cull, *Esq.*), *and adapted for the use of travellers and others in studying the Varieties of Man* *.

The late Dr. Prichard read a paper at the Meeting of the British Association held at Birmingham in 1839, "On the Extinction of some Varieties of the Human Race." He cited instances in which total extinction has already taken place, and other instances in which a continually decreasing population threatens a total extinction. He pointed out the irretrievable loss to science if so many tribes of the human family are suffered to perish, before those highly important questions of a physiological, psychological, philological and historical character in relation to them, have been investigated. In order to direct inquiry rightly into the subject, a set of questions was drawn up by a Committee of the British Association, which was largely circulated by means of successive grants of money for that purpose. These questions were however adapted, not only to direct inquiry respecting those tribes which are threatened with extinction, but also to the rest of the human family. The object in publishing these questions is to induce Consuls, political and other

* Copies of this Manual may be had on application to the Assistant General Secretary, York; Messrs. Taylor and Francis, Red Lion Court, Fleet Street; and Richard Cull, Esq., 13 Tavistock Street, Russell Square.

residents and travellers, to obtain precise knowledge in reply to them, and to send it to a centre, the British Association.

It should always be borne in mind that the verification of what is already known is of importance in Ethnology, as in other sciences. The discovery of new tribes of the human family falls to the lot of but few observers, while many have the opportunity of adding to our knowledge of those tribes that are partially known, besides which, recent observation may differ from the older in consequence of changes that may have taken place in the people. Any amount of knowledge, however trifling it may appear in itself, may be of great value in connexion with other knowledge, and therefore will be welcomed. We are seeking Facts, and not inferences; what is observed, and not what is thought.

The following questions might be much increased in number, and the reasons and motives for framing them stated, but such detail would swell the tract to a volume.

Physical Characters.

1. Ascertain the form, size and weight of the people. Measure the height of several men; state those measures, and whether they are above or below the ordinary stature. Measure the length of the limbs, giving the situation of the elbow and knee. Measure the circumference of the chest, thighs, legs, arms, neck and head of the same men: and weigh the same men. Observe if the women be less than the men in stature and relative dimensions; and, if possible, measure and weigh them also. If any remarkable deviations above or below the ordinary stature occur in the adults, measure and weigh them also.

2. Note if there be any prevailing disproportion between different parts of the body, or any peculiarity of form.

3. What is the prevailing complexion? It is impossible to accurately describe colour by words. The best method is to imitate the colour on paper; if this be impracticable, state what the colour is in comparison with some well-known complexion. The colour and character of the hair can be obtained by bringing home specimens. State at what age the hair falls off or turns grey. The colour, form, size, situation and other character of the eyes should be accurately described. It is very desirable to obtain individual likenesses by means of some photographic process.

4. Is there, apart from lack of personal cleanliness, any peculiar odour, as in the Negro? If so, describe it.

5. The importance of the head claims particular attention. The head consists of two parts, viz. the face and the brain-box. Is the shape of the face round, oval, long, broad, lozenge-shaped, or of any other marked form? In addition to the best verbal description, give three sketches of the whole head, by which means the character of the features, their relation to each other and to the whole head, can be at once displayed. These sketches should be,—1st, a profile; 2nd, a front face; and 3rd, a view looking down on the top of the head. Let sufficient neck be taken in order to show how the head is set on and carried. And in these sketches accuracy of drawing is indispensable, without which picturesque effect is valueless.

The form and size of the head, and the relative proportions of its parts, can be obtained with minute precision, by measuring it in the method laid down by phrenologists. If the observer be competent, by a previous study of phrenology, he is requested to observe the manifestations of mind in connexion with the cerebral development, as indicated by the form, size and proportions of the head.

6. Human skulls should be collected, and care should be taken to bring away such specimens as fairly represent the people. Remarkable skulls should also be preserved and marked as such, their deviations should be accurately described. And besides those specimens which are brought away, it is desirable to observe certain things in a large number, always stating the number observed.

a. Is the os frontis divided by a middle suture?
b. Are the skull-bones thick, thin, heavy, light, dense, &c.?
c. Are the sutures much indented?
d. Are ossa triquetra frequent? if so, in what sutures do they occur?
e. Does the squamous bone well abut on the frontal bone?
f. Open some crania to ascertain if there be large frontal sinuses; if so, state the condition of the ossification, and also of the teeth.
g. Observe the bones of the face, their relation to each other, and to the cranium.
h. What is the form of the outer orbitar process?
i. Is the palatine arch flat or vaulted?
j. Does the upper jaw project forwards?
k. What is the form of the lower jaw?
l. What is the shape of the chin?
m. What is the relative position of the ossa nasi and unguis?
n. What is the situation of the foramen magnum?
o. What is the state of development of the paroccipital processes?
p. Observe the number, position, character and mode of wear of the teeth.
q. Have they any artificial means of modifying the form and appearance of the teeth?

7. The number of lumbar vertebræ should be ascertained, as an additional one is said to occur in some tribes.

8. Measure the length of the sternum, and that of the whole trunk, so that comparisons may be instituted.

9. Give some idea of the relative magnitudes of the chest and abdomen.

10. What is the character of the pelvis in both sexes?

11. What is the form of the foot?

12. The form of the scapula deserves attention, especially its breadth and strength, and the clavicle also in relation to it.

13. The blood-vessels and internal organs can be subjected to examination, but with greater difficulty: observe any peculiarities in regard to them.

Peculiarities may exist which cannot be anticipated by special question; the observer should, if possible, examine each organ in detail, and, comparing one with another, he will find few things escape him.

14. Are Albinos found? if so, what characters do they present? State their parentage, and all that can be gathered to throw a light on their origin. State the physical characters of their children if they have any.

15. Where a district obviously possesses two or more varieties of the human race, note the typical characters of each in their most distinct form, and indicate to what known groups or families they may belong: give some idea of the proportion of each, and state the result of their intermixture on physical and moral character. When it can be ascertained, state how long intermixture has existed, and of which the physical characters tend to predominate. It is to be observed, that this question does not so much refer to the numerical strength or political ascendency of any of the types, but to the greater or less physical resemblance which the offspring may bear to the parents, and what are the characters which they may appear to derive from

each: whether there is a marked difference arising from the father or the mother belonging to one of the types in preference to another; also whether the mixed form resulting from such intermarriage is known to possess a permanent character, or after a certain number of generations to incline to one or other of its component types.

16. Any observations connected with these intermarriages, relating to health, longevity, physical and intellectual character, will be particularly interesting, as bringing light on a field hitherto but little systematically investigated. Even when the people appear to be nearly or quite free from intermixture, their habits, in respect of intermarriage within larger or smaller circles, and the corresponding physical characters of the people, will be very interesting.

Language.

17. The affinity of languages is one line of evidence of high value in ethnological researches, and hence the importance of obtaining accurate information concerning the language of a people.

18. If the language be a written one, care should be taken to obtain specimens of the best compositions in it, both of verse and prose. If possible, procure native manuscripts; if not, obtain copies of them.

If there be no written language, and therefore no literature, yet traditions will be found which should be obtained and recorded as closely as possible verbatim, so as to preserve their own collocation and arrangement of words, taking care to select as the most valuable, such as relate to their own origin, history, wars, habits, superstitions, &c.

19. If possible, cause some competent person to translate into their language a well-known continuous composition, as the Lord's Prayer, the 1st Chapter of Genesis, and the 6th and 7th Chapters of St. Luke's Gospel, for with these examples a philologist will be able to give a very good account of any language.

20. In compiling a vocabulary from the mouth of an intelligent native, two objects must be steadily kept in view, viz. 1st, the right selection of words; and 2nd, their accurate reproduction.

1st. *The proper selection of words.*—In selecting the words to form the first vocabulary of a strange language, we must reject,—1st, all words which have no corresponding words in our own language; 2nd, all words which only imperfectly correspond to words in our own language; and take only such words as perfectly correspond. Words are names of things, events, qualities, conditions, &c. Words of the following classes should be taken.

α. The names of natural physical objects, as *sun*, *moon*, *fire*, *water*, *man*, *arm*, *river*, *hill*, &c.; the names of animals, &c.

β. The names of physical qualities, as *red*, *blue*, *round*, *long*, *heavy*, &c.

γ. The names of events, actions, conditions, &c., as *to fall*, *to walk*, *to eat*, *to sleep*.

δ. The names of family relationships, as *father*, *mother*, *sister*, *uncle*, &c.

ε. The names of the numbers as high as they can enumerate. The ordinal numerals should also be given.

It should be ascertained if there be Distributives, Multiplicatives, and Proportionals. Is there anything corresponding to our Numeral Adverbs?

ζ. Personal Pronouns.

η. Particles such as prepositions, conjunctions, &c.

In compiling a vocabulary, the observer should verify every word he receives from one informant by the testimony of others.

2nd. *Their accurate reproduction.*—The words should be so written, that a person quite ignorant of the language, and with no other guide than the vocabulary, shall be able from it alone to pronounce each word with accuracy, sufficient for philological researches.

If elementary sounds peculiar to the language, as the clicks of the Kaffirs, or the sounds represented by ص and ع of the Persian alphabet, occur in the words of the vocabulary, it is obvious that no alphabetic notation will enable one who is ignorant of the language to reproduce those words even though the compiler invents characters to represent them. Mr. Ellis's Ethnic Alphabet is a useful stock of characters to those whose lingual knowledge is sufficient to use it. Our own alphabet, however, is found to be sufficient to write many vocabularies, including both Kaffir and Persian, with an accuracy sufficient for our purpose.

In writing the vocabulary it is of great importance to mark the accented syllable of the word. The mark ʹ of the acute accent is commonly adopted for this purpose, and is recommended to be continued by future compilers.

21. Ascertain the extent of the geographical area over which the language is spoken.

22. Ascertain what languages it comes in contact with at the periphery of its area: and if unknown, or but partially known languages occur, collect vocabularies of them also.

23. Ascertain if the same language without dialectic variations be spoken over the whole lingual area. If variations occur, give examples of them; always bearing in mind that Facts are of greater value than opinions.

Grammar.

In giving an outline of the Grammar, the following hints may be useful.

24. Give the various forms which words assume, as—

- α. The plural forms of Nouns, and the Dual if it exist.
- β. The cases of Nouns.
- γ. Adjectives, their inflections and modes of concord.
- δ. Pronouns, their various forms, with the Dual if it exist.

25. Exhibit the formation of compound words.

26. What is the order of words in a sentence?

27. Beyond the mere order of words, observe if the subject take precedence of the predicate: the cause of the effect, and of any peculiarity in the statement of propositions.

Individual and Family Life.

28. Are there any ceremonies connected with the birth of a child? Is there any difference whether the child be male or female?

29. Does infanticide occur to any considerable extent, and if it does, to what causes is it to be referred, want of affection, deficient subsistence, or superstition?

30. Are children exposed, and from what causes, whether superstition, want of subsistence or other difficulties, or from deformity, general infirmity, or other causes of aversion?

31. What is the practice as to dressing and cradling children, and are there any circumstances connected with it calculated to modify their form; for example, to compress the forehead, as amongst the western Americans; to flatten the occiput, as amongst most Americans, by the flat straight board to which the child is attached; to occasion the lateral distortion of the head,

by allowing it to remain too long in one position on the hand of the nurse, as amongst the inhabitants of the South Seas?

32. Are there any methods adopted, by which other parts of the body may be affected, such as the turning in of the toes, as amongst the North Americans; the modification of the whole foot, as amongst the Chinese?

33. How are the children educated, what are they taught, and are any methods adopted to modify their character, such as to implant courage, impatience of control, endurance of pain and privation, or, on the contrary, submission, and to what authorities, cowardice, artifice?

34. Is there anything remarkable amongst the sports and amusements of children, or in their infantile songs or tales?

35. At what age does puberty take place?

36. What is the ordinary size of families, and are there any large ones?

37. Are births of more than one child common? What is the proportion of the sexes at birth and among adults?

38. Are the children easily reared?

39. Is there any remarkable deficiency or perfection in any of the senses? It is stated, that in some races sight is remarkably keen, both for near and distant objects.

40. To what age do the females continue to bear children? and for what period are they in the habit of suckling them?

41. What is the menstrual period, and what the time of utero-gestation?

42. Are there any ceremonies connected with any particular period of life?

43. Is chastity cultivated, or is it remarkably defective, and are there any classes amongst the people of either sex by whom it is remarkably cultivated, or the reverse, either generally or on particular occasions?

44. Are there any superstitions connected with this subject?

45. What are the ceremonies and practices connected with marriage?

46. Is polygamy permitted and practised, and to what extent?

47. Is divorce tolerated, or frequent?

48. How are widows treated?

49. What is the prevailing food of the people? Is it chiefly animal or vegetable, and whence is it derived in the two kingdoms? Do they trust to what the bounty of nature provides, or have they means of modifying or controlling production, either in the cultivation of vegetables, or the rearing of animals? Describe their modes of cooking, and state the kinds of condiment which may be employed. Do they reject any kinds of aliment from scruple, or an idea of uncleanness? Have they in use any kind of fermented or other form of exhilarating liquor, and, if so, how is it obtained? What number of meals do they make? and what is their capacity for temporary or sustained exertion?

50. Describe the kind of dress worn by the people, and the materials employed in its formation. What are the differences in the usages of the sexes in this respect? Are there special dresses used for great occasions? and, if so, describe these, and their modes of ornament. Does any practice of tattooing, piercing, or otherwise modifying the person for the sake of ornament, prevail amongst the people? N.B. Such modifications not to be blended with other modifications used as signs of mourning, &c.

51. Have the people any prevailing characteristic or remarkable modes of amusement, such as dances and games exhibiting agility, strength or skill?

52. Are games of chance known to the people, and is there a strong passion for them?

53. Do the people appear to be long- or short-lived? If any cases of extreme old age can be ascertained, please to state them. Such cases may

sometimes be successfully ascertained by reference to known events, as the previous visits of Europeans to the country. Is there a marked difference between the sexes in respect of longevity?

54. What is the general treatment of the sick? Are they cared for, or neglected? Are any diseases dreaded as contagious, and how are such treated? Is there any medical treatment adopted? Are there any superstitious or magical practices connected with the treatment of the sick? What are the most prevailing forms of disease, whence derived, and to what extent? Is there any endemic affection, such as goitre, pelagra, plica, or the like? With what circumstances, situations, and habits do they appear to be connected, and to what are they referred by the people themselves?

55. Where there are inferior animals associated with man, do they exhibit any corresponding liability to, or exemption from disease?

56. Do entozoa prevail, and of what kind?

57. What is the method adopted for the disposal of the dead? Is it generally adhered to, or subject to variation?

58. Are any implements, articles of clothing, or food, deposited with the dead?

59. Is there any subsequent visitation of the dead, whether they are disposed of separately, or in conjunction with other bodies?

60. What is the received idea respecting a future state? Does this bear the character of transmigration, invisible existence about their accustomed haunts, or removal to a distant abode?

Buildings and Monuments.

61. What are the kinds of habitations in use among the people? Are they permanent or fixed? Do they consist of a single apartment, or of several? Are the dwellings collected into villages or towns, or are they scattered, and nearly or quite single? If the former, describe any arrangement of them in streets or otherwise which may be employed.

62. Have any monuments been raised by the present inhabitants or their predecessors, and more especially such as relate to religion or war? State their character, materials, and construction. If they are still in use amongst the people, state this object, even if they should be of the simplest construction, and be little more than mounds or tumuli. If these monuments are no longer in use, collect, as far as possible, the ideas and traditions of the natives regarding them, and, if possible, have them examined by excavation or otherwise, taking care to deface and disturb them as little as possible.

63. In these researches be on the look out for the remains of the skeletons of man or other animals; and, if discovered, let them be preserved for comparison with those still in existence.

Works of Art.

64. Let works of art, in metal, bone, or other materials, be likewise sought and preserved, and their similarity to, or difference from implements at present in use amongst the people of the district, or elsewhere, be noted. Have they any kind of commerce or exchange of commodities with the people of other tribes or countries, civilized or uncivilized? and, if so, what are the articles which they give and which they take in exchange? Is this trade or barter in continued or irregular operation, or periodical by means of fairs, stated journeys to or visits from other people?

65. Name the people and channels of this trade.

66. Is it of long standing, or recent?

67. Has it undergone changes, when and how?

68. When a people display their ingenuity by the extent or variety of their works of art, it will not only be desirable to describe what these are, but also the materials of which they are constructed, the modes in which these materials are obtained, the preparation which they undergo when any is required, and the instruments by which they are wrought. Such particulars will not only throw light on the character and origin of the people, but will, directly or indirectly, influence the commercial relations which may be profitably entered into when commerce alone is looked to. When colonization is contemplated, the facts contained in the replies to these queries will point out the mutual advantages which might be obtained by preserving, instead of annihilating, the aboriginal population.

Domestic Animals.

Are there any domestic animals in the possession of the people? Of what species are they? Whence do they appear to have been derived, and to what variety do they belong? Have they degenerated or become otherwise modified? To what uses are they applied?

Government and Laws.

69. What is the form of government? Does it assume a monarchical or democratic character, or does it rest with the priests?

70. Are the chiefs, whether of limited or absolute power, elective or hereditary?

71. Is there any division of clans or casts?

72. What are the privileges enjoyed by or withheld from these?

73. What care is taken to keep them distinct, and with what effect on the physical and moral character of each?

74. What laws exist among the people? How are they preserved? Are they generally known, or confided to the memory of a chosen set of persons? What are their opinions and regulations in reference to property, and especially the occupation and possession of the soil? Does the practice of hiring labourers exist among them?

75. Have they any knowledge or tradition of a legislator, to whom the formation of laws is ascribed?

76. Do they rescind, add to, or modify their laws? and how?

77. Are they careful in the observance of them?

78. What are their modes of enforcing obedience, and of proving and punishing delinquency?

79. How are judges constituted? Do their trials take place at stated periods, and in public?

80. How do they keep prisoners in custody, and treat them?

81. What are the crimes taken cognizance of by the laws? Is there gradation or commutation of punishment?

Geography and Statistics.

82. Briefly state the geographical limits and character of the region inhabited by the people to whom the replies relate.

83. State approximately the number of inhabitants. As this is an important, but very difficult question, it may not be amiss to point out the modes in which the numbers may be ascertained. The people themselves may state their number with more or less accuracy, but it should be known whether they refer to all ranks and ages, or merely comprehend adult males, who may be mustered for war, or other general purpose requiring their combination. In this case state the apparent proportion between adult males and other

members of families. The number of habitations in a particular settlement may be counted, and some idea of the average numbers of a family be given. Where the people inhabit the water-side, the number and dimensions of their craft may be taken, and some idea of the proportion between the number of these and of the individuals belonging to them, may be formed. In drawing conclusions from observations of this kind, it will be necessary to have due regard to the different degrees of density or rarity, in which, from various causes, population may be placed.

84. Has the number of inhabitants sensibly varied, and within what period?

85. If it have diminished, state the causes; such as sickness, starvation, war, and emigration. When these causes require explanation, please to give it. If the inhabitants are on the increase, is this the result of the easy and favourable circumstances of the people causing an excess of births over deaths, or is it to be assigned to any cause tending to bring accessions from other quarters? State whether such causes are of long standing, or recent.

86. Is the population generally living in a manner to which they have been long accustomed, or have new relations with other people, and consequently new customs and practices, been introduced?

87. If the people, being uncivilized, have come under the influence of the civilized, state to what people the latter belong, how they are regarded, and what is the kind of influence they are producing*. State the points of their good influence, if any, and those of an opposite character, as the introduction of diseases, vices, wars, want of independence, &c.

88. Is there any tendency to the union of races? how is it exhibited, and to what extent?

Social Relations.

89. What kind of relationship, by written treaty or otherwise, subsists between the nation and other nations, civilized or not? Have they any intercourse by sea with other countries? Do any of them understand any European language? Or are there interpreters, by whom they can communicate with them?

90. Are they peaceable, or addicted to war? Have they any forms of declaring war, or making peace? What is their mode of warfare, either by sea or land? their weapons and strategy? What do they do with the slain, and with prisoners? Have they any mode of commemorating victories by monuments, hieroglyphics, or preservation of individual trophies, and of what kind? Have they any national poems, sagas, or traditions respecting their origin and history? Where Europeans have introduced fire-arms, ascertain the modes of warfare which have given place to them.

State whatever particulars respecting their origin and history are derived, either from traditions among themselves or from other sources.

Religion, Superstitions, &c.

91. Are the people addicted to religious observances, or generally regardless of them?

92. Do they adopt the idea of one great and presiding Spirit, or are they polytheists?

93. If polytheism exist, what are the names, attributes, and fables connected with their deities, and what are the modes in which devotion is paid to each?

* This question will comprise the existence of missions—the success or the want of it from causes connected with missionaries themselves or others.

Are any parts of the body held sacred, or the reverse? Do they offer sacrifices, and are they of an expiatory character, or mere gifts?

94. Have they any sacred days or periods? fixed or moveable feasts, or religious ceremonies of any kind, or any form of thanksgiving or other observance connected with seasons?

95. Have they any order of priests, and if so, are they hereditary, elective, or determined by any particular circumstance?

96. Is the religion of the people similar to that of any other people, neighbouring or remote? If different, are they widely so, or dependent on particular modifications, and of what kind?

97. In what light do they regard the religion and deities of neighbouring tribes?

98. Is there any idea of an inferior order of spirits and imaginary beings, —such as ghosts, fairies, brownies, and goblins; and how are they described?

99. Have they any notions of magic, witchcraft, or second sight?

100. What ideas are entertained respecting the heavenly bodies? Have they any distinction of stars, or constellations? and if so, what names do they give them, and what do these names signify?

101. Are they in any manner observed with reference to the division of the year, and how?

102. If time is not divided by observations of those bodies, what other mode is adopted? and do observances connected with them rest with the priests or chiefs?

103. When the traveller, by personal acquaintance with the language, or by means of competent assistance from interpreters, can freely converse with the people, it will be desirable that he should form some idea of their amount of intelligence, their tone of mind with regard to social relations, as respects freedom, independence, or subserviency, and their recognition of moral obligations, and any other psychological character which observation may detect; and more especially such as may contribute to an estimation of the probable results of efforts to develope and improve the character.

In using this little manual, it should be borne in mind that it is not a mere guide to inquire into those tribes that are threatened with extinction, nor to make out certain details which are desiderata in our knowledge of the people of any given locality, but is intended to direct inquiry generally respecting the varieties of man.

Mean Temperature of the Day and Monthly Fall of Rain at 127 *Stations under the Bengal Presidency, from official Registers kept by Medical Officers, for the year* 1851. *By* COLONEL SYKES, *F.R.S.*

[Ordered to be printed entire among the Reports.]

DR. GEORGE LAMBE, late Physician-General in Bengal, has been good enough to transmit to me the following analysis of official meteorological returns, made by medical officers of the Bengal Presidency to the Medical Board in Calcutta. They are limited to the returns of mean daily temperature and fall of rain, the extreme difficulty of getting barometers conveyed in safety to distant stations, not one in three sent over reaching its destination in an efficient state, having left the great majority of medical officers without the means of determining the varying pressure of the atmosphere; and with regard to the moisture in the atmosphere and fixing dew-points, although several medical officers kept registers of the dry- and wet-bulb thermometers (there not being any hygrometers on Daniell's plan in use), yet the registers appeared so little satisfactory, that Dr. Lambe did not think it desirable to include them in the analysis. The daily mean temperature was determined by daily observations from three to six in number; but as these were made during the day and not at all at night, the mean temperature is necessarily higher than the mean of the 24 hours would be. Proper precautions were taken against direct radiated or reflected heat, by the thermometers being placed in the hospitals or in the surgeons' houses, properly shaded and with a northern aspect; but the errors of construction in the instruments do not appear to have been generally verified; they are not to be relied upon therefore for absolute results; but as the same mode of observation obtains throughout, the different meteorological records have a relative value to each other which makes them acceptable. The records of the pluviometer are more free from objections than those of the other instruments, and they contain some highly interesting results respecting the unequal distribution of rain, and in support of the facts adduced by myself from Western India, and by Mr. Miller from Cumberland, testifying that the rain-fall becomes a maximum in mountainous districts at a certain height, and then diminishes as the height increases. For the reasons previously assigned, I shall circumscribe my observations on temperature within narrow limits; but as the stations are arranged in groups, within certain areas of latitude and longitude, some few facts of interest may be selected. For instance, in the Calcutta group of 15 stations, within lat. 19° 48′ and 25° 42′ N. and long. 85° 49′ and 89° 14′ E., Cuttack, in lat. 20° 28′, has a lower mean daily temperature in January than Balasore, a degree further N.; but in February this is reversed, but reversed again in a marked manner in March, April, May and the remaining months until September, when Cuttack becomes hotter than Balasore; but in October it is reversed again. The maximum daily mean temperature in this group is 99° in May at Kishnaghur, lat. 23° 24′, long. 88° 22′ E. The next is the Dacca group of 19 stations between the parallels of lat. 20° 8′ and 27° 31′ N., and long. 90° 17′ and 95° 1′E. The same discrepancies are observed here as in the preceding, of the higher latitude having a higher mean daily temperature than the lower in some months, witness Burisaul, lat. 22° 35′, temperature in January 66°, while Sylhet, lat. 24° 53′, in the same month is 67°·7 Fahr. The highest daily mean temperature in this group is 88°·6 at Burisaul in May. The next group of 10 stations is in ascending the Ganges from Hazareebaugh, lat. 24° 0′, to Darjeeling, lat. 27° 3′, at 7000 feet above the sea*; and from Gyah, long. 85° 3′, to Dinagepore, long. 88° 41′. The highest daily mean temperature is at Gyah in Behar, lat. 24° 48′, viz. 96°·9 in May†. The next is the Benares group of 7 stations, from Mirzapore, lat. 25° 9′, to Goruckpore, lat. 26° 46′, and from long. 82° 6′ Sultanpore to long. 83° 37′ Ghazeepore. The highest mean temperature is 101° in May at Sultanpore, in a higher latitude than any station of the group

* Cherrapoonjie and Decca are in the same group, the former at 4500 feet above the sea; the latter is on the Delta of the Brahmaputra. Their difference of latitude is 1° 33′ 35″; their difference of mean temperature in May is 19°·1, which would give 235 feet to a degree. In October the difference is 13°·7, which gives 329 feet to 1° Fahr.

† Darjeeling at 7000 feet, and Sarun on the plains differ 17½ miles in latitude; the difference of mean daily temperature in May is 31°·1, giving 225 feet for each degree of temperature; but in December the difference of mean temperatures is only 14°·8, giving 473 feet for each degree of temperature. Tirhoot and Darjeeling differ 55 miles in lat. The difference of the mean temperature in May is 30°, giving 233 feet to 1°; the difference in December is 17°·4, giving 102 feet to a degree.

except Goruckpore, and at 1050 feet above the level of the sea. The next group is in the N.W. Provinces, and consists of 18 stations, from lat. 21° 51′ Baitool to lat. 27° 23′ Futteghur, and from long. 77° 45′ Hoshungabad to long. 81° 54′ Allahabad. The highest mean temperature is 103° in May at Mynpoorie, lat. 27° 1′, and 100°·1 at Allahabad and Nursingpore, the former in lat. 25° 27′ on the confluence of the Ganges and Jumna. The daily mean temperatures run very high in May and June at all the stations in this group. The Agra group, embracing Rajpootana, has 9 stations, but the observations are incomplete. The highest mean daily temperature at Agra, lat. 27° 10′, was 96°·1 in June. The Meerut and Delhi group has 13 stations, embracing Almorah at 5500 feet, from Budaon, lat. 27° 50′, to Deyrah, lat. 30° 19′, and from Delhi, long. 77° 13′, to Almorah, long. 79° 41′. The highest mean temperature is 104° at Goorgaon, 38 miles south of Delhi, lat. 27° 53′, in June, and at Delhi, lat. 28° 31′, the temperature in May is 98°·6. The Umballa group of 11 stations embraces Simla, at 7500 feet, and other hill stations. At Ferozepore, on the Sutlege and Simla, differing 9 miles, in lat. 30° 57′ and 31° 6′, the highest mean temperature at both is respectively in June, 97°·5 and 69°·2; the difference of elevation giving 220 feet for each degree of difference of temperature in the month of June; but in the month of January the difference of mean daily temperatures, 40° and 55°·9, gives 397 feet for each degree of temperature. The last group takes us to the Punjab, where there are 25 stations between Mooltan, lat. 30° 10′, and Peshawur, lat. 34° 0′, and Kohat, long. 71° 26′, to long. 76° 19′ Kangra. Lahore in this group is 1180 feet above the sea, and Peshawur 1068; and I presume none of the stations, excepting probably Mooltan, have a lower elevation than these. The returns are defective, but it would appear a very high daily mean temperature exists in some months, notwithstanding the comparatively high latitude; Mooltan, lat. 30° 10′, temp. 99°·4; Jehlum, lat. 32° 55′, temp. 97°; and Mean Meer, at Lahore, lat. 31° 33′, temp. 98°·2, all in June. The general results would seem to indicate that the daily mean temperature in the summer months increases with the latitude; that is to say, that the daily mean temperature in lat. 32° in June, July and August, is greater than in lat. 22°. The rain-fall manifests in a marked manner, as I have formerly had occasion to show, the great discrepancies in the fall within very limited areas; and in the increase in the fall up to certain maximum elevations. In the case of Calcutta and Barrackpore, only 9 miles separate in latitude and 4½ in longitude, the fall of rain respectively for 1851 was 64·16 and 42·75, differing 22 inches. Hooghly is 20 miles N. of Calcutta, and differs only 6 miles in longitude, but the fall was only 36 inches, differing from Calcutta 28 inches. Barrackpore is intermediate between Calcutta and Hooghly, and only 1½ mile west of the longitude of Barrackpore, but the difference in the rain-fall is 6¾ inches. All these three places are on the Ganges, on the same level, about 20 feet above the sea. Burdwan, which is 40 miles N. of Calcutta and 28 miles W., had only a fall of 28 inches; but more remarkable still, Midnapore, 8 miles south of Calcutta and 59 west of it, had only 22·78 inches; while Cuttack, 76 miles south and 1½° of longitude west, had 50·17 inches. In the Dacca group, which contains the hill station of Cherraponjie in the Cossya hills, the most extraordinary discrepancies occur. Chittagong, only 13 miles south of the latitude of Calcutta, but 3½° to the E., has 86·33 inches of rain, and lying under the same meridian as Cherraponjie, which is 116 miles N. of Chittagong, at an elevation of 4500 feet, it has 524·02 inches of rain less than Cherraponjie, at which station the almost incredible quantity of 610·35 inches fell in 1851; and that this deluge is no mistake of record, independently of the official report which I quote, I have a letter from Professor Oldham in confirmation of the fact, who spent the monsoon of 1851 at Cherraponjie, and kept a separate record: 50 feet 10 inches depth of water may be said to have fallen chiefly in 7 months, for in November and December there was not a shower; in January only $\frac{3}{4}$ of an inch, in February 3·05 in., and in March $1\frac{1}{2}$ inch. The S.W. monsoon would appear to commence in April with 67 in., followed by 115·15 in May, 147·20 in June, 99·40 in July, 103·9 in August, 71·7 in September, and 40·3 in October; so that the vapour from the south passed over Chittagong, and little of it was condensed until it reached Cherraponjie and the Cossya hills. But the discrepancy in the fall in the neighbourhood of Cherraponjie itself is not the least remarkable circumstance. Sylhet, which lies below Cherraponjie 23 miles to the S. of it, and only 7 miles to the W., had only 209·85 in. of rain; the fall at the proximate places differing 400·5 in. The greatest fall in any month at Sylhet was 43·35 in May. The explanation of this extraordinary fall at Cherraponjie is in the physical circumstances connected with its location. The station is on the Cossya hills, at 4500 feet above the sea, facing the south; and the vapour from the Bay of Bengal, floating at a height of about 4500 feet, passes over the plains of the Deltas of the Ganges and Brahmapootra, and first impinges upon the Cossya hills, and is immediately condensed by the lower temperature at the hills; and then comparatively little of the vapour reaches the higher regions, as is the case in the Western Ghauts of India, where the maximum condensation takes place also at about 4500 feet. This is shown at Darjeeling, 1500 feet above Cherraponjie, 134 miles to the N., and $3\frac{1}{4}°$ of longitude to the W. of Cherraponjie, the fall being only 125·20 in.; and yet rain fell in every month of the year, the maximum fall being 31 in. in June. The rain-tables are not complete for Simla at 7500 feet, but the maximum fall in the monsoon months was only 17·95 in. in July and 11·65 in August, the most rainy months; so that there can be no question but that the fall does not exceed that at Darjeeling, and we have then the fact that those stations so widely separated in India as Simla, Darjeeling and Dodabetta on the Neilgherries, at about an elevation above the sea of from 7000 to 8400 feet, have about the same amount of rain-fall; while the lower elevations of 4500 feet in the peninsula of India have the maximum fall, ranging from 300 to 600 inches. It will scarcely be desirable to make further comment upon the rain-tables; but it may be stated generally, that as the latitude is increased, and westing made, from Calcutta the mean annual fall appears to decrease, the fall at Ferozepore being as low as 23 in.; but the discrepancies in the fall in neighbouring localities continue, as is manifest in the case of Goruckpore, lat. 26° 3′, long. 83° 13′, having 61·70 in., Azimghur, 42 miles south and 9 miles east, having only 39·96 in. The rain-tables from the Punjab are incomplete.

The above meteorological observations suggest to us to be cautious in generalizing from local facts, not less with regard to temperatures and falls of rain, than on the supposed law fixing a fall of one degree of Fahrenheit for a certain number of feet of ascent into the atmosphere.

Abstract of Mean Temperature of the Day and Fall of Rain from Registers ke[pt] ... N.W. Provin[ces]

	Height above the level of the sea.	Latitude.	Longitude.	January.		February.		March.		April.		May.	
				Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	R[ain.]
	ft.	° ′	° ′	°	in.	°	in.	°	in.	°	in.	°	i[n.]
Calcutta	18.11	22 33.01	88 20.34	71.2	0.07	76.01	2.41	85.5	1.05	88.7	3.75	92.9	
Barrackpore	..	22 42.35	88 25.4	72.5	0.24	70.5	1.17	85.7	0.24	90.	2.79	95.5	
Hooghly	..	22 53.24	88 26.34	68.5	0.95	68.	0.65	80.4	..	85.	2.10	89.	
Jessore	..	23 9.	89 10.30	64.	0.40	72.	0.0	80.	0.0	86.	3.85	94.	
Kishnughur	..	23 24.	88 22.20	70.	2.50	69.	1.20	94.	..	96.	2.60	99.	
Burdwan	..	23 13.10	87 52.20	70.5	0.30	76.5	1.10	83.	0.30	86.	0.40	90.	
Moorshedabad	76	24 11.50	88 13.20	63.	0.20	65.5	1.65	79.2	..	83.	2.35	88.	
Rungpore	..	25 42.50	89 14.50	65.3	1.10	68.7	0.10	79.8	0.50	82.6	3.70	86.2	
Bauliah	..	24 23.15	88 33.45	66.3	..	71.6	0.60	81.3	0.20	85.9	0.23	90.8	
Beerbhoom	..	23 54.25	87 34.00	69.5	..	73.1	0.60	82.7	1.16	86.9	2.50	92.2	
Bancoora	..	23 14.8	87 6.31	71.9	0.90	74.	0.93	82.4	1.10	89.	4.22	95.	
Balasore	..	21 30.7	86 58.11	72.9	0.50	74.9	0.27	85.8	1.20	87.5	3.35	96.	
Midnapore	..	22 25.13	87 19.25	69.	0.26	69.	0.23	74.	1.54	81.5	1.74	87.	
Poorie	..	19 48.09	85 49.10	71.6	..	75.6	0.40	82.	..	85.	1.00	88.	
Cuttack	..	20 28.55	85 54.15	72.	0.10	78.	0.04	82.5	0.25	86.	1.66	94.	
Dacca	22	23 43.10	90 23.40	67.3	0.69	71.	0.99	82.5	..	84.	4.28	88.2	
Akyab	..	20 8.	92 56.	71.5	..	73.8	..	76.9	..	83.	..	85.1	
Sandowy	..	....	....	78.	..	81.	..	..	..	85.	0.50	83.5	
Ramree	..	....	....	65.5	..	66.	..	75.	..	77.5	..	81.	
Chittagong	..	22 20.30	91 47.30	67.7	..	72.9	1.90	80.3	..	81.7	2.55	80.6	
Tipperah	..	23 27.30	91 5.40	69.2	0.75	71.4	1.25	77.	..	82.1	5.50	83.3	
Burisaul	..	22 35.40	90 17.	66.	..	72.6	2.50	82.5	..	84.8	3.18	88.6	
Pubna	..	....	....	70.3	0.55	74.	1.60	80.7	..	84.2	2.30	87.5	
Bogra	..	....	....	61.	0.72	68.2	1.70	76.	1.22	83.5	1.20	86.8	
Mymensing	..	24 44.50	90 24.20	62.	0.75	64.7	3.25	75.1	0.50	77.3	5.30	82.8	
Sylhet	..	24 53.	91 50.30	67.7	0.30	69.6	4.50	76.5	2.15	77.7	19.35	81.5	
Cherraponjie	4500	25 16.35	91 43.55	53.7	0.75	55.1	3.05	65.3	1.30	67.1	27.60	69.3	1[illegible]
Gwalparah	..	26 11.	90 40.	64.2	0.70	66.1	0.70	76.1	1.05	77.6	10.20	79.3	
Gowahuttee	..	26 11.15	91 47.10	66.4	0.51	68.3	0.47	77.5	1.45	78.9	5.57	81.1	
Cachar	..	24 48.40	92 47.17	62.5	..	66.	..	76.7	..	77.7	12.11	81.6	
Seebsagur	..	....	....	60.	0.84	62.3	4.39	70.5	1.06	72.8	8.85	77.6	
Tezpore	..	26 36.45	92 50.10	65.2	..	65.2	1.87	74.	2.07	77.3	4.27	79.1	
Debroghur	..	27 31.45	95 1.	63.6	0.61	63.7	5.49	73.1	2.25	73.5	9.43	76.2	
Nowgong A.	..	....	....	..	..	66.5	2.85	72.4	2.10	75.8	8.55	79.	
Dinapore	..	25 37.45	85 5.10	63.6	1.75	67.7	1.	78.5	2.	87.8	..	96.4	
Tirhoot	..	26 7.20	85 26.15	61.8	3.75	65.2	1.45	75.7	0.90	84.2	..	91.9	
Dinagepore	..	25 37.30	88 41.00	69.	0.80	71.	0.80	82.5	0.30	89.5	0.70	94.5	
Purneah	..	25 48.00	87 33.00	64.5	2.12	65.5	3.25	71.5	1.50	88.	2.00	84.5	
Darjeeling	7000	27 3.	88 18.40	40.9	3.45	41.7	2.40	51.8	4.00	55.3	4.55	61.9	
Sarun	..	26 45.27	85 29.12	..	..	..	..	75.5	..	92.5	..	93.	
Monghyr	..	25 27.26	86 43.38	65.5	0.85	68.	1.25	76.5	0.20	84.5	..	92.5	
Hazareebaugh	..	24 0.0	85 24.20	64.3	..	65.4	1.00	76.8	0.35	83.	0.40	89.1	
Gyah	..	24 48.44	85 3.16	70.	0.30	72.	1.25	79.8	..	91.	..	96.9	
Bhaugulpore	..	25 14.50	87 0.00	66.7	0.75	72.5	1.50	80.	0.00	86.5	0.80	92.5	
Benares	..	25 18.26	83 3.12	64.3	2.31	67.8	1.60	74.5	0.65	87.3	..	96.3	
Goruckpore	..	26 46.35	83 22.6	62.2	3.60	65.4	0.20	75.	0.20	82.9	0.10	90.8	
Azimghur	..	26 3.2	83 13.20	64.3	3.80	66.9	1.08	76.1	0.60	81.9	0.80	84.8	
Sultanpore	1050	26 15.35	82 6.40	65.5	..	70.6	..	83.4	..	92.2	..	101.	

by Medical Officers at Civil and Military Stations in Bengal and the
for 1851.

June.		July.		August.		September.		October.		November.		December.		
an pe- re he y.	Rain.	Mean tempe- rature of the day.	Rain.	Mean tempe- rature of the day.	Rain.	Mean tempe- rature of the day.	Rain.	Mean tempe- rature of the day.	Rain.	Mean tempe- rature of the day.	Rain.	Mean tempe- rature of the day.	Rain.	Rain-fall.
	in.	°	in.	°	in.	°	in.	°	in.	°	in.	°	in.	in.
1	8·39	84·7	12·89	86·1	10·78	86·7	8·49	83·1	16·25	78·5	..	71·8	..	64·16
	6·04	83·5	9·71	87·	7·39	87·	3·82	84·5	10·80	74·9	..	67·3	..	42·75
	5·75	83·	9·60	84·5	4·20	84·5	2·75	82·7	10·00	71·2	..	62·5	..	36·00
	8·60	85·	9·90	91·	4·40	90·5	5·40	86·	7·15	80·	..	..	..	40·30
5	4·15	84·	23·	85·	10·75	85·	11·	84·	2·50	75·	..	66·	..	57·70
5	3·25	85·	8·85	86·8	5·20	87·2	2·55	82·	5·65	73·	0·60	..	..	28·20
5	4·61	82·7	10·67	88·	7·75	88·	3·60	83·	7·10	75·	0·00	68·	..	40·48
7	23·90	84·5	11·70	84·5	14·40	87·1	6·30	80·	3·20	79·	..	70·6	..	74·60
1	6·88	85·	11·56	87·	4·95	87·5	3·35	81·3	3·30	72·2	0·17	..	..	31·56
6	3·50	85·3	11·30	86·2	5·40	86·9	2·70	82·	4·90	75·3	..	69·7	..	32·06
6	4·43	86·7	8·76	87·7	2·75	88·2	4·05	..	2·90	73·5	..	73·7	..	31·04
5	3·22	88·	5·86	89·5	3·65	82·	3·40	83·	9·10	72·	0·15	55·5	..	30·79
5	3·10	81·5	4·44	84·	4·13	83·5	..	77·	7·34	69·	..	62·	..	22·78
7	4·50	85·4	14·30	86·2	7·35	85·6	4·45	83·	blown down	76·	..	72·6		
	7·31	84·	10·20	86·	12·11	86·	6·10	79·	11·65	..	..	75·	..	50·17
2	18·78	86·3	13·76	85·3	10·30	85·6	4·70	81·9	12·70	75·7	..	69·5	..	68·93
	59·54	83·7	22·43	83·4	27·58	84·	17·57	83·1	14·09	81·5	..	75·1	2·52	155·07
5	52·18	82·7	30·64	81·7	37·49	81·4	29·67	81·3	10·90	80·7	1·30	74·7	0·62	178·48
	17·30													
	25·88	78·1	13·11	79·1	7·99	80·5	16·27	77·2	10·75	72·8	..	67·5	0·42	86·33
	19·50	81·5	16·08	82·2	25·25	81·2	11·00	78·4	13·50	72·7	..	66·1	..	95·95
	20·70	83·3	17·90	82·5	21·00	84·3	6·90	81·8	21·15	75·6	..	69·5	..	94·47
	8·90	82·8	7·65	85·2	6·20	85·4	6·10	81·6	5·75	73·	..	66·	..	39·05
	14·65	..	7·95	..	8·40	..	6·25	..	6·00	..	..	..	..	51·44
	35·25	84·5	20·00	85·1	20·38	85·5	6·52	81·7	10·70	74·5	..	67·3	..	109·90
	39·70	82·5	33·50	82·6	28·30	83·1	17·85	78·4	20·40	73·9	..	69·	0·45	209·85
	147·20	71·8	99·40	72·4	103·90	72·4	71·70	68·2	40·30	..	..	..	..	610·35
	42·55	81·3	17·90	81·8	11·65	82·1	7·40	77·9	8·85	71·6	..	65·8	..	116·10
	16·61	84·7	9·35	83·8	4·53	83·3	3·05	80·3	3·68	75·1	0·38	69·1	0·50	52·74
	15·35	83·4	15·60	85·	8·94	84·7	9·32	80·9	11·26	76·1	2·00	68·3	0·48	102·84
	16·35	84·4	10·43	84·1	16·40	84·1	7·40	79·2	6·38	71·4	0·05	65·8	0·50	85·18
	16·82	84·5	4·50	83·3	16·58	83·2	4·50	79·4	3·00	71·2	..	66·1	0·30	63·49
	12·85	83·4	13·74	82·2	18·42	..	11·98	..	17·73	..	..	..	..	106·95
	17·50	83·9	7·35	83·8	22·20	82·8	4·65	80·1	7·00	70·6	0·40	66·	2·00	83·45
	4·50	86·2	3·75	86·6	6·75	85·4	7·50	81·5	3·75	71·	..	62·3	..	31·
	3·50	85·8	8·45	86·3	7·33	84·5	3·50	80·	4·50	69·	..	62·2	..	33·38
	12·50	..	12·70	89·5	6·70	89·5	3·20	85·	6·50	80·	..	73·	..	46·70
	9·75	85·5	15·12	84·5	11·80	86·	3·35	79·8	3·75	71·7	..	65·	..	53·39
	31·00	63·7	27·15	64·3	16·70	63·2	19·60	55·8	9·40	50·4	0·10	44·8	0·10	125·20
	..	86·4	4·55	..	..	83·5	8·90	80·2	3·40	63·	..	59·6		
	8·20	86·	6·65	86·5	3·36	85·	8·10	80·5	6·65	70·5	..	..	..	36·66
	8·76	79·9	7·95	79·3	5·70	77·8	5·65	73·5	0·90	69·5	0·85	64·7	..	32·06
	3·25	86·5	9·35	89·8	3·25	86·4	4·25	83·	2·50	65·3	0·50	65·2	..	24·65
	10·45	87·	14·40	85·6	3·50	85·	2·35	82·	7·90	72·	..	66·5	..	42·45
	6·30	86·5	7·10	86·	5·57	84·5	9·68	81·6	3·85	73·1	..	68·3	..	37·06
	15·60	85·9	14·10	86·2	5·	84·7	9·90	80·8	11·60	70·4	..	63·2	..	61·70
	4·48	85·3	8·72	86·4	3·83	83·8	9·45	81·3	7·20	71·3	..	64·3	..	39·96
	..	88·												

1852.

TABL

	Height above the level of the sea.	Latitude.	Longitude.	January.		February.		March.		April.		May.	
				Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.
	ft.	° ′	° ′	°	in	°	in.	°	in.	°	in.	°	in.
Mirzapore	..	25 9·19	82 37·23	60·	..	72·5	..	..	..	88·	..	96·	..
Ghazeepore	..	25 34·25	83 37·9	64·5	1·70	68·	1·40	79·	0·60	88·	0·00	95·	0·0
Juanpore	..	25 43·48	82 44·7	58·5	..	65·	..	74·	..	82·5	..	93·	..
Cawnpore	..	26 28·15	80 23·45	62·6	..	67·6	..	76·9	..	88·1	..	95·3	2·0
Futteghur	..	27 23·20	79 40·25	59·7	4·95	64·7	0·66	75·5	0·57	85·0	0·11	92·6	0·29
Mynpoorie	..	27 1·24	79 13·58	59·5	..	72·	..	83·	..	93·	..	103·	..
Itawah	..	26 45·31	79 3·18	61·	2·76	65·5	0·63	75·8	0·04	85·5	0·05	94·7	0·35
Humeerpore	..	26 7·49	79 47·22	..	1·50	58·5	0·80	78·5	..	95·	0·30	93·5	..
Oorai	..	....	....	..	..	..	..	..	..	..	..	86·5	..
Banda	..	....	....	66·5	..	71·	..	77·2	..	92·	..	98·5	..
Futtepore	..	26 6·2	80 24·18	58·5	..	61·2	..	70·	..	80·	..	90·2	..
Allahabad	..	25 27·43	81 54·12	64·7	2·90	69·	2·00	80·6	..	92·6	..	100·1	..
Saugor	..	23 50·	78 47·55	..	..	..	1·30	..	..	89·	..	91·5	2·0
Dumoh	..	....	....	..	..	..	..	..	..	..	..	..	..
Nursingpore	..	....	....	62·	..	67·	..	..	..	95·	..	100·1	0·31
Hoshungabad	..	22 45·43	77 45·5	..	..	..	..	79·	..	90·	..	94·	..
Baitool	..	21 51·13	77 58·15	70·8	..	77·6	..	85·3	0·02	92·9	..	87·4	1·2
Seeonie.													
Jubbulpore	..	23 9·39	79 59·43	67·4	0·50	72·3	0·90	79·5	..	94·5	..	99·8	0·4
Nowgong	..	25 3·30	79 31·	65·7	3·92	70·4	0·66	..	..	91·6	..	96·4	0·3
Jhansee	..	....	....	..	..	..	..	80·8	..	88·6	..	96·2	..
Agra	..	27 10·26	78 5·4	57·5	1·18	68·	1·08	79·6	..	88·4	0·20	95·1	0·7
Neemuch	..	24 27·30	75 2·30	65·5	..	73·50	..	81·5	..	88·5	..	90·	..
Muttra	..	27 28·42	77 22·3	59·	..	..	..	77·					
Erinpoora	..	25 9·15	73 9·40										
Allyghur.													
Khewaree	..	....	....	65·6									
Beawur	..	....	....	52·	..	63·5	..	71·5	..	80·5	..	87·	..
Bolundshuhur.													
Ajmere.													
Meerut	..	29 0·41	77 45·3	58·5	..	64·8	..	74·1	..	83·1	0·60	86·1	..
Delhie	..	28 31·23	77 13·39	55·2	2·60	62·2	0·30	71·1	2·60	86·4	0·96	98·6	0·0
Goorgaon	..	27 53·24	77 24·35	..	..	76·	..	..	..	92·	3·30	104·	..
Moradabad	..	29 12·49	78 59·46	..	..	63·5	..	72·5	0·10	81·5	0·50	92·	..
Bareilly	..	28 12·17	79 34·45	60·5	2·85	63·0	2·90	76·	0·22	82·	..	..	..
Shajehanpore	..	28 1·35	79 35·11	58·	..	64·	..	74·	..	81·5	..	89·5	..
Seharunpore	..	29 57·18	77 35·30	48·	..	55·5	..	61·5	..	72·5	..	80·3	..
Deyra	..	30 18·58	78 4·27	..	..	..	..	..	..	83·3	..	91·5	..
Almorah	5500	29 35·10	79 41·16	..	4·59	..	2·88	..	..	70·1	1·23	8c·4	..
Budaon	..	27 50·33	78 44·58	..	..	..	..	76·5	..	90·5	..	96·5	..
Bijnore	..	29 22·36	78 10·32	..	..	..	..	74·5	..	81·	..	87·5	..
Nynetal	..	....	....	42·1	6·29	46·5	3·71	56·	1·56	61·2	1·17	69·5	0·
Landour	..	....	....	35·9	..	40·7	..	51·3	..	..	..	..	..
Umballa	..	30 23·4	76 48·42	57·	3·15	60·3	7·15	73·2	..	81·2	2·16	87·9	0·
Simla	7500	31 6·6	77 11·1	40·	2·50	44·1	..	53·4	0·50	61·3	..	66·3	0·
Kussouli	..	....	....	..	..	47·4	3·50	58·5	..	..	..	77·2	0·
Dugshai	..	....	....	42·9	0·37	45·05	2·10	56·8	0·30	64·1	0·75	74·2	0·
Ferozepore	..	30 57·05	74 41·48	55·9	1·17	62·5	1·68	72·3	0·36	84·	0·14	92·8	0·
Loodiana	..	30 55·45	75 56·57	..	..	61·1	3·25	70·2	..	81·9	..	90·5	..
Sirsa	..	....	....	..	..	..	0·11	..	0·15	..	0·14	..	0·

(*continued.*)

June.		July.		August.		September.		October.		November.		December.		
Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Rain-fall.
°	in.	°	in.	°	in.	°	in.	°	in.	°	in.	°	in.	in.
96°	..	..	..	..	..	..	..	84.5	..	71°	..	64°	..	
94.5	8.40	88°	6.20	86°	5.70	86°	5.70	83.5	6.10	69°	0.00	64°	0.0	35.8
94°	..	..	..	..	..	..	..	80°	..	68°	..	57.5		
95.8	..	86.3	..	86.9	..	77.5	..	77.5	..	72°				
92.2	3.22	84.3	15.35	85.5	5.43	83.4	6.27	78.5	0.44	69.4	..	63.4	..	37.29
98.5	..	94.5	..	88.3	..	88.5	..	74.5	..	61°				
94.7	0.87	91.5	11.40	87.5	9.23	82.5	6.16	76.5	0.29	70.7	0.01	62.7	0.05	31.84
93.5	6.70	89°	12.63	87°	10.54	86.2	4.81	82.5	0.64	68.2	..	..	..	37.92
91.5	..	83.5	..	84.5	..	78.5	..	73°	..	65°				
93°	..	86°	..	87.5	..	83°	..	80.5	..	62.5				
91°	1.10	90°	8.50	..	..	..	6°	77.5	1.20					
96.3	..	88.9	..	91.8	..	88°	..	81°	..	75.6	..	68.8		
92°	2.38	86°	14.77	81.2	12.40	76.5	13.23	76.5	1.26	65.5	..	63.5		
..	..	..	..	82.5	..	79°	..	77°	..	68°				
92.3	1.30	83°	17.67	81.5	7.38	80.1	10.96	79.2	0.41	74.3	0.59	68.5		
90°	2.00	85°	14°	82°	9.50	81°	17.90	80°	1.25	70°	0.50			
85.6	3.50	81°	14.50	78.7	8.90	79.5	3.70	82.5	..	67.8	0.20	70.8	..	32.02
90.8	5.97	82.5	17.17	83°	3.93	79.6	8.22	79.5	1.34	70.8	0.37	65.5	..	38.87
94.8	3.92	..	..	..	..	84.6	..	84.3	..	74.6	..	67.9		
94.4	..	..	..	..	..	81.1	..	85.1	..	73.6	..	65.7		
96.1	0.30	86.3	9.80	85.4	9.95	83.6	3.98	81.2	0.57	67.4	..	..	..	27.81
86°	5.00													
85.5														
93.5	4.00	86.7	14.70	87.5	5.10	85°	0.60	80.1	..	69.8	..	59.2		
97.9	0.39	86.4	11.62	88.5	6.56	92°	..	81.5	..	68.8	..	59.6	..	25.08
04°	..	93.5	14.10	87°	4.80	90.1								
93°	..	86°	13.25	87.5	6.10	84°	4.70	84°	2.00					
92.7	3.04	85.5	16.81	87.5	7.75	80°	1.75	77.5	2.70	..	..	56.8		
94.5	..	89°	..	87°	..	82°	..	78°						
94.8	..	86°	..	90°	..	82°	..	78°	..	68.4	..	62.6		
85.9	..	83°	..	82°	..	80°	..	75.2	..	64.5	..	59.5		
81.2	6.90	74.6	10.00	76.9	2.00	77.7	5.55	72.3	2.10	61.1	..	53.2		
93.2	..	88°	8.85	88.5	..	83.2	..	79°						
92°	..	86°	..	87.5	..	87°	..	79°						
69.6	11.65	67.8	23.95	69.2	24.69	65.1	5.67	61.5	2.36	50.1	0.31	47.9	..	82.31
..	..	..	..	..	..	68°	..	64.1	0.95	49.6	2.10	46.3		
96.3	1.30	87.1	7.80	90.7	3.10	91.6	0.60	84.3	..	67.1	..	62.2	..	25.76
69.2	3.50	64.6	17.95	63.4	11.65	66.3	..	60.2	..	52.3	..	46.1		
80.9	..	75.5	2.40	73.7	..	70°	..	67.9						
73.9	3.00	70.5	22.13	70.6	6.50	72.1	..	66.2						
97.5	0.74	88.8	18.81	93.3	0.18	94°	..	86.1	..	70.8	..	61°	..	23.13
92.9	1.50	86.1	10.62	88.4	2.50	88.9	..	82°	..	66.6	..	61.6	0.50	
85°	2°	85°	16°											

TABLE

	Height above the level of the sea.	Latitude.	Longitude.	January.		February.		March.		April.		May.	
				Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.
	ft.	° ′	° ′	°	in.	°	in.	°	in.	°	in.	°	in.
Hissar	..	....	....	..	0·54	..	1·09	..	0·13	..	0·47	..	0·18
Landour	..	....	....	35·9	..	40·7	..	51·3					
Paneeput.													
Rhotuck	..	....	....	..	..	..	..	..	..	..	..	..	..
Lahore	1180	31 35·0	74 22·0	53·6	2·40	..	..	..	..	81·3	1·00	..	..
Jullunder	..	31 19·30	75 36·45	57·4	3·20	59·9	3·42	69·1	..	79·9	0·20	..	..
Hooshearpore	..	31 31·30	75 57·45	51·	6·75	51·4	4·75	70·2	..	81·8	..	..	..
Kangra	..	32 6·10	76 19·5	49·3	7·25	57·6	3·65	68·7	0·90	78·1	0·25	82·5	..
Umritsir	..	....	....	..	..	..	..	82·5	..	..	..	104·	..
Mean Meer	..	31 33·10	74 24·30	55·8	0·58	59·7	2·47	71·4	0·08	83·5	..	..	..
Nakoda	..	31 7·0	75 30·25	55·3	3·28	61·	2·17	71·9	0·29	83·4	0·20	..	..
Kurtapore	..	31 26·40	75 32·30	57·2	2·58	60·9	2·40	70·1	0·37	82·	0·50	..	..
Peshawur	1068	34 0·5	71 38·	48·8	3·24	..	..	...	..	..	..	..	..
Kohat	..	33 32·30	71 26·25	50·5	3·24	58·5	2·02	67·3	1·65	77·7	1·15	88·	0·0
Rawulpindee	..	33 34·40	73 5·20	49·8	3·59	57·1	6·08	55·1	2·61	74·2	2·50	86·9	2·1
Murrie	..	....	....	..	..	..	..	..	..	..	..	..	..
Jhelum	..	32 55·10	73 45·25	53·1	3·73	60·	3·50	71·8	1·56	85·3	1·35	86·	..
Wuzeerabad	..	32 26·20	74 9·50	53·8	..	61·9	..	68·5	..	81·8	..	91·1	..
Sealkote	..	....	....	53·	..	58·5	..	65·5	..	..	..	79·5	..
DheraGhazeeKh.	..	....	....	..	..	..	..	..	..	..	..	93·5	..
DheraIsmael Kh.	..	....	....	..	..	..	..	..	..	..	..	92·	..
Ghoojarea	..	....	....	50·	..	59·	..	69·5	..	77·5	..	90·	..
Mooltan	..	30 10·40	71 33·25	51·	..	58·5	..	69·	..	80·8	..	89·4	..
Shapore	..	....	....	48·5	..	53·5	..	59·5	..	73·5	..	78·5	..
Shaikapoora	..	....	....	59·	..	66·5	..	..	..	86·	..	88·	..
Ghoojrat.													
Jhung.													
Leia.													
Mozuffergur.													

On Experiments on the Laws of the Conduction of Heat. *By* J. D. FORBES, *F.R.S. L. & E.*

I REGRET to state that my experiments have been altogether suspended since the time of my last report by a severe illness which occurred just when I was about to renew them. Consequently only a trifling amount of the sum voted in 1851 for prosecuting the experiments has been expended; not is it my wish at present to have a fresh grant of money, as it is altogether uncertain when they may be recommenced. I have not, however, neglected to examine narrowly the results of the experiments already made, so far as they have been reduced. I am glad to say that they appear to be very consistent, and the experimental numbers to be worthy of preservation as valuable data in the science of heat.

It is with more reserve that I communicate any conclusions affecting the basis of the theory of conductivity as commonly received. But having been in possession for more than a year of a result which seems highly probable, if not quite certain, I am unwilling to withhold it longer on account of an outstanding difficulty which I have not been able satisfactorily to remove. The result is this, that in the case of iron (the only one yet tried) *the flux*

(continued.)

June.		July.		August.		September.		October.		November.		December.		
Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Mean temperature of the day.	Rain.	Rain-fall.
°	in.	°	in.	°	in.	°	in.	°	in.	°	in.	°	in.	in.
..	2·16	..	6·27											
..	..	85·5												
94·3	0·54	86·	..	89·3	..	87·8	..	76·5						
89·4	1·78	85·9	..	88·3	..	86·	..	76·2	..	66·	..	59·4		
92·9	..	86·	..	85·6	..	86·6	..	80·9	..	64·6	..	59·2	0·12	
91·2	3·00	81·8	..	81·9	..	83·5	..	78·4	..	59·5	1·90	57·4	0·50	
94·	..	..	..	..	..	85·	..	..	..	61·5				
98·2	..	86·4	..	89·1	..	87·5	..	77·6	..	64·	0·60	59·4	0·10	
94·7	1·54	87·3	..	90·3	..	90·1	..	82·	..	66·4	1·09	60·4		
94·8	1·25	87·5	..	90·6	..	..	..	82·6	..	68·5	1·35	60·6	0·25	
..	..	95·5	..	88·7	..	87·1	..	74·	..	60·6	..	57·5		
93·	0·98	92·1	..	90·4	..	..	..	..	..	57·9	..	58·		
90·9	3·70	85·5	..	83·2	..	85·7	..	76·2	..	45·				
69·5	..	68·4	..	66·7	..	62·1	..	62·8						
97·	..	..	..	90·	..	84·	..	..	..	55·				
95·5	..	88·3	..	92·1	..	88·7	..	85·	..	67·	..	61·		
81·5	..	84·1	..	81·7	..	84·	..	..	..	64·5	..	58·6		
..	..	..	..	..	..	..	..	..	..	62·				
..	..	..	..	..	..	..	..	..	..	63·				
95·5	..	..	..	89·5	..	82·	..	..	..	58·				
99·4	..	92·3	..	92·1	..	92·5	..	86·9	..	68·4				
86·5	..	..	..	86·5	..	81·	..	..	..	56·				
95·	..	..	..	93·	..	93·	..	..	..	67·				

of heat through the solid is not in a simple direct proportion to the difference of temperature of two contiguous thin slices, but varies in a less rapid proportion; or, *the conductivity diminishes as the temperature increases.* My experiments were so framed as to give the numerical relation between the conductivity and the temperature; but though the numbers, given by experiments under circumstances essentially different, substantially agree, I do not as yet feel justified in assigning a numerical value to the effect of temperature on the conductivity of iron, until the possible disturbing effect of the cause which I have mentioned shall be better ascertained.

I take this opportunity of expressing my acknowledgements to Professor Kelland for the advice which he has, with his usual kindness, from time to time afforded me. I still hope to be able to renew these experiments, and I shall not cease to devise plans for their improvement; in the meantime I intend to put on record both the principles of the method and the direct results obtained, as well as the reductions; and also the manipulations which experience has taught me, and which I believe will be found of use to any future observer.

Ambleside, 25th August, 1852.

On the Chemical Action of the Solar Radiations. *By* Robert Hunt.

(1). The following results are offered as a small instalment of an extensive system of examination which I have undertaken. The object in view is to determine, with all the accuracy possible, the relation which each coloured ray of the prismatic spectrum bears to the chemical action which takes place upon the different agents employed in the production of the sensitive surface. Since different media exhibit very various degrees of absorbent action upon the chromatic rays, as well as on the chemical rays, of the spectrum, by employing them we obtain indications by which we may determine the relation in which these phænomena stand to each other.

(2). The plan upon which I am proceeding is this. Having obtained a very extensive series of coloured glasses, and by the solution of chemical compounds, procured a still more varied set of transparent coloured solutions, I analyse the luminous spectrum of a well-formed vertical opening between two knife-edges, by passing the spectrum through a particular absorbent medium. The spectra are obtained, first, by means of an excellent flint-glass prism; again, by one of crown-glass of faultless purity, the manufacture of Messrs. Chance, Brothers, of Birmingham; and, thirdly, by a hollow prism, in which I have the means of employing fluids of very different refracting powers. For obtaining the chemical impression of the spectrum, I procure a flame-like chromatic image of great intensity, 1 inch in length, from a vertical opening in my steel plate. I have adopted this as my measure throughout, dividing it into 100 equal parts: thus, all the numbers employed are intended to express inches, or the one-hundredth part of an inch.

(3). The first part of the present Report is devoted to the examination of the prismatic spectrum by coloured glasses of various kinds. The numbers affixed may appear somewhat irregular, but as they correspond with a very extensive series, over many of which I have no control, but which are well known to me by these numbers, and can always be obtained, I have thought it best to retain them. I have however adopted the plan of numbering my paragraphs, so that in referring back there will be no difficulty in comparing the chemical with any particular luminous spectrum.

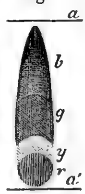
As I hope to present to the next meeting a far more complete examination of this subject, I refrain from offering a single speculation, contenting myself for the present with the record of careful observations and exact experiments.

The lines *a a*′ indicate throughout the length of the normal spectrum.

Analysis of Spectrum by Absorbent Media.—No. 1.

(A.) *Series of Yellow Glasses.*

Fig. 1.



(4) 16. Deep yellow. *Colouring matter Carbon*, fig. 1.—The ordinary red rays very intense, but partaking more of a scarlet colour from the mixture of yellow than a pure red; the orange and red rays blend so perfectly that it is difficult to define their boundaries. Combined, these rays occupy ·12. The yellow rays are reduced to a line of bright light equal to ·10. Beyond these the green rays appear very intense, and occupy a well-defined space equal to ·25. Blue and violet rays, confined within a space equal to ·38, appear somewhat more luminous than the green, presenting no decided colour, but appearing rather as a patch of a pale neutral tint.

(5) 15. Straw-yellow. *Silver stain upon one surface only.*—Shortens the spectrum by two-thirds of the violet, so that its entire length is reduced

to ·80; the other rays continue unchanged, exhibiting a tolerable degree of intensity. When concentrated by a lens the violet ray is seen to suffer yet further extinction relatively to the other rays.

(6) 18. Medium yellow, *believed to be Charcoal.*—The red ray exhibits more crimson from the introduction of blue; orange and yellow well-defined; green ray somewhat shortened, but exhibiting considerable intensity, and well-defined. The blue ray reduced to a small band, and the rays beyond are only indicated by a pale stream of light, neutral in colour.

(7) 14. Brown yellow, *by Carbon*, fig. 2.—Red and yellow rays are considerably reduced; the green is well-defined, shading off into blue, of which a faint portion alone remains, the space beyond appearing rather a lavender colour than violet.

Fig. 2.

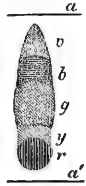
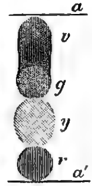


Fig. 3.



(8) 17. Deep yellow, *by Iron*, fig. 3.—This spectrum consists of four well-defined and nearly equal circles, or rather oval spaces. No blue can be detected in the spectral image; the green rays occupying the place of the blue; the yellow rays considerably extended; the red rays are well-defined, but on the upper edge a band of scarlet or deep orange is detected when the eye has become accustomed to the light. The violet has more red than usual in the rays; and at the upper edge, after long gazing, is seen a faint line of neutral gray, the lavender ray of Herschel.

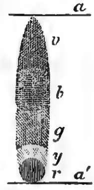
(9) 45. A yellow glass, *having a peculiar pink hue.*—Does not produce any change on the coloured rays of the spectrum; it appears to prolong the yellow by reducing the upper edge of the orange and the lower edge of the green.

(10) 113. Very dark smoky brown.—All blue flowers appear of a deep red brown. Purple and claret-coloured flowers lose all their blue, and appear red. The red, orange and green rays only are visible through this glass, and the illuminating power of those is very considerably diminished.

(11) 114. A lighter brown than 113.—A very much more decided action on natural colours than 113. An examination of the spectrum shows that the red rays are slightly shortened; the orange and yellow rays blend, the yellow coming out in much purity; the green rays are well-defined, but cut off somewhat sharply at the more refrangible end. Beyond these, by accustoming the eye to the light, a faint trace of blue becomes gradually apparent.

(B.) *Series of Red Glasses.*

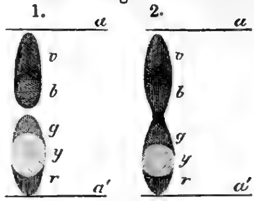
Fig. 4.



(12) 50. Pink glass (not very clear), fig. 4.—The illuminating powers of all the rays considerably reduced. The violet rays are lengthened and the indigo lost; the blue also considerably shortened. The influence of this glass is of a very marked character in separating the rays from each other, every ray visible being well marked out. The orange rays are only made out after long examination as a line of inconsiderable width edging the red rays. By using two thicknesses of this glass, and a spectrum concentrated by a lens, the orange rays are brought out as a well-marked band, edged by two black lines.

(13) 13. Violet glass, fig. 5.—1st. Rays passed through the glass to the prism. The spectrum appears divided into two distinct parts. The illuminating power of all the rays lessened. In the lower section (1, *a*), red, orange and green are visible; blue and violet occupying the space *b*. If

Fig 5.



the spectrum is concentrated by a lens and then examined *through* this glass, the images appear as in (2 *a*), joined by a thin neck of a neutral tint. Few spectra are more beautiful than this when all the extraneous light is cut off, each colour being so very distinctly and clearly made out, the lower illumination enabling the eye to examine it without weariness or confusion.

(14) 12. Red glass (Gold), fig. 6.—The spectrum becomes an oval spot of intense redness with a prolongation of the same colour; the red oval comprehending all the rays from the upper end of yellow to the end of ordinary red, and the prolongation extends to the edge of the blue.

Fig. 6.

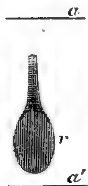
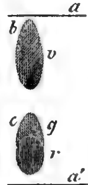


Fig. 7.

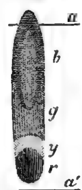


(15) 117. Violet-coloured glass, fig. 7.—Blue flowers observed through it appear far more red than under ordinary circumstances. The spectrum separated into two long ovals, one, *b*, being violet, and the other, *c*, exhibiting the red and green rays only, the spectrum being very considerably shortened at the least refrangible end.

(16) 119. Violet.—This glass obstructs but a very small quantity of light, and its action upon the spectrum is not very decided. The red rays are seen in great beauty and purity extending over the space covered by the orange rays; the yellow is very pure, but the green is somewhat diminished in intensity, and also in length. The violet rays are prolonged into the blue, thus shortening the latter, which are however very brilliant.

(17) 48. *A deep and not very pure violet.*—The red rays are slightly shortened at the lower end, but they appear extended as they increase in refrangibility, so that the orange and yellow rays present a long band of a pale orange tint uniform throughout. The blue rays are sharply cut off from the violet, the interposing indigo being nearly black; the violet rays being themselves exceedingly beautiful and clear.

Fig. 8.

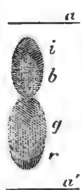


(18) 104. Lilac glass (Manganese), fig. 8.—Reds of flowers seen in strong contrast with the leaves, which appear darker from the loss of their yellow. The yellow rays of the spectrum are nearly obliterated; red shortened; green is gradually lost in black shadow, and all the other rays blended in an intense oval patch of blue.

(C.) *Series of Green Glasses.*

(19) 36. Apple-green glass.—The red rays are shortened one-half, the yellow extends into the orange, and is sharply cut off without any blending at the edge of the red; on the more refrangible side the green encroaches considerably on the yellow, and upwards into the blue; the violet by extending into the blue obliterates the indigo.

Fig. 9.

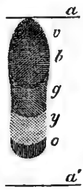


(20) 33. Intense green, fig. 9.—All the rays below the orange are cut off; the yellow and green form one tint of pale pea-green. The blue rays are very light in colour, losing but little of their illuminating power, and these are fringed with a deep band of indigo; no violet rays apparent.

(21) 34. Green. *Copper of great brilliancy*, fig. 10.—The red below the orange cut off; does not shorten the violet end, but produces a great extension of the blue; the green rays encroach consi-

derably on the yellow. The chemical action commences at ·18 from the line a'; the orange occupies the space of ·10, the yellow about ·16, but blending with the green; this is not easy of exact determination; the green occupying about ·25, and the blue and violet ·38. There is a considerable loss of light in the spectrum.

Fig. 10.

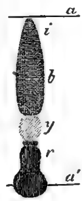


(22) 120. Green glass acting powerfully on all the reds of flowers, &c.—Cuts off one-half the red, extends the yellow, and consequently reduces the green of the spectrum. The blue is shortened by an extension of the violet. Although the reds of the least refrangible end of the spectrum suffer considerably, those which are most refrangible pass this glass (copper) freely.

(23) 121. Green glass (Copper).—Reduces the reds of spectrum; brings the violet down on the blue; but the violet less red than ordinary.

(24) 122. Green glass.—Nearly the same as the last (121). There is little change on the lower rays, but the blue and violet rays are reduced to one-half their ordinary linear dimensions.

Fig. 11.

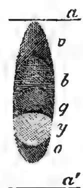


(25) 116. Deep iron-green, fig. 11.—All the reds of flowers observed through this glass become nearly black. The spectrum exhibits two spots of pure crimson; perfect blackness between them. A spot of yellow of great purity, from which the green shades off into a light blue, which becomes very bright, and then passes into a line of indigo. The violet is entirely wanting.

(26) 115. A pale smoky-green.—Acts but very slightly upon any of the rays.

(27) 44. Deep iron-green, fig. 12.—Cuts off the lower red rays; admits the permeation of the orange rays freely. The green very much blended with the yellow, so that it is only by adjusting with great care that a line of yellow can be seen. The blue and violet rays suffer scarcely any change, the lengths of these rays being relatively as follows:—green ·30, blue ·25, violet ·15.

Fig. 12.



(28) 6. Intense copper-green.—The spectrum appears as orange, green, blue and violet. The yellow rays are entirely wanting; a very thin line of red appears at the lower end of orange; the violet is considerably reduced by the loss of red.

In all the deep greens we find the violet rays almost entirely destroyed owing to the removal of the red. It is from results of this character that I am led to believe the violet rays to be due to a reappearance of red rays amongst the more refrangible ordinary rays.

(29) 52. Yellowish-green glass.—This glass has but very slight action on the spectrum, defining more perfectly than ordinary the limits of the violet, but producing no sensible change on any other of the chromatic rays.

(30) 107. Light green.—The reds of flowers are lost, the flowers appearing purple. Yellows are also lost, the yellow blossom of the Elder tree, &c. becoming pure white.

The violet rays are considerably cut off; the other rays are well-defined, but more green and less yellow than ordinary.

(31) 119. Light bottle-green.—Produces no evident change on natural colours; its action on the spectrum is merely to define the spaces of the rays without producing any other change.

(32) 110. Deep bottle-green.—Natural blues are blackened, and the paler reds suffer slightly. This glass cuts off all the most refrangible rays; a band of violet, or blue with some red, is seen lining the edge of the green. The green rays very brilliant, and yellow passing to whiteness; the red rays suffering scarcely any change.

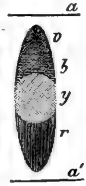
(33) 102. Olive-green.—Green of spectrum somewhat more yellow; the violet diminished by an elongation of the indigo; the violet appearing as a border to the indigo only.

(34) 103. Deep olive-green.—Red flowers not to be distinguished from the green leaves; spectrum diminished to red, yellow and green rays, the red being very much reduced in extent, and the yellow and orange blended.

(D.) *Series of Blue Glasses.*

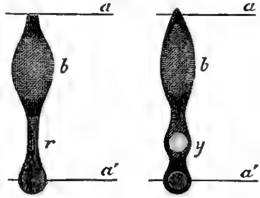
(35) 49. A light blue, fig. 13.—The spectrum is represented in its three primary rays, suffering a little reduction in length; when concentrated by a lens a little violet appears at the extreme edge of the blue. Natural objects do not suffer much change when observed through this glass; purple flowers lose more of their red than blue, and violet-coloured ones appear nearly pure blue.

Fig. 13.



(36) 46. Intense cobalt-blue, fig. 14.—The ordinary red ray disappears, and a pure crimson ray, the extreme red, is seen below the lower edge a' of the ordinary spectrum and extending up to the mean yellow. All the rays but the blue, which becomes very intense, and a trace of violet at v, are obliterated, the red rays being sharply cut off at y, between which and the blue a dark band appears. When concentrated by a lens, the spectrum is changed, as shown in (2). The lower crimson ray at a' becoming a defined circle, surrounded by a band of intense blackness, which extends to the second circle at y, which, instead of being crimson, as was continued in the neck of (1), is now of a lavender hue, from the mixture of some yellow with the red, the *blue* is condensed, the black at the lowest edge being an intense indigo.

1. Fig. 14. 2.



(37) 3. Combined blue and green glasses, fig. 16.—Looking at the spectrum through these glasses, every trace of red is obliterated, the resulting spectrum being a pure green and blue. Making the rays pass from the prism to a lens (fig. 15), and causing the concentrated rays to permeate this combination, the result is somewhat more decided. The spectrum is not shortened at the most refrangible end, but the red of the violet is entirely removed, forming a pure blue patch equal to ·8. Over the space marked g the green is far more luminous than over any other part, and the rays gradually darken towards the lower end.

Fig. 16.

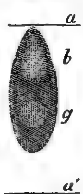
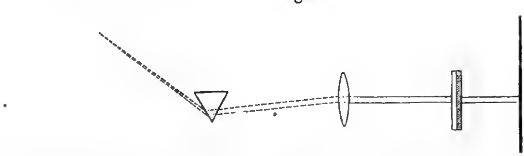


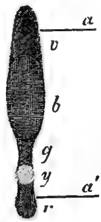
Fig. 15.



(38) 105. Deep cobalt-blue, fig. 17.—The red of flowers, as of the Fuchsia, &c., is entirely lost, and not to be distinguished from the green leaves. The surface of leaves appears a grey or blue, with a few exceptions; the *Arbor vitæ* assumes a red-brown colour, remarkable from the striking contrast it makes with the surrounding trees. The leaves of the Currant and several

other plants appear red on their under surface when examined through this glass, the light falling on the upper surface, and being transmitted. Yellow Nasturtiums become of an intense brown. Blue Larkspurs not to be distinguished from the leaves. The violet and blue rays form a large oval, which, encroaching on the green, reduces it to a line bordering the lower edge of the blue. Yellow, a well-defined circular spot, ordinary red obliterated, and the extreme red forming a well-defined circular image quite surrounded by a black band. A prism of crown-glass gives the same result, as does also the hollow prism filled with Castor oil. The extension of this spectrum is remarkable.

Fig. 17.



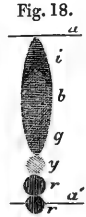
(39) 108. Pale grey-blue appears to act most upon the yellow of natural objects, but produces no marked difference in the general tints. Its action on the spectrum is very slight; the yellow ray is somewhat reduced in size, and appears whiter than ordinary; and the green is lessened by the blue ray encroaching on it.

(40) 112. A smoky-blue.—No effect on colours generally; increases the extent of the violet and diminishes the blue. The yellow suffers, green passing into it; orange lost in the red.

(41) 111. Blue-grey.—Produces a slight, but by no means a marked change on the colours of natural objects; defines more perfectly the line between the blue and violet, and by lowering the yellow gives a more decided margin to the green.

(42) 118. Pale blue, fig. 18.—The reds of flowers are nearly lost when observed through this glass, all extraneous light being shut off from the eyes. The red rays of the spectrum are thrown into two circles, and the yellow into a well-marked patch. The green rays are well defined; blue and indigo do not appear to suffer change. The red of the violet is completely lost.

Fig. 18.



(43) 123. Light cobalt-blue.—The red of the spectrum is brought into a well-defined oval, the yellow very distinct; the green rays are considerably reduced. The blue rays extended, and consequently the violet rays are much diminished.

(44) 47. Deep purple glass.—Red, orange, green, and blue rays admitted; violet only distinguished after long examination. When concentrated by a lens, the violet becomes quite visible as a well-defined band of coloured light.

(E.) *Miscellaneous.*

(45) 101. Smoke-coloured glass.—Does not appear to alter the colours of natural objects observed through it. Blue of spectrum nearly obliterated, but the indigo and violet rays are extended; entire length of spectrum is not lessened. The most remarkable feature is the way in which the spectrum is extended over the violet end, proving the existence of red rays far down in the ordinary blue rays.

(46) 106. A grey glass.—Removes some red from the violet and shortens it. All the rays lose in luminous power, otherwise they do not appear, relatively, to change.

(47) 115. Smoke-coloured, having a green tint.—Scarcely any action on either of the rays; there is a little loss of light.

(48) 151. Glass very slightly smoky.—No change can be detected when this glass is interposed.

CHEMICAL SERIES, No. 1.

Chemical Spectra obtained after the Prismatic Spectrum has been analysed by the interposition of Transparent Coloured Screens.

PHOTOGRAPHIC AGENT.

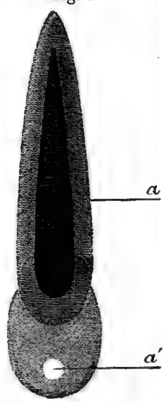
Collodio-iodide of Silver on Glass Plates.*

The numbers preceding the coloured glass employed, refer to the numbers attached to each particular medium in the previous series. No. 1. Those following the colour refer to the paragraph.

(49). NORMAL SPECTRUM, formed by a very pure flint-glass prism.—Light admitted between two knife-edges, separated $\frac{1}{8}$th of an inch, and generally passed through a hole of the same diameter in an inner screen. The chromatic image was received on a white tablet in a perfectly black box; its length, when most accurately adjusted, was 1 inch and $\frac{3}{20}$ths, but for convenience this has been reduced to 1 inch and divided into 100 parts, and relatively to this all the chemical spectra have been corrected (1:2).

(50). *Without any interposed medium*, fig. 19.—Chemical action commences ·40 above the lower end of red, and from this point extends to the length of $1\frac{1}{2}$ inch. Over the space covered by the red and orange rays are indications of a well-defined circle of protective action; immediately above this a dusky brown commences, forming a kind of fringing which is extended to ·60, and in a similar manner it bounds the whole of the spectrum. This is due to diffused light, which I always find bordering the spectrum. Over a space equal to ·10 a well-defined black space appears, then the action weakens, but is still strong over ·7, when it again increases just at the end of the violet, and is somewhat sharply cut off at 1·90 above 0, or lowest red, presenting an image similar to that represented in the margin. Placing the glass at a small angle, and observing the spectrum by reflexion, the lower dark space comes out very strongly, and the whole space above it appears of a dark semi-metallic purple shaded by a dusky brown border.

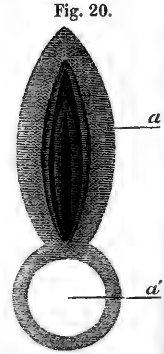
Fig. 19.



Glasses (A.) *Yellow Media.*

(51) 16. DEEP YELLOW (4), fig. 20.—Chemical action commencing over the region of the indigo and violet rays, the most intense action appearing to take place about the line H of Fraunhofer. It forms eventually a well-defined oval, the greatest amount of darkening going on in the centre of the impressed spectrum, a protected band, well-defined from the other parts of the surface, in

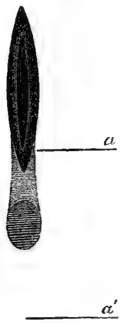
Fig. 20.



* The collodion was made with gun-cotton which had been prepared with nitrate of potash and sulphuric acid. This being well washed was dissolved in æther. Iodide of potassium was dissolved in spirits of wine and iodide of silver added so long as it would take up any, and two drachms of this were mixed with one fluidounce of the collodion. The solution of silver employed was 30 grains to the fluidounce of distilled water. The image was always developed by pyrogallic acid.

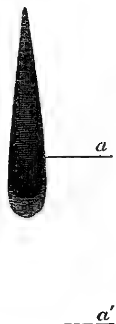
contrast with the little darkening from extraneous light beyond the luminous image. The space between *a* and the lower end of the impressed spectrum is very decidedly protected from change. Upon placing the glass in a solution of hyposulphite of soda, and allowing it to remain for some time, the variations of action are more apparent:—1st, the very dark centre; 2nd, a band of much weaker action; 3rd, a far more energetic band surrounding the whole; and 4th, a protected band extending from the lower point far below this as a protected circle, as indicated by the shading in the figure.

Fig. 21.



(52) 18. Medium yellow (6), fig. 21.—Chemical action commences above the yellow ray, upon the confines of, but *in* the green, commencing ·40 above lower red, the space occupied by the green rays being impressed as a well-defined oval of the length of ·25, then a neck of very much lower intensity of ·20; a large and well-defined oval ·90 in length, exhibiting the greatest degree of intensity in the middle space, shaded off to the edges. The length of impressed spectrum 1·40, and from the zero *a′* to end of chemical action 1·85, or length of action beyond luminous spectrum at *a* ·85. Here we have an extinction of the violet and indigo rays; and over the space occupied by the blue rays a comparatively weak action, this action being continued with very much energy over the space occupied by the dark rays. The indication of protected spaces around the spectrum is less evident than in many other examples.

Fig. 22.



(53) 114. Light red-brown (11), fig. 22.—Action commencing at ·75 and extending with tolerably uniform intensity to 1·60, and gradually shading off to 1·85. At the lower end the action descends slowly to ·65. A brown line of shading appears around this spectrum, but this is probably due to dispersed light, since this shading is considerably increased when many clouds are floating about.

Glasses (B.) *Red Media.*

(54) 13. Violet glass (13), fig. 23.—Chemical action commences at ·60 above 0, and is then continued with tolerable uniformity to 1·35, a faint shading being prolonged about ·15 further, or ·50 beyond the luminous spectrum. The long dark oval in the interior of the spectrum exhibits a more intense chemical action than the other portion; this darkened space appears to belong mainly to the upper oval of the luminous spectrum and over the dark space beyond it. In some other experiments, during a period when the sky was covered with light white clouds, and consequently when the intensity of the sunshine was varying, the chemical limits were subject to constant changes, commencing sometimes as high as ·70 and terminating at ·30.

Fig. 23.

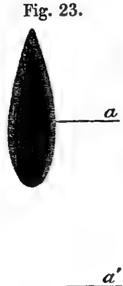


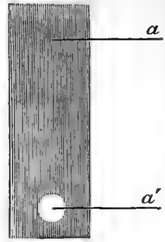
Fig. 24.

(55) 104. Lilac glass (18), fig. 24.—Chemical action commences at ·75 and ceases entirely at 1·25, forming thus one small patch of changed silver, commencing near the line H, and occupying but about one half-inch of space.

More than half of the blue rays are inactive, the action being confined to the space of the violet and the lavender rays.

(56) 12. Red (Gold) (14), fig. 25.—A great number of experiments have been made with the hope of detecting some chemical action on the iodized collodion by the bright crimson rays which permeate this glass. In no instance have I been successful; instead of obtaining any indication of change, the only result has been the occasional evidence of a protecting action over the spot on which the oval red patch, described in the analysis of the spectrum, falls when diffused radiations have acted on the sensitive surface generally.

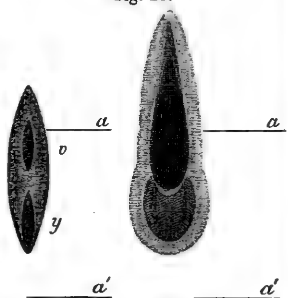
Fig. 25.



Glasses (C.) *Green Media.*

(57) 36. Bright apple-green (19), fig. 26.—Action appears singularly divided. Two spaces of most intense action, corresponding with the green and violet rays as shown at *y*, *v*, these being surrounded with a band of a chocolate-brown colour. By placing the glass in a strong solution of the hyposulphite of soda the outer band is readily dissolved off, but the ovals *y*, *v* resist for a long time the action of the solvent, dissolving indeed, only when the film of collodion separates from the glass.

Fig. 26.



(58). The former result was obtained in *London*. On repeating the experiments at *Falmouth*, a very different result was obtained. The action commencing at ·60, and continuing to 1·60, an extended though much weaker action is prolonged to ·35. The experiments having been repeated several times in both localities under precisely the same conditions as regards prism, size of opening between knife-edges, length of spectrum, &c., these results indicate some peculiar atmospheric conditions. These, however, can only be determined by several sets of experiments at different times.

(59) 6. Intense copper-green (28), fig. 27.—Intense action, producing a bronzed line, commences at ·60 and extends to 1·10, or over a space equal to ·50. A weak action extends down to ·45, marking the space occupied by the green ray. A similar modified action extends upward to 1·60. By long exposure a light fringe appears over the space occupied by the yellow rays, the actual *chemical* spectrum being 1·35 in length. The fringe around the lower part of the spectrum, which is not readily explained, is a tolerably constant result. It may possibly arise from some refraction of the rays near the Fraunhofer line B, within the glass plate.

Fig. 27.

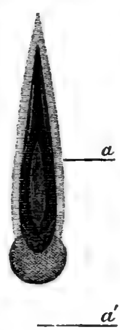
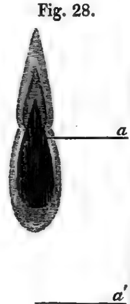


Fig. 28.



(60) 34. Green (Copper) (21), fig. 28.—Action commences at ·60, and it is continued

with full intensity to 1·15. This forms a well-defined dark olive-green oval spot; it is somewhat smaller at the upper end; the chemical action is then continued faintly to 1·35, and still more faintly to 1·60. At the lower end the impressed image descends to ·50, and a faint border of dusky brown surrounds the spectrum, which is impressed over a space equal to 1·5. The principal action is limited to the blue and the rays above it.

Fig. 29.

(61) 33. Intense green (20), fig. 29.—The action here on the most sensitive collodion plates is exceedingly slow, and after an exposure of five minutes in the brightest sunshine, the only indication of any chemical action is the appearance of a faint spot near the line H. This when acted on by the pyrogallic acid becomes very dark, and another spot a little beyond the violet rays makes its appearance.

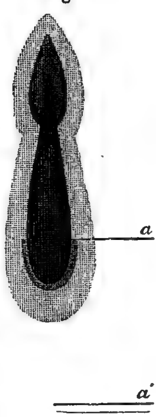
(62). In the camera obscura, which has been devised for working with the very sensitive and beautiful collodion process in the open air, yellow glasses have been introduced for the purpose, as it was thought, of cutting off the chemical rays, at the same time as light enough was admitted to enable the operator to see his work. The results obtained (see *Yellow Media*) clearly prove that rays, chemically active for collodion, pass the yellow media very freely; some green glasses, as the above, offer much more obstruction, but red glasses appear to be still more effective.

(63) 44. Deep iron-green (27).—The action of this spectrum is very slow, and confined to the limits between the mean green ray and the extreme violet. In a great many experiments the spectrum impressed has been always limited to the space ·50; that is, it has commenced in the middle of the luminous spectrum and terminated with the violet rays. Very weak hyposulphite of soda washes off the darkened portion so readily, that I am led to infer that it is an exceedingly superficial dust upon the surface only.

(64) 116. Another deep iron-green (25).—By long-continued action there is scarcely a trace of any chemical change. Here we have an example of a spectrum in which the blue class of rays, ordinarily called the *chemical* rays, are very brilliant, yet they are chemically inactive upon this most sensitive photographic preparation.

Glasses (D.) *Blue Media.*

Fig. 30.



(65) 105. Deep cobalt-blue (38), fig. 30.—The rapidity of action with this medium prevents the marking of many of the more remarkable gradations of change which appear to go on within the chemical spectrum. Chemical action commences between ·70 and 1·70, and extends up to 2·20. The inner portion of this spectrum appears the lightest, but in reality the action has been much more intense over this section than on any other part, and the semi-transparency of this portion is due to the complete production of metallic silver in a state of fine division. Ammonia will dissolve off the outer dark brown edge, but does not act in the slightest degree on the inside oval space. The spectrum obtained without any interposed medium is, upon collodion, of less extent than that now described; it is, usually, a long flame-shaped band of 1·60 or 1·70 in length, and of uniform intensity throughout. The operation of the cobalt-blue

glasses on the spectrum indicates some peculiar influences, which require more extensive study than they have yet received. The remarkable difference between the luminous and the chemical spectrum is very striking, and it appears to indicate the independent existence of the actinic or chemical rays.

(66) 3. COMBINATION BLUE AND GREEN (37), fig. 31.—The spectrum impressed by long exposure commences at ·45 and terminates sharply at 1·0, there being no indication of any action beyond the visible spectrum. It will be found by examining the drawing of the luminous spectrum obtained when the light has passed this combination of glasses, that the action commences at the lower edge of the green rays. The whole space impressed has equal intensity throughout, with a brightening of the silver in the middle.

Fig. 31.

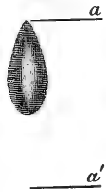
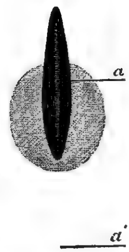
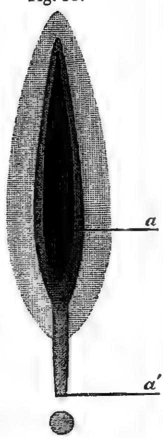


Fig. 32.



(67) 49. A LIGHT BLUE (35), fig. 32.—The action commences at the lower edge of the blue rays ·55 from 0, and extends to 1·40, when it is suddenly interrupted. Considering the usual character of blue glasses, and that this one is of an unusually transparent nature, it will be necessary to subject it to a much more searching examination than it has yet received. That the chemical change is very superficial, is proved by the rapidity with which the hyposulphite of soda removes the impression.

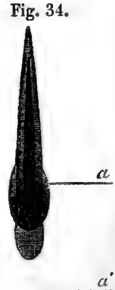
Fig. 33.



(68) 46. COBALT-BLUE (36), fig. 33.—Action commencing at ·75, extending with full energy to 1·50; at the lower edge it is continued with faint shading to ·55, and even some very slight continuation to ·0, which is to be detected by placing the collodion glass plate upon a sheet of white paper and viewing it at a small angle, and shading off at the most refrangible end, until at 2·10 all action appears to cease. This is the greatest extension of the spectrum which up to this date (August 20, 1852) has been obtained; and in two experiments made in very intense sunshine at noon-day, a well-marked spot has been obtained ·10 below 0, as marked in the drawing. This spot will be found to correspond with one of Sir John Herschel's heat spots, and may possibly be referred to some peculiar chemical action due to the so-called *parathermic* rays. The presence of vapour, in the form of light cloud or mist, however attenuated, appears to obstruct this peculiar class of rays.

(E.) *Miscellaneous Series.*

Fig. 34.



(69) 101. SMOKY-COLOURED GLASS (46), fig. 34.—Chemical action commences at ·70 and extends to 1·90. At the least refrangible end the impression descends faintly to ·50. The maximum of action is within the limits of the visible most refrangible rays, the most intense spot being near Fraunhofer's line H.

Those media which have been employed in the analysis of the prismatic spectrum, and are described in the optical series, but which do not appear in the chemical one, have been omitted, until further experiments confirm, or the contrary, the results which have been obtained.

On the Composition and Œconomy of the Flax Plant. By Dr. Hodges, *F.C.S., Professor of Agriculture, Queen's College, Belfast, and Chemist to the Chemico-Agricultural Society.*

Next in importance to the study of the substances which serve man for food, is the investigation of the composition and œconomy of the materials which yield him clothing. Among the plants which, from the most remote antiquity, have been valued for their textile adaptation, those of the Linaceæ family—and especially the *Linum usitatissimum,* a native of our own country, and widely spread over Europe, and also found in Hindostan and North America—have occupied a prominent place; the flax plant, we have reason to believe, having been cultivated for its fibre in the earliest seats of civilization, and manufactured in the tents of the patriarchal fathers of our race. We find that it was worn in the temples, and the microscope has demonstrated that it was entombed in the sepulchres of Egypt. It also appears that its valuable qualities were known to the ancient tribes of northern and western Europe.

A complete account of the flax plant, and its industrial applications in Ireland, should include—1st, the history of flax cultivation in Ireland; 2nd, an account of the processes of cultivation; 3rd, an examination of the chemical composition of the plant; 4th, an account of its technical preparation.

The second division of the subject, however, belongs so exclusively to the practical department of agriculture, that its consideration may at present be properly omitted; and though it would be out of place to occupy much time in this Section with the first division, yet a few remarks may be permitted, for the purpose of exhibiting the attention which, from a very remote period, seems to have been directed to flax cultivation in this country, and as illustrative of its vast importance to the inhabitants of the province in the commercial capital of which we are now assembled.

1. *The History of Flax Cultivation in Ireland.*—From the earliest periods, we have reason to believe that the inhabitants of this island were acquainted with the valuable qualities possessed by the fibre of the flax plant, and manufactured it for clothing. By whom, however, or from what country it was introduced, we have no satisfactory record; for the assertion made by some writers, that the Phœnicians were the instructors of the Irish people, is totally destitute of historical foundation. Our Irish name for flax is *Lhin,* which word is also applied to thread, while the term *Anairt,* which is used to express a kind of coarse linen cloth worn by the peasantry, Dr. O'Donovan, of Queen's College, whose extensive and valuable researches in connexion with the native records of this kingdom are so well known, informs me has no cognate term in any language with which he is acquainted, and is evidently a word of great antiquity. In the Brehon laws, also, we find it enjoined that the Brughaidhs or farmers must be acquainted with the mode of working flax. The linen shirt, dyed yellow, indeed, appears to have been a national dress; and the celebrated jesuit, Edmund Campion, speaking of the "meere" Irish, describes their fondness for capacious linen garments. "Linen shirts," he says, "the rich doe weare for wantonness and bravery, with wide hanging sleeves, playted; thirtie yards are little enough for one of them." The importance of flax cultivation in Ireland appears to have been fully recognized by the English government, as may be inferred from the number of legislative enactments and grants for its encouragement. In 1809, we find that government appropriated the sum of £20,000 for this purpose. The exertions of several national societies have also been directed to the promotion of flax

cultivation; and by the labours of the Royal Dublin Society, the parent of all our agricultural associations, important improvements were introduced in the management of this crop. Since the establishment, in 1841, of the Royal Flax Improvement Society of Ireland—an association of proprietors and manufacturers, which was originated, and holds its meetings in this town—there has been expended of money, collected by subscriptions from members, £8000, and of money granted by the government to the Society, for the promotion of flax cultivation in the south and west of Ireland, £4000. Yet, notwithstanding the efforts which have been made by governments and societies to stimulate the culture of flax, and though the total extent of the crop produced last year was estimated by the Census Commissioners as equal to 138,619 acres, the value of which would be about £1,700,000, this produce is only about a fourth of that annually required by the rapidly increasing manufactures of the United Kingdom. Though flax is at present cultivated in almost every part of Ireland, yet it is in Ulster that this branch of industry has attained its chief development. Of the 138,619 acres of flax grown in 1851, only 14,893 acres were beyond the bounds of this province. It is in Ulster, also, that the principal seats of its manufacture are to be found.

2. *The Composition of the Flax Plant.*—In reference to the third division of the subject, I conceive that the most satisfactory method will be to communicate the history of a crop grown by myself for experimental purposes, the progress of which I was able carefully to watch, from the sowing of the seed till its conversion into dressed flax for the market. Some of the details which I have collected, though of importance in the study of agricultural science, have not been hitherto much attended to in this country.

The field selected for the experiments was situated about a mile and a half from Belfast; it has a south-west aspect, and the soil is a sandy loam, composed of transported materials, such as are common in the districts surrounding Belfast. It had been occupied as a grazing field for four years, and allowed to produce rich crops of thistles and ragweeds. Its chemical examination proved that it contained a fair supply of all the ingredients required for the purposes of cultivation: 100 parts had the following composition:—

Organic matters	6·60
Oxide of iron	2·06
Alumina	2·00
Carbonate of lime	1·91
Sulphate of lime	1·01
Phosphate of lime	0·18
Carbonate of magnesia	0·06
Salts of potash and soda	2·40
Insoluble siliceous matters	83·32
	99·54
Water in the sample	3·00

Textural composition.—Clay, fine sand, and organic matters	16·50
Coarse sand and gravel	83·50
	100·00

Progress of the Crop.—On the 16th of April, 1851, a portion of the field, measuring exactly 70 yards by 70, which had been prepared by spade labour in winter, was reduced to a fine tilth by harrowing and rolling, and sown with two and a half bushels of clean Riga seed of superior quality. The weather had been dry for some time; but in the evening, after the sowing, 0·300 inches of rain fell.

On the 28th of April the young plants appeared above the soil.

Mean temperature, from 16th April, 46°·5 Fahr.
Quantity of rain .... 1·385 inch.

On the 14th of May the surface of the field was green; each plant consisted of two leaves.

May 31.—Each plant, with root, measured about 6 inches. Eight plants were taken for examination, and were found, when all traces of adherent earth were removed, to weigh 36 grs. They were dried at 212°, and carefully incinerated in a platinum vessel, and were found to be composed as follows:—

		Per-centage composition. Fresh plants.	Dry.
Water	30·18	83·833	
Organic matters	5·09	14·139	87·446
Inorganic matters ..	0·73	2·028	12·554
	36·00	100·000	100·000

June 26.—Two plants, with roots, were taken from the same part of the field as those last examined. The plants were just about to flower. Height of each above surface of soil, 22½ inches. Both together weighed 60 grs.

	Per-centage composition. Fresh plants.	Dry.
Water	81·917	
Organic matters	16·837	93·11
Inorganic matters......	1·246	6·89
	100·000	100·000

June 28.—The plants were in flower. Mean temperature, from their first appearance above the soil (60 days), 53°·7 Fahr.

July 7.—One plant in flower was taken. Height, 29 inches. Weight of entire plant, 26·05 grs.

	Per-centage composition. Fresh plants.	Dry.
Water................	73·321	
Organic matters........	25·144	94·25
Inorganic matters	1·535	5·25
	100·000	100·000

July 28.—One plant of flax, in seed, was taken; height above ground, 31 inches, root 5½ long; length from surface of the field to the first branch 24 inches. About 5 inches of the lower end of stem had become yellow. The weight of the entire plant was 71·1 grs.

	Per-centage composition. Fresh plant.	Dry.
Water................	69·210	
Organic matters........	30·045	97·58
Inorganic matters	0·745	2·42
	100·000	100·00

The plant was cut into three portions, which were separately incinerated, with the following results:—

1. Root and lower part of stem weighed, dried, 6·60 grs., gave 0·094 ash, 1·424 per cent.

2. Capsules and branches, dry, weighed 9·47, gave ·293 ash, 3·094 per cent.

3. Middle portion, dry, weighed 5·53, gave ·143 ash, 2·584 per cent.

August 10.—One plant taken; entire length, with root, 37 inches; length from surface of soil to branches, 29 inches; stem of a light straw colour; leaves withered on 10 inches of stem; capsules 10 in number—seeds green; weight of entire plant 71 grs.; branches and capsules 31·8 grs.; water in plant 45·336 grs.; solid matter in ditto 25·665 grs.; inorganic matter in ditto 1·006 gr.

Per-centage Composition.

Water	63·852	
Organic matters	34·732	96·08
Ash	1·416	3·92
Total	100·000	100·00

August 25.—The pulling of the crop was begun—a plant was taken and examined; weight of entire plant 62·40 grs.; weight of capsules 22·50 grs.

Per-centage Composition of Stem.

	In fresh plant.	Dry.
Water	56·64	
Organic matters	41·97	96·80
Ash	1·39	3·20
Total	100·00	100·00

The crop was placed in stooks, and remained in the field until the 8th of September, when it was weighed at the Cregagh Steeping Works. At this period the air-dried straw was found to contain 12·2 per cent. of water, and the bolls 11·84 per cent.

The weight of the produce of the experimental field (straw and bolls), air-dried, was 7770 lbs., for which the sum of £12. 2*s.* 9*d.* was obtained.

Amount of Nitrogen and Inorganic Matters in the Straw and Capsules, as pulled on the 25th August, dried at 212°.

	In the straw.	In the bolls.
1. Nitrogen, per cent.	0·53	1·26
2. Ash, per cent.	3·20	4·77

Composition of the Inorganic Matter of the Crop.

100 parts of the ash of the straw and capsules had respectively the following composition:—

	Ash of straw.	Ash of capsules.
Potash	20·32	16·38
Soda	2·07	6·25
Chloride of sodium	9·27	12·98
Lime	19·88	13·95
Magnesia	4·05	3·91
Oxide of iron	2·83	0·38
Sulphuric acid	7·13	14·51
Phosphoric acid	10·24	23·26
Carbonic acid	10·72	6·37
Silica	12·80	0·67
Total	99·31	99·02

One of the earliest among those who directed their attention to the chemical composition of flax, was a distinguished member of this Association, Sir Robert Kane. Since that time analyses of the ash of the straw of flax have been published by Professor Johnston of Durham; by Messrs. Mayer and Brazier, and by Mr. Way in England; by Leuchtweiss in Germany; and by the reporter. The only examination however of the proximate constituents of the plant, so far as I am aware, consists of an analysis of the seed by Leo Mayer. It is, indeed, strange that a plant, the straw of which has afforded occupation to the industry of so large a portion of the world in all ages, and the preparation of which, for commercial purposes, consists in acting upon its proximate constituents, should not have been more carefully studied. Having been for some time engaged with investigations in this important department, I shall, on some other occasion, bring forward the details of my analyses. At present I shall merely state the general results of the examination of a specimen of flax-straw taken from the experimental crop. A preliminary examination having indicated the presence of a volatile oil, a quantity of the stems of the plant, carefully deprived of the seed capsules, was distilled with water containing common salt, and from the distillate, which was without action on litmus, I obtained an oil of a yellow colour; 5 lbs. of the fully-grown fresh stems afforded about 10 grs. of this oil, which had an agreeable penetrating odour, and suggested the peculiar smell which is remarked on entering a room where flax is stored. In my examination of the proximate constituents of the plant, the straw, coarsely powdered, was placed in an extraction apparatus, and successively treated with æther, absolute alcohol, water, dilute hydrochloric acid, and weak solution of potash. The solutions obtained on examination were found to contain a fat oil, wax, traces of chlorophyle, a peculiar green resin, a gum resin, which presented some of the characters of the principle which Pagenstecher termed linine, and described as existing in the *Linum catharticum* or "purging flax," but could not be identified with it, a modification of tannic acid, which afforded a gray precipitate with perchloride of iron, but was not affected by solutions of isinglass or tartar emetic, gum, not affected by solution of borax or basic silicate of potash, a brown colouring matter, albumen, caseine, starch, pectine, cellulose, and salts. The following table exhibits the action of the various solvents employed:—

1. Soluble in æther	2·83
2. Soluble in absolute alcohol	3·52
3. Soluble in water	5·92
4. In dilute hydrochloric acid	22·76
5. In dilute solution of caustic potash	16·39
6. Cellulose and salts	48·58
	100·00

I shall now proceed to the fourth division of the subject, and describe the various methods which are adopted for the purpose of preparing the flax plant for the spinner. I shall not in this place allude to the œconomy of its seed, but confine myself to the management of the fibre of the plant, to obtain which, of superior quality, is the main object of the flax-growers of Ulster.

When a portion of the straw, as it is termed, of the flax plant is examined, it is found to consist of three parts: first, of a woody, central, hollow column, which the microscope shows to be composed of cellular tissue; second, of a tubular sheath, composed of long and firm bast-cells; and thirdly, of a delicate covering of epidermis. By rubbing a piece of dried flax-straw between the fingers, the woody central part and delicate epidermis can be readily broken to pieces, while the tough fibres of the bast-cells will be found to remain but little injured. Those tough fibres, which are capable of being split into filaments of extreme delicacy, constitute the raw material of our greatest national manufacture. In the country farm-houses and manufacturing towns of Ulster, they afford employment to thousands of our people, and are made to assume almost innumerable forms. They are moulded into the costly lace and beautiful cambric. They cover our tables, and supply us with "fine linen," equal to that which was once the pride of Egypt. The coarser fibres give stout sails to our ships, and even the refuse rejected by the spinner is worked up into a cheap and substantial material for covering our farm-houses, while the sweepings of the Belfast warehouses are sold to the paper-makers of England, and used to produce the broad sheets upon which the *Times* and *Morning Chronicle* newspapers are printed.

To separate this invaluable fibre from the worthless parts connected with it is the first step in its preparation for the spinner. Numerous plans have been proposed for this purpose, both by scientific and practical men. The examination of the plant shows us that its parts are bound together by gummy and resinous substances, and that vegetable jelly fills its cells. The separation of the fibre, therefore, merely by mechanical means, as might be expected, cannot be perfectly accomplished; yet at various times patents have been taken out for the application of machinery for this purpose; and in 1815 the Linen Board expended £6000 in the attempt to introduce into Ireland a machine which had been invented by a Mr. Lee. One of those machines was lately sold as lumber at the White Linen Hall in this town. In other countries the dry preparation has also been tried, and though it has been found capable of producing a coarse, discoloured fibre, adapted for inferior fabrics, such as bagging, &c., yet it has been nearly discontinued. The specimens on the table will serve to illustrate the results of this method of treatment, as pursued in the jail at Cork, where it serves to give useful employment to the prisoners.

From the earliest times only one method has been found capable of yielding the textile material in a condition adapted for every purpose, and possessing all the qualities demanded by the spinner, viz. the decomposition, by the process of fermentation, of the adhesive substances which connect together the bast fibres and the ligneous tissues of the straw. It is by this process, variously modified in the arrangements for conducting it, that nearly all the fibre produced in the great flax-growing countries of Europe is at present prepared. In many parts of Germany the fermentation is induced by exposing the flax, spread in the fields, to the influence of the air and moisture; while in Belgium, which is justly regarded as the model country for flax management, the practice of enclosing the straw in wooden frames, and immersing it in the waters of rivers until the necessary changes are produced, is in many places adopted and found to yield fibre of superior quality.

In Ireland, at the present time, two modifications of the system of fermentation are in use—one of which consists in steeping the straw in pools of water in the open air at ordinary temperatures, while, according to the other method, the steeping is transferred from the farm to the factory, and the fermentation accelerated by employing water maintained at an elevated temperature. The former method of steeping has prevailed in this country and in other parts of Europe to some extent from the earliest times; and though it has been asserted by some writers, without, however, any authority for the statement, that the ancient inhabitants of this island prepared the flax in the same rude manner, by beating the unsteeped straw, as observed among some of the people of the South Sea Islands, yet we may, I think, infer from the number of places to which the name "*poll a lin*," *i. e.* flax hole, is applied, that they steeped in water. The plan followed by the farmer, who adopts the plan of steeping the flax on his farm in the open air, is to excavate a pond in connection with some convenient stream. The dimensions preferred are from twelve to eighteen feet broad, and about four feet deep. The quality of the water employed requires careful consideration, hard waters being found materially to interfere with the process; ferruginous waters also are avoided; and in those districts where the steeper is obliged to make use of them, the flax acquires a dark tinge, which the bleacher finds it difficult to remove. From the action of the salts of iron upon the modification of tannic acid, which I have shown to exist in the straw, we can readily understand that the presence of iron in the water of the steep-hole must be prejudicial. As the oozing of water from the adjoining soil also frequently produces discoloration of the flax, careful steepers place on each side of the pond a small drain, to prevent the entrance of drainage waters. The flax, after pulling, is prepared for steeping by removing the seed capsules, or bolls, by means of a simple machine, composed of a number of iron teeth, about eighteen inches long, screwed to a socket of wood, and fixed perpendicularly on a long bench, upon which the workmen sit. The bolls are separated from the stems by the workmen taking a handful of the flax, spreading it out, and drawing it through the teeth of the ripple, as the machine is termed. Sometimes, however, the steeping does not take place until the flax has been stored for some time, and has become so dry that the fibre would be liable to injury by using the common rippling-machine. In such cases the seed is beaten off by means of a "beater," formed of a block of wood furnished with a curved handle.

In England, where the flax plant is cultivated more for supplying food for cattle than for its fibre, the value of its nutritious seed is acknowledged by every farmer; but in Ireland, unfortunately, industrial knowledge is only beginning to influence the practice of the agricultural population. It is in Ulster that the chief progress has been made. The Royal Flax Society has diffused much useful information; and another institution, the Chemico-Agricultural Society, by its lectures and publications, has also contributed, in no small degree, to overcome ancient prejudices. Yet it must, I fear, be regarded by this meeting as but little creditable to our agriculture, that, though annually nearly 650,000 qrs. of flax-seed and 70,000 tons of flax-seed cake are purchased by the farmers of the United Kingdom from foreign countries, only about one-tenth of the seed grown in this country is saved, the remaining portion, by the prejudices or indolence of the farmer, being consigned to the steep-hole.

In placing the bundles of flax in the steeping-pond, they are arranged in regular rows, placed in an inclined position, so that the tie which confines the straw in one bundle rests upon the root end of the preceding bundle; the bundles of flax of equal length being arranged in different parts of the pond. When the pond is filled, a thin layer of straw or rushes is spread evenly over the flax, and on this covering old sods are placed, so as to keep the bundles from rising above the water. In a day or two, according to the temperature of the season, fermentation commences in the pool, and in warm weather in from eight to ten days, at other times in from twelve to fourteen, the steeping and retting, as the process is usually termed, is completed. During the steeping the water acquires a dark brown colour, carbonic acid is disengaged in great abundance, and the surface becomes covered with a gelatinous scum. To remove this matter it is usual to allow a gentle current of water to flow over the surface of the pond from the supplying stream, as, when it is allowed to remain, the colour of the flax is found to be injured. Various methods are resorted to in this and other flax-growing countries, to ascertain the proper period for the removal of the flax from the pond. Thus the Silesian steepers take some stalks of the flax from the pits, and place them on the surface of the water. If the stalks sink they remove the flax, but if they swim they allow the steeping to continue for some days longer; while the Irish farmer, day after day, when the fermentation has fairly commenced, anxiously tests the progress of decomposition by drawing a few stalks from one of the flax bundles and breaking them across in two places, about two inches apart. If he can readily pull away the central woody column without tearing the filaments of bast which surround it, he considers that the period has arrived for removing it from the pit.

It is easy to perceive that the peculiar series of changes which facilitate the breaking up of the various organic compounds which compose the structure of the flax plant, must, in our fickle climate, where so many sudden alterations of temperature occur, be liable to frequent disturbance, and that the progress of the fermentation, in the shallow steeping-pools, must be exceedingly irregular and uncertain. It is not, indeed, to be wondered, that, notwithstanding the closest supervision, the most experienced steepers should frequently be deceived, and that one part of the flax should be too much decomposed while another part has not properly experienced the alterations which facilitate the complete separation of the valuable material.

The disagreeable odour evolved from a flax-pool must be familiar to those who have travelled in the north of Ireland in the steeping season, and the black hue which the streams in some country districts acquire at that period, from the refuse waters of the pools being allowed to fall into them, excites the surprise of strangers.

It is interesting to discover, amongst those wonderful records, not merely of the military achievements, but of the rural occupations and manufactures of the ancient inhabitants of Egypt, which have come down to us on the walls of their temples, that the steeping of flax and its preparation for their "fine linen," was conducted nearly, we may conclude, in the same manner as by our farmers at the present time. The drawings exhibit to us large wooden vats for containing the flax-straw, and men are represented carrying water to fill them.

To render the history of the crop complete, it is necessary to give some account of the treatment which the flax undergoes on its removal from the steeping-pool. I shall confine myself to a description of the ordinary system of this country. The first operation to which it is subjected is what is technically termed *grassing*, which consists in spreading the steeped straw in thin and even layers upon pasture ground, for from six to ten days, according to the season, frequently turning it during its exposure, that the air may act equally on every part of it. By *grassing* the eremacausis of the woody matter and loosening of the fibre is still further promoted, and the colour of the flax also improved. After grassing, the straw is either stored up in stacks, for subsequent treatment, or at once subjected to the action of machines which break up and remove the brittle woody parts. To break up the woody matters so as to facilitate their removal in the ordinary practice of the farm, a simple machine, termed "the break," is employed. It consists of two wooden frames, each of which is furnished on one side with a number of parallel angular bars, so arranged, that, when the frames are connected together by a hinge, the angular surfaces of the bars on one frame are received into the hollows formed between the bars of the other. One of the frames is permanently fixed on a support, while motion is communicated to the other frame by means either of an iron spring, or by an elastic pole of wood attached to it and connected with a treadle, upon which the workman presses with his foot. By placing a handful of the straws between the frames, and pressing upon the treadle, the moveable frame descends and bruises, or breaks the inelastic woody matter, while the supple fibre is uninjured. So prepared, the straw is ready for the second and final operation, which it undergoes before it is transferred from the farm to the factory. Steeping and grassing have destroyed the cohesion between the various structures of the straw, the break has fractured the woody matters, it only now remains to liberate completely the valuable textile material from its worthless encumbrance. This is effected on the farm by means of a simple implement of manual labour; an improved form has been introduced from Belgium. It consists of a thin blade of wood, attached to a handle, and an upright wooden stand, with a notch cut on one side, in which the workman inserts a handful of the steeped and bruised flax, and turning the flax so as to present every part to the implement, by the blows of the "scutcher" the brittle and broken woody matters, technically termed "shoves," are knocked away, and at the same time any very short or injured fibres are removed, producing what is known as "scutching tow." Sometimes bits of "shove" adhere so closely to the bast fibre, that the workman requires to scrape them away by means of a blunt knife.

Amongst the various obstacles which impede the extension of flax cultivation to the south and west of Ireland, is the difficulty of obtaining experienced scutchers; and serious loss has frequently been sustained, by persons who have attempted the preparation of the crop, from the want of that skilled labour which is available in almost every part of Ulster. Thus it was found that while the northern scutchers can turn out from 12 lbs. to 14 lbs. of fibre per day, the workmen in the south and west have not been able to prepare more than from 5 lbs. to 6 lbs. daily, and frequently not more than 2 lbs. It is therefore of great importance to this country that government is about to afford encouragement to the erection of machinery for scutching, in districts where skilled workmen cannot be obtained. Even in Ulster, for some years the opinion has begun to prevail, that, as in other departments of our manufactures, hand labour must, in the preparation of the flax fibre, give place to machinery, and "scutch-mills," where the work is performed for the farmer, are to be found in all our flax-growing districts.

The fibre of the flax, prepared either by manual labour, or in the scutch-mill, is ready for market, and is sold according to its quality, at prices ranging from £30 to £150 per ton. It is not yet, however, suitable for the operations of the spinner. In the same bundle there exist fibres of various qualities; and it is also necessary that the filaments should be arranged in parallel "*reeds*." They must be sorted and hackled. "Hackling" consists in drawing the mass of fibres through sets of iron teeth, fixed in a stand of wood, which, like the teeth of a comb, separate and arrange the fibres, and remove all broken pieces. Thus treated, flax is rendered fit for its various textile uses.

Produce of Fibre, &c.—The amount of rippled flax-straw, viz. 5824 lbs., obtained in my experiment, considerably exceeded the ordinary produce of the farmer. From the returns of the Royal Flax Society, and from my own inquiries, I would estimate the average produce of a statute acre, in the north of Ireland, of air-dried flax-straw, with bolls, at two tons, which by the seeding machine are usually reduced to 3360 lbs. By the various processes of the rural manufacturer, the amount of dressed flax or fibre obtained averages from four to five cwt. per acre. Some time ago I made an experiment at one of the country scutch-mills near Belfast, for the purpose of ascertaining the relative proportions of the various qualities of fibre, and also the distribution of the inorganic matters. The flax employed had been steeped in the usual way, and was found to contain 1·73 per cent. of inorganic matters:—

4000 lbs. of air-dried straw produced of—

Dressed flax	500 lbs.
Fine tow	132 lbs.
Coarse tow	192 lbs.
	824 lbs.

An examination of the amount of ash which the above materials respectively contained, showed that its distribution was as follows:—

In the flax	4·48 lbs. of inorganic matters.
In the fine tow	2·08
In the coarse tow	2·56, or in all 9·12 lbs.

So that 59·08 lbs. of the inorganic matters, which the crop had withdrawn from the field, remained locked up in the woody shoves, which, as obstinately resisting decomposition, are used for fuel, while 9·12 lbs. were carried away in the dressed flax and tow sold to the spinner.

Accelerated Fermentation—The Patent System.—For so far, we have considered the preparation of the flax fibre solely as constituting a part of the ordinary farm operations of this country. Where the necessary amount of intelligence prevails among the agricultural community, with regard to the proper cultivation of the crop and its after treatment, as is the case in Belgium, in some provinces of which country frequently 10 per cent. of the cultivated area is devoted to its production, and in Ulster, where we find that, in 1851, one out of every 44 acres was under flax, experience has taught the farmer, that even with the various disadvantages attendant upon the old and uncertain methods of management, it is capable of yielding considerable profit to the grower. Notwithstanding, however, the efforts which have been made by societies and government to extend the cultivation of the crop to those districts in the south and west of the kingdom, where, for various reasons, it was most important that the means of occupation which it was found to afford in Ulster should be rendered available, great difficulties were experienced, both from the deficiency of skilled labour and the want of convenient markets for the produce. Fortunately, at a time when great discouragements had been experienced by those who had entertained the expectation that the fertile soils of the south of Ireland were destined to render our manufacturers independent of the supplies of foreign countries, the attention of the flax-growers of Ulster was directed to a system of flax management, proposed by an American named Schenck, which appeared to remove all the difficulties of the old system, and promised completely to revolutionize the œconomy of the crop. In the method of Mr. Schenck, as in the old system, a process of fermentation is employed for the separation of the fibre; but instead of the steeping being conducted in the open air in shallow pools, it is made a factory operation, and the requisite changes are accelerated by placing the rippled flax in water maintained at an elevated temperature. This method is not new, but had been proposed by Professor Scheidweiler in Belgium, and tried in this country several years before the arrival of Mr. Schenck. It also appears to have been employed by the Malays and the natives of Bengal; but it is to the late

Mr. Schenck, and his successors, Messrs. Bernard and Koch, that the credit of organizing establishments for working the process is to be ascribed.

The advantages which the new system presented were most important:—

1st. By leading to the establishment of factories for the steeping of flax, and the purchase of the crop from the farmer, who would thus be relieved from the trouble of its preparation, it rendered it possible to extend the cultivation of the crop beyond the bounds of the ordinary flax-growing districts.

2nd. It introduced greater certainty and œconomy into the preparation of the fibre.

3rd. It prevented the destruction of the valuable seed, and also increased the per-centage of fibre. With these advantages, as might be expected, the new system made rapid progress, and establishments were erected, not merely in Ireland, but in England and Scotland, and the attention of several Continental countries was also at once directed to it.

To enable you completely to understand the system of management pursued at these establishments, one of which those interested in the subject will have an opportunity of inspecting in the neighbourhood of Belfast, I shall continue the description of the treatment of the experimental crop, of which I have already given a portion of the history. When the crop had been completely air-dried, by exposure in the field, so as to yield, as already stated, in the straw, when dried at 212°, only 12 per cent. of water, it was removed to the steeping-works at Cregagh. It was there placed in stacks, and after some time prepared for steeping. The first operation for this purpose is the removal of the valuable bolls or capsules. This, in these establishments, where the cost of labour is carefully considered, is usually most expeditiously and perfectly effected by means of a machine composed of two massive cast-iron rollers, to which motion is communicated by a belt from the steam-engine. Between these the flax is passed and the capsules bruised, so that the seed can be readily shaken out. Having been deprived of its bolls by this machine, it was found that the 7770 lbs. of flax plants were reduced to 52 cwt., or 5824 lbs.

Of the portions of the plant removed by the seeding machine, 910 lbs. consisted of clean seed, 1036 lbs. of husks, leaves, and sand. The vats to which the flax is now removed are formed of wood, strongly bound together by hoops, the oval shape being preferred. They are furnished with false bottoms, pierced with holes beneath, through which, by means of a coil of pipe, as represented in the drawing, steam is conveyed. The flax having been placed in the vats, with the bundles resting on the butt or root ends, and in single layers, as in the ordinary steeping-pools, a wooden frame is fixed above them, so as to prevent their rising out of the water during the fermentation. The vats are now filled with water, so as completely to cover the flax, and the steam-cock opened so as gradually to raise the temperature to 90° F. The overseers are furnished with thermometers, and instructed carefully to maintain the temperature at that point day and night. Reckoning from the time at which the steam is admitted to the vats, the duration of the steeping averages about sixty-six hours. When the object is to obtain a very fine fibre, the retting is continued for a longer period. The method of ascertaining the proper period for the removal of the flax from the water is the same as has already been described as relied on by the common steeper. The loss experienced by the seeded flax in steeping was 13 cwt.

Drying.—When the steeping is completed, the flax is carried from the vats to an adjoining apartment of the factory, and placed in layers upon tables, and fixed by women in the drying holders. These consist of two wooden rods,

$5\frac{3}{4}$ feet long, between which a thin layer of flax is secured, by passing metal rings over the ends of the holders, fifty holders being employed for about 1 cwt. of flax. Thus secured, the holders are carried to open drying sheds, and suspended from cross-beams. In three days, in favourable weather, the drying is completed; but in damp weather it is placed in a hot chamber, to heat which the waste steam of the steam-engine is employed.

Breaking and Scutching.—As in the patent steeping establishments a sufficient number of skilled workmen could not be at all times obtained, a new impulse was given to the invention of machines capable of performing the work of the hand-scutcher, and several ingenious and beautiful mechanical arrangements have been proposed, both for breaking and scutching the flax. In this department Belfast has produced some excellent examples, and the machines of Messrs. M'Adam, Brothers and Co., and of Mr. Richard Robinson, are to be found in almost every flax-growing district both in this country and in England. From the 52 cwt. of seeded straw, the produce of the experimental crop, there remained 6 cwt. 1 qr. 2 lbs. of marketable fibre.

After the introduction of the new system, and that several establishments were occupied in the preparation of fibre, objections were made to the quality of the material, and considerable doubts were expressed, both with regard to the amount of produce obtained, and its adaptation for its various uses. These objections, however, were at the time removed by experiments instituted by experienced manufacturers, both in this country and at the admirably-conducted works of the Messrs. Marshall in Yorkshire. In Messrs. Marshall's experiments, samples of the products of which are on the table, flax-straw grown in Holland was the material employed; the steeping of a portion was conducted at two establishments, on Schenck's system, while another portion from the same lot was steeped in Holland in the ordinary way. The results were regarded as in all respects confirmatory of the superiority of the patent process; and a Committee of the Royal Flax Society also reported, that all objections with respect to any injurious influence of the accelerate fermentation on the strength and bleaching qualities of the fibre had been shown to be groundless, and that the yield of the fibre was greater than when "the old, slovenly, and uncertain process of watering" was practised.

The process of fermentation, as conducted in the patent establishments, so far as my investigatious have extended, does not appear in any respect to present phænomena different from what I have observed in the ordinary steeping-pools of the country, when only rippled flax is employed. Usually, in eight or ten hours after the flax had been placed in the vats, a copious extrication of gas is observed, and sometimes the vat becomes covered with a head of froth, like the vat of the brewer; and at this period an odour is evolved in the establishment closely resembling that of the brewery. The gas evolved at this period is chiefly carbonic acid. The liquid at the same time exhibits a slight acid reaction. As the process continues the temperature rises, so that an additional admission of steam is seldom required to maintain the liquid at from 85 to 90 degrees. Towards the conclusion of the operation, usually in about 60 hours, the escape of gas becomes less abundant, and a covering of slimy matter collects on the surface of the liquid.

The steep-water at this period has a light brown colour, is transparent, and closely resembling bitter ale. It is strongly acid to litmus, but the original blue colour of the test-paper is restored on drying.

Its taste at first is rather agreeably acid, but followed by the peculiar plant-like taste of the flax. Contrary to what has been stated in some reports on this subject, the liquid I found, at the conclusion of the process, yields nearly a trace of acetic acid, and in numerous experiments no trace of the evolution of sulphuretted hydrogen could be detected at any stage of the fermentation. When the flax is allowed to remain in the vats after the usual time, a new series of changes, and a fresh and rapid extrication of gas, take place. I have made, during the last three years, numerous experiments with respect to the composition of the steep-water from several establishments, and also from the common steep-pools, which afforded me some interesting results, and satisfied me that the fermentation which is induced by steeping flax in water resembles the so-called butyric acid fermentation, merely traces of acetic acid, and invariably large quantities of butyric acid, having been detected in every case. In fact, the fragrant butyric æther, so extensively employed in the preparation of pine-apple rum, and in flavouring confectionery, might readily be obtained in large quantities from the stinking waters of the flax-pool.

Œconomy of the Flax Water.—With regard to the refuse waters of the vats, some years ago, upon the opening of Mr. Schenck's establishment in Belfast, I made an analysis of the water in which the flax had been steeped, which confirmed the conclusions to which I had been conducted, from my examinations of the waters of the country steep-ponds, that an opinion which had been promulgated by scientific authority, of the possibility of restoring to the fields of the farmer all the ingredients abstracted from the soil during the growth of the flax, by means of the steep-water and other refuse parts of the plant, was not, even supposing that these matters could be œconomically employed as manure, which is impossible, supported by investigations with respect to the amount of fertilizing ingredients which they contained.

Chemistry is, I conceive, contributing in no small degree to the progress of agricultural knowledge. It has even already introduced greater œconomy into many departments of the farmer's business, and has opened up to him new sources of fertilizing agents. But in some cases it is to be feared that the chemist has himself raised obstacles to the reception of agricultural science by the practical agriculturist, by proposals which, though capable of being carried out in the laboratory, are totally inapplicable in the great operations of the husbandman.

To ascertain exactly the effect produced by steeping, and the composition of the steep-water, I obtained from the works at Cregagh a sample of flax-straw unsteeped, a portion of steeped straw taken from the same lot, and a gallon of the steep-water taken from the vat immediately after the removal of the flax. The composition of the ash obtained by burning the extract of the steep-water, and the samples of the straw, is given in the Table. The spring-water employed at the works is moderately hard, indicating, on Dr. Clarke's scale, 8 degrees. It was not considered necessary to deduct the ingredients supplied in it, as these would add but little to its fertilizing value. An imperial gallon of the liquid of the vat was found to contain, in grains and tenths,—

Organic matters	136·7
Inorganic matters	131·4
Total solid matters	268·1

Composition of the Ash of the Flax-straw before and after steeping, and of the Inorganic Matters of the Steep-water.

100 parts of each respectively contained—

	Unsteeped flax.	Steeped flax.	Ash of the steep water.
Potash	13·88	11·40	19·31
Soda	5·33	4·17	...
Chloride of potassium	...	...	3·83
Chloride of sodium	6·47	3·28	21·24
Lime	18·86	17·69	8·23
Magnesia	4·10	5·50	10·18
Oxide of iron	5·40	5·76	2·02
Sulphuric acid	11·16	4·07	6·10
Phosphoric acid	9·63	11·87	3·77
Carbonic acid	10·37	20·06	23·30
Silica	15·23	15·78	1·12
Sand	...	...	0·60
	100·43	99·58	99·77
Ash per cent. in the straw	3·89	2·59	...

100 grs. of the dried extract of the steep-water contained 1·56 nitrogen, =1·89 grs. of ammonia; therefore an imperial gallon would be capable of supplying 5 grs.; and a vat containing 3000 gallons of water, $2\frac{1}{10}$ lbs., worth about 1*s.* 2*d.*, and would convey to the fields of the farmer about the same weight of phosphoric acid.

By the kindness of the proprietors of the Patent Steeping-Works at Cregagh, who have liberally given me an opportunity of inspecting the books of their establishment, I am enabled to give the following average statement of the changes which 100 tons of flax undergo, when treated by Schenck's process. 100 tons of air-dried flax-straw yield—

	Tons.
1. *By Seeding*—33 tons of seed and husks, leaving of seeded flax	67
2. *By Steeping*—67 tons of seeded flax yield of steeped straw	39·5
3. *By Scutching*—$39\frac{1}{2}$ tons of steeped straw yield of dressed flax	5·90
Of tow and pluckings	1·47

Flax Cotton.—The irregularity in the supply of cotton, the raw material of an important allied branch of English manufacture, and of which it is calculated the mills of the United Kingdom require annually a quantity equal to 1000 tons daily, has at various times suggested attempts to convert our indigenous flax into a form which might render it capable of being spun with the ordinary cotton machinery. It appears that attempts to produce from flax a substance possessing the properties of cotton, were many years ago made by a Swede named Des Charmes, and that in 1775 Lady Moira communicated to the Society of Arts some experiments which, suggested by those of the Swede, she had made in this country. Her ladyship's experiments are to us peculiarly interesting, as her letters show that they were carried on at her seat, the present residence of David Ker, Esq., M.P., only twelve miles distant from Belfast. Neither Des Charmes' nor Lady Moira's experiments seem to have led to any practical application of the proposed substitute for the foreign material; and though subsequent trials for the same purpose were made by various persons, the public do not appear to have placed any confidence in their plans. Lately, however, the project has been revived by a Brazilian gentleman, the Chevalier Claussen, known to the public as the inventor of an ingenious loom. This gentleman has been more successful than his predecessors in exciting attention, and his processes have been described by several chemists of reputation in England, as affording a new and beautiful application of the powers of chemistry to practical purposes. In every part of Europe, indeed, much interest has been excited by the accounts which have been published respecting his discoveries, which were regarded as calculated to render Great Britain nearly altogether independent of foreign supplies of cotton. The proposals of M. Claussen were not confined to cottonizing flax, but also embraced a method of preparing long-line or fibre for the flax-spinner, substituting for fermentation the more rapid action of a weak solution of caustic soda, followed by boiling, or simple immersion in water, acidulated with sulphuric or muriatic acid. The material employed for the production of his cotton was at first unsteeped flax-straw; but at present I find that the flax in its original state is not used, and that the refuse tow of the scutch-mills is preferred. This limitation of the application of M. Claussen's patent removes some of the objections which were urged against his original proposal to cut up valuable flax, so as to produce what the opponents of the invention regarded as an inferior article; now, however, it is merely the waste tow of the scutching-mill, which can be purchased at from £4 to £7 per ton, that is used in M. Claussen's establishments: and from this, as the interesting series of samples which have been kindly supplied to me by Dr. Ryan show, a beautiful material, capable, it is stated, not merely of being spun with cotton machinery, but of being combined with wool, silk, and other fibres, and exhibiting, apparently, that increased affinity for colouring matters which Mr. Mercer has found to be possessed by cotton fibre, acted upon by caustic alkali, has been obtained. The first operation at M. Claussen's works is to pass the tow through a carding and hackling machine, for the purpose of arranging its fibres parallel; so straightened, it is cut by another machine (somewhat similar in its operations to the chaff-cutter of the farmer) into pieces of about one and a half inch in length, and is then conveyed to the steeping vats. The vats are placed side by side; and by means of a cradle and a travelling railway, the tow can be transferred from one to the other, as required. It is, in the first place, steeped for twenty-four hours in a cold solution of caustic soda, of 1° Twaddel. The next step is to plunge it in another vat containing a similar solution, but furnished with a steam-pipe, so that the liquid can be kept at a boiling temperature for two hours. The peculiar part of the process, or the Claussenizing of the tow, is commenced by transferring the material prepared, as described, to a third vat, which holds a solution containing 5 per cent. carbonate of soda. It is allowed to remain immersed about an hour, so as to be completely saturated with this liquid, and is then raised from the vat and placed in a solution containing about one-half per cent. of sulphuric acid. In the bath of sulphuric acid it is alleged that important chemical and mechanical changes are effected in the character of the flax fibre. It is stated that it becomes at once changed, as if "by a new instance of natural magic," from a damp aggregation of flax to a light expansive mass of cottony texture, increasing in size, like leavening dough or an expanding sponge; and this material, it is asserted, can be produced at a cost not exceeding $2\frac{1}{4}d.$ per lb., which is considerably below the price at which cotton can be grown and imported from the United States or any other cotton-producing country. By a simple process of bleaching, and subsequently "carding," the tow thus modified assumes both the texture and appearance of foreign cotton, and can at once be employed by the cotton-spinner.

With such alleged advantages to recommend it, it was not wonderful that M. Claussen's proposal attracted the attention and excited the sympathies of Mr. Porter and other eminent œconomists, and that the late Lord Lieutenant of Ireland, the Earl of Clarendon, should desire that a scheme which promised such important results to this country, so deeply interested in the production of flax, should be carefully tested on a proper commercial scale.

An inquiry having been committed to Sir Robert Kane, Director of the Museum of Œconomic Geology, I was requested, together with Professors Blyth and Murphy of Cork, to make such investigations as might properly ascertain the value of the various methods proposed. But, unfortunately, the mechanical arrangements which had been made by M. Claussen's agents, to illustrate the production of the new material from unsteeped flax, were not capable of affording satisfactory results; and, though some trials with tow proved more successful, it was found impossible to carry out the object of the inquiry at the locality selected. I am informed that it is the intention of the patentees to solicit a full investigation of the methods pursued in their operations at works which they have established near London, and where, they state, the material is produced in large quantities. The real value however of Claussen's substitute for cotton must be decided by the experience of the manufacturers of England. With regard to the œconomy of the processes, it would be improper to give an opinion until the investigation which M. Claussen solicits has taken place. The specimens show what can be made from the waste tow of the spinner; and it is interesting to find both Berthollet and Gay-Lussac, many years ago, pointing out the advantages which appear here to be realized from the conversion of tow into a substitute for cotton.

I have now to request attention to a new process, entirely different from any of those which have been described, and the first public announcement of which I am permitted by the patentees to make to this meeting. The methods adopted are the invention of Mr. Watt, a countryman and namesake of the great philosopher. In this process neither fermentation nor the action of acid nor alkaline solutions are employed, the separation of the fibre from the useless matters of the straw being effected by subjecting the stems to the action of steam, and afterwards by pressure applied by powerful rollers. In the first place, Mr. Watt proposes to take seeded flax, and to expose it to steam, at the ordinary pressure of the atmosphere, in a close chamber, of peculiar construction, so as to soften and dissolve out the gummy and other soluble matters. The chambers which he employs are square vessels constructed of wood, or of plates of cast iron, and provided with false bottoms, formed of the perforated iron plates used in malt-kilns. Two doors are placed in the ends of the chambers, for putting in and removing the flax. The top of each vat is formed of cast-iron plates so arranged as to constitute a shallow tank for containing water, and through which, extending for some inches above the surface of the water, passes an iron pipe, which communicates with the interior of the chamber. To the opening of this pipe a valve is fixed, which can be opened or closed as required. Resting upon the false bottom, there is an arrangement of pipes, which are intended to act like the vomiter, or throw-pipe of the bleacher. The process is commenced by placing the flax in bundles, as received from the seeding machine, on the false bottom, until the chamber is nearly filled. The doors are then secured by screws, and steam is discharged into the chamber by a pipe which passes between the bottoms, and for some time allowed to escape through the valve-pipe in the roof, so as to remove the volatile oil contained in the straw. After some time the valve is closed; and the escape of the steam being prevented, it penetrates through the mass of the flax, softening and loosening its various parts. Water is now admitted into the metal tank, and the steam, which strikes against the cooled roof of the chamber, is condensed and made to descend in showers of distilled water, by which the soluble and softened extractive matters are washed out and carried below the false bottom, and conveyed by pipes into a reservoir and preserved. It is, however, proposed at intervals, during the operation, to allow the flax liquid to accumulate until it rises above the false bottom, and then, by the pressure of the steam, to cause it to ascend in the throw-pipes, and to descend in streams over the straw, so as completely to wash away all the softened matters. In about ten hours the entire operation may be completed, though the patentee regards it advantageous to subject the flax to the action of the steam for from twelve to eighteen hours.

The second part of Mr. Watt's process consists in submitting the straw, as it is removed, softened and swollen, from the steam chambers to the successive action of two pairs of very heavy iron rollers, somewhat resembling the seeding rollers used in the hot-water steeping establishments, for the purpose both of quickening the drying process, and of expressing any adherent colouring or glutinous matter. By this operation, also, he finds that not only is the drying facilitated, but that a considerable portion of the enveloping cuticle of the stems is removed, and that the separation of the fibre in scutching is rendered more perfect by the bruising and splitting up of the woody parts consequent upon the longitudinal pressure to which they are exposed under the rollers. This new method, which is in operation at present in the extensive works of Messrs. Leadbetter in this town, appears to offer most striking advantages. It is peculiarly adapted for rendering the separation of the fibre a manufacturing operation. No disagreeable smelling odours are evolved; and, if experience confirms the expectations of the patentees with respect to the quality of the fibre obtained, and the comparatively low expenditure required in its production, the new process will, in no trifling degree, contribute to the extension of flax cultivation in this country.

A striking peculiarity of this process, and one which renders it exceedingly interesting to the scientific agriculturist, is, that it offers the only satisfactory method of œconomizing the matters which are dissolved from the flax plant in its treatment. The dark liquid which accumulates in the lower chamber of the vat can be obtained in a most concentrated form; it is totally free from the disagreeable odour of the flax-pool, and experiments which have been tried prove that it is found by pigs a palatable and nutritious food.

I have to apologize for the length to which this Report has extended, and I feel that some of the details which I have included in it may appear unnecessary to those who are familiar with the various process of the flax manufacture; but as many persons present, though acquainted with the beautiful fabrics, which, in every market in Europe and America, attest the skill and ingenuity of the linen manufacturers of Ulster, have probably now for the first time visited a district which, like the north of Ireland, on every side exhibits, in its steeping-establishments, busy flax-mills and extensive bleach-greens evidences of the advantages which this country has derived from the cultivation and skilful management of the flax plant, I trust, that, whilst inspecting the various processes to which our manufacturers have liberally invited the attention of the members of the Association, the outline which I have endeavoured to give them of the œconomy of the crop may tend to increase their interest in this important department of our national industry. And if my remarks on the composition of the plant and the various plans proposed for the preparation of its valuable fibre should induce any of those whom I have the honour to address to undertake investigations which may contribute to improve either the agricultural or technical management of the crop, the present visit of the British Association will be regarded, if possible, with still greater satisfaction by the manufacturers of Ulster.

The Freshwater Fishes of Ulster, as enumerated in the MSS. of the late William Thompson, *Esq., President of the Belfast Natural History and Philosophical Society. Contributed by* Robert Patterson, *Esq. and* James R. Garrett, *Esq.*

The contributors of this paper stated that they had prepared it from their late friend's MSS., in consequence of a suggestion which had been made to them, to the effect that an accurate catalogue of the freshwater fishes of Ulster would, on the present occasion, be interesting to many who had not before had an opportunity of observing the physical features of the North of Ireland. The several species of fish which inhabit purely fresh water for at least a portion of the year, and which Mr. Thompson had noted as having been found in the province of Ulster, were enumerated thus:—

Perca fluviatilis, *Linn.*
Gasterosteus aculeatus, *Linn.*, including the several varieties figured in Yarrell's British Fishes, viz.
G. trachurus, *Cuv. & Val.*
—— semiarmatus, *Cuv. & Val.*
—— leiurus, *Cuv. & Val.*
—— brachycentrus, *Cuv. & Val.*
—— spinulosus, *Cuv. & Val.*
—— pungitius, *Linn.*
Gobio fluviatilis, *Will.*
Tinca vulgaris, *Cuv.*? } Introduced into
Cyprinus carpio, *Linn.* } ponds but not considered
—— auratus, *Linn.* } indigenous.
Abramis Brama, *Cuv.*
—— Buggenhagii, *Thomp.* }
(Cyprinus ——, *Bloch*). }
Leuciscus erythrophthalmus, *Cuv.*
Cobitis barbatula, *Linn.*
Esox lucius, *Linn.*
Salmo salar, *Linn.* }
(—— Salmulus.) }
—— Eriox, *Linn.*
—— trutta, *Linn.*
—— fario, *Linn.*
—— ferox, *Jard.*
—— umbla, *Linn.* }
(S. Salvelinus, *Don.*) }
Coregonus Pollan, *Thomp.*
Platessa flesus, *Cuv.*
Anguilla acutirostris, *Yarr.*
—— mediorostris, *Yarr.*
—— latirostris, *Yarr.* (?).
Petromyzon marinus, *Linn.*
—— fluviatilis, *Linn.*
—— Planeri, *Bl.*
Ammocætes branchialis, *Cuv.*

Supplementary Report on the Fauna of Ireland by the late William Thompson, Esq., *President of the Belfast Natural History and Philosophical Society.*

Robert Patterson and James R. Garrett, Esqs., the two gentlemen by whom this communication was brought forward, gave the following explanation as to the circumstances under which it was prepared:—At the Meetings of the British Association held in the years 1840 and 1843, Mr. Thompson presented Reports on the Fauna of Ireland, drawn up by him at the request of the Association. Shortly after his untimely decease in February last (1852), his MSS. were—in pursuance of directions contained in his will—handed over to the two gentlemen above-named, with a view to publication, so as to complete his work on the Natural History of Ireland, three vols. of which—on the Birds of Ireland—had appeared during the author's lifetime. On examination of these MSS., a memorandum was found containing a list of the papers which it had been Mr. Thompson's intention to submit to the Belfast meeting of the Association, and, amongst others, there was specified a supplement to his former reports. The materials of this Supplement were also discovered, partly arranged, and it was considered desirable that the author's intentions should be carried out as far as possible. The remaining volumes of "The Natural History of Ireland" being in course of preparation for the press, the present communication was confined to an enumeration of the several species of animals now recorded as Irish, but which had not been made known at the date of the publication of Mr. Thompson's previous reports.

Div. VERTEBRATA.

Class Mammalia.

Vespertilio Nattereri, *Kuhl.*	M'Coy, in Ann. Nat. Hist. vol. xv. p. 270.
Delphinus tursio, *Fabr.*	Gray, in Ann. Nat. Hist. vol. vii. p. 84.

Class Aves.

Vultur fulvus, *Linn.*	Yarrell, Br. Birds, ed. 2. vol. i. p. 1; Thomp. Nat. Hist. Ireland, vol. i. p. 84.
Aquila Nævia, *Brisson*	Yarr. Br. B. vol. i. p. 10; Thomp. N. H. Ire. vol. i. p. 13.
Circus cineraceus, *Mont.* (sp.)	Thomp. N. H. Ire. vol. i. p. 427.
Motacilla alba, *Linn.*, *Gould*	„ „ p. 218.
Alauda cristata, *Gould*	Yarr. Br. B. vol. i. p. 455.
Alcedo Alcyon, *Linn.*	Thomp. N. H. Ire. vol. i. p. 373.
Hirundo purpurea, *Wilson*	Yarr. Br. B. vol. ii. p. 257.
Perdix rufa, *Mont.*	Thomp. N. H. Ire. vol. ii. p. 65.
Charadrius cantianus, *Latham*	„ „ p. 104.
Grus cinerea, *Bechst.*	„ „ p. 131.
Botaurus lentiginosus, *Mont.* (sp.)	„ „ p. 168.
Ciconia alba, *Brisson*	„ „ p. 175.
Scolopax Brehmi, *Kaup.*	„ vol. iii. p. 447.
Tringa platyrhynca, *Temm.*	„ vol. ii. p. 282.
—— Schinzii, *Bonap.*	„ „ p. 297.
—— Bonapartei, *Schlegel.*	„ „ p. 297.
—— rufescens, *Vieill.*	M'Coy, in Ann. Nat. Hist. vol. xv. p. 271.
—— Temminckii, *Leisler*	Thomp. N. H. Ire. vol. ii. p. 302.
Crex Bailloni, *Vieill.* (sp.)	„ „ p. 321.
Gallinula Martinica, *Gmel.*	„ „ p. 331.
Anser Canadensis, *Gmel.* (sp.)	„ vol. iii. p. 24.
—— Ægyptiacus, *Linn.* (sp.)	„ „ p. 64.
Tadorna rutila, *Pallas* (sp.)	„ „ p. 65.
Anas Americana, *Gmel.*	„ „ p. 112.
Oidemia perspicillata, *Linn.* (sp.)	„ „ p. 118.
Mergus cucullatus, *Linn.*	„ „ p. 161.
Uria leucophthalmus, *Faber*	„ „ p. 211.
Sterna Velox, *Ruppel*	„ „ p. 266.
—— leucopareia, *Natterer*	„ „ p. 298.
—— leucoptera, *Meissner & Schinz.*	M'Coy, in Ann. N. H. vol. xv. p. 271; Thomp. N. H. Ire. vol. iii. p. 307.
Larus Bonapartii, *Rich. & Swains.*	„ „ p. 317.
Procellaria glacialis, *Linn.*	„ „ p. 406.

Class Pisces.

Cottus Grœnlandicus, *Cuv. & Val.*	Specimen in Dublin University Museum, obtained by Dr. Ball at Youghal; another procured by Mr. Wm. Andrews from Dingle Bay, Feb. 1850.
Sebastes Norvegicus, *Cuv. & Val.*	Obtained from Dingle Bay by Mr. Wm. Andrews.
Pagellus erythrinus, *Cuv. & Val.*	Taken on south-west coast by the same gentleman.

Cantharus lineatus, *Mont.* (sp.)	Ann. N. H. vol. xviii. p. 313.
Brama Raii, *Cuv. & Val.*	,, vol. xv. p. 311.
Xiphias gladius, *Linn.*?	,, vol. xviii. p. 314.
Cepola rubescens, *Linn.*	Obtained by Dr. Farran on southern coast, Dec. 1848.
Scopelus borealis, *Nillson*	Ann. N. H. vol xx. p. 171.
Platessa limandoides, *Jenyns*	Obtained by Mr. W. Todhunter off Cape Clear, in winter of 1848.
Pleuronectes Arnoglossus, *Schn.*	Obtained by Mr. W. Todhunter on Galway coast, Sept. 1848.
Solea pegusa, *Yarr.*	Obtained by Mr. W. Todhunter on Galway coast, Sept. 1848.
Echeneis remora, *Linn.*	Ann. N. H. vol. xviii. p. 314.
Syngnathus ophidion, *Linn.*	,, vol. i. (new series) p. 63.
Orthagoriscus oblongus, *Schn.*	Specimen obtained near Tramore (Co. Waterford), in Sept. 1845; now in the Collection of the Dublin Nat. Hist. Society.
Acipenser huso, *Linn.*	Ann. N. H. vol. xx. (1847) p. 172.
Scymnus borealis, *Flem.*?	Mr. R. Ball (MS.).
Amphioxus lanceolatus, *Pallas* (sp.)	Ann. N. H. vol. xviii. p. 314.

Div. INVERTEBRATA.

Mollusca.

Testacellus Maugei, *Férussac*	Ann. N. H. vol. xx. p. 174.
Succinea oblonga, *Drap.*	,, vol. vii. (new series) p. 501.
Acteon viridis, *Mont.* (sp.)	,, vol. xv. p. 314.
Eolis violacea, *Alder & Han.*	,, vol. xv. p. 313.
Alderia modesta, *Lovèn* (sp.)	Allman, in Ann. N. H. vol. xvii. p. 1.
Idalia aspersa, *Lovèn* (sp.)	Thomp. in Ann. N. H. vol. i. (new series) p. 63.
Polycera punctilucens, *D'Orb.*	,, ,, vol. xv. (1845) p. 313.
Doris obvelata, *Johnst.*	,, ,, ,, p. 311.
—— Ulidiana, *Thomp.*	,, ,, ,, p. 312.
Aplysia nexa, *Thomp.*	,, ,, ,, p. 313.
Orbis foliaceus, *Phil.*	,, ,, vol. iii. (n. s.) p. 351.
Bullæa pruinosa, *Clark*	,, ,, ,, p. 381.
Utriculus ——, *Brown*	,, ,, vol. xv. (1845) p. 314.
Volvaria subcylindrica, *Brown*	,, ,, ,, p. 315.
Cylichna (Bulla) strigella, *Lovèn*	,, ,, vol. vii. (n. s.) p. 501.
Bulla mammillata, *Phil.*	,, ,, vol. iii. (n. s.) p. 351.
—— producta, *Brown*	,, ,, vol. xv. (1845) p. 314.
Bulla? acuminata, *Brug.*	,, ,, vol. iii. (n. s.) p. 351.
Ovula patula, *Penn.* (sp.)	,, ,, vol. xviii. (1846) p. 384.
Pleurotoma Farrani, *Thomp.*	,, ,, vol. xv. p. 316.
—— coarctata, *Forbes*	,, ,, vol. xx. p. 174.
—— striolata, *Scacchi*	,, ,, vol. xviii. p. 384.
—— brachystoma, *Phil.*	,, ,, ,, p. 384.
—— lævigata, *Phil.*	,, ,, ,, p. 384.
—— teres, *Forbes*	,, ,, vol. xviii. p. 383.
—— Ulidiana, *Thomp.*	,, ,, vol. xv. p. 316.
Triton elegans, *Thomp.*	,, ,, ,, p. 317.
Fusus Sabini, *Gray*	,, ,, vol. iii. (n. s.) p. 352.
Buccinum Zetlandicum, *Forbes*	,, ,, vol. xv. (1845) p. 316.
Nassa varicosa, *Turt.* (sp.)	,, ,, vol. xviii. p. 383.
Trichotropis borealis, *Brod. & Sow.*	,, ,, vol. iii. (n. s.) p. 352.
Natica Montagui, *Forbes*	,, ,, vol. xviii. (1846) p. 384.
—— sordida, *Lam.*	,, ,, vol. iii. (n. s.) p. 352.
Odostomia crassa, *Thomp.*	,, ,, vol. xv. (1845) p. 315.
Eulima nitida (Melania), *Lam.*	,, ,, vol. iii. (n. s.) p. 352.
Stylifer Turtoni, *Brod.*	,, ,, ,, p. 351.

Rissoa Warreni, *Thomp.*	Thomp. in Ann. N. H. vol. xv. (1845) p. 315.
—— fulgida, *Mont.* (sp.)	,, ,, vol. iii. (n. s.) p. 351.
—— proxima, *Alder*	,, ,, vol. xx. (1847) p. 174.
—— inconspicua, *Alder*	,, ,, ,, p. 173.
—— costulata, *Risso*	,, ,, vol. xv. (1845) p. 315.
—— abyssicola, *Forbes*	,, ,, vol. iii. (n. s.) p. 351.
—— ——?*	
Lacuna Montacuti, *Turt.*	,, ,, vol. xx. (1847) p. 173.
Scissurella crispata, *Flem.*	,, ,, vol. vii. (n. s.) p. 501.
Emarginula crassa, *Sow.*	,, ,, vol. xviii. (1846) p. 384.
Puncturella noachina, *Linn.* (sp.)	,, ,, vol. vii. (n. s.) p. 501.
Chiton Hanleyi, *Bean*	,, ,, vol. iii. (n. s.) p. 352.
Pecten similis, *Laskey*	,, ,, vol. xviii. (1846) p. 385.
—— fuci, *Gmelin*	,, ,, ,, p. 385.
Arca raridentata, *S. Wood*	,, ,, ,, p. 385.
Nucula Polii, *Phil.*	,, ,, vol. iii. (n. s.) p. 352.
—— decussata, *Sow.*	,, ,, vol. xx. (1847) p. 174.
Modiola vestita, *Phil.*	,, ,, vol. xv. p. 318.
Galeomma Turtoni, *Sow.*	,, ,, vol. iii. (n. s.) p. 352.
Montacuta oblonga, *Turt.*	,, ,, vol. xviii. (1846) p. 385.
Lucina lactea, *Poli* (sp.)	,, ,, ,, p. 385.
Cardium Loveni, *Thomp.*	,, ,, vol. xv. p. 317.
Ervilia castanea, *Mont.* (sp.)	,, ,, vol. iii. (n. s.) p. 352.
Amphidesma intermedia, *Thomp.*	,, ,, vol. xv. (1845) p. 318.
Tellina pygmæa, *Phil.*	,, ,, vol. i. (n. s.) p. 63.
—— balaustina, *Linn.*	,, ,, vol. xviii. (1846) p. 385.
Neæra cuspidata, *Olivi* (sp.)	,, ,, ,, p. 385.
Teredo bipalmulata, *Del. Chia.*	,, ,, vol. xx. p. 237.
Didemnum gelatinosum, *Edw.*	,, ,, vol. i. (n. s.) p. 64.
Ascidia grossularia, *Van Beneden*	,, ,, ,, p. 63.
—— tubularis, *Müll.*	,, ,, ,, p. 63.
—— virginea, *Forb. & Han.*	,, ,, vol. iii. (n. s.) p. 352.
Botrylloides rubrum, *M. Edw.*	,, ,, ,, p. 353.
—— rotifera, *Edw.*	,, ,, vol. xviii. (1846) p. 386.
—— albicans, *Edw.*	,, ,, ,, p. 385.
Botryllus smaragdus, *Edw.*	,, ,, vol. i. (n. s.) p. 64.
—— violaceus, *Edw.*	,, ,, ,, p. 64.
Amoroucium albicans, *Edw.*	,, ,, ,, p. 64.
Aplidium fallax, *Johnst.*	,, ,, vol. iii. (n. s.) p. 352.

Cirrhipeda.

Adna anglica, *Leach*	Ann. N. H. vol. xviii. p. 386.

Crustacea.

Obisium maritimum, *Leach*	Ann. N. H. vol. xviii. p. 386.
Stenorhynchus tenuirostris, *Leach*	,, vol. xx. p. 237.
Eurynome scutellata, *Risso*	,, ,, p. 238.
Polybius Henslowii, *Leach*	,, vol. xv. p. 319.
Thia polita	Dr. Scouler, in Ann. N. H. vol. xvii. p. 176.
Pagurus Forbesii, *Bell*	Dr. Melville, in Ann. N. H. Sept. 1851, p. 236.
Gebia deltura, *Leach*	Ann. N. H. vol. xx. p. 239.
Crangon fasciatus, *Risso*	,, vol. i. (n. s.) p. 64.
—— sculptus, *Bell*	Dr. Melville, in Ann. N. H. Sept. 1851, p. 236.
—— bispinosus, *Bell*	,, ,, p. 236.
Hippolyte Thompsoni, *Bell*	Bell, Brit. Crust. p. 291.
—— Pandaliformis, *Bell*	,, p. 289.

* This shell has, since Mr. Thompson's decease, been identified by S. Hanley, Esq. as *Rissoa Beanii*: found in shell sand in deep water,—mouth of Belfast Bay.

Cynthia —— ? *Thomp.* (J. V.)	Ann. N. H.	vol. xx. p. 240.
Themisto brevispinosa, *Goodsir*	,,	,, p. 240.
Orchestia —— ?	,,	,, p. 242.
Amphithöe fucicola, *Leach* (sp.)	,,	,, p. 242.
—— rubricata, *Mont.* (sp.)	,,	,, p. 242.
—— —— ?	,,	,, p. 242.
Gammarus marinus, *Leach*	,,	,, p. 242.
—— campylops, *Leach*	,,	,, p. 242.
—— longimanus, *Leach* (sp.)	,,	,, p. 242.
—— punctatus, *Johnst.*	,,	,, p. 243.
Opis typica, *Kroyer*	,,	,, p. 243.
Anonyx (sp.?)	,,	,, p. 243.
—— ?	,,	,, p. 243.
Cerapus falcatus, *Mont.* (sp.)	,,	,, p. 244.
Hyperia Latreillii, *Edw.*	,,	,, p. 244.
—— Galba, *Mont.* (sp.)	,,	,, p. 244.
Lestrigonus —— ?	,,	,, p. 244.
Caprella lobata, *Müll.*	,,	,, p. 244.
—— tuberculata, *Goodsir*	,,	,, p. 244.
—— acuminifera, *Leach*	,,	,, p. 245.
Idotea acuminatum, *Leach?*	,,	vol. iii. (n. s.) p. 354.
Tanais Dulongii, *Audouin* (sp.)	,,	vol. xx. p. 245.
Jæra albifrons, *Mont.* (sp.)	,,	,, p. 245.
Praniza cærulata, *Mont.* (sp.) ?	,,	vol. i. (new series) p. 65.
Sphæroma Prideauxiana, *Leach*	,,	vol. xx. p. 245.
—— Griffithsii, *Leach MSS.?*	,,	,, p. 246.
Cymodocea truncata, *Mont.* (sp.)	,,	,, p. 246.
Cirolana hirtipes, *Edw.*	,,	,, p. 246.
Eurydice pulchra, *Leach*	,,	,, p. 246.
Bopyrus hippolytes, *Kroyer*	,,	vol. i. (new series) p. 65.
—— (new) } —— ——? }	"Found in Galathea in Belfast Bay" [*Thomps. MSS.*]	
Sida crystallina, *Müll.* (sp.) *Edw.* Crust. }	Ann. N. H.	vol. i. (n. s.) p. 65.
Daphnia crystallina, *Müll.* Entom. }	,,	,, p. 65.
Lynceus lamellatus, *Müll.*	,,	vol. xviii. p. 386.
Cypris reptans, *Baird?*	,,	,, p. 386.
Canthocarpus minuticornis, *Müll.* (sp.)	,,	vol. xx. p. 247.
Cetochilus septentrionalis, *Goodsir*	,,	,, p. 247.
Notodelphis ascidicola, *Allman*	Proc. Roy. Irish Acad. April 1847.	
"Caligus minutus, *Otto, Nordm.*" *Edw.*	Ann. N. H.	vol. xx. p. 247.
—— diaphanus, *Nordm.*	,,	,, p. 247.
—— Stromii, *Baird*	,,	vol. iii. (n. s.) p. 354.
—— curtus, *Kroyer*	,,	vol. xx. p. 247.
—— rapax, *Edw.*	,,	vol. iii. (n. s.) p. 357.
—— Mulleri	,,	,, p. 357.
—— Nordmanni, *Edw.*	,,	,, p. 357.
—— pectoralis, *Kroyer*	,,	vol. xx. p. 247.
Trebius caudatus, *Kroyer*	,,	,, p. 248.
Chondracanthus gibbosus, *Kroyer*	,,	,, p. 248.
Lernæopoda galei, *Kroyer*	,,	,, p. 248.
Nymphon Johnstoni, *Goodsir*	,,	vol. xv. p. 319.
—— spinosum, *Goodsir*	,,	,, p. 319.
—— femoratum, *Leach*	,,	vol. xx. p. 249.
Phoxichilidium globosum, *Goodsir*	,,	,, p. 249.
Munna Kroyeri, *Goodsir*	,,	,, p. 247.
Pasithöe vesiculosa, *Goodsir*	,,	vol. xv. p. 319.
Ægina? longispina, *Kroyer*	,,	vol. xx. p. 245.

ANNELIDA.

*Udonella caligorum, *Johnst.*	Ann. N. H. vol. xv. p. 320.
Borlasia alba, *Thomp.*	„ „ p. 320.
—— octoculata, *Johnst.*	„ vol. xviii. p. 388.
—— purpurea, *Johnst.*	„ „ p. 388.
—— olivacea, *Johnst.*	„ „ p. 388.
Planaria cornuta. *Müll.*	„ vol. xv. p. 320.
—— rosea, *Müll.*	„ „ p. 321.
—— lactea, *Müll.*	„ vol. xviii. p. 388.
—— nigra, *Müll.*	„ „ p. 389.
—— torva, *Müll.*	„ „ p. 389.
—— flexilis, *Dalyell*	„ vol. iii. (n. s.) p. 354.
—— arethusa	„ vol. vii. (n. s.) p. 501.
Nemertes melanocephala, *Johnst.*	„ vol. xviii. (1846) p. 387.
Nephelis octoculata, *Moquin-Tandon*	„ „ p. 389.
Glossiphonia Eachana, *Thomp.*	„ „ p. 389.
Pontobdella lævis, *Blainville*	„ „ p. 391.
Tristoma coccineum, *Cuv.*	„ vol. xx. p. 175.
Euphrosina foliosa, *Aud. & Edw.*	„ vol. iii. (n. s.) p. 355.
"Octobothrium (?) Merlangi (Octostoma Merlangi, *Kuhn*)," *Nord.*	„ „ p. 356.

FORAMINIFERA.

Rotalina communis, *D'Orb.*	Ann. N. H. vol. xx. p. 175.
Rotalia crassula, *Mont.* (sp.)	„ „ p. 175.
Guttulina communis, D'Orb.	„ „ p. 175.
Quinqueloculina semilunaris, *D'Orb.*	„ „ p. 175.
"Quinqueloculina cora, *D'Orb.* —— semilunaris, var.?" *Wood*	„ „ p. 175.
Triloculina minuta, *Brown* (sp.)	„ „ p. 175.
Globulina gibba, *D'Orb.*	„ „ p. 175.
Spirolina subarcuatula, *Mont.* (sp.)	„ „ p. 175.
Arethusa lactea, *Mont.* (sp.)	„ „ p. 176.

ENTOZOA.

Tetrarhynchus megacephalus, *Rud.*	Ann. N. H. vol. vii. (n. s.) p. 501.
Echinorhynchus gigas, *Rud.*	„ „ p. 501.

ECHINODERMATA.

Brissus lyrifer, *Forbes*	Ann. N. H. vol. xviii. p. 393.
Holothuria inhærens, *Müll.*	„ vol. xv. p. 321.
—— niger, *Couch*	Obtained by Mr. W. Todhunter on west coast, Sept. 1848.
—— ——?	Ann. N. H. vol. xviii. p. 393.
Thyone raphanus, *Duben & Koren*	„ vol. xx. p. 176.
Chirodota digitata, *Mont.* (sp.)	„ vol. xv. p. 321.
Syrinx Harveii, *Forbes* —— granulosus (*M'Coy* in Ann. N. H. vol. xv. p. 272)	„ vol. xviii. p. 393.
—— ——?	[Two specimens found under stones, on beach at Tory Island, by Mr. Hyndman.—*Thomp. MSS.*]
—— Forbesii, *M'Coy*	Ann. N. H. vol. xv. p. 273.
—— tenuicinctus, *M'Coy*	„ „ p. 273.
Sipunculus ——?	[From Belfast Bay. Intermediate in some respects between the genera *Syrinx* and *Sipunculus*.—*Thomp. MSS.*]

* Included by Mr. Thompson amongst the *Crustacea* in Ann. N. H., but subsequently noted by him as belonging to the *Annelida*.

Priapulus ——?	M'Coy in Ann. N. H. vol. xv. p. 273. [Not distinct from *P. caudatus*.—W. T.]
—— ——?	

ACALEPHA.

Velella subemarginata, *Thomps.*	Ann. N. H. vol. xv. p. 321.

ZOOPHYTA.

Syncoryna Listeri, *Van Ben.* (sp.) ...	Ann. N. H.	vol. xviii.	p. 394.
Gorgonia verrucosa, *Linn.*	,,	vol. iii. (n. s.)	p. 356.
Turbinolia milletiana, *Defrance*	,,	vol. xviii. (1846)	p. 394.
Corynactis Allmani, *Thomps.*	,,	,,	p. 394.
Dysidea? papillosa, *Johnst.* .... (Zoanthus Couchii)	,,	,,	p. 394.
Lucernaria campanulata	W. H. Harvey and W. Andrews, Esqs.		
Iluanthos Scoticus, *Forbes*	Ann. N. H.	vol. xv.	p. 322.
Alecto granulata, *Edw.*	,,	vol. xx.	p. 176.
—— major, *Johnst.*	,,	vol. iii. (n. s.)	p. 357.
—— dilatans, *Johnst.*	,,	,,	p. 357.
Hippothoa sica, *Couch*	,,	vol. i. ,,	p. 65.
Cellepora Skenei, *Ellis & Soland.* (sp.)	,,	vol. xv. (1845)	p. 322.
Lepralia simplex, *Johnst.*	,,	vol. iii. (n. s.)	p. 357.
—— Hyndmanni, *Johnst.*	,,	,,	p. 357.
—— granifera, *Johnst.*			
—— annulata, *Fabr.* (sp.) *Johnst.* ...	,,	,,	p. 357.
—— Peachii, *Johnst.*	,,	,,	p. 357.
—— reticulata, *Macgillivray*			
—— innominata, var.? *Couch.* ...... (description, *not* figure) *Johnst.*...	,,	,,	p. 357.
—— Ballii, *Johnst.*	,,	,,	p. 357.
—— trispinosa, *Johnst.*	,,	,,	p. 357.
—— coccinea, *Abilgaard*	,,	,,	p. 357.
—— violacea, *Forbes*			
—— concinna, (*Busk MS.*)			
—— labrosa, (*Busk MS.*)			
Eschara foliacea	Obtained by Mr. W. Todhunter off Cape Clear, winter of 1848.		
Retepora cellulosa, *Linn.* (sp.)	Ann. N. H.	vol. xv.	p. 322.

AMORPHOZOA.

Halichondria hispida, *Mont.* Wern. Mem. vol. ii. p. 86. pl. 5. figures 1 & 2; *Johnst.* B. S. p. 98	Dr. Scouler in Ann. N. H. vol. xviii. p. 396.
—— macularis	See Dr. Johnston in Berw. Club, Proc. vol. ii. p. 196.

Note.—Mr. Thompson's MSS. contain references to several sponges in his collection, which he considered to be of species not previously described. They are now in the Museum of the Belfast Natural History and Philosophical Society.

Observations on the Meteorology of Birmingham. By WILLIAM WILLS, *Esq., F.G.S.*

THE accompanying Tables have been compiled from a Meteorological Register kept at the Birmingham Philosophical Institution.

The observations for temperature, pressure, rain and wind, extend over a period of eight years, from 1837 to 1844 inclusive. The dew-point tables embrace a period of five years, from 1838 to 1842 inclusive; and the evaporation tables the two years of 1843 and 1844 only. The whole of these observations, with the exception of those for the four months from August to November 1844, were made by the late Dr. Ick, the Curator of that Institution, whose accuracy as an observer is well known; the observations for the excepted months were made by a gentleman who acted as his substitute during his last illness, and continued to do so for a short time after his death, and as they bear internal marks of care and accuracy, I have not hesitated to incorporate them with those of Dr. Ick.

This Register came into my possession during an official connection with the above-mentioned Institution, and from the care with which it appeared to have been kept, the long period over which it extends, and the importance of Birmingham as a meteorological station, it occurred to me that a reduction of the recorded observations was likely to repay the necessary labour, and that the results would probably form an acceptable contribution to this department of knowledge; and the rather so, that with the exception of Mr. Osler's papers on the winds, contained in the Reports of the Association, I am not aware of the existence of any long-continued series of trustworthy observations on the Meteorology of Birmingham.

I will briefly notice the subjects of these observations, and recapitulate their chief results.

1. *Temperature* (Tables I. to VII.).—The instruments were placed in the shade, for the first two years $4\frac{1}{2}$ feet, and subsequently about 38 feet above the ground, and about 437 and 470 feet respectively above the mean level of the sea, the place of suspension being nearly in the centre of the town of Birmingham. In consequence of breakages, the same instruments were not employed throughout the whole series of observations, so that it has not been possible to submit them to verification. The self-registering thermometer was of Rutherford's construction.

The mean monthly and annual temperatures are deduced in Tables I., II., III.,—first, from continuous daily observations at 9 A.M. and 3 P.M. local time; secondly, from the highest and lowest daily markings of the self-registering thermometer; and thirdly, from the highest and lowest annual indications of the same instrument.

The mean annual temperature for eight years, as deduced,—

1st. From the daily observations at 9 A.M. and 3 P.M., is........ 49°·90

2nd. From the highest and lowest daily observations of the self-registering thermometer.......................... 49°·17

3rd. From the highest and lowest yearly observations of the self-registering thermometer.......................... 50°·00

4th. The mean temperature of the five years, from 1838 to 1842 inclusive (see Table XXI.), which excludes the year 1837 and the unusually warm years 1843 and 1844, is........ 49°·694

Of these amounts some portion is doubtless due to the great number of our manufacturing and domestic fires.

In Table IV. is shown the distribution of the temperature through the several meteorological seasons, with the differences from the mean.

The Tables III., V., VI. exhibit the mean range of the self-registering thermometer through the several years, months and seasons, with the differences from the seasonal and annual means. The mean annual range of temperature is 64°·25, and the mean monthly range 32°·51; while the greatest monthly range, that of April, is 6°·49 in excess, and the least monthly ranges, namely, those of November and December, are severally 4°·95 in defect from the general mean.

In Table VII. is given the number of days on which the self-registering thermometer was at or below 32°; the average yearly number being 53.

2. *Barometric pressure* (Tables VIII., IX., X., XI.).—The instrument employed was a standard barometer of Newman's construction, of ·546 in. bore, with moveable brass scale, and which had been compared with the flint-glass barometer at the Royal Society's rooms. The cistern was 18 feet above the ground, and about 447 feet above the mean level of the sea.

The Tables VIII., IX., X. exhibit the mean monthly and annual barometric pressure, deduced from observations at 9 A.M. and 3 P.M., corrected for temperature, with its distribution through the several meteorological seasons, the corresponding barometrical ranges, and the differences of pressure and range between each season, and the general mean of the several seasons.

The mean annual barometric pressure is 29·381 inches, from which the greatest yearly difference in excess is +·084 in., and in defect —·109 in.

In Table XI. is shown the mean monthly and annual pressures as derived from the highest and lowest of the pressures at 9 A.M. and 3 P.M. The mean annual pressure thus obtained is 29·303 in., differing from the mean of the two daily observations by ·078 in. only.

In the synoptical Table XXI. the barometric pressure is resolved into its gaseous and vapour constituents; and their mean monthly amounts, shown for the period of five years, comprised in the dew-point register, namely, from 1838 to 1842 inclusive, with their respective differences from the several annual means:—

	Inches.
The mean annual gaseous pressure is......	29·065
Ditto vapour pressure..................	·324
Total pressure (from 5 years' observations)..	29·389

This result differs from that obtained from the mean of the daily observations for eight years by only +·008 in.

3. *Rain* (Tables XII. to XV.).—The receiver of the rain-gauge was placed 38 feet above the ground, and about 470 feet above the mean level of the sea. The quantities which fell were registered daily at 9 A.M. The average annual amount was 25·258 in. The tables show the distribution of the aggregate annual amounts through the several months and meteorological seasons, with the differences from the means; and also the number of days on which rain fell in each year and season, and their mean monthly and annual numbers.

The greatest excess in any year above the average amount was in 1839, when it amounted to about +3·907 in., and the greatest deficiency in 1844, when it amounted to —5·332 in., making a total difference between the two years of 9·269 in. The mean monthly quantity is 2·105 in., which, on the average of eight years, is exceeded in November, February, July, August, September, and October, in the order of enumeration. The smallest monthly amount falls in April, and next to that month, in December, after which follow, in order of dryness, March, May and June.

The greatest quantities of rain fell in the several seasons in the following order, namely, autumn, summer, winter, spring.

4. *Dew-point* (Tables XVI. XVII.).—The dew-point register extends over five years, from 1838 to 1842 inclusive. The Table XVI. shows the monthly and annual means as derived from observations made daily at 9 A.M. and 3 P.M. with Daniell's hygrometer.

The mean annual dew-point from Table XVI. is 44°·95, while the same result deduced in Table XVII. from the highest and lowest monthly dew-point at the above-mentioned hours is 44°·18.

Adopting the first quantity, 44°·95, the mean annual dryness of the climate of Birmingham is 4°·95, and its mean humidity (complete saturation being represented by unity) is =0·707; and consequently the weight of vapour in a cubic foot of air is =3·03 grs., and the quantity required for saturation about 1·28 gr.

5. *Evaporation* (Table XVIII.).—The amount of evaporation is recorded for two years only, namely, 1843 and 1844; and was registered daily at 9 A.M., by Howard's evaporation gauge, which was placed 37 feet above the ground. In 1843 the greatest amount took place in the months of June, July and August, and the least in February; while in 1844 the greatest amount took place in the months of May, June and July, and the least in December.

The total amount of evaporation was, for 1843, 32·166 in., and for 1844, 35·113 in.

6. *Winds* (Tables XIX. XX.).—The Table XIX. records the direction of the winds at 9 A.M., through the several months of the years 1837 to 1844 inclusive; Table XX. being a summary of the aggregate number of the several winds throughout that period, with the corresponding barometric pressures, reduced to 32°, with their variations from the mean. The mean of the barometric pressures at 9 A.M. was 29·403 in.; differing only by +·014 in. from the mean of the observations at 9 A.M. and 3 P.M.; and the forces, as shown by the pressures, balance each other to the hundredth of an inch.

The prevailing winds at Birmingham are from the S.W., S., and S.S.W. in the order indicated. Of 2914 registered winds, not fewer than 906, or nearly one-third, blew from those quarters alone; namely, from the S.W. 341, from the S. 300, and from the S.S.W. 265.

It is an anomalous fact, of which I do not understand the cause, that the barometer is lower with the S.E. than with the S.W. winds, the mean pressure with the S.E. winds being 29·191, and with the S.W. winds 29·347.

Conclusion.—In the synoptical Table XXI. the meteorological elements of temperature, pressure, and dew-point, during the five years for which the materials of comparison exist, are brought into juxtaposition; and in the appended curves (Plate V.) these elements are represented graphically.

It is not my intention to enter into any enumeration or discussion of the many interesting deductions suggested by the before-mentioned tables. I may, however, remark, in general, that they exhibit some important results in comparison with similar tables constructed from data derived from other localities, and show a marked difference between the climate of the south-western and other parts of our island and its interior; and illustrate, moreover, the influence of situation and local circumstances, even at moderate distances, in modifying the general laws of climate, and their influence on human health, longevity, and enjoyment.

The striking accordance of form between the accompanying curves and similar ones formed by numerous observers, from facts obtained at different and widely separated places, is strongly corroborative of the simplicity, uniformity, and universality of the laws by which the great agencies of meteorologic change are restrained from destructive irregularity and excess, and controlled and adjusted, with the nicest exactness, to the exigences of animal and vegetable existence.

TABLE I.—Mean Monthly and Annual Temperature from daily observations
Differences from

Years.	Dec.	Jan.	Feb.	Mar.	April.	May.	June.
1837.	39°·73	38°·30	43°·34	37°·03	42°·02	52°·15	63°·43
1838.	40·72	29·34	32·86	42·38	44·85	53·18	59·58
1839.	39·81	37·92	41·32	41·32	47·88	57·00	56·47
1840.	38·94	40·12	39·73	42·22	54·61	55·67	60·71
1841.	35·19	35·41	37·12	49·21	49·31	59·55	61·73
1842.	40·81	33·80	41·01	45·38	51·10	55·34	61·06
1843.	46·70	39·64	36·74	43·03	49·26	52·41	57·26
1844.	45·49	40·56	36·27	41·75	54·83	54·73	61·53
Means...	40·924	36·886	38·548	42·79	49·232	55·003	60·221

TABLE II.—The Highest and Lowest Monthly Temperature by the Self-
Monthly and Annual Means, and the Dif-

Month.	1837.			1838.			1839.			1840.		
	High.	Low.	Mean.	High.	Low.	Mean.	High.	Low.	Mean.	High.	Low.	Mean.
Dec....	55°·0	23°·00	39°·00	55°·00	27°·50	41°·25	52°·00	25°·00	38°·50	52°·00	28°·00	40°·00
Jan. ...	51·0	25·50	38·25	46·00	9·00	27·50	51·00	20·00	35·50	54·00	22·00	38·00
Feb. ...	54·0	28·25	41·12	45·50	22·00	33·75	55·00	22·50	38·75	51·50	25·00	38·25
Mar....	49·0	19·00	34·00	62·00	29·00	45·50	55·00	22·00	38·50	57·50	25·00	41·25
Apr. ...	58·5	27·50	43·00	61·50	27·00	44·25	72·00	27·50	49·75	81·50	33·50	57·50
May ...	69·0	34·00	51·50	75·00	35·00	55·00	78·00	30·50	54·25	74·00	38·00	56·00
June...	79·0	39·00	59·00	74·00	42·00	58·00	78·00	41·00	59·50	80·50	43·00	61·75
July ...	79·0	47·00	63·00	72·50	47·00	59·75	76·00	45·00	60·50	75·50	46·00	60·75
Aug....	76·0	44·50	60·25	78·00	45·00	61·50	79·00	42·50	60·75	82·00	46·50	64·25
Sept ..	67·5	42·00	54·75	68·50	40·50	54·50	70·00	42·50	56·25	74·00	38·00	56·00
Oct. ...	68·5	33·00	50·75	63·00	33·50	48·25	66·00	36·00	51·00	60·00	34·00	47·00
Nov....	56·5	27·50	42·00	57·00	26·00	41·50	55·00	30·00	42·50	58·50	27·50	43·00
Means.	63·6	32·52	48·05	63·16	31·96	47·56	65·58	32·04	48·81	66·75	33·87	50·31
Diff. fr.	An. M.		−1·12			−1·61			−0·36			+1·14

Mean of the 8 years 49°·17.

TABLE III.—Showing the Highest and Lowest Temperature of each yea
the Means d

	1837.		1838.		1839.		1840.	
Highest	79°·0	June 23.	78°·0	August 27.	79°·0	August 2.	82°·0	August 9.
Lowest	19·0	March 24.	9·0	January 20.	20·0	January 30.	22·0	January 8
Mean Temp...	49·0		43·5		49·5		52·0	
Ann. Range...	60·0		69·0		59·0		60·0	

Mean of the extremes of Temperature 50°.

...t 9 A.M. and 3 P.M. for 8 years, from 1837 to 1844 inclusive, with the ...he General Mean.

July.	Aug.	Sept.	Oct.	Nov.	Annual Means.	Differences from Annual Means.
65·43	62·61	56·61	52·23	42·37	49·604	− ·299
62·03	61·54	57·38	51·40	41·62	48·073	−1·830
62·93	62·02	57·86	51·45	45·43	50·117	+ ·214
59·57	65·62	54·85	48·59	44·08	50·392	+ ·489
59·85	61·63	59·93	49·26	42·12	50·025	+ ·122
61·85	61·16	57·85	46·88	42·62	49·905	+ ·002
61·28	63·12	61·79	47·31	43·60	50·178	+ ·275
63·06	59·59	61·06	49·75	42·61	50·935	+1·032
62·00	62·161	58·416	49·608	43·056	49·903	

...egistering Thermometer for 8 years, from 1837 to 1844 inclusive, with the ...erences from the Mean of the 8 years.

1841.			1842.			1843.			1844.		
High.	Low.	Mean.	High.	Low.	Mean.	High.	Low.	Mean.	High.	Low.	Mean.
52·50	22·0	37·25	51·50	22·00	36·75	58·00	32·00	45·00	54·0	30·00	42·00
50·00	12·0	31·00	42·00	21·50	31·75	53·50	26·00	39·75	51·0	23·00	37·00
52·50	17·5	35·00	53·50	25·00	39·25	48·50	18·50	33·50	46·5	21·00	33·75
67·50	32·0	49·75	57·50	31·50	44·50	62·00	26·00	44·00	57·5	27·00	42·25
71·00	34·0	52·50	76·50	30·00	53·25	67·00	29·00	48·00	67·5	35·00	51·25
85·00	40·0	62·50	70·00	39·50	54·75	70·00	37·00	53·50	70·0	31·00	50·50
72·50	40·0	56·25	85·00	44·00	64·50	71·50	42·00	56·75	82·0	43·00	62·50
74·00	44·5	59·25	76·00	45·00	60·50	78·00	46·00	62·00	85·0	47·50	66·25
78·00	45·0	61·50	86·50	45·00	65·75	82·50	46·00	64·25	82·5	44·50	63·50
81·00	39·0	60·00	77·00	42·00	59·50	79·00	36·50	57·75	85·0	40·00	62·50
59·00	36·0	47·50	58·00	29·00	43·50	64·50	31·00	47·75	61·0	32·00	46·50
56·50	22·0	39·25	52·00	32·00	42·00	55·00	30·00	42·50	56·0	31·00	43·50
66·62	32·0	49·31	65·46	33·87	49·66	65·79	33·33	49·56	66·5	33·75	50·12
		+0·14			+0·49			+0·39			+0·95

...om 1837 to 1844 inclusive, by the Self-Registering Thermometer, with ...uced therefrom.

1841.	1842.	1843.	1844.
85·0 May 27.	86·5 August 18.	82·5 August 18.	85·0 July 24 & Sept. 1.
12·0 Jan. 8 & Feb. 7.	21·5 January 24.	18·5 February 16.	21·0 February 23.
48·5	54·0	50·5	53·0
73·0	65·0	64·0	64·0

Mean of the yearly Range 64°·25.

TABLE IV.—Temperature of the Meteorological Seasons, and Differences from the Means for 8 years, from 1837 to 1844 inclusive.

Years.	Winter.	Difference from Mean.	Spring.	Difference from Mean.	Summer.	Difference from Mean.	Autumn.	Difference from Mean.
1837.	40°·45	+1°·67	43°·73	−5°·28	63°·82	+2°·36	50°·40	+0°·05
1838.	34·30	−4·48	46·80	−2·21	61·05	−0·41	50·13	−0·22
1839.	39·68	+0·90	48·73	−0·28	60·47	−0·99	51·58	+1·23
1840.	39·59	+0·81	50·83	+1·82	61·96	+0·50	49·17	−1·18
1841.	35·90	−2·88	52·69	+3·68	61·07	−0·39	50·43	+0·08
1842.	38·54	−0·24	50·60	+1·59	61·35	−0·11	49·10	−1·25
1843.	41·02	+2·24	48·23	−0·78	60·55	−0·91	50·90	+0·55
1844.	40·77	+1·99	50·43	+1·42	61·39	−0·07	51·14	+0·79
Means...	38·78	......	49·01	......	61·46	......	50·35	

Mean Annual Temperature 49°·9.

Means of the Seasons.		Difference from Mean of the Year.	
Winter	38·78	Winter	−11·12
Spring	49·01	Spring	− ·89
Summer	61·46	Summer	+11·56
Autumn..............	50·35	Autumn............	+ ·45

TABLE V.—Monthly Range of the Self-Registering Thermometer for 8 years, from 1837 to 1844 inclusive.

Month.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	Means.
Dec....	32°·00	27°·50	27°·00	24°·00	30°·50	29°·50	26°·00	24°·00	27°·56
Jan. ...	25·50	37·00	31·00	32·00	38·00	20·50	27·50	28·00	29·93
Feb. ...	25·75	23·50	32·50	26·50	35·00	28·50	30·00	25·50	28·40
Mar....	30·00	33·00	33·00	32·50	35·50	26·00	36·00	30·50	32·06
Apr....	31·00	34·50	44·50	48·50	37·00	46·50	38·00	32·50	39·00
May ...	35·00	40·00	47·50	36·00	45·00	30·50	33·00	39·00	38·25
June...	40·00	32·00	37·00	37·50	32·50	41·00	29·50	39·00	36·06
July ...	32·00	25·50	31·00	29·50	29·50	31·00	32·00	37·50	31·00
Aug....	31·50	33·00	36·50	35·50	33·00	41·50	36·50	38·00	35·69
Sept...	25·50	28·00	27·50	36·00	42·00	35·00	42·50	45·00	35·20
Oct. ...	35·50	29·50	30·00	26·00	23·00	29·00	33·50	29·00	29·43
Nov ...	29·00	31·00	25·00	31·00	34·50	20·00	25·00	25·00	27·56
Means.	31·06	31·21	33·54	32·92	34·62	31·58	32·46	32·75	32·51

TABLE VI.—Range of Temperature in the several Meteorological Seasons from the Self-Registering Thermometer, and Differences from the Means for 8 years, from 1837 to 1844 inclusive.

Years.	Winter.	Difference from Mean.	Spring.	Difference from Mean.	Summer.	Difference from Mean.	Autumn.	Difference from Mean.
1837.	32°·0	−3°·0	50°·0	+0°·5	40°·0	+0°·5	41°·0	−6°·5
1838.	46·0	+11·0	48·0	−1·5	36·0	−3·5	42·5	−5·0
1839.	35·0	......	56·0	+6·5	38·0	−1·5	40·0	−7·5
1840.	32·0	−3·0	56·5	+7·0	39·0	−0·5	46·5	−1·0
1841.	30·5	−4·5	53·0	+3·5	38·0	−1·5	59·0	+11·5
1842.	32·0	−3·0	46·5	−3·0	42·5	+3·0	48·0	+0·5
1843.	39·5	+4·5	44·0	−5·5	40·5	+1·0	49·0	+1·5
1844.	33 0	−2·0	43·0	−6·5	42·0	+2·5	54·0	+6·5
Means...	35·0	......	49·5	......	39·5	......	47·5	

Mean Range of the four Seasons 42·875.

Mean Range of each Season.		Diff. from the Mean Range of the four Seasons.	
Winter	35·0	Winter	−7·875
Spring	49·5	Spring	+6·625
Summer...............	39·5	Summer............	−3·875
Autumn...............	47·5	Autumn............	+4·625

TABLE VII.—Number of days in each year, from 1837 to 1844 inclusive, in which the Temperature was at or below 32°.

Months.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.
December	9	7	9	12	18	6	2	1
January	9	26	18	9	16	21	9	6
February.........	5	23	8	12	13	7	16	20
March............	20	3	10	13	1	1	10	8
April	15	6	7	...	...	4	5	
May	...	...	...	...	...	...	...	1
October	...	...	...	...	...	3	5	1
November	4	9	1	4	8	1	3	5
Sums...	62	74	53	50	56	43	50	42

TABLE VIII.—Mean Monthly and Annual Barometrical Pressure, from ob-
(corrected for

Months.	1837.			1838.			1839.			1840.		
	9 A.M.	3 P.M.	Means.	9 A.M.	3 P.M.	Means.	9 A.M.	3 P.M.	Means.	9 A.M.	3 P.M.	Mea
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
December	29·227	29·245	29·236	29·349	29·367	29·358	29·464	29·452	29·458	29·123	29·109	29·1
January	·402	·392	·397	·378	·376	·377	·360	·127	·243	·177	·034	·1
February.........	·366	·354	·360	·033	·035	·034	·375	·387	·381	·337	·337	·3
March............	·440	·414	·427	·220	·207	·214	·225	·240	·232	·715	·684	·6
April	·279	·264	·271	·247	·199	·223	·517	·513	·515	·504	·464	·4
May	·415	·390	·402	·356	·339	·347	·409	·402	·405	·383	·359	·3
June	·469	·446	·457	·296	·281	·288	·383	·335	·359	·510	·502	·5
July	·434	·408	·421	·399	·406	·402	·273	·340	·306	·408	·394	·4
August	·406	·434	·420	·402	·321	·361	·414	·396	·405	·494	·445	·4
September	·362	·277	·319	·415	·434	·424	·033	·028	·030	·369	·319	·3
October	·574	·530	·552	29·428	29·383	29·405	·425	·424	·424	·575	·552	·5
November	29·275	29·252	29·263	28·683	28·980	28·831	29·118	29·100	29·109	29·211	29·137	29·1
Annual Means			29·377			29·272			29·322			29·3
Diff. from Mean			—·004			—·109			—·059			—·0

TABLE IX.—Barometrical Pressure in the several Seasons, with the Differences from the Mean for 8 years, from 1837 to 1844 inclusive.

Years.	Winter.	Difference from Mean.	Spring.	Difference from Mean.	Summer.	Difference from Mean.	Autumn.	Difference from Mean.
	in.	in.	in.	in.	in.	in.	in.	in.
1837.	29·331	—·029	29·367	—·046	29·422	+·004	29·378	+·044
1838.	·256	—·104	·261	—·152	·350	—·068	·220	—·114
1839.	·361	+·001	·384	—·029	·353	—·065	·188	—·146
1840.	·186	—·174	·518	+·105	·450	+·032	·361	+·027
1841.	·462	+·102	·410	—·003	·430	+·012	·232	—·102
1842.	·412	+·052	·431	+·018	·544	+·126	·401	+·067
1843.	·340	—·020	·378	—·035	·455	+·037	·457	+·123
1844.	29·531	+·174	29·558	+·145	29·339	—·078	29·434	+·100
Means...	29·360	......	29·413	......	29·418	......	29·334	

Mean of the 8 years 29·381.

Means of the Seasons.		Differences from Mean of 8 years.	
Winter..............	29·360	Winter..............	—·021
Spring..............	29·413	Spring	+·032
Summer	29·418	Summer	+·037
Autumn	29·334	Autumn	—·047

ervations at 9 A.M. and 3 P.M. daily, for 8 years, from 1837 to 1844 inclusive
Temperature).

1841.			1842.			1843.			1844.			Means.		
M.	3 P.M.	Means.	9 A.M.	3 P.M.	Means.	9 A.M.	3 P.M.	Means.	9 A.M.	3 P.M.	Means.			
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
00	29·685	29·692	29·257	29·188	29·222	29·644	29·657	29·650	29·894	29·889	29·891	29·457	29·449	29·453
46	·338	·342	·588	·544	·566	·126	·273	·199	·562	·547	·554	·369	·329	·348
19	·338	·343	·467	·431	·449	·197	·143	·170	·163	·133	·148	·284	·269	·277
14	·401	·422	·406	·377	·391	·502	·485	·493	·267	·386	·326	·402	·399	·400
37	·386	·411	·318	·595	·456	·319	·310	·314	·682	·646	·664	·413	·422	·417
04	·389	·396	·452	·439	·445	·335	·318	·326	·699	·671	·685	·431	·413	·422
27	·481	·504	·588	·551	·569	·408	·387	·397	·493	·466	·479	·459	·431	·445
59	·379	·369	·497	·499	·493	·503	·456	·479	·455	·434	·444	·416	·414	·415
13	·419	·416	·581	·550	·570	·507	·470	·488	·055	·133	·094	·409	·396	·403
99	·274	·291	·442	·393	·417	·739	·718	·728	·593	·900	·746	·408	·418	·413
78	·152	·115	·556	·534	·548	·262	·264	·263	·215	·210	·212	·389	·381	·385
98	29·280	29·289	29·249	29·225	29·237	29·397	29·366	29·381	29·356	29·335	29·345	29·323	29·335	29·324
		29·382			29·447			29·407			29·465	Final Mean......29·381		
		+·001			+·066			+·026			+·084			

TABLE X.—Range of Barometrical Pressure in the Meteorological Seasons, as observed at 9 A.M. and 3 P.M. for 8 years, from 1837 to 1844 inclusive, and Differences from the Means.

Years.	Winter.	Difference from Mean.	Spring.	Difference from Mean.	Summer.	Difference from Mean.	Autumn.	Difference from Mean.
	in.	in.	in.	in.	in.	in.	in.	in.
1837.	1·587	−·263	1·134	−·172	1·403	+·273	1·894	+ ·270
1838.	1·843	−·007	1·732	+·426	1·158	+·028	2·028	+ ·404
1839.	1·599	−·251	1·233	−·073	1·055	−·075	1·424	− ·200
1840.	1·988	+·138	1·303	−·003	1·250	+·120	2·299	+ ·675
1841.	1·806	−·044	1·266	−·040	1·116	−·014	1·661	+ ·037
1842.	1·699	−·151	1·361	+·055	·918	−·212	1·784	+ ·160
1843.	2·401	+·551	1·125	−·181	1·075	−·055	1·459	− ·165
1844.	1·881	+·031	1·298	−·008	1·069	−·061	·444	−1·180
Means...	1·850	......	1·306	......	1·130	......	1·624	

Mean Annual Range 1·477.

Means of the Seasons.		Differences from Mean Annual Range.	
Winter	1·850	Winter...............	+·373
Spring	1·306	Spring	−·171
Summer...............	1·130	Summer	−·347
Autumn...............	1·624	Autumn	+·147

TABLE XI.—Mean Monthly and Annual Barometric Pressure, deduced from for 8 years, from 1837 to 1844 in-

Months.	1837.						1838.					
	9 A.M.			3 P.M.			9 A.M.			3 P.M.		
	High.	Low.	Mean.	High.	Low.	Mean.	High.	Low.	Mean.	High.	Low.	Mean.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Dec.......	29·800	28·520	29·160	29·837	28·453	29·145	29·924	28·723	29·323	29·931	28·675	29·303
Jan.	30·030	·793	·411	·997	·700	·348	·865	·824	29·344	·835	·809	·322
Feb.	29·883	·645	·264	·784	·443	·113	·868	·088	28·977	·833	·181	·007
March ...	·871	·748	·309	·867	·747	·307	·941	·503	29·222	·907	·534	29·220
April ...	·881	28·846	·363	·878	28·755	·316	·698	·620	·159	·624	·209	28·916
May	·778	29·034	·406	·783	29·129	·456	·828	·920	·374	·786	·962	29·374
June......	·799	29·021	·410	·743	29·015	·379	·700	28·973	·336	·690	28·983	·336
July	·776	28·669	·222	·780	28·453	·116	·656	29·066	·361	·645	29·012	·328
Aug.......	·856	·903	·379	·813	·883	·348	·645	28·542	·093	·601	28·573	·087
Sept......	29·803	·533	·168	29·781	·520	·150	·937	·695	·316	·915	·652	·283
Oct.	30·137	·730	·433	30·114	·558	·386	·929	28·705	29·317	·898	28·795	29·346
Nov.......	29·803	28·395	29·099	29·798	28·243	29·020	29·879	27·909	28·894	29·844	27·969	28·906
Annual Means.........			29·302			29·257			29·226			29·202
Diff. from Final Mean			−·001			−·046			−·077			−·101

TABLE XI.—

Months.	1841.						1842.					
	9 A.M.			3 P.M.			9 A.M.			3 P.M.		
	High.	Low.	Mean.	High.	Low.	Mean.	High.	Low.	Mean.	High.	Low.	Mean
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
December ...	30·257	28·716	29·486	30·199	28·789	29·494	29·726	28·519	29·122	29·717	28·469	29·09
January	29·970	·451	·210	29·979	·519	·249	30·097	·754	·425	30·097	·398	·24
February	29·993	·557	·275	·944	·599	·271	30·092	·680	·386	30·044	·636	·34
March	30·044	·778	·411	·983	·879	·431	29·896	·787	·341	29·878	·889	·38
April	29·786	·921	·353	·770	·961	·365	29·955	·872	·413	·900	·884	·39
May............	·826	28·766	·296	·819	28·677	·248	30·021	28·660	·340	·961	28·692	·32
June............	·933	29·057	·495	·878	29·019	·448	29·874	29·177	·525	·852	29·072	·46
July	·719	28·817	·268	·718	28·962	·340	·952	·108	·530	·962	·093	·52
August.........	·834	·953	·393	·782	29·080	·431	·990	29·287	·638	·944	29·202	·57
September ...	·726	·623	·174	·691	28·752	·221	29·831	28·841	·336	29·802	28·958	·38
October	·743	·345	·044	·579	·454	·016	30·095	·320	·207	30·064	·415	·23
November ...	29·975	28·314	29·144	29·934	28·416	29·170	30 096	28·312	29·204	30·028	28·329	29·17
Ann. Means...............			29·296			29·307			29·372			29·34
Diff. from Final Mean			−·007			+·004			+·069			+·0

the Highest and Lowest Monthly Observations at 9 A.M. and 3 P.M. daily
clusive (corrected for Temperature).

1839.						1840.					
9 A.M.			3 P.M.			9 A.M.			3 P.M.		
High.	Low.	Mean.	High.	Low.	Mean.	High.	Low.	Mean.	High.	Low.	Mean.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
29·874	28·755	29·314	29·941	28·788	29·364	29·761	28·545	29·153	29·741	28·573	29·157
·992	·393	·192	·989	·463	·226	29·852	·568	·210	·867	·236	·051
·855	·848	·351	·872	·855	·363	30·029	28·089	·059	29·999	28·041	·020
·593	·797	·195	·583	·765	·174	30·076	29·258	·667	30·050	29·230	·640
·998	·810	·404	·955	·813	·384	29·760	29·064	·412	29·756	29·079	·417
·695	·851	·273	·694	·825	·259	·916	28·820	·368	·908	28·773	·340
·703	·789	·246	·668	·812	·240	·741	29·245	·493	·721	29·208	·464
·746	28·713	·229	·728	·759	·243	·816	29·002	·409	·809	28·999	·404
·753	29·021	29·387	·692	·698	29·195	·807	28·566	·186	·769	·723	·246
·418	28·389	28·903	·475	·384	28·929	29·782	·344	·063	29·744	·459	·101
·800	·851	29·325	·808	·926	29·367	30·195	·667	·431	30·166	28·695	29·430
9·644	28·644	29·144	29·636	28·686	29·161	30·025	28·300	29·162	29·993	27·896	28·944
		29·247			29·242			29·301			29·268
		—·056			—·061			—·002			—·035

(*Continued.*)

1843.						1844.						Means.	
9 A.M.			3 P.M.			9 A.M.			3 P.M.				
igh.	Low.	Mean.	High.	Low.	Mean.	High.	Low.	Mean.	High.	Low.	Mean.	9 A.M.	3 P.M.
n.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
0·042	28·883	29·462	30·024	28·874	29·449	30·085	29·424	29·754	30·065	29·310	29·687	29·347	29·336
0·072	27·671	28·871	30·037	27·716	28·876	29·976	28·711	29·343	29·946	28·731	29·338	·251	·176
9·704	28·570	29·137	29·680	28·486	29·083	29·729	·204	28·966	29·730	·243	28·986	·177	·148
·967	29·013	·490	·935	·942	·438	30·096	28·798	29·447	30·040	28·816	29·428	·385	·378
·672	28·906	·289	·663	·842	·252	·051	29·179	·615	30·010	29·196	·603	·376	·331
·786	29·039	·412	·757	·961	·359	30·044	·410	·727	29·967	·402	·684	·399	·381
·683	28·816	·249	·712	28·753	·232	29·736	·187	·461	·735	·191	·463	·402	·378
·800	29·005	·402	·756	29·090	·423	·804	29·042	·423	·783	29·026	·404	·355	·348
9·828	·039	·433	29·808	·001	·404	·880	28·817	·348	·857	28·811	·334	·357	·327
0·126	29·348	·737	30·097	29·288	·692	·920	29·273	·596	·916	29·276	·596	·287	·294
9·714	28·758	·236	29·703	28·667	·185	·848	28·506	·177	·855	28·476	·165	·271	·267
9·922	28·866	29·394	29·908	28·880	29·394	29·917	28·525	29·221	29·893	28·550	29·221	29·158	29·124
		29·342			29·315			29·465			29·409	29·314	29·291
		+·039			+·012			+·120			+·106		

Final Mean 29·303 in.

TABLE XII.—Rain at Birmingham during 8 years, from 1837 to 1844 inclusive, for each Month and Year, with the Monthly and Annual Means, and the Differences from the General Mean.

Years.	Dec.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Yearly Quantity.	Difference from Mean.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1837.	1·3	3·23	3·135	1·175	1·89	1·081	1·88	2·11	3·99	1·98	2·6	2·55	26·921	+1·484
1838.	1·62	0·695	2·07	1·42	1·8	2·335	2·08	2·76	1·91	1·695	1·89	3·145	23·42	−2·017
1839.	1·34	1·365	2·04	1·865	1·63	0·52	4·47	4·26	2·66	2·865	2·355	3·795	29·165	+3·728
1840.	1·787	2·755	2·04	0·145	0·48	2·385	2·05	2·355	2·11	1·68	0·98	4·105	22·872	−2·565
1841.	0·355	1·99	1·265	2·14	1·46	2·015	2·06	2·47	3·3	4·705	3·1	2·29	27·15	+1·713
1842.	3·8	2·025	1·29	2·69	0·555	2·49	1·11	2·77	1·655	2·995	0·885	4·5	26·765	+1·328
1843.	0·8	1·75	2·748	1·01	1·935	3·915	2·605	1·748	3·12	0·73	4·14	2·775	27·276	+1·839
1844.	0·24	1·38	3·086	2·65	0·37	0·245	0·545	1·89	2·26	2·03	2·445	2·785	19·926	−5·511
Means...	1·405	1·898	2·209	1·636	1·265	1·873	2·1	2·545	2·625	2·335	2·299	3·243	25·437	

TABLE XIII.—Rain at Birmingham during the several Meteorological Seasons for 8 years, from 1837 to 1844 inclusive, with the Differences from the Means.

Years.	Winter.	Difference from Mean.	Spring.	Difference from Mean.	Summer.	Difference from Mean.	Autumn.	Difference from Mean.	Annual Quantity.	Diff. from Annual Mean.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1837.	7·665	+2·152	4·146	−0·629	7·980	+0·709	7·130	−0·747	26·921	+1·484
1838.	4·385	−1·128	5·555	+0·780	6·750	−0·521	6·730	−1·147	23·420	−2·017
1839.	4·745	−0·768	4·015	−0·760	11·390	+4·119	9·015	+1·138	29·165	+3·728
1840.	6·582	+1·069	3·010	−1·765	6·515	−0·756	6·765	−1·112	22·872	−2·565
1841.	3·610	−1·903	5·616	+0·841	7·830	+0·559	10·095	+2·218	27·150	+1·713
1842.	7·115	+1·602	5·735	+0·960	5·535	−1·736	8·380	+0·503	26·765	+1·328
1843.	5·298	−0·215	6·860	+2·085	7·473	+0·202	7·645	−0·232	27·276	+1·839
1844.	4·706	−0·807	3·265	−1·510	4·695	−2·576	7·260	−0·617	19·926	−5·511
Means...	5·513	....	4·775	....	7·271	....	7·877	....	25·437	

TABLE XIV.—Number of Days in which Rain fell at Birmingham in each Month and Year during the 8 years, from 1837 to 1844 inclusive, with the Monthly and Yearly Means.

Months.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	M. Monthly Number.
December	22	20	19	20	7	26	13	10	17·125
January	19	9	21	19	19	18	21	16	17·750
February.........	17	11	17	18	14	15	14	18	15·500
March............	17	19	20	6	19	27	12	19	17·375
April	16	19	9	6	18	6	20	5	12·375
May	18	16	10	19	15	16	21	7	15·250
June	10	22	19	17	15	9	15	10	14·625
July	15	20	19	23	22	15	21	13	18·500
August	17	17	19	15	21	12	16	16	16·625
September	17	13	22	20	22	14	9	13	16·250
October	15	15	22	19	24	11	25	21	19·000
November	19	20	26	20	17	21	22	18	20·375
	202	201	223	202	213	190	209	166	16·73

Mean Annual Number 200·75.

TABLE XVIII.—Evaporation in inches at 9 A.M., for the years 1843 and 1844.

Months.	1843.	1844.
	in.	in.
January	1·945	1·580
February	1·045	0·995
March............	1·875	2·940
April	3·160	3·761
May	3·490	4·865
June	3·654	5·380
July	4·225	4·767
August	3·922	4·130
September	3·315	3·000
October	2·620	2·200
November	1·510	1·215
December	1·405	0·280
Sums	32·166	35·113

TABLE XV.—Number of Days on which Rain fell in the Meteorological Seasons for 8 years, from 1837 to 1844 inclusive.

Years.	Winter.	Difference from Mean.	Spring.	Difference from Mean.	Summer.	Difference from Mean.	Autumn.	Difference from Mean.	Rainy days in the year.	Diff. from Annual Mean.
1837.	58·0	+ 7·63	51	+ 6	42·00	− 7·75	51·00	− 4·62	202·00	+ 1·25
1838.	40·0	−10·37	54	+ 9	59·00	+ 9·25	48·00	− 7·62	201·00	+ 0·25
1839.	57·0	+ 6·63	39	− 6	57·00	+ 7·25	70·00	+14·38	223·00	+22·25
1840.	57·0	+ 6·63	31	−14	55·00	+ 5·25	59·00	+ 3·38	202·00	+ 1·25
1841.	40·0	−10·37	52	+ 7	58·00	+ 8·25	63·00	+ 7·38	213·00	+12·25
1842.	59·0	+ 8·63	49	+ 4	36·00	−13·75	46·00	− 9·62	190·00	−10·75
1843.	48·0	− 2·37	53	+ 8	52·00	+ 2·25	56·00	+ 0·38	209·00	+ 8·25
1844.	44·0	− 6·37	31	−14	39·00	−10·75	52·00	− 3·62	166·00	−34·75
Means...	50·37	....	45	....	49·75	....	55·62	....	200·75	

TABLE XVI.—Mean Monthly and Annual Dew-Point, from Observa-

	1838.			1839.			
	9 A.M.	3 P.M.	Means.	9 A.M.	3 P.M.	Means.	9 A.M.
December	39·08°	40·98°	40·03°	37·88°	39·05°	38·46°	37·24°
January	27·02	28·56	27·79	34·42	35·41	34·91	39·46
February	30·25	32·69	31·47	36·73	38·56	37·64	36·51
March	36·51	37·88	37·19	37·22	40·34	38·78	34·21
April	36·90	38·76	37·83	38·77	39·62	39·19	47·58
May	44·89	46·65	45·77	50·56	47·31	48·93	48·49
June	51·96	54·13	53·04	52·70	54·63	53·66	51·35
July	55·08	56·24	55·66	55·06	56·26	55·66	52·84
August	55·54	56·65	56·09	54·25	54·37	54·31	56·95
September	51·55	52·52	52·03	53·26	53·47	53·36	49·50
October	46·00	46·45	46·22	46·93	48·02	47·47	43·90
November	38·10	39·36	38·73	44·20	45·40	44·80	40·05
Annual Means	42·74	44·24	43·49	45·15	46·03	45·59	44·84

TABLE XVII.—Highest and Lowest Monthly Dew-Point, observed at 9 A.M. Annual Means

	1838.			1839.			
	Highest.	Lowest.	Means.	Highest.	Lowest.	Means.	Highest.
December	51·00°	30·50°	40·75°	48·00°	27·50°	37·75°	50·50°
January	44·00	10·00	27·00	48·00	24·00	36·00	50·50
February	42·25	21·00	31·62	50·00	24·50	37·25	47·00
March	47·50	28·50	38·00	50·00	26·50	38·25	44·00
April	50·50	23·50	37·00	54·00	27·00	40·50	56·00
May	53·50	33·50	43·50	59·50	33·00	46·25	59·00
June	64·00	42·00	53·00	63·50	39·00	51·25	61·00
July	65·00	46·50	55·75	61·50	44·00	52·75	63·20
August	64·50	46·50	55·50	61·50	42·00	51·75	67·50
September	59·00	37·00	48·00	61·00	43·50	52·25	64·50
October	57·00	32·00	44·00	57·50	33·00	45·00	52·50
November	52·00	24·00	38·00	52·50	33·00	42·75	53·50
Annual Means	54·187	31·25	42·676	55·58	33·08	44·31	55·76

tions at 9 A.M. and 3 P.M. for 5 years, from 1838 to 1842 inclusive.

1840.		1841.			1842.			Monthly Means.
3 P.M.	Means.	9 A.M.	3 P.M.	Means.	9 A.M.	3 P.M.	Means.	
° 39·10	° 38·17	° 31·70	° 34·12	° 32·91	° 40·46	° 40·43	° 40·44	° 38·00
36·09	37·77	33·15	33·35	33·25	32·29	33·30	32·78	33·30
36·86	36·68	34·48	35·56	35·02	37·19	39·67	38·43	35·84
34·52	34·36	43·54	45·03	44·28	40·90	41·73	41·31	39·18
44·80	46·19	41·48	43·30	42·39	41·15	41·90	41·52	41·42
49·59	49·04	47·28	52·06	49·67	46·98	47·14	47·06	48·09
51·96	51·65	48·36	48·63	48·49	53·57	54·70	54·13	52·19
54·99	53·91	52·22	52·29	52·25	54·99	54·79	54·89	54·47
57·96	57·45	55·83	56·45	56·14	60·25	61·37	60·81	56·96
48·72	49·11	54·48	55·80	55·14	53·58	55·16	54·37	52·80
44·01	43·95	46·66	45·95	46·30	42·89	43·73	43·31	45·45
42·78	41·41	39·86	43·60	41·73	40·82	42·92	41·87	41·70
45·10	44·97	44·08	45·51	44·79	45·42	46·40	45·91	44·95

and 3 P.M. for 5 years, from 1838 to 1842 inclusive, with the Monthly and deduced therefrom.

1840.		1841.			1842.			Monthly Means.
Lowest.	Means.	Highest.	Lowest.	Means.	Highest.	Lowest.	Means.	
° 30·00	° 40·25	° 50·00	° 23·50	° 36·75	° 50·00	° 24·00	° 37·00	° 38·50
24·50	37·50	46·50	15·00	30·75	41·00	21·00	31·00	32·45
23·00	35·00	46·50	18·00	32·25	49·00	26·50	37·75	34·77
22·50	33·25	53·00	34·00	43·50	51·00	31·50	41·25	38·85
28·50	42·25	58·00	32·50	45·25	52·00	32·50	42·25	41·45
33·50	46·25	64·00	42·50	53·25	56·00	39·00	47·50	47·35
38·50	49·75	59·00	35·50	47·25	65·00	43·50	54·25	51·10
44·50	53·85	65·00	43·00	54·00	63·00	43·00	53·00	53·87
45·50	56·50	68·00	46·00	57·00	73·00	43·00	58·00	55·75
39·00	51·75	65·50	41·00	53·25	64·00	45·00	54·50	51·95
34·50	43·50	53·00	36·00	44·50	54·00	30·00	42·00	43·90
30·50	42·00	52·00	25·50	38·75	50·50	33·00	41·75	40·25
32·87	44·32	56·70	32·66	44·70	57·70	34·33	45·02	44·18

Table XIX.—Winds registered daily at 9 a.m. during 8 years, from 1837 to 1844 inclusive.

1837.

	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	
Dec. ...	2	...	6	...	2	...	...	1	...	...	6	...	8	...	6	...	31
Jan. ...	2	...	...	...	1	...	3	...	1	...	7	...	1	...	7	2	24*
Feb. ...	1	...	1	...	...	...	3	1	6	1	8	1	3	...	2	1	28
March...	2	...	7	1	...	1	3	...	1	1	1	3	4	2	1	4	31
April ...	2	2	2	...	...	...	...	2	1	4	2	...	5	...	4	6	30
May ...	2	4	3	1	2	1	...	...	3	6	4	...	...	1	1	3	31
June ...	...	...	1	...	4	1	3	2	3	5	3	1	1	...	2	4	30
July ...	3	...	2	...	4	1	...	...	1	3	2	3	4	4	1	3	31
Aug. ...	...	3	6	3	2	1	1	1	2	3	5	1	1	...	1	1	31
Sept. ...	...	2	3	4	2	...	1	5	3	2	2	...	2	2	1	1	30
Oct.......	...	1	1	...	...	1	1	...	4	7	7	5	...	3	...	1	31
Nov. ...	2	1	...	...	...	...	1	2	5	6	4	2	3	3	...	1	30
	16	13	32	9	17	6	16	14	30	38	51	16	32	15	26	27	358

* From the 25th to the 31st inclusive, wind not registered.

1838.

	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	
Dec. ...	1	2	5	...	...	1	3	7	5	3	2	1	...	...	...	1	31
Jan. ...	2	1	3	3	6	4	1	3	3	1	...	...	...	...	1	3	31
Feb. ...	...	4	8	3	5	2	2	1	1	...	...	...	...	1	1	...	28
March...	1	1	...	1	...	1	4	1	3	2	6	1	1	8	...	1	31
April ...	4	1	...	...	...	...	...	1	4	2	3	1	2	9	1	2	30
May ...	5	5	2	4	2	2	2	1	2	1	2	...	2	1	...	...	31
June ...	2	...	2	1	1	...	4	3	6	3	2	1	1	2	1	1	30
July ...	1	...	...	...	1	...	2	4	6	4	2	2	3	3	2	1	31
Aug. ...	2	...	...	...	1	...	1	1	10	4	4	2	4	1	1	...	31
Sept. ...	1	2	1	...	...	2	3	4	4	3	3	1	3	3	...	...	30
Oct.......	3	2	1	...	...	1	1	4	3	5	2	2	3	1	1	2	31
Nov. ...	3	1	3	...	6	...	1	5	3	3	1	1	...	2	1	...	30
	25	19	25	12	22	13	24	35	50	31	27	12	19	31	9	11	365

1839.

	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	
Dec. ...	...	...	...	1	...	1	5	6	4	2	1	3	...	5	1	2	31
Jan. ...	...	1	...	...	...	...	...	1	5	2	7	5	5	3	1	1	31
Feb. ...	1	1	2	...	...	...	1	2	6	5	4	3	2	1	...	...	28
March...	2	3	...	4	1	4	1	2	4	3	2	1	1	...	...	3	31
April ...	2	4	4	4	1	...	2	1	1	...	7	1	1	...	2	...	30
May ...	4	3	3	...	1	...	1	...	1	4	...	2	3	1	7	1	31
June ...	...	...	4	3	3	...	3	1	4	1	4	3	1	...	3	...	30
July ...	...	1	...	...	...	...	2	3	10	4	3	2	1	1	4	...	31
Aug. ...	1	1	...	1	...	...	2	...	5	2	5	4	2	4	3	...	30*
Sept. ...	...	...	...	...	...	...	4	2	7	7	4	2	3	...	1	...	30
Oct.......	3	2	5	2	...	2	3	2	8	1	...	...	2	...	...	1	31
Nov. ...	1	1	...	5	...	2	1	1	3	6	4	2	...	...	2	2	30
	14	17	18	20	6	9	25	21	58	37	41	28	21	15	24	10	364

* Wind not registered on the 31st.

TABLE XIX.—(*Continued.*)

1840.

	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	
c. ...	...	...	3	...	1	4	5	4	5	3	2	2	...	...	2	...	31
l. ...	...	1	...	...	1	1	...	2	10	5	4	2	2	2	...	1	31
). ...	1	...	3	4	4	3	...	1	3	4	3	1	1	1	...	...	29
rch...	4	4	3	6	1	...	...	...	...	1	1	1	1	3	3	3	31
il ...	1	3	2	2	1	...	1	2	4	1	2	...	3	1	4	3	30
y ...	3	3	2	4	2	...	1	1	2	3	3	...	3	1	2	1	31
ie ...	...	...	...	...	...	...	...	2	6	2	6	3	1	5	4	1	30
y ...	1	2	...	...	...	...	...	...	2	5	9	2	8	2	...	...	31
g. ...	...	2	2	...	1	2	...	3	3	2	9	2	2	...	3	...	31
t. ...	...	...	2	...	...	...	1	...	5	4	5	4	3	3	2	1	30
......	1	1	1	1	...	1	2	2	1	...	2	1	5	3	7	3	31
v. ...	...	3	1	...	...	3	4	...	3	4	7	1	...	1	2	1	30
	11	19	19	17	11	14	14	17	44	34	53	19	29	22	29	14	366

1841.

	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	
. ...	2	2	7	1	3	1	1	2	1	2	1	...	1	2	4	1	31
. ...	2	1	2	1	...	...	2	1	1	2	2	2	5	4	4	2	31
. ...	2	1	1	5	2	1	...	3	4	1	2	1	...	2	3	...	28
ch...	1	...	...	...	...	...	2	3	8	3	8	2	3	1	...	...	31
il ...	1	5	2	1	...	...	1	2	5	2	4	1	3	3	...	...	30
...	1	2	2	1	2	1	1	5	3	3	5	1	1	...	3	...	31
e ...	3	1	1	2	1	1	1	1	3	5	2	...	2	3	3	1	30
...	4	...	4	...	...	...	...	...	1	2	3	3	4	4	5	1	31
. ...	3	...	1	...	...	...	...	...	...	4	5	5	4	4	4	1	31
. ...	...	1	...	...	...	4	3	...	7	3	6	1	3	...	1	1	30
......	1	1	3	2	2	...	...	2	...	2	2	5	3	2	4	2	31
. ...	2	...	1	...	1	...	1	2	3	3	5	2	6	3	1	...	30
	22	14	24	13	11	8	12	21	36	32	45	23	35	28	32	9	365

1842.

	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	
...	1	...	...	1	...	...	...	2	3	1	3	3	6	3	6	2	31
......	1	...	...	2	2	1	2	3	5	2	1	2	1	2	4	3	31
......	...	...	1	...	...	2	3	2	5	4	6	2	1	2	...	...	28
...	1	...	1	...	...	...	...	2	1	5	4	4	5	4	3	1	31
...	2	2	8	4	4	2	1	3	...	1	1	...	...	...	2	...	30
...	...	1	3	...	3	1	...	4	5	2	4	5	1	2	...	...	31
...	1	...	3	3	2	...	2	1	2	4	2	1	2	1	4	2	30
...	1	1	2	1	2	...	3	1	4	1	3	4	1	2	2	3	31
...	2	...	1	6	...	2	4	...	2	5	3	1	2	...	2	1	31
...	2	1	5	2	1	2	1	...	2	...	3	1	3	3	2	2	30
......	4	3	2	1	...	...	...	1	1	1	2	3	4	...	4	5	31
...	2	1	2	2	3	...	...	4	5	4	2	2	1	...	1	1	30
	17	9	28	22	17	10	16	23	35	30	34	28	27	19	30	20	365

Table XIX.

1843.

	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.
Dec. ...	1	...	...	...	...	...	2	...	1	4	11	5	4	2	1	...
Jan.......	2	1	...	...	...	...	...	1	4	2	1	9	5	2	2	2
Feb.......	2	3	3	4	4	1	1	...	...	1	...	2	1	...	2	4
Mar......	1	2	...	4	5	2	2	1	4	1	5	1	...	...	2	1
April ...	3	1	...	3	...	1	1	...	3	2	5	6	...	4	1	...
May ...	1	...	2	2	6	2	1	...	2	2	5	3	1	3	1	...
June ...	1	1	9	5	...	2	...	...	1	2	3	1	2	...	...	3
July ...	2	2	...	...	...	...	1	...	1	1	5	4	4	2	8	1
Aug. ...	1	2	2	1	4	1	...	...	5	3	1	4	2	3	2	...
Sept. ...	3	1	2	3	3	1	1	...	2	2	2	...	1	3	1	5
Oct.......	3	1	...	1	1	...	...	...	2	3	3	6	2	2	4	3
Nov. ...	...	...	2	...	...	1	2	2	1	5	5	3	3	1	2	3
	20	14	20	23	23	11	11	4	26	28	46	44	25	22	26	22

Table XX.—General Summary of the number and direction of the W
1844 inclusive, with the corresponding Barometric Pressures, red

	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.
Dec.	8	4	21	3	6	7	19
Jan.	12	6	6	6	10	6	8
Feb.	8	9	19	17	15	9	10
March......	16	10	13	18	8	8	13
April	16	18	18	16	7	4	8
May	22	20	30	18	19	7	6
June	8	4	23	14	13	5	13
July	15	7	9	2	8	1	11
Aug.	11	9	12	11	9	6	9
Sept.	6	9	20	13	6	10	14
Oct.	15	12	14	8	3	7	8
Nov.	11	9	10	9	12	7	12
No. of Winds.	148	117	195	135	116	77	131
Barom. Pressure.	29·509	29·537	29·545	29·482	29·432	29·349	29·191
Var. from mean press.	+·106	+·134	+·142	+·079	+·029	−·054	−·212

Mean Pressure of

tinued.)

1844.

	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	
...	1	...	...	...	...	...	3	...	2	8	7	4	5	...	...	1	31
......	3	1	1	...	...	...	...	1	...	3	2	1	5	2	12	...	31
......	1	...	...	1	...	...	...	...	3	2	7	1	5	3	3	3	29
......	4	...	2	2	1	...	1	...	1	2	1	3	7	1	4	2	31
...	1	...	...	2	1	1	2	1	3	2	4	3	3	3	1	3	30
...	6	2	13	6	1	...	...	...	...	...	1	...	...	...	1	1	31
...	1	2	3	...	2	1	...	...	1	6	4	3	3	2	...	2	30
...	3	1	1	1	1	...	3	1	2	1	2	2	2	6	4	1	31
...	2	1	...	...	1	...	1	1	1	...	3	5	8	3	3	2	31
...	...	2	7	4	...	1	...	...	3	2	2	5	1	2	1	...	30
...	...	1	1	1	...	2	1	2	4	5	4	...	2	3	3	2	31
...	1	2	1	2	2	1	2	2	1	4	7	3	...	1	1	...	30
	23	12	29	19	9	6	13	8	21	35	44	30	41	26	33	17	366

tered daily at 9 A.M. during each month of the period from 1837 to
2° Fahrenheit, and their Variations from the Mean.

.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	Total number.
1	23	33	18	24	12	20	7	248
9	17	24	21	24	15	31	14	241
8	18	30	11	13	10	11	8	226
2	18	28	16	22	19	13	15	248
1	14	28	12	17	20	15	14	240
8	21	24	11	11	9	15	6	248
6	28	26	13	13	13	17	14	240
7	21	29	22	27	24	26	10	248
8	23	35	24	25	15	19	5	247
3	23	27	14	19	16	9	10	240
3	24	22	22	21	14	23	19	248
4	35	35	16	13	11	10	8	240
0	265	341	200	229	178	209	130	2914
286	29·301	29·347	29·381	29·369	29·448	29·473	29·495	
117	−·102	−·056	−·022	−·034	+·045	+·070	+·092	

the Winds 29·403.

Table XXI.—Synopsis of the Mean Annual and Monthly Temperature, Dew-point, and Barometrical, Vapour, and Gaseous Pressures for 5 years, from 1838 to 1842 inclusive, with the Differences from the Means.

	Temp.	Difference from Mean.	Barom. Pressure.	Difference from Mean.	Dew-point.	Difference from Mean.	Vapour Pressure.	Difference from Mean.	Gaseous Pressure.	Difference from Mean.
December	39·094	−10·600	29·369	−·020	38·00	− 6·95	·246	−·078	29·123	+·059
January	35·318	−14·376	·466	+·077	33·30	−11·65	·209	−·115	·257	+·193
February.........	38·408	−11·286	·309	−·080	35·84	− 9·11	·228	−·096	·081	+·017
March...........	44·102	− 5·592	·391	+·002	39·18	− 5·77	·256	−·068	·135	+·071
April	49·450	− 0·244	·418	+·029	41·42	− 3·53	·277	−·047	·141	+·077
May	56·148	+ 6·454	·393	+·004	48·09	+ 3·14	·350	+·026	·043	−·021
June	59·910	+10·246	·445	+·056	52·19	+ 7·24	·402	+·078	29·043	−·021
July	61·246	+11·552	·395	+·006	54·47	+ 9·52	·435	+·111	28·960	−·104
August	62·394	+12·700	·444	+·055	56·96	+12·01	·472	+·148	·972	−·092
September	57·574	+ 7·880	·301	−·088	52·80	+ 7·85	·411	+·087	28·890	−·174
October	49·516	− 0·178	·411	+·022	45·45	+ 0·50	·320	−·004	29·091	+·027
November	43·174	− 6·520	29·328	−·061	41·70	− 3·25	·280	−·044	29·040	−·024
Annual Means...	49·694	......	29·389	......	44·95	......	·324	......	29·065	

On the Vortex Water-Wheel. By JAMES THOMSON, *A.M., Civil Engineer, Belfast.*

[A Communication ordered to be printed among the Reports.]

NUMBERLESS are the varieties, both of principle and of construction, in the mechanisms by which motive power may be obtained from falls of water. The chief modes of action of the water are, however, reducible to three, as follows:—First, The water may act directly by its weight on a part of the mechanism which descends while loaded with water, and ascends while free from load. The most prominent example of the application of this mode is afforded by the ordinary bucket water-wheel. Secondly, The water may act by fluid pressure, and drive before it some yielding part of a vessel by which it is confined. This is the mode in which the water acts in the water-pressure engine, analogous to the ordinary high-pressure steam-engine. Thirdly, The water, having been brought to its place of action subject to the pressure due to the height of fall, may be allowed to issue through small orifices with a high velocity, its inertia being one of the forces essentially involved in the communication of the power to the moving part of the mechanism. Throughout the general class of water-wheels called Turbines, which is of wide extent, the water acts according to some of the variations of which this third mode is susceptible. The name Turbine is derived from the Latin word *turbo*, a top, because the wheels to which it is applied almost all spin round a vertical axis, and so bear some considerable resemblance to the top. In our own country, and more especially on the Continent, turbines have attracted much attention, and many forms of them have been made known by published descriptions. The subject of the present communication is a new water-wheel, which belongs to the same general class, and which has recently been invented and brought successfully into use by the author.

In this machine the moving wheel is placed within a chamber of a nearly circular form. The water is injected into the chamber tangentially at the circumference, and thus it receives a rapid motion of rotation. Retaining this motion it passes onwards towards the centre, where alone it is free to make its exit. The wheel, which is placed within the chamber, and which almost entirely fills it, is divided by thin partitions into a great number of radiating passages. Through these passages the water must flow on its course towards the centre; and in doing so it imparts its own rotatory motion to the wheel. The whirlpool of water acting within the wheel chamber, being one principal feature of this turbine, leads to the name *Vortex* as a suitable designation for the machine as a whole.

The vortex admits of several modes of construction, but the two principal forms are the one adapted for high falls and the one for low falls. The former may be called the High-pressure Vortex, and the latter the Low-pressure Vortex*. Examples of these two kinds, in operation at two mills near Belfast, are delineated in Plates 1 and 2, with merely a few unimportant deviations from the actual constructions.

Plates 1 and 2 are respectively a vertical section, and a plan of a vortex of the high-pressure kind in use at the Low Lodge Mill near Belfast, for grinding Indian corn†. In these figures AA is the water-wheel. It is fixed

* These terms correspond to Hochdruckturbine, and Niederdruckturbine, used in Germany to express the like distinction in turbines.

† This vortex was only in course of erection at the time of the meeting of the British Association in Belfast. The water-wheel itself, removed from its case, being light and of small dimensions, was exhibited in Section G. It is composed chiefly of thick-tinned iron plates united by soft solder.

on the upright shaft, B, which conveys away the power to the machinery to be driven. The water-wheel occupies the central part of the upper division of a strong cast-iron case, CC; and the part occupied by the wheel is called the *wheel-chamber*. DD is the lower division of the case, and is called the *supply chamber*. It receives the water directly from the supply pipe, of which the lower extremity is shown at E, and delivers it into the outer part of the upper division, by four large openings, F, in the partition between the two divisions. The outer part of the upper division is called the *guide-blade chamber*, from its containing four guide-blades, G, which direct the water tangentially into the wheel-chamber. Immediately after being injected into the wheel-chamber the water is received by the curved radiating passages of the wheel, which are partly seen in figure 2, at a place where both the cover of the wheel-chamber and the upper plate of the wheel are broken away for the purpose of exposing the interior to view. The water, on reaching the inner ends of these curved passages, having already done its work, is allowed to make its exit by two large central orifices, shown distinctly on the figures at the letters L, L; the one leading upwards and the other downwards. It then simply flows quietly away; for, the vortex being submerged under the surface of the water in the tail race, the water on being discharged wastes no part of the fall by a further descent. At the central orifices, close joints between the case and the wheel, to prevent the escape of water otherwise than through the wheel itself, are made by means of two annular pieces, L, L, called *joint-rings*, fitting to the central orifices of the case, and capable of being adjusted, by means of studs and nuts, so as to come close to the wheel without impeding its motion by friction. The four openings, H, H, Plates 1 and 2, through which the water flows into the wheel-chamber, each situated between the point or edge of one guide-blade and the middle of the next, determine, by their width, the quantity of water admitted, and consequently the power of the wheel. To render this power capable of being varied at pleasure, the guide-blades are made moveable round gudgeons or centres near their points; and a spindle, K, is connected with the guide-blades by means of links, cranks, &c. (see the Plates) in such a way that, when the spindle is moved, the four entrance orifices are all enlarged or contracted alike. This spindle, K, for working the guide-blades is itself worked by a handle in a convenient position in the mill; and the motion is communicated from the handle through the medium of a worm and sector, which not only serve to multiply the force of the man's hand, but also to prevent the guide-blades from being liable to the accident of slapping suddenly shut from the force of the water constantly pressing them inwards. The gudgeons of the guide-blades, seen in fig. 2 as small circles, are sunk in sockets in the floor and roof of the guide-blade chamber; and so they do not in any way obstruct the flow of the water.

M, in Plate 1, is the pivot-box of the upright shaft. It contains, fixed within it, an inverted brass cup, shown distinctly on the figure; and the cup revolves on an upright pin, or pivot, with a steel top. The pin is held stationary in a bridge, N, which is itself attached to the bottom of the vortex-case. For adjusting the pin as to height, a little cross bridge, O, is made to bear it up, and is capable of being raised or lowered by screws and nuts shown distinctly on the figure. Also, for preventing the pin from gradually becoming loose in its socket in the large bridge, two pinching-screws are required, of which one is to be seen in the figure. A small pipe, fixed at its lower end into the centre of the inverted brass cup, and sunk in an upright groove in the vortex-shaft (see the Plates), affords the means of supplying oil to the rubbing surfaces, over which the oil is spread by a radial groove in the brass. A cavity, shown in the Plates, is provided at the lower part of the cup, for the purpose of preventing the oil from being rapidly washed away by the water*.

Four tie-bolts, marked P, bind the top and bottom of the case together, so as to prevent the pressure of the water from causing the top to spring up, and so occasioning leakage at the guide-blades or joint-rings.

The height of the fall for this vortex is about 37 feet, and the standard or medium quantity of water, for which the dimensions of the various parts of the wheel and case are calculated, is 540 cubic feet per minute. With this fall and water supply the estimated power is 28 horse power, the efficiency being taken at 75 per cent. The proper speed of the wheel, calculated in accordance with its diameter and the velocity of the water entering its chamber, is 355 revolutions per minute. The diameter of the wheel is $22\frac{5}{8}$ inches, and the extreme diameter of the case is 4 feet 8 inches.

A low-pressure vortex, constructed for another mill near Belfast, is represented in vertical section and plan in Plates 3 and 4. This is essentially the same in principle as the vortex already described, but it differs in the material of which the case is constructed, and in the manner in which the water is led to the guide-blade chamber. In this the case is almost entirely of wood; and, for simplicity, the drawings represent it as if made of wood alone, though in reality, to suit the other arrangements of the mill, brick-work, in certain parts, was substituted for the wood. The water flows with a free upper surface, W, W, into this wooden case, which consists chiefly of two wooden tanks, AA and BB, one within the other. The water-wheel chamber and the guide-blade chamber are situated in the open space between the bottom of the outer and that of the inner tank, and will be readily distinguished by reference to the figures. The water of the head race, having been led all round the outer tank in the space CC, flows inwards over its edge, and passes downwards by the space DD, between the sides of the two tanks. It then passes through the guide-blade chamber and the water-wheel, just in the same way as was explained in respect to the high-pressure vortex already described; and in this one likewise it makes its exit by two central orifices, the one discharging upwards and the other downwards. The part of the water which passes downwards flows away at once to the tail race, and that which passes upwards into the space E within the innermost tank, finds a free escape to the tail race through boxes and other channels, F and G, provided for that purpose. The wheel is completely submerged under the surface of the water in the tail race, which is represented at its ordinary level at YYY, Plate 3, although in floods it may rise to a much greater height. The power of the wheel is regulated in a similar way to that already described in reference to the high-pressure vortex. In this case, however, as will be seen by the figures, the guide-blades are not linked together, but each is provided with a hand-wheel, H, by which motion is communicated to itself alone.

* Great stress has been by continental engineers and authors laid on the supposed necessity for oiling the pivots of turbines. The author of the present communication has thus been led to endeavour to find and adopt the best means for oiling pivots working under water. The oiling, however, is a source of much trouble; and he has found in the course of his experience, that pivots of the kind described above, made with brass working on hard steel, and with a radial groove in the brass suitable for spreading water over the rubbing surfaces, will last well without any oil being supplied. The rapid destruction, which is commonly reported as having been of frequent occurrence in turbine pivots, he believes may in many cases have arisen from the employment of an inverted cup like a diving-bell as one of the rubbing parts, without any provision for the escape of air from the cup. It is evident that a pivot of this kind, although under water, might be perfectly dry at the rubbing surfaces.

In this vortex, the fall being taken at 7 feet, the calculated quantity of water admitted, at the standard opening of the guide-blades, is 2460 cubic feet per minute. Then, the efficiency of the wheel being taken at 75 per cent., its power will be 24 horse power. Also the speed at which the wheel is calculated to revolve is 48 revolutions per minute.

In connexion with the pivot of this wheel arrangements are made which provide for the perfect lubrication of the rubbing surfaces with clean oil. The lower end of the upright revolving shaft enters a stationary pivot box, K, through an opening made oil-tight by hemp and leather packing. Within the box there is a small stationary steel plate on which the shaft revolves. Within the box, also, there are two oil-chambers, one situated above and round the rubbing surface of this plate, and the other underneath the plate. A constant circulation of the oil is maintained by centrifugal force, which causes it to pass from the lower chamber upwards through a central orifice in the steel plate, then outwards through a radial groove in the bottom of the revolving shaft to the upper chamber, then downwards back to the lower chamber, by one or more grooves at the circumference of the steel plate. The purpose intended to be served by the provision of the lower chamber combined with the passages for the circulation of the oil, is to permit the oil, while passing through the lower chamber, to deposit any grit or any worn metal which it may contain, so that it may be maintained clean and may be washed over the upper surface of the steel plate at every revolution of the radial groove in the bottom of the shaft. A pipe leading from an oil cistern, L, in an accessible situation conducts oil to the upper chamber of the pivot-box; and another pipe leaves the lower chamber, and terminates, at its upper end, in a stop-cock, M. This arrangement allows a flow of oil to be obtained at pleasure from the cistern, down by the one pipe, then through the pivot-box, and then up by the other pipe, and out by the cock. Thus, if any stoppage were to occur in the pipes, it could be at once detected; or if water or air were contained in the pivot-box after the first erection, or at any other time, the water could be removed by the pipe leading to the stop-cock, or the air would of itself escape by the pipe leading to the cistern, which, as well as the other pipe, has a continuous ascent from the pivot-box. Certainty may consequently be attained that the pivot really works in clean oil.

The author was led to adopt the pivot-box closed round the shaft with oil tight stuffing, from having learned of that arrangement having been successfully employed by Köchlin, an engineer of Mühlhausen. As to the other parts of the arrangements just described, he believes the settling chamber with the circulation of oil to be new, and he regards this part of the arrangements as being useful also for pivots working not under water. In respect to the materials selected for the rubbing parts, however, he thinks it necessary to state that some doubts have arisen as to the suitableness of wrought iron to work on steel even when perfectly lubricated; and he would, therefore, recommend that a small piece of brass should be fixed into the bottom of the shaft, all parts being made to work in the manner already explained.

The two examples which have now been described of vortex water-wheels adapted for very distinct circumstances, will serve to indicate the principal features in the structural arrangements of these new machines in general. Respecting their principles of action some farther explanations will next be given. In these machines the velocity of the circumference is made the same as the velocity of the entering water, and thus there is no impact between the water and the wheel; but, on the contrary, the water enters the radiating conduits of the wheel gently, that is to say, with scarcely any motion in relation to their mouths. In order to attain the equalization of these velocities, it is necessary that the circumference of the wheel should move with the velocity which a heavy body would attain in falling through a vertical space equal to half the vertical fall of the water, or in other words, with the velocity *due* to half the fall; and that the orifices through which the water is injected into the wheel-chamber should be conjointly of such area that when all the water required is flowing through them, it also may have a velocity due to half the fall. Thus one-half only of the fall is employed in producing velocity in the water; and, therefore, the other half still remains acting on the water within the wheel-chamber at the circumference of the wheel in the condition of fluid pressure. Now, with the velocity already assigned to the wheel, it is found that this fluid pressure is exactly that which is requisite to overcome the centrifugal force of the water in the wheel, and to bring the water to a state of rest at its exit, the mechanical work due to both halves of the fall being transferred to the wheel during the combined action of the moving water and the moving wheel. In the foregoing statements, the effects of fluid friction, and of some other modifying influences, are, for simplicity, left out of consideration; but in the practical application of the principles, the skill and judgement of the designer must be exercised in taking all such elements as far as possible into account. To aid in this, some practical rules, to which the author as yet closely adheres, were made out by him previously to the date of his patent. These are to be found in the specification of the patent, published in the Mechanics' Magazine for Jan. 18 and Jan. 25, 1851 (London).

In respect to the numerous modifications of construction and arrangement which are admissible in the Vortex, while the leading principles of action are retained, it may be sufficient here merely to advert,—first, to the use (as explained in the specification of the patent) of straight instead of curved radiating passages in the wheel; secondly, to the employment, for simplicity, of invariable entrance orifices, or of fixed instead of moveable guide-blades; and lastly, to the placing of the wheel at any height, less than about thirty feet, above the water in the tail race, combined with the employment of suction pipes descending from the central discharge orifices, and terminating in the water of the tail race, so as to render available the part of the fall below the wheel.

In relation to the action of turbines in general, the chief and most commonly recognised conditions, of which the accomplishment is to be aimed at, are that the water should flow through the whole machine with the least possible resistance, and that it should enter the moving wheel without shock, and be discharged from it with only a very inconsiderable velocity. The vortex is in a remarkable degree adapted for the fulfilment of these conditions. The water moving centripetally (instead of centrifugally, which is more usual in turbines) enters at the period of its greatest velocity (that is, just after passing the injection orifices) into the most rapidly moving part of the wheel, the circumference; and, at the period when it ought to be as far as possible deprived of velocity, it passes away by the central part of the wheel, the part which has the least motion. Thus in each case, that of the entrance and that of the discharge, there is an accordance between the velocities of the moving mechanism and the proper velocities of the water.

The principle of injection from without inwards, adopted in the vortex, affords another important advantage in comparison with turbines having the contrary motion of the water; as it allows ample room, in the space outside of the wheel, for large and well-formed injection channels, in which the water can be made very gradually and regularly to converge to the most contracted parts, where it is to have its greatest velocity. It is as a concomitant also of the same principle, that the very simple and advantageous mode of regulating the power of the wheel by the moveable guide-blades already described can be introduced. This mode, it is to be observed, while giving great variation to the areas of the entrance orifices, retains at all times very suitable forms for the converging water channels.

Another adaptation in the vortex is to be remarked as being highly beneficial, that namely according to which, by the balancing of the contrary fluid pressures due to half the head of water and to the centrifugal force of the water in the wheel, combined with the pressure due to the ejection of the water backwards from the inner ends of the vanes of the wheel when they are curved, only one-half of the work due to the fall is spent in communicating *vis viva* to the water, to be afterwards taken from it during its passage through the wheel; the remainder of the work being communicated through the fluid pressure to the wheel, without any intermediate generation of *vis viva*. Thus the velocity of the water, where it moves fastest in the machine, is kept comparatively low; not exceeding that due to half the height of the fall, while in other turbines the water usually requires to act at much higher velocities. In many of them it attains at two successive times the velocity due to the whole fall. The much smaller amount of action, or agitation, with which the water in the vortex performs its work, causes a material saving of power by diminishing the loss necessarily occasioned by fluid friction.

In the Vortex, further, a very favourable influence on the regularity of the motion proceeds from the centrifugal force of the water, which, on any increase of the velocity of the wheel, increases, and so checks the water supply; and on any diminution of the velocity of the wheel, diminishes, and so admits the water more freely; thus counteracting, in a great degree, the irregularities of speed arising from variations in the work to be performed. When the work is subject to great variations, as for instance in saw-mills, in bleaching works, or in forges, great inconvenience often arises with the ordinary bucket water-wheels and with turbines which discharge at the circumference, from their running too quickly when any considerable diminution occurs in the resistance to their motion.

The first vortex which was constructed on the large scale was made in Glasgow, to drive a new beetling-mill of Messrs. C. Hunter and Co., of Dunadry, in County Antrim. It was the only one in action at the time of the Meeting of the British Association in Belfast; but the two which have been particularly described in the present article, and one for an unusually high fall, 100 feet, have since been completed and brought into operation. There are also several others in progress; of which it may be sufficient to particularize one of great dimensions and power, for a new flax-mill at Ballyshannon in the West of Ireland. It is calculated for working at 150 horse-power, on a fall of 14 feet, and it is to be impelled by the water of the River Erne. This great river has an ample reservoir in the Lough of the same name; so that the water of wet weather is long retained, and continues to supply the river abundantly even in the dryest weather. The lake has also the effect of causing the floods to be of long duration, and the vortex will consequently be, through a considerable part of the year, and for long periods at a time, deeply submerged under back-water. The water of the tail race will frequently be 7 feet above its ordinary summer level; but as the water of the head race will also rise to such a height as to maintain a sufficient difference of levels, the action of the wheel will not be deranged or impeded by the floods. These circumstances have had a material influence in leading to the adoption in the present case of this new wheel in preference to the old breast or undershot wheels.

On the Composition of Foods, in relation to Respiration and the Feeding of Animals. *By* J. B. Lawes, *Esq., of Rothamsted; and* J. H. Gilbert, *Ph.D., F.C.S.*

During the last twelve years our knowledge of the adaptation of food, according to its composition, to the various exigences of the animal system, has assumed much of definiteness; and it is to the experiments and writings of MM. Boussingault, Liebig and Dumas, that we must attribute, either directly or indirectly, much of the progress that has been made. There are, however, connected with this important subject still many open questions; and it is with the hope of aiding the solution of one or two of these, and thus providing a new starting-point for further inquiry, that we propose in the present paper to bring forward some results of our own which bear upon them, and to point out the conclusions to which they appear to us to lead.

The writers to whom we have above referred, as well as many others, whether themselves experimenters or more systematic writers on the subject of the chemistry of food, may, with few exceptions, and with some limitations, be said to agree on two main points, viz. on the one hand, as to the connection of the *nitrogenous* constituents of the food, with the formation in the animal body of compounds containing nitrogen, and with the exercise of force; and on the other, as to the general relationship of the *non*-nitrogenous constituents of the food with respiration, and with the deposition of animal fat. It is indeed upon the assumption of this broad and fundamental classification of the constituents of food, according to their varied offices in the animal œconomy, that a vast series of analyses of foods have of late years been made and published; whilst, founded upon the results of these analyses, numerous tables have been constructed, professing to arrange the current articles of diet both of man and other animals, according to their comparative values as such. Among the labourers in this field of inquiry, we are much indebted to MM. Liebig, Dumas, Boussingault, Payen, Playfair, R. D. Thomson, Horsford, Schlossberger and Kemp, and others.

When speaking generally then, of the various requirements of the animal organism, the more special adaptations of the several proximate compounds and ultimate elements of which our vegetable and animal aliments are made up, are, as we have already said, fully admitted; but in attempting to apply to practice the principles herein involved by the construction of tables of the comparative value of foods, it seems to have been generally assumed, that our current food-stuffs are thus measurable rather by their flesh-forming than by their more specially respiratory and fat-forming capacities. Hence, with some limitations, the per-centage of nitrogen has always been taken as the standard of comparison.

Founded upon their per-centage of nitrogen, M. Boussingault first arranged tables of the comparative values of different articles of food, chiefly in reference to the dieting of the animals of the farm; and with this method Professor Liebig has expressed his concurrence. At page 369 of the 3rd edition of his Chemical Letters, he says—"The admirable experiments of Boussingault prove, that the increase in the weight of the body in the fattening or feeding of stock (just as is the case with the supply of milk obtained from milch cows), is in proportion to the amount of plastic constituents in the daily supply of fodder." And at page 349 of the same, speaking of the nitrogenous compounds of food, he says—"It is found that animals require for their support less of any vegetable food in proportion as it is richer in these peculiar matters, and cannot be nourished by vegetables in which these matters are absent."

In like manner, various specimens of flour and of bread have been arranged by Dr. R. D. Thomson; other articles of vegetable diet by Mr. Horsford; and a large series of aliments from the animal kingdom by MM. Schlossberger and Kemp. Dr. Anderson also, in his valuable Report on the Composition of Turnips, grown under different circumstances and in different localities, has taken their per-centage of nitrogen as the measure of their comparative feeding value.

The views which have thus led to a vast number of analyses of foods, as well as the information supplied by the analyses themselves, have contributed much to the advancement of our knowledge of the chemistry of food. It has however been found, that the indications of tables of the comparative values of foods, founded on the per-centages of proteine compounds, were frequently discrepant with those which common usage or direct experiment affords. These discrepancies have not escaped the attention of the authors of the theoretical tables; but they have attributed them rather to the erroneous teachings of common practice or experiments on feeding, than to any defect in the theoretical method of estimation. On all hands, however, it has been admitted, that further direct experiment bearing upon this important subject was much needed; and it is the acknowledgement of this necessity that seems to justify the publication, under the auspices of the British Association, the results of this kind which we have now to submit.

The question to which we shall first call attention, is, whether, in the use of our current foods, under ordinary circumstances, but especially in the case of animals fattening for the butcher, *the amount of food consumed*, and that of *increase produced*, have a closer relationship to the supplies in such foods of the *nitrogenous*, or of the *non*-nitrogenous constituents? That is to say, whether the sum of the requirements of the animal system is such, that, in ordinary circumstances, and in the use of ordinary articles of food, the measure of the *amount taken*, or of the *increase produced*, will be regulated more by the supplies of the "Plastic," or of the more peculiarly respiratory and fat-forming constituents. According to the views upon which all the tables of the comparative values of foods are constructed, it is the supplies of the plastic elements of food chiefly, that should regulate both the consumption, and the increase in weight, of a fattening animal. If, however, we bear in mind the views which are generally entertained as to the influence of respiration on the demands of the system for the oxidizable elements of food, it would appear more consistent to suppose that the measure, at least of the *consumption* of food, would be chiefly regulated by its supplies of those elements.

In the experiments to which we shall call attention, sheep and pigs have been the subjects. As, however, their object has partly been the solution of certain questions of a more purely agricultural character than those now under consideration, the details, as to the selection of the animals, and the general management of the experiments, will be given more appropriately in another place. Indeed, the particulars of some of the experiments with sheep, so far as their agricultural bearings are concerned, have already appeared in the Journals of the Royal Agricultural Society of England; and those of the rest, and also of the experiments with pigs, will probably do so shortly. It should here be stated, however, that the general plan has been to select several different descriptions of food, containing respectively various amounts of nitrogenous and non-nitrogenous constituents, the proportions of which were ascertained by analysis. To one or more sets of animals to be compared, a fixed and limited amount of food of a high or of a low per-centage of nitrogen, as the case might be, was allotted, and they were then allowed to take *ad libitum* of another or complementary food. In this way, in obedience to the instinctive demands of the system, the animals were enabled to fix for themselves, according to the composition of the respective foods, the quantities of each class of constituents which they required.

In the tables which follow the results of the experiments are arranged to show—

1st. The amounts respectively of the *nitrogenous* and the *non*-nitrogenous constituents *consumed weekly per* 100 *lbs. live weight of animal.*

2nd. The amounts consumed of each of these classes of constituents *to produce* 100 *lbs. increase in live weight.*

Summary tables of the results of the analyses of the foods are also given.

In the tables showing the amounts of the constituents consumed, &c.—the weights of the animals themselves—of the foods consumed—and their per centages, of dry matter, of ash, and of nitrogen—have formed the basis of the calculations. Thus, the column of nitrogenous substances consumed, is obtained by multiplying the amount of nitrogen by 6·3, on the assumption that they all exist as proteine compounds. This method of estimation will, we think, be found sufficient for our present purpose; though, as we shall have occasion to point out further on, it is frequently far from accurate, and especially when applied to succulent vegetable substances.

The amounts of *non*-nitrogenous constituents are obtained by deducting those of the mineral and nitrogenous constituents from the amount of the total dry matter consumed.

In the tables showing the amounts of the respective constituents consumed *by a given weight of animal within a given time,* it is their *mean weights* that are taken for the calculation; namely, those obtained by adding together their weights at the commencement and at the conclusion of the experiment, and dividing by 2.

In the tables showing the constituents consumed *to produce a given weight of increase,* the figures are obtained by simple rule of three; taking as the elements of calculation, the consumption during the total period of the experiment, and the total increase in weight during the same period.

With these short explanations we may now introduce the tables themselves.

TABLE I.

Summary Table of the Per-centage Composition of the Sheep Foods.

Description of Food.	Mean Per-centage Results.					
	Dry Matter.		Ash.		Nitrogen.	
	Inclusive of Ash.	Exclusive of Ash.	In Fresh Substance.	In Dry Matter.	In Fresh Substance.	In Dry Matter.
Foods eaten by Series 1.						
Swedish Turnips, No. 1.	10·58	10·00	0·577	5·46	0·263	2·49
Swedish Turnips, No. 2.	12·12	11·49	0·632	5·21	0·151	1·25
American Oil-cake...............	89·50	84·08	5·42	6·06	5·08	5·68
Oats	85·18	82·24	2·94	3·45	2·08	2·44
Clover-chaff	78·61	72·33	6·28	7·99	1·85	2·35
Oat-straw Chaff	81·28	74·86	6·42	7·87		
Foods eaten by Series 2.						
Oil-cake	87·36	81·88	5·48	6·27	5·01	5·74
Linseed, No. 1.	90·56	86·28	4·28	4·72	3·68	4·07
Linseed, No. 2.	91·54	87·46	4·08	4·45	4·05	4·44
Barley	85·54	83·23	2·31	2·70	1·49	1·74
Malt	91·65	89·34	2·31	2·52	1·51	1·65
Clover-chaff	84·66	77·39	7·27	8·58	2·11	2·50

TABLE I. (*continued.*)

Description of Food.	Mean Per-centage Results.					
	Dry Matter.		Ash.		Nitrogen.	
	Inclusive of Ash.	Exclusive of Ash.	In Fresh Substance.	In Dry Matter.	In Fresh Substance.	In Dry Matter.
Foods eaten by Series 3.						
Norfolk White Turnips, grown by mineral manures only	9·37	8·74	0·627	6·69	0·146	1·56
Norfolk White Turnips, grown by mineral manures and ammoniacal salts	8·42	7·79	0·630	7·48	0·175	2·08
Norfolk White Turnips, grown by mineral manures and rape-cake	7·78	7·14	0·639	8·21	0·183	2·36
Norfolk White Turnips, grown by mineral manures, rape-cake and ammoniacal salts	7·88	7·17	0·703	8·92	0·252	3·20
Foods eaten by Series 4.						
Long Red Mangold, No. 1.	12·94	11·94	1·002	7·74	0·30	2·36
Long Red Mangold, No. 2.	13·14	12·16	0·979	7·45	0·28	2·18
Mean	13·04	12·05	0·990	7·59	0·29	2·27
Barley	81·84	79·51	2·32	2·84	1·45	1·78
Malt	95·39	92·78	2·60	2·73	1·62	1·70
Malt-dust	93·76	85·06	8·70	9·28	4·10	4·38
Oil-cake	89·74	83·60	6·12	6·82	5·26	5·87

TABLE II.

Summary Table of the Per-centage Composition of Sheep Foods (*continued*).

Series 5.

Foods eaten by Hants and Sussex Downs.

Description of Food.	Mean Per-centage Results.					
	Dry Matter.		Ash.		Nitrogen.	
	Inclusive of Ash.	Exclusive of Ash.	In Fresh Substance.	In Dry Matter.	In Fresh Substance.	In Dry Matter.
Swedish Turnips, Lot 1.	9·81	9·20	0·607	6·19	0·231	2·36
Swedish Turnips, Lot 2.	10·32	9·73	0·607	5·87	0·301	2·61
Oil-cake	87·54	80·84	6·70	7·65	4·98	5·70
Clover-hay	81·24	72·82	8·42	10·36	2·03	2·51

TABLE II. (*continued.*)

Description of Food.	Mean Per-centage Results.					
	Dry Matter.		Ash.		Nitrogen.	
	Inclusive of Ash.	Exclusive of Ash.	In Fresh Substance.	In Dry Matter.	In Fresh Substance.	In Dry Matter.
Eaten by Cotswolds.						
Swedish Turnips, Lot 1.	10·88	10·37	0·504	4·63	0·18	1·66
Swedish Turnips, Lot 2.	10·70	10·12	0·579	5·41	0·28	2·63
Swedish Turnips, Lot 3.	12·60	11·84	0·758	6·00	0·27	2·21
Oil-cake	87·54	80·84	6·70	7·65	4·99	5·70
Clover-hay	83·66	76·46	7·20	8·60	2·24	2·68
Eaten by Leicesters; and by Cross-bred Ewes and Wethers, [Leicester and South Down.]						
Swedish Turnips, Lot 1.	10·89	10·38	0·520	4·79	0·23	2·15
Swedish Turnips, Lot 2.	11·88	11·26	0·623	5·23	0·25	2·14
Oil-cake	86·32	78·52	7·80	9·04	5·05	5·86
Clover-hay, Lot 1.	80·48	72·38	8·10	10·06	2·73	3·40
Clover-hay, Lot 2.	80·08	71·90	8·18	10·17	2·73	3·42

TABLE III.

Summary Table of Per-centage Composition of the Pig Foods.

Description of Food.	Mean Per-centage Results.					
	Dry Matter.		Ash.		Nitrogen.	
	Inclusive of Ash.	Exclusive of Ash.	In Fresh Substance.	In Dry Matter.	In Fresh Substance.	In Dry Matter.
Eaten by Series 1.						
Egyptian Beans..................	88·30	83·57	4·72	5·35	4·24	4·80
Lentils, Lot 1.	87·30	82·42	4·87	5·58	4·52	5·18
Lentils, Lot 2.	86·62	81·64	4·98	5·75	4·56	5·26
Indian meal, Lot 1.	89·70	88·33	1·37	1·53	1·72	1·92
Indian meal, Lot 2.	89·89	88·61	1·28	1·42	1·95	2·17
Bran	84·79	78·77	6·02	7·10	2·61	3·08
Barley	81·86	79·72	2·14	2·61	1·83	2·24
Eaten by Series 2.						
Egyptian Beans..................	88·17	84·45	3·72	4·22	4·21	4·78
Lentils, Lot 1.	89·42	86·44	2·98	3·33	4·54	5·08
Lentils, Lot 2.	89·97	85·10	4·87	5·41	4·18	4·65
Barley, Lot 1.	82·38	80·19	2·19	2·66	1·82	2·21
Barley, Lot 2.	80·95	78·77	2·18	2·69	1·83	2·26
Barley, Lot 3.	82·53	80·48	2·05	2·48	1·55	1·88
Bran	85·08	78·67	6·41	7·53	2·62	3·08

TABLE IV.

Experiments with Sheep.—*Weekly* consumption of Nitrogenous and Non-nitrogenous constituents of Food *per* 100 *lbs. live weight of animal* (quantities stated in lbs., tenths, &c.).

Pen, No.	Limited Food.	Complementary or ad libitum Food.	Nitrogenous Organic Substance.			Non-nitrogenous Organic Substance.			Total dry Organic Substance.
			In limited Food.	In ad libitum Food.	In total Food.	In limited Food.	In ad libitum Food.	In total Food.	
	Series 1.—Five sheep in each pen, 14 weeks.								
1.	Oil-cake	Swedish Turnips	1·63	0·82	2·46	2·75	7·10	9·85	12·31
2.	Oats	ditto	0·88	0·69	1·57	4·76	6·61	11·36	12·93
3.	Clover-chaff	ditto	0·69	0·94	1·64	3·99	9·13	13·12	14·76
4.	Oat-straw chaff	ditto	...	1·07	1·07	...	9·82	10·17	11·24
		Means	1·071	0·882	1·68	3·83	8·16	11·13	12·81
	Series 2.—Five sheep in each pen, 19 weeks.								
1.	Oil-cake	Clover-chaff	1·64	2·14	3·78	2·55	10·38	12·93	16·71
2.	Linseed	ditto	1·26	1·95	3·21	3·19	9·47	12·66	15·87
3.	Barley	ditto	0·50	2·08	2·58	3·83	9·96	13·79	16·37
4.	Malt	ditto	0·44	2·08	2·52	3·98	10·04	14·02	16·55
		Means	0·96	2·06	3·02	3·39	9·96	13·35	16·38
	Series 3.—Five sheep in each pen, 10 weeks.								
1.	Barley	Mangold-wurtzel	0·44	1·26	1·70	3·53	7·06	10·59	12·29
2.	Malt and malt-dust	ditto	0·43	1·20	1·64	3·32	6·80	10·12	11·76
3.	Barley (steeped)	ditto	0·43	1·65	2·08	3·35	9·24	12·60	14·68
4.	Malt and malt-dust (steeped)	ditto	0·40	1·36	1·77	3·09	7·60	10·70	12·47
5.	Malt and malt-dust (extra quantity)	ditto	0·52	1·36	1·89	3·97	7·66	11·63	13·52
		Means	0·44	1·37	1·82	3·45	7·67	11·13	12·94
	Series 4.—Five sheep in each pen, 10 weeks; no limited Foods.								
1.	Norfolk White Turnips, mineral manures only				1·20			10·30	11·50
2.	Norfolk White Turnips, mineral manures and ammoniacal salts				1·51			9·24	9·75
3.	Norfolk White Turnips, mineral manures and rape-cake				1·64			8·86	10·50
4.	Norfolk White Turnips, mineral manures, rape-cake and ammoniacal salts				2·14			7·60	9·74
		Means			1·62			9·00	10·37

TABLE IV. (*continued.*)

Series 5.—Different breeds of sheep.

	Limited Food.	Complementary or ad libitum Food.	Nitrogenous Organic Substance. In limited Food.	Nitrogenous Organic Substance. In ad libitum Food.	Nitrogenous Organic Substance. In total Food.	Non-nitrogenous Organic Substance. In limited Food.	Non-nitrogenous Organic Substance. In ad libitum Food.	Non-nitrogenous Organic Substance. In total Food.	Total dry Organic Substance.
Forty Hants Downs, twenty-six weeks	Oil-cake and Clover-chaff.	Swedish Turnips.	2·27	1·12	3·39	5·43	5·63	11·06	14·45
Forty Sussex Downs, twenty-six weeks			2·31	1·06	3·37	5·64	5·35	10·99	14·36
Forty-six Cotswolds, twenty weeks			2·27	1·14	3·41	5·37	6·65	12·02	15·43
Forty Leicesters, twenty weeks			2·30	1·07	3·37	4·70	6·46	11·16	14·53
Forty cross-bred Ewes, twenty weeks			2·39	1·09	3·48	4·91	6·60	11·51	14·99
Forty cross-bred Wethers, twenty weeks			2·41	1·12	3·53	4·96	6·73	11·69	15·22
		Means	2·32	1·10	3·42	5·17	6·23	11·40	14·83

TABLE V.

Experiments with Sheep.—Consumption of Nitrogenous and Non-nitrogenous constituents of Food *to produce* 100 *lbs. increase in live weight of animal* (quantities stated in lbs.).

Series 1.—Five sheep in each pen, 14 weeks.

Pen, No.	Limited Food.	Complementary or ad libitum Food.	Nitrogenous Organic Substance. In limited Food.	Nitrogenous Organic Substance. In ad libitum Food.	Nitrogenous Organic Substance. In total Food.	Non-nitrogenous Organic Substance. In limited Food.	Non-nitrogenous Organic Substance. In ad libitum Food.	Non-nitrogenous Organic Substance. In total Food.	Total dry Organic Substance.
1.	Oil-cake	Swedish Turnips..	111	56	167	181	469	650	817
2.	Oats	ditto	55	48	103	289	395	684	787
3.	Clover-chaff	ditto	43	59	102	223	513	736	838
4.	Oat-straw chaff	ditto	...	102	102	...	881	913	1015
		Means	70	66	118	231	565	746	864

Series 2.—Five sheep in each pen, 19 weeks.

Pen, No.	Limited Food.	Complementary or ad libitum Food.	Nitrogenous Organic Substance. In limited Food.	Nitrogenous Organic Substance. In ad libitum Food.	Nitrogenous Organic Substance. In total Food.	Non-nitrogenous Organic Substance. In limited Food.	Non-nitrogenous Organic Substance. In ad libitum Food.	Non-nitrogenous Organic Substance. In total Food.	Total dry Organic Substance.
1.	Oil-cake	Clover-chaff	138	183	321	219	884	1103	1424
2.	Linseed	ditto	112	177	289	291	853	1144	1433
3.	Barley.....................	ditto	45	190	235	353	916	1269	1504
4.	Malt	ditto	49	217	266	412	1045	1457	1723
		Means	86	192	278	319	925	1244	1521

TABLE V. (*continued.*)

Series 3.—Five sheep in each pen, 10 weeks.

Pen, No.	Limited Food.	Complementary or ad libitum Food.	Nitrogenous Organic Substance. In limited Food.	Nitrogenous Organic Substance. In ad libitum Food.	Nitrogenous Organic Substance. In total Food.	Non-nitrogenous Organic Substance. In limited Food.	Non-nitrogenous Organic Substance. In ad libitum Food.	Non-nitrogenous Organic Substance. In total Food.	Total dry Organic Substance.
1.	Barley	Mangold-wurtzel	31	87	118	243	488	731	850
2.	Malt and malt-dust	ditto	29	82	111	220	457	677	788
3.	Barley (steeped)	ditto	25	96	121	194	536	730	851
4.	Malt and malt-dust (steeped)	ditto	32	104	136	237	584	821	958
5.	Malt and malt-dust (extra quantity)	ditto	35	91	126	265	511	776	903
		Means	30	92	123	232	515	747	870

Series 4.—Five sheep in each pen, 10 weeks; no limited Food.

Pen, No.	Food.	Nitrogenous Organic Substance.	Non-nitrogenous Organic Substance.	Total dry Organic Substance.
1.	Norfolk White Turnips, mineral manures only	192	1627	1819
2.	Norfolk White Turnips, mineral manures and ammoniacal salts	153	930	1083
3.	Norfolk White Turnips, mineral manures and rape-cake	324	1682	2006
4.	Norfolk White Turnips, mineral manures, rape-cake and ammoniacal salts	Lost weight.	Lost weight.	
	Means	223	1413	1636

Series 5.—Different breeds of sheep.

	Limited Food.	Complementary or ad libitum Food.	Nitrogenous Organic Substance. In limited Food.	Nitrogenous Organic Substance. In ad libitum Food.	Nitrogenous Organic Substance. In total Food.	Non-nitrogenous Organic Substance. In limited Food.	Non-nitrogenous Organic Substance. In ad libitum Food.	Non-nitrogenous Organic Substance. In total Food.	Total dry Organic Substance.
Forty Hants Downs, twenty-six weeks	Oil-cake and Clover-chaff.	Swedish Turnips.	124	62	186	300	312	612	798
Forty Sussex Downs, twenty-six weeks	Oil-cake and Clover-chaff.	Swedish Turnips.	129	60	189	318	302	620	809
Forty-six Cotswolds, twenty weeks	Oil-cake and Clover-chaff.	Swedish Turnips.	111	55	166	260	322	582	748
Forty Leicesters, twenty weeks	Oil-cake and Clover-chaff.	Swedish Turnips.	127	59	186	261	358	619	805
Forty cross-bred Ewes, twenty weeks	Oil-cake and Clover-chaff.	Swedish Turnips.	127	58	185	260	350	610	795
Forty cross-bred Wethers, twenty weeks	Oil-cake and Clover-chaff.	Swedish Turnips.	127	59	186	261	355	616	802
		Means	124	59	183	277	333	610	793

TABLE VI.

Experiments with Pigs.—*Weekly* consumption of Nitrogenous and Non-nitrogenous constituents of Food *per* 100 *lbs. live weight of animal* (quantities stated in lbs., tenths, &c.).

Series 1.—Three pigs in each pen, 8 weeks.

Pen, No.	Limited Food, per head, per day.	Complementary or ad libitum Food.	Nitrogenous Organic Substance. In limited Food.	Nitrogenous Organic Substance. In ad libitum Food.	Nitrogenous Organic Substance. In total Food.	Non-nitrogenous Organic Substance. In limited Food.	Non-nitrogenous Organic Substance. In ad libitum Food.	Non-nitrogenous Organic Substance. In total Food.	Total dry Organic Substance.
1.	None	Bean and Lentil meal	...	8·84	8·84	...	17·6	17·6	26·4
2.	Indian meal	ditto	0·83	7·30	8·13	5·5	14·3	19·8	27·9
3.	Bran	ditto	1·32	6·39	7·71	5·0	12·8	17·8	25·5
4.	Indian meal and Bran...	ditto	2·14	4·73	6·87	10·6	9·4	20·0	26·9
		Means	1·07	6·82	7·89	5·3	13·5	18·8	26·7
5.	None	Indian meal	...	2·91	2·91	...	19·3	19·3	22·2
6.	Bean and Lentil meal ..	ditto	1·95	2·60	4·55	3·9	17·2	21·1	25·7
7.	Bran	ditto	1·21	2·74	3·95	4·6	17·9	22·5	26·4
8.	Bean and Lentil meal, and Bran	ditto	3·05	2·15	5·20	8·1	14·0	22·1	27·3
		Means	1·55	2·60	4·15	4·1	17·1	21·2	25·4
9.	Bean and Lentil meal...	Bran	3·34	1·85	5·19	6·7	7·0	13·7	18·9
10.	Indian meal	ditto	1·44	2·46	3·90	9·4	9·3	18·7	22·6
11.	Bean and Lentil meal, and Indian meal ...	ditto	3·23	1·73	4·96	10·4	6·6	17·0	22·0
12.	None	Bean and Lentil meal, Indian meal, Bran, each *ad libitum*	...	6·12	6·12	...	20·1	20·1	26·2
		Means	2·00	3·04	5·04	6·6	10·8	17·4	22·4
	Means of the 12 pens		1·54	4·15	5·69	5·3	13·8	19·1	24·8

Series 2.—Three pigs in each pen, 8 weeks.

Pen, No.	Limited Food, per head, per day.	Complementary or ad libitum Food.	Nitrogenous Organic Substance. In limited Food.	Nitrogenous Organic Substance. In ad libitum Food.	Nitrogenous Organic Substance. In total Food.	Non-nitrogenous Organic Substance. In limited Food.	Non-nitrogenous Organic Substance. In ad libitum Food.	Non-nitrogenous Organic Substance. In total Food.	Total dry Organic Substance.
1.	None	Bean and Lentil meal	...	6·69	6·69	...	14·5	14·5	21·2
2.	3 lbs. Barley meal	ditto	1·23	7·06	8·29	7·3	15·3	22·6	30·9
3.	1 lb. Bran	ditto	0·66	8·07	8·73	2·5	17·5	20·0	28·7
4.	3 lbs. Barley meal, 1 lb. Bran	ditto	1·95	4·85	6·80	10·1	10·5	20·6	27·4
		Means	0·96	6·67	7·63	5·0	14·4	19·4	27·0

TABLE VI. (*continued.*)

Pen, No.	Limited Food, per head, per day.	Complementary or ad libitum Food.	Nitrogenous Organic Substance. In limited Food.	Nitrogenous Organic Substance. In ad libitum Food.	Nitrogenous Organic Substance. In total Food.	Non-nitrogenous Organic substance. In limited Food.	Non-nitrogenous Organic substance. In ad libitum Food.	Non-nitrogenous Organic substance. In total Food.	Total dry Organic Substance.
5.	None	Barley meal	...	3·91	3·91	...	23·6	23·6	27·5
6.	1½ lb. Bean, and 1½ lb. Lentil meal	ditto	2·81	2·36	5·17	6·1	13·9	20·0	25·2
7.	1 lb. Bran	ditto	0·61	3·45	4·06	2·3	20·9	23·2	27·3
8.	1½ lb. Bean, 1½ lb. Lentil meal, and 1 lb. Bran	ditto	2·98	1·66	4·64	7·2	10·0	17·2	21·8
		Means	1·60	2·84	4·44	3·9	17·1	21·0	25·4
9.	None	Mixture of 1 part Bran, 2 parts Barley meal, and 3 parts Bean and Lentil meal	...	6·65	6·65	...	20·6	20·6	27·2
10.	None	Duplicate of pen 9.	...	7·03	7·03	...	21·9	21·9	28·9
11.	None	Mixture of 1 part Bran, 2 parts Bean and Lentil meal, and 3 parts Barley meal	...	5·86	5·86	...	21·4	21·4	27·3
12.	None	Duplicate of pen 11.	...	6·02	6·02	...	22·1	22·1	28·1
		Means	...	6·39	6·39	...	21·5	21·5	27·9
		Means of the 12 pens	0·85	5·30	6·15	2·9	17·7	20·6	26·8
		Means of the 24 pens	1·19	4·73	5·92	4·1	15·8	19·9	25·8

TABLE VII.

Experiments with Pigs.—Consumption of Nitrogenous and Non-nitrogenous constituents of Food, *to produce* 100 *lbs. increase in live weight of animal* (quantities stated in lbs.).

Series 1.—Three pigs in each pen, 8 weeks.

Pen, No.	Limited Food, per head, per day.	Complementary or ad libitum Food.	Nitrogenous Organic Substance. In limited Food.	Nitrogenous Organic Substance. In ad libitum Food.	Nitrogenous Organic Substance. In total Food.	Non-nitrogenous Organic substance. In limited Food.	Non-nitrogenous Organic substance. In ad libitum Food.	Non-nitrogenous Organic substance. In total Food.	Total dry Organic Substance.
1.	None	Bean and Lentil meal	...	138	138	...	275	275	413
2.	Indian meal	ditto	12	102	114	77	201	278	392
3.	Bran	ditto	28	133	161	105	267	372	533
4.	Indian meal and Bran	ditto	38	83	121	185	166	351	472
		Means	19	114	133	92	227	319	452

TABLE VII. (*continued.*)

Pen, No.	Limited Food, per head, per day.	Complementary or ad libitum Food.	Nitrogenous Organic Substance. In limited Food.	Nitrogenous Organic Substance. In ad libitum Food.	Nitrogenous Organic Substance. In total Food.	Non-nitrogenous Organic substance. In limited Food.	Non-nitrogenous Organic substance. In ad libitum Food.	Non-nitrogenous Organic substance. In total Food.	Total dry Organic Substance.
5.	None	Indian meal	...	57	57	...	378	378	435
6.	Bean and Lentil meal	ditto	31	42	73	62	275	337	410
7.	Bran	ditto	18	40	58	68	264	332	390
8.	Bean and Lentil meal, and Bran	ditto	43	30	73	114	195	309	382
		Means	23	42	65	61	278	339	404
9.	Bean and Lentil meal	Bran	127	71	198	255	268	523	721
10.	Indian meal	ditto	48	82	130	311	309	620	750
11.	Bean and Lentil meal, and Indian meal	ditto	74	40	114	240	151	391	505
12.	None	Bean and Lentil meal, Indian meal, Bran, each *ad libitum*	...	107	107	...	350	350	457
		Means	62	75	137	202	269	471	608
		Means of the 12 pens	35	77	112	118	258	376	488
		Series 2.—Three pigs in each pen, 8 weeks.							
1.	None	Bean and Lentil meal	...	146	146	...	317	317	463
2.	3 lbs. Barley meal	ditto	20	117	137	120	254	374	511
3.	1 lb. Bran	ditto	12	140	152	43	305	348	500
4.	3 lbs. Barley meal, 1 lb. Bran	ditto	36	89	125	186	192	378	503
		Means	17	123	140	87	267	354	494
5.	None	Barley meal	...	64	64	...	385	385	449
6.	1½ lb. Bean and 1½ lb. Lentil meal	ditto	50	41	91	107	245	352	443
7.	1 lb. Bran	ditto	10	56	66	38	341	379	445
8.	1½ lb. Bean, 1½ lb. Lentil meal, and 1 lb. Bran	ditto	64	36	100	157	215	372	472
		Means	31	49	80	75	297	372	452
9.	None	Mixture of 1 part Bran, 2 parts Barley meal, and 3 parts Bean and Lentil meal	...	117	117	...	362	362	479
10.	None	Duplicate of pen 9.	...	110	110	...	342	342	452
11.	None	Mixture of 1 part Bran, 2 parts Bean and Lentil meal, and 3 parts Barley meal	...	88	88	...	320	320	408
12.	None	Duplicate of pen 11.	...	87	87	...	321	321	408
		Means	...	101	101	...	336	336	437
		Means of the 12 pens	16	91	107	54	300	354	461
		Means of the 24 pens	25	84	109	86	279	365	474

A glance at the Tables as a whole must show, that in all comparable cases there is much more of uniformity of amount in the total columns of *non*-nitrogenous than in those of nitrogenous substance, both as to the quantities consumed *to a given weight of animal within a given time*, and to those required *to produce a given weight of increase.* The deviations from this general regularity in the amount of non-nitrogenous substance consumed under equal circumstances, are indeed, in most cases such, that when examined into they tend the more clearly to show, that the uniformity would be considerably more strict if the amounts only of the really available respiratory and fat-forming constituents could have been represented, instead of, as in the case of these Tables, that of the *gross* or *total non*-nitrogenous substance consumed. For, in reading the actual figures of the Tables, allowance has to be made both for those of the non-nitrogenous constituents of the food which would probably become at once effete, and also for the different respiratory and fat-forming *capacities* of the portions of them which are digestible and available for the purposes of the animal œconomy. It must further be remembered, that even after all due allowance has been made for the sources of discrepancy just referred to, the amounts which we may suppose to be so corrected must still cover all variations, whether arising from differences of external circumstances—from individual peculiarities in the animals themselves—from the different amounts stored up in them according to the adaptation of the respective foods—as well as from the many other uncontrollable circumstances which must always interfere with any attempts to bring within the range of accurate numerical measurement the results of those processes in which the subtle principle of animal life exerts its influence. Bearing, then, all those points in mind which must tend to modify the true indications of the actual figures in the Tables, it appears to us, that the coincidences in the amounts of *available* respiratory and fat-forming constituents consumed by a given weight of animal, under equal circumstances, within a given time, and also in those required under equal circumstances to produce a given amount of increase in weight, must be admitted to be much more striking and conclusive than *à priori* we could have expected to find them. With this general uniformity, however, as to the amounts of *non*-nitrogenous substance consumed under given circumstances, or for a given result, those of the *nitrogenous* constituents are found to vary, under the same circumstances, in the proportion of from 1 to 2 or 3.

In illustration of our statements let us examine the Tables for a moment somewhat more in detail.

In Table IV. we have the amounts of the two classes of constituents respectively, which were consumed *weekly per* 100 *lbs. live weight of animal*, in the case of five different series of experiments with sheep. In all cases the experiments extended over a period of many weeks, and in some even of several months. Each series comprised several pens, to each of which (except in Series 4, in which there were no limited foods) there was allotted a different description of fixed or limited food, the *ad libitum* or complementary food being (except in Series 4) the same throughout the several pens of the same series, but different in the different series. In the Series 1, 2, 3 and 4, there were five or six sheep in each pen; in Series 5, from 40 to 50 sheep in each pen.

In Series 1, the complementary or *ad libitum* food was Swedish turnips, and the limited foods were—

In pen 1, oil-cake.
In pen 2, oats.
In pen 3, clover-chaff.
In pen 4, oat-straw chaff.

The oat-straw chaff of pen 4 was given as adding to the otherwise only succulent matter of the turnip, the *bulk* of solid matter which seems to be demanded particularly by ruminant animals. So small a quantity of this straw was eaten, however, that it need scarcely enter into our calculations. Turning to the results of pens 1, 2 and 3, it is seen that the weekly consumption of non-nitrogenous matter per 100 lbs. live weight of animal is, with the oil-cake as limited food, 9·8 lbs.; with the oats, 11·3 lbs.; and with the clover-chaff 13·1 lbs. Now, of these three descriptions of food, the oil-cake would contain by far the most of oleaginous matter, the respiratory and fat-forming capacity of which is about twice and a half as great as that of the starch series of compounds which would more abound in the oats. Hence we find that a less actual weight of non-nitrogenous substance was consumed with the oil-cake than with the oats. But to the reason just given, to which a part of the result was doubtless due, we might add that there was a comparatively large and somewhat excessive amount of nitrogenous matter consumed in the oil-cake pen, a part of which at least might serve the respiratory and fat-forming functions. Then, again, in pen 3, where clover-chaff was the limited food, the animals would consume a much larger amount of effete woody fibre than with either the oil-cake or the oats; in this pen therefore a larger gross weight of non-nitrogenous substance must be eaten to yield the same equivalent of that which is available for respiratory or fat-forming purposes than with either of the other foods. When therefore, allowance has been made for the different quantities and capacities of the available constituents in the several foods, it will be seen, that the equivalents of the available non-nitrogenous constituents consumed in the different cases, are in reality much more nearly identical, than the figures as they stand in the Table would indicate. But if we now turn to the column of the nitrogenous substance consumed under the same circumstances, we find that it varies, comparing one pen with another in this first series, nearly as much as from 1 to $2\frac{1}{2}$.

In the second series (Table IV.) we have clover-chaff as the *ad libitum* or complementary food in all the pens, instead of Swedish turnips as in Series 1; and again, with the much larger amount of effete woody fibre, we have a larger gross amount of the non-nitrogenous substance consumed. The average of the four pens of this Series 2 is indeed almost identical with the amount where clover-chaff was employed in Series 1. Again, comparing one pen with another in this clover-chaff series, we have with the larger amounts of oleaginous matter supplied in the linseed and oil-cake, less of gross non-nitrogenous substance taken than with the barley or the malt, in which there is a proportionally larger amount of the starch series of compounds. When due allowance is made, then, for the different respiratory and fat-forming capacities of the several foods, we have again a closer coincidence than would at first sight appear, in the equivalents of the non-nitrogenous substances consumed in the different pens of this second series—as also when we compare this series with the former one. Turning now to the column of the nitrogenous substances consumed in this second series, we see that the gross amounts vary more than in those of the non-nitrogenous; and more indeed than, according to any knowledge we at present possess, could be accounted for by a consideration as to the state in which the nitrogen existed in the several pens. Comparing now the result of the one series with those of the other, although in the two cases the description of the larger portion of the food is widely different, and we have found that there is nevertheless considerable coincidence in the amounts of non-nitrogenous substance consumed, yet the columns of nitrogenous substance throughout the two series show a very great variation in the quantities of these consumed—amounting, indeed, in the extreme cases, to as much as from one to three and a half. There can be little doubt that the method of estimating the amount of available nitrogenous substance from the per-centage of nitrogen must be more or less faulty, both in the case of the succulent turnips of the first series, and in that of the also unripened produce—clover-chaff—of the second; but whether or in what degree the differences in the amounts consumed in the two series would be lessened by corrections due to this source of discrepancy, we have not the means of accurately deciding.

In the third series, which consisted of five pens, mangold-wurtzel was the complementary food; and the limited foods were barley and malt, respectively, in different states and proportions in the several pens. Throughout this series the proportion of nitrogenous to non-nitrogenous constituents varied but little in the limited foods, and being also constant in the complementary foods of the several pens, we have but little difference in this series in the amounts respectively of either class of constituents when comparing pen with pen. Comparing the results of this series with those of the others, however, we observe that there was a very close coincidence between the amounts of available *non*-nitrogenous substance consumed; but in those of the nitrogenous substances there is little in common when thus taking at one view the results of the several series.

In the fourth series we have no supply of limited food. In all the four pens Norfolk-white turnips only were given *ad libitum*. Those supplied to the different pens, were however, respectively grown by very different manures, and differed in all cases very much in ultimate composition and other qualities. Thus, the per-centage of dry substance and the state of maturity were greatest in the turnips of pen 1, and diminished in the order of the pens, they being in pen 4 the worst in both these respects. On the other hand, the per-centage of water, of mineral matter, and of nitrogen, and the degree of unripeness or unfitness for food, were in the inverse order. The turnips eaten in pen 1 were, however, too ripe, and what is called "pithy"; and those were in the best condition which were supplied to pen 2.

In this series there was, with a probably generally lower amount of effete matter, at the same time a generally less amount of non-nitrogenous substance consumed—though most where the turnips were known to be too ripe and *pithy*. In pen 4 there was a very small amount of *non*-nitrogenous substance taken; but there is no doubt that here the limit to consumption was fixed by the unfitness of the turnips as food, and not by their high value in this respect; for these turnips were very succulent and unripe, and notwithstanding they contained *a very high per-centage of nitrogen,* all the animals fed upon them lost weight. Taking the circumstances into account, then, we have as much uniformity in the amounts of non-nitrogenous constituents consumed as we could expect, both among the several pens of the series, and in comparing this series with the rest. In the column of nitrogenous constituents, on the other hand, there is nothing to indicate any uniformity of demand for the supply of them, whether we compare pen with pen, or the results of this series with those of the others. It might perhaps be objected, from what we have already said of the varying qualities of the turnips used in this series, that the nitrogenous compounds themselves would exist in the different lots in a more or less assimilable condition; and hence probably some of the differences in the amounts consumed. Doubtless there were differences in this respect in the different lots, but it is seen that there is nearly twice as much of nitrogen consumed in one pen as in another; and we cannot suppose that by any such method of correction as has been suggested, so large a difference as this, or even that the whole of the lesser ones observed in the other cases, could be thus accounted for. It is worthy of observation, however, that in this series the amounts of the nitrogenous constituents consumed are in an inverse ratio to those of the non-nitrogenous; and if we are to calculate, that in the case of a defect of the latter or an excess of the former, a notable portion of the nitrogenous constituents would serve as respiratory material, such an assumption in the present case would tend yet more clearly to show the closer dependence of *consumption* upon respiration, than upon the supplies by the food of the plastic elements of nutrition, as such.

In the next and last series of experiments to be noticed with *sheep*, as far as possible the same description of foods is used throughout; but animals of different breeds and weights and other admitted qualities are now the subject of experiment in the several pens. The breeds which have thus been compared are,—the Hampshire Down, Sussex Down, Cotswold, Leicester, Half-bred Wethers (Leicester and Southdown), and Half-bred Ewes (Leicester and Southdown). In all these experiments oil-cake and clover-chaff were the limited foods, and Swedish turnips the complementary food. About 1 lb. per head per day of each of the limited foods was given to the Hampshires; and taking this allowance as the standard, the other breeds had quantities of these foods exactly in proportion to their weights. There were from 40 to 50 sheep in each lot; and each experiment extended over several months. The experiments were, however, not all made in the same season; the turnips were therefore of different growths; and the oil-cake and clover-chaff, though chosen as nearly as possible of similar quality, were not always from the same stocks. These circumstances, then, as well as the intrinsic differences in the breeds themselves, if any, might be supposed perhaps to have some share in any variations in result. We see, however, that there is nevertheless a very striking coincidence in the amounts of constituents consumed to a given weight of animal among the different breeds. But what is more to the purpose, the amounts of non-nitrogenous substance consumed to a given weight of animal by these different breeds, and at different times, are, after making, as before, due allowance for the probable different equivalents of the foods, exactly consistent with the indications of the other series with all their varied foods. This result, then, further shows that in all, the respiratory and fat-forming exigences of the animals have fixed the limit to their consumption of food; and also that these requirements have, on an average, and under somewhat similar circumstances, a pretty constant relationship to their weights. With this general coincidence in the amount of non-nitrogenous substance consumed to a given weight of animal in the several pens of this series, there could not, of course, with foods of similar composition in all, be much variation in the amounts of the nitrogenous constituents taken under the same circumstances. Of these, however, we have throughout this series twice or thrice as much as in many cases of the other series, which would not happen if the demand for them had been the guide to *consumption*; nor shall we afterwards find that *the increase in weight* obtained was by any means proportional to this large amount of nitrogenous substance consumed.

In our experiments with sheep, then, whether with different descriptions of food, or with different breeds of the animal, *the amount of food consumed would seem to be regulated by the quantities which it supplied of the non-nitrogenous rather than by those of the nitrogenous constituents.*

So much, then, for the bearing of our sheep experiments upon the question of the amount of food consumed according to its composition: but before entering upon a consideration of the results of these same experiments in relation to the second question, namely, that of the *increase produced*, it will be well to see how far the experiments with pigs afford us similar indications in relation to the former one.

The pig requires much less of mere *bulk* in his food than the ruminant animal. Indeed, the food of the pig, when on a liberal fattening diet, consists generally, weight for weight, of a much larger proportion of digestible or convertible constituents, and contains much less of effete woody fibre than that of the sheep. Thus, whilst the food of the fattening sheep is principally composed of grass, hay and roots, with a comparatively small proportion of cake or corn, that of the fattening pig comprises a larger proportion of corn, which contains a comparatively small amount of indigestible woody fibre, and is comparatively abundant in starch, sugar, &c., and in highly nitrogenous compounds. Notwithstanding the generally richer character of his food, however, the fattening pig is found to consume a much larger quantity of dry substance in relation to his weight than the sheep. We should at least expect, therefore, that he would yield a greater proportion of increase, and this he is found to do. Such, indeed, is the greediness of the animal, and so much larger is the proportion of the food which he will consume beyond that which is necessary for the respiratory function, or for the formation of flesh, and which is therefore employed in storing up fat, that the amounts of non-nitrogenous matter consumed must obviously, in his case, have a less close numerical relationship to the requirements of the respiratory system than in that of the sheep. Hence, no doubt, is in part the reason that the exact indications of the figures of the Tables are, on the whole, not so consistent as with the sheep. The experiments with the pigs however bear testimony in the same direction as those with the sheep on the question now in discussion, and the evidence they afford on the point is, indeed, very conclusive.

In the arrangement of the pig experiments the selection of the foods was made rather according to composition than to cost. In the first series (see Tables VI. and VII.) the foods chosen were—

A mixture of equal parts of bean and lentil meal, as *a highly nitrogenous food.*

Indian corn meal, as the *comparatively non-nitrogenous food.* And—

Bran, as containing a considerable amount of woody fibre.

The series comprised twelve pens, in each of which three pigs were placed. In the first four pens, the bean and lentil mixture constituted the *ad libitum* food; in one of these it was given alone, and in the others with a limited amount of one or both respectively of the other two descriptions of food. In the second set of four pens, the Indian corn meal was the *ad libitum* food; and it, in its turn, was in one case given alone, and in the others with a certain amount of the other or limited foods. In the third set of pens, bran was the *ad libitum* food; the other two then constituting the fixed or limited food. In this way there was secured a great diversity in the proportion of the nitrogenous to the non-nitrogenous constituents of the food in the several pens; and as the animals were allowed to fix for themselves the limit of their consumption, the results afford us the means of judging, whether in doing this, their natural instincts have led them to any uniformity in relation to their weights, in the amounts taken of either of these classes of constituents.

In Table VI. are given the amounts of the nitrogenous and non-nitrogenous constituents respectively, consumed *weekly by every* 100 *lbs. live weight of animal.* In this Table we see at a glance, that although there are some apparent discrepancies, yet the figures in the column of *non*-nitrogenous constituents are much more uniform than in that of the nitrogenous ones. And, as to the few apparent deviations from this uniformity, we think it will be much more reasonable to attempt to explain, or even considering the nature of the subject, to admit as inexplicable, a few discrepant cases, than to reject on their account the general testimony of much more numerous, more consistent, and otherwise sufficiently conclusive results. Thus in the first set of four pens in this series, there is, upon the whole, a less amount of the non-nitrogenous constituents consumed than in the second; and this lessened amount of non-nitrogenous constituents consumed in the former is seen to be coincident with excessive consumption of the nitrogenous ones, and it is even the less the greater that excess. It is also worthy of remark, too, that in pens 5 to 8, where there was this larger amount of non-nitrogenous substance consumed, it was supplied chiefly by Indian corn meal, which, containing more oily matter than that of the foods in pens 1 to 4, would also possess a higher respiratory and fat-forming capacity, weight for weight, than that in the other cases. We may here suppose, that perhaps a surfeit of the nitrogenous substances put a limit to the further consumption of non-nitrogenous constituents which would otherwise have been taken; or, that being in excess, the nitrogenous substances have substituted other respiratory material; and it is consistent with such a supposition, that with the less amount of non-nitrogenous constituents consumed, where the nitrogenous are in excess, there is nevertheless a larger amount consumed of *total* organic substance than where there is more of the non-nitrogenous constituents.

That a larger amount of the complementary food was consumed when it consisted of the comparatively low nitrogenized Indian meal, was not due only to a craving for a supply of nitrogen which a less quantity would not have yielded, would appear, among other considerations, from the fact, that when, after a time, the pigs in pen 5, where Indian meal alone was given, had become affected with large tumours breaking out on their necks, their breathing and swallowing becoming at the same time difficult, we, in order to test the question as to whether this arose from a defect of nitrogen or from other causes, supplied them with a trough of *mineral* substances: they soon recovered from their complaint, and eventually proved to be among the fattest and best of the entire series of pigs; at least, a dealer in pork with a practised eye, purchased by preference one of these animals from among the whole set of carcases. The mineral mixture that was supplied to them was composed of twenty parts coal ashes, four parts common salt, and one part superphosphate of lime; and for it they seemed to exhibit considerable relish.

In pens 9, 10 and 11, a comparatively small quantity of the more digestible foods was allowed, the complementary food being in these cases bran; and as we have before said, the digestive apparatus of the pig is not adapted for a large amount of bulky woody substance. Here the animals consumed a less amount of non-nitrogenous substance in proportion as the bran predominated in their food; and they at the same time also increased and fattened much less than those in the other pens. In fact, until 3lbs. per head per day of the limited foods were allowed instead of only two, as was at first given, several of the pigs lost weight and became unwell; being as it were paralysed (gouty ?), and almost deprived of the use of their legs. There can be little doubt that the proportion of woody matter in the bran, which food only they had at full command, was too great for the convenience of their stomachs; and that hence, after their respiratory requirements had been fulfilled, a limit was put to further consumption to serve the mere purpose of fattening.

In pen 12, the several foods, namely, the bean and lentil mixture, the Indian meal, and the bran, were each put into a separate trough, and the animals were allowed to take of all or any of them *ad libitum*. Were it not that one of the pigs in this pen was unwell in the same way as those referred to in the previous pens during a considerable portion of the period of the experiment, we might have assumed perhaps, that the results of this pen would have pointed to the proportions of the several foods best adapted to the wants of the animals; and if such a conclusion were a legitimate one, it would indeed appear, that their natural demands called for a larger proportion of nitrogen than was within the reach of the animals in any of those pens in which Indian meal was the *ad libitum* or complementary food. Two of the pigs, however, in this pen 12, increased exceedingly well, and gave eventually the highest proportion of carcass to live weight, of any in this entire series of experiments. It is, too, an interesting fact, that as the experiment proceeded, and the animals matured, their consumption diminished very considerably. Thus, the proportion of the bean and lentil mixture to the total food consumed was only two-thirds as great at the conclusion as at the commencement of the experiment, whilst that of the Indian meal was not three-fifths as much at the commencement as at the conclusion. We have in this fact some indication of the large proportion of the non-nitrogenous constituents of the food which is appropriated by the fatting animal.

Reviewing, as a whole, the reults of these twelve dietaries, and carefully considering the bearing of the various circumstances which must influence our reading of the actual figures of the Table relating to them, we think it cannot be doubted, that here, as in the case of the sheep, we have very clear evidence that it is the non-nitrogenous, rather than the nitrogenous constituents of the food, that have fixed the limit to *consumption*.

In the lower section of this Table VI., we have the results bearing upon the same point, of a second series of experiments with pigs, conducted on a similar plan to that of the former one. In this second series of pig experiments, we have, as before, the bean and lentil mixture as the highly nitrogenous food. Barley meal is in this case used as the non-nitrogenous food, instead of Indian corn as in the former series. Bran, again, constitutes the third food. In this series however, when either the bean and lentil mixture, or the barley meal, constituted the limited food, the daily allowance per head was 3 lbs. instead of 2, as in the former series. When the limited food was bran, 1lb. only, instead of 2 as previously, was now given. In other respects, excepting that in this series bran was in no case given alone as the *ad libitum* food, the arrangements were the same as in the case of the previous series.

The weather during part of the period of this second series of experiments was exceedingly hot; from this several of the animals suffered considerably; and some, either from this or other causes, became quite ill and died, or were "killed to save their lives." Nevertheless it is seen, that there was, upon the whole, a larger amount of respiratory food consumed in relation to weight in this series than in the previous one during the cooler season.

If we compare the column of the amounts of non-nitrogenous constituents consumed weekly, per 100 lbs. live weight of animal, for this series, as given in the lower section of Table VI., with that in the upper section for Series 1, we shall see that there was, upon the whole, a greater uniformity in the former than in the latter. There are, however, one or two marked exceptions to the regularity of amount of non-nitrogenous matter consumed in this Series 2, which, but for coincident circumstances, and the abundance we have of evidence in the opposite direction, might lead to different conclusions than those which we have drawn from the results as a whole; but at any rate the uniformity is still greater here than in the column of the nitrogenous substances. The more obvious exceptions to the rule are pens 1 and 8; but apart from any incidental causes which might account for these—and in each of these pens one of the animals died—we shall see, when we come to consider the question of the amount of increase produced by a given amount of food consumed, that although the pigs were satisfied to eat a smaller proportion of food in relation to their weight in these pens where the proportion of nitrogen was comparatively large, yet the proportion of increase to the food consumed was less than where the amount of *non*-nitrogenous substance consumed was much greater. Hence, in these cases, if there were a smaller amount of food consumed, there was also a smaller proportion of increase produced by it, and there would therefore at the same time obviously be a larger proportion of it available for the purposes of respiration. These apparent exceptions are not, then, necessarily adverse to the view that the respiratory process was the gauge of consumption.

We have already noticed, that notwithstanding the weather was much hotter during the progress of the second series of experiments, yet that there was here, upon the whole, a larger amount of non-nitrogenous substance consumed in proportion to weight of animal than in the first. This apparent excess, if indeed it show any real excess in respiratory and fat-forming equivalent, at any rate does not do so in the degree which the bare figures of the Table would indicate. Thus, the Indian corn of the first series, of which a less amount seems to have sufficed than of the barley in the second, contained about 6 per cent. of oleaginous matter, instead of less than 3 per cent., as in the barley. And as a deficiency of 3 per cent. in fatty substance would, for respiratory and fat-forming purposes, require to be substituted by about twice and a half that amount of the other non-nitrogenous constituents, it is obvious that the respiratory and fat-forming capacity of the Indian meal non-nitrogenous matter was therefore somewhat higher than that of the barley; and hence a less amount of it would be required to produce the same result.

We could add to the results already given those of further experiments both with pigs and sheep, as well as some with bullocks, bearing upon the point we have been considering; but those we have already adduced are, we think, sufficient to justify our conclusion, that, in reference to this first question, at least so far as fattening animals are concerned, the amount of food consumed is regulated more by its supplies of the non-nitrogenous, than of the nitrogenous constituents.

We now come to the second question; namely, that of the relationship of the *increase in live weight produced* to the consumption of nitrogenous and non-nitrogenous constituents in the food.

Turning first to the experiments with sheep, we have in Table V. the amounts respectively of the non-nitrogenous, of the nitrogenous, and of the total organic substance consumed to produce 100 lbs. increase in live weight.

In viewing the Tables in reference to this point, we must, as before, read the indications of the actual figures as modified by the obviously different *capacities* for the purposes of the animal œconomy of the substances, the amounts of which they in each case represent. Especially, too, when considering the results with the sheep, we must bear in mind the fact, which we have ascertained by direct experiment, namely, that other things being equal, the more succulent the food, the less will be the proportion of real dry substance in the increase obtained by its means; and also, that the greater the amount of fat produced the greater considerably will be the per-centage in the gross increase of real dry substance. And we must further remember, that as in the Tables showing the relationship of *consumption* to respiration, the figures also included the increase in weight obtained, so now, in the Tables professing to show the relationship of the *increase* to the constituents consumed, the figures at the same time include the amounts which have been expended in the respiratory process.

Looking down the entire columns of Table V., it is at once seen that wherever clover-chaff was employed, that is to say, wherever there was a large amount of innutritious woody fibre, the gross amount of non-nitrogenous substance consumed to produce a given amount of increase is always great. The analysis of the excrements of this series showed, indeed, that there was, in relation to the non-nitrogenous matter consumed in the food, a very much larger proportion of it voided by the animals than in the case of the series where the amount of woody fibre in the food was less. This, therefore, must be allowed for in comparing the figures in the column. It will at once be seen, when due allowance has thus been made, that the amounts of *available* non-nitrogenous substance consumed to produce a given weight of increase, are at any rate much more nearly uniform than are those of the nitrogenous constituents. Of the differences which will still remain after the allowance for woody fibre has been made, many can be again reduced by a consideration of the different equivalents of the remaining *available* non-nitrogenous constituents; as for instance, when in comparable cases these contain, in one instance, more of oil, and in another more of the starch series of compounds. A less amount of the former than of the latter is required to produce the same resulting increase in the animal; and again, less of the starchy series than of some of the peculiar products of the root crops.

In the column showing the proportion of the total nitrogenous substance consumed to increase produced (Table V.), we have a much wider range of difference than in that of the non-nitrogenous, and much wider, indeed, than can be explained away by such considerations as have above been alluded to in reference to the latter. It is true that these figures cannot, any more than in the column of the non-nitrogenous constituents, be taken as showing absolutely proportional nutritious values of the matters represented; for as we have before observed, the figures assume the whole of the nitrogen of the food to exist in the form of proteine compounds, which obviously would not be the case with the succulent and unripened produce, such as the roots and clover-chaff; and hence, this consideration must more affect the correctness of the statement of nitrogenous constituents consumed for a given result in the sheep experiments than in those with the pigs, where the foods employed were ripened seeds. But, as we have observed, the differences in the figures in the Table would seem to be too great to be satisfactorily accounted for by the correction of any errors arising from this cause.

Looking at this Table V. rather more in detail, we see, taking the first two pens in Series 1, which are comparable so far as the description of the *ad libitum* food is concerned, that whilst the non-nitrogenous substance consumed to produce 100 lbs. increase in weight is very nearly equal in the two cases, yet that of the nitrogenous constituents varies in the two in the proportion of from three to two; but a difference in the nature of the nitrogenous substance cannot be supposed to have made a difference so great in the amount of constituents consumed to produce a given result. On the other hand, the higher *capacity* of the oleaginous matter of the oil-cake than of the starch, &c. of the oats, is sufficient further to lessen the but small difference in the amounts of the non-nitrogenous substance in the two cases. In pens 2, 3 and 4 of the first series of sheep, we have all but identical amounts of gross nitrogenous substance consumed for a given amount of increase; but this would be of the most highly elaborated kind in pen 2 with the oats, and the least so in pen 4, with turnips only; and in the latter, besides having less of *available nitrogenous* substance, the respiratory and fat-forming *capacity* of the non-nitrogenous substance in the exclusive turnip diet would be less than in the other instances; and hence the larger amount consumed for a given result.

Turning to the results of the second series, with clover-chaff instead of turnips as the *ad libitum* food, we have, with the larger amount of woody fibre, which would become at once effete, much more gross non-nitrogenous matter consumed to produce 100 lbs. of increase than in Series 1. This is less, however, in pens 1 and 2, with the large proportion of oleaginous matter, than in pens 3 and 4. There is, moreover, in this second series, with this greater amount of *non*-nitrogenous matter consumed for a given effect than in Series 1, a much larger amount also of the *nitrogenous* constituents; the gross amount of the latter, indeed, in this second series, is twice, and even sometimes thrice as great as in Series 1.

In the next series, namely, Series 3, with barley and malt in different states and proportions as limited food, and mangold-wurtzel as the complementary food, we have, upon the whole, about the same amounts of non-nitrogenous substance required to produce the same result as in Series 1, with, besides, a small quantity of grain or other limited food and Swedish turnips as the complementary food, which latter are in great degree comparable with the mangold-wurtzel; and of course, as in Series 1, the average amount is very different from that in the second series with the large proportion of clover-chaff. Looking to the three total columns, namely, of nitrogenous, of non-nitrogenous, and of total organic constituents consumed, although it is true the differences are not great, and perhaps such as might be covered by differences in the composition of the increase, yet it may be noticed, that larger amounts, both of non-nitrogenous and of total organic substance, were consumed to produce the same result the larger the proportion in the latter of the nitrogenous constituents.

In Series 4, we have a more marked instance of the result last noticed. But, apart from the question as to whether the increase of the fattening animal has a closer relationship with the amount of the *true proteine compounds,* or, within certain limits, of the available non-nitrogenous constituents of its food, we have here a striking illustration of the inapplicability on other grounds of the *per-centage of nitrogen* as the measure of feeding value, or indeed of any analytical method, unless a detailed determination of the *proximate compounds*, when succulent products, such as in this instance, the roots, are the subjects of the experiment. Thus, in the fourth pen of this series, where there was by far the largest amount of nitrogen consumed, the animals lost weight; and in the other three pens, the productiveness of the food is in the inverse order of the amounts of nitrogen taken in the food. This arose of course from the different states of maturity, and the consequent state of elaboration of the constituents of the various turnips, the produce of the different manures. Indeed, we believe that an unusually high per-centage of nitrogen in succulent produce is frequently a pretty sure indication of immaturity and innutritious qualities. Comparing the results of this series with those of the others, we have, considering how small would be the proportion of inert woody fibre in the unripe turnips, about twice as much dry substance (in pens 1 and 3 at least) consumed to produce a given amount of increase—a difference which could, at any rate in only a small degree, be accounted for by any difference in the capacities of the digestible and available portions of the foods in the cases thus compared.

Considering only the ostensible similarity of the foods in the several pens constituting the 5th and last series of experiments with sheep, there is, perhaps, no more of coincidence in the amounts that have been required to produce a given increase in the different pens, than, judging from previous results, we might have anticipated. From what we know, however, of the varying character of the several breeds as fatteners, greater differences might have been expected; for, in some cases a less or larger proportion of the gross increase would be solid substance than in others; whilst this solid substance itself would be composed of more or less of fat or lean—circumstances which obviously imply the appropriation in the increase, of varying amounts and proportions of the constituents of the food consumed. Then, again, though nominally the same, there were unavoidably slight differences in the qualities of the food used in the different cases, and the experiments themselves were not all conducted in the same season; that with the Hampshire and Sussex Downs being made in the winter of 1850–51, that with the Cotswolds in 1851–52, and with the Leicesters and half-breeds in 1852–53. There is also, upon the whole, a very general coincidence in the amounts of non-nitrogenous and total organic substance, consumed to produce a given amount of increase in this series with the different breeds, and the Series 1 and 3. At least the general coincidence throughout these several series is quite as close as the variations in the foods could lead us to look for. But in the column of nitrogenous substance the agreement between this series and the others is by no means so obvious; nor, so far as we know, can the want of agreement in the cases thus compared together be accounted for by differences in the composition and applicability of the nitrogenous constituents themselves.

Reviewing then the whole of the experiments with sheep,—if we consider that it is the results obtained under the subtle agency of animal life that we are seeking to measure and express in figures, and if we also bear in mind the various sources of modification to which our actual figures must be submitted in order to attain their true indications, we think that it cannot be doubted, that beyond a limit below which few, if any, of our current fattening food-stuffs are found to go, it is their available non-nitrogenous constituents, rather than their richness in the nitrogenous ones, that measure both the amount consumed to a given weight of animal, within a given time, and the increase in weight obtained.

But we have still to examine the results of the experiments with pigs as to the latter point, namely, that of the relationship of the *increase produced* to constituents consumed; and owing partly to the peculiarities of the animals, and partly to the nature of the foods employed, the actual figures themselves even (see Table VII.) bear out the view that has been maintained more obviously at first sight, than those relating to the sheep. Thus, casting the eye down the column of total non-nitrogenous substance consumed, and more particularly that of the total organic matter, we see with but few exceptions, a strikingly close coincidence in the amounts required to produce 100 pounds of gross increase throughout the two series of twenty-four pens, and as many different dietaries. Some of the exceptions, such as those where a large quantity of bran was used, are at once explained by a consideration of the more obvious qualities of that substance; and many of the minor differences by that of the different capacities of those portions of the foods which would be digestible and available for the purposes of the animal œconomy; and in this way, as we have already noticed when speaking on the first question, we must account for the generally larger amount consumed with the barley meal in Series 2, than in the comparable cases with the Indian corn in Series 1.

Looking to pens 1 and 2 of Series 1, where the food consisted chiefly of the highly nitrogenous Leguminous seeds, we have comparatively very small amounts of non-nitrogenous substance required to produce a given amount of increase; a result which at first sight appears to lead to conclusions opposite to those from the experiments as a whole. If we look down the column of *total organic substance*, however, we observe that the amounts of it in the second section of Series 1, where the Indian corn predominated, and where the nitrogenous constituents consumed were only about half as great as in the pens 1 and 2, are generally as small, or even smaller, than in these two pens. It is not, then, that there was in reality a very great productiveness in gross increase from a given amount of food in these two pens, but rather only that with the large supply of available nitrogenous constituents in the Leguminous seeds, a certain amount of the non-nitrogenous constituents have been substituted by it. It was observed, too, that although all the pigs were very fat, excepting the few with an excessive allowance of bran, yet those apparently *grew* more, where, with no deficiency of other matters, the nitrogenous constituents were very liberally supplied. Hence the gross increase obtained might be somewhat more nitrogenous with the large supply of nitrogenous food; but it would in that case, according to some experiments of our own, contain a larger proportion of water, and less of solid matter, than where more *fat* had been produced.

But, with the very great regularity of non-nitrogenous equivalent consumed throughout this large series of pig experiments *to produce a given amount of increase*, we have, in the column of total nitrogenous substance, on the other hand, a difference in the amounts required, in the proportion of from one to two, or three, or even more; though, since all the foods used in these experiments were ripened vegetable products, a very trifling error, if any, can arise from representing, in all cases, the whole of the nitrogen as existing as proteine compounds. And, there is throughout, a generally larger amount of total organic substance required to yield a given amount of gross increase, the larger the proportion in that substance of the nitrogenous constituents.

It is seen, as has been already noticed, that where the amount of nitrogen consumed in these pig experiments to produce a given amount of gross increase is comparatively large, it is where a large proportion of the Leguminous seeds have been employed. Some writers who have taken the per-centage of nitrogenous compounds as the measure of feeding value, have recognised, and endeavoured to explain in various ways, the fact that the records of practical feeding experiments do not award to the Leguminous seeds a feeding value in proportion to their richness in nitrogen; and they have concluded, that it is the accepted indications of the practical experiments, and not the theoretical conclusions, that are at fault. Thus, it has been objected against the teachings of such experiments, that the variations in the composition of the same description of food used in different cases has not been determined; that the test has been the gross increase or loss in weight; that the increase may be only fat formed from starch, &c.; that the loss in weight, if any, may be the result of activity, and not of defective diet; that the food in the different cases has been employed in different states, that is, coarse or fine, raw or prepared; that the animals have been variously circumstanced as to temperature, exposure and activity; that individual animals have very various tendencies to increase, and so on. Now we believe that not one of all these objections can vitiate the comparisons which we have made, unless, indeed, in some degree, the one which refers to the difficulty of determining whether the gross increase obtained be composed chiefly of fat formed from the starch and oily series of compounds; or whether of flesh from the nitrogenous ones. We believe, indeed, from the many direct experiments which we have made, that in reality, the composition of our domestic animals generally, but especially that of the gross increase of the *so-called* "fattening" animals, consists of a much larger proportion of fat than is usually supposed. We have instituted very extensive and laborious investigations in regard to this point, the details, or even the general results of which must be reserved for some future occasion; before closing this paper, however, we propose to call attention to a mere summary statement of one of these experiments. But, apart from the considerations involved in the question of the varying composition of increase, or from the fact that our own feeding experiments (which, so far as we are aware, are the largest comparable series bearing upon the point) afford testimony in the same direction, we think there is evidence of another kind of the probable correctness of the decisions of practical experiments which have thus been objected to. Thus the comparative prices of the Leguminous seeds and the Cereal grains, may be taken as a pretty safe condemnation of the measurement of feeding value according to their percentage of nitrogenous constituents. In matters of this kind, indeed, especially when staple and generally used articles of food are concerned, the *market* is one of our shrewdest judges, as we shall presently endeavour a little further to illustrate.

Whilst speaking of the comparative feeding values of the Leguminous seeds and the Cereal grains, we may casually allude to some other considerations of much interest bearing upon this question, which, however, we cannot in any degree adequately discuss in this place.

As a general rule, it may be said, that weight for weight, the Leguminous seeds contain about twice as much of the nitrogenous constituents as the Cereal grains. We have elsewhere shown, that in a Leguminous crop, under equal circumstances of soil and season, an acre of land will frequently yield twice or thrice as much of nitrogenous constituents as in a Cereal grain; and again, that in the latter an *increase* of produce is not obtained except at the cost of more nitrogen in the manure than is contained in that increase. How is it, we would ask, if this be the case, and if really these foods are valuable in proportion to their richness in nitrogenous constituents, that according to the usual state of the market, we can obtain, for a given sum, about twice as much nitrogenous substance in the Leguminous seeds as in the Cereal grain; or how is it, on the other hand, that the Leguminous crop does not, much more than is in fact the case, supersede the Cereal grain in the field, the feeding shed, or even on the table? We have, it is true, much yet to learn of those minor differences of composition to which is due the greater or less adaptation to the instinctive wants of the system of the various constituents of which our staple articles of food are made up, but we think that in no considerations of this kind could we seek an adequate solution of our question. On the other hand, we believe that in the Leguminous seeds the due proportion of the non-nitrogenous to the nitrogenous constituents is not observed. It is obvious, if this be the case, that in the use of the Leguminous seeds, instead of the Cereal grains, more than was requisite of nitrogen would be taken into the system before the adequate supply were attained of the non-nitrogenous or respiratory materials; nor, as the markets go, would the relative prices of these seeds and grains be found to interfere with a somewhat lavish use and expenditure of nitrogen in the former.

In the facts which are here briefly stated, we have surely very curious and interesting matter for reflection; and we have brought to our view a striking instance of the mutual adaptations which are everywhere traceable in the practical operation of natural laws. Thus, then, we have said, that under given circumstances, the Leguminous crop will give a much larger acreage yield of nitrogen than the Cereal grain; and that an increase of produce of the latter is not obtained except at the cost of more nitrogen in the manure than is obtained in this increased produce; whilst in point of fact, in the ordinary practice of rotation in this country, the growth of the Leguminous corn or fodder crop, with its large per-centage and actual amount of nitrogen, is itself frequently either the direct or indirect source of the nitrogenous manure by which the increased Cereal is obtained; and again, this Cereal, obtained at the *cost* of, but with its lessened *produce* of nitrogen, is found in practice to be of equal, or of a more highly feeding value than the more highly nitrogenized Leguminous product which perhaps has been expended to produce it. It would thus appear, therefore, that the demands of the respiratory function which again, more than any other, regulate the consumption of food, would, in point of fact, not be satisfied in the use of the Leguminous diet unless by a consumption or expenditure of an amount of nitrogen beyond that which the due balance of the constituents of food would seem to require; whilst on the other hand, in the use of the Cereal grain, its better proportion of respiratory to nitrogenous constituents has only been attained by the sacrifice of nitrogen expended in its growth. It would seem, therefore, that whether we would seek our supplies of respiratory food in the direct use of the highly nitrogenized Leguminous seeds, or in the better balanced diet of the Cereal grains, in either case the end is attained only at the cost or expenditure of nitrogen; in the one case, by the consumption of a larger amount of it in the food than the due balance of constituents would seem to require, whilst in the other this due balance has not been attained without a loss of nitrogen during growth. The claims of health and natural instinct generally leave little doubt which alternative should be adopted, in the case of human food at least; and it becomes us, therefore, to investigate and understand the practical bearings of these curious and interesting facts; for upon the principles they involve depend much for their success those fundamental practices of the farm,—the feeding of our stock, for their *double products of meat and manure*, and the adaptation of our rotations.

It would appear, then, from our experiments, that taking our current food-stuffs as we find them, it is their supply of the *non*-nitrogenous, rather than of their nitrogenous constituents, which guides both the amount of food consumed, and of increase produced, by a fattening animal. When we consider the nature of the respiratory process, and the large share which its demands must necessarily have upon the consumption of food, it can scarcely appear surprising that *consumption*, at least, should be chiefly regulated by the supply in the food of compounds rich in carbon and hydrogen, rather than nitrogen. That the amount of *increase* produced should also bear a closer relationship to the supply of these constituents than to that of the latter, does not perhaps at first sight seem so obvious, especially if we supposed, as some writers on this subject have done, that the amount of nitrogen in the current food of man and other animals was frequently insufficient to supply the amount required for the production or restoration of the nitrogenous products of the animal organism. We believe, however, that a closer examination of the facts would show that this exceedingly rarely happens; and we think, moreover, as we have already intimated, that in fact, that portion of nitrogen which is stored up in the *increase* of a growing, and especially of a "fattening" animal, is much less than is usually supposed. We cannot in any degree adequately discuss this question in this place; but when maintaining a greater relative importance of the *non*-nitrogenous constituents of food than is usually accorded to them, it seems somewhat pertinent briefly to adduce some evidence in confirmation of our conclusions on this point.

We propose, therefore, to give a very brief summary of one of our experiments, in which pigs were the subjects, which was undertaken chiefly for the purpose of ascertaining the *composition of the increase of the fattening animal*; but to obtain also, some clear evidence in reference to the much-debated question, whether or not more fatty matter is stored up in the animal, than is contained, as such, in its food.

Taking first the question of the *composition of the increase*, we have in the following table a summary statement of the composition of the foods employed in the experiment referred to; and also of the pigs themselves, both in the store, and in the fat condition; as well as that of the *increase* in weight during the fattening process, as deduced by calculation.

Table VIII.

Summary of the Per-centage Composition of the Foods employed—of the Store Pig, and of the Fat Pig—and also of the Increase in Live Weight of the latter.

Description.	Dry Matter.		Mineral Matter (Ash).		Nitrogen.		FattyMatter(by æther).	
	Inclusive of Ash.	Organic only.	In Fresh Substance.	In Dry Substance.	In Fresh Substance.	In Dry Substance.	In Fresh Substance.	In Dry Substance.
Egyptian Beans	87·8	84·53	3·274	6·73	4·214	4·80	2·26	2·58
——— Lentils	86·96	82·03	4·926	5·66	4·487	5·16	2·23	2·56
Foreign Barley	81·86	79·72	2·140	2·61	1·834	2·24	2·34	2·86
Bran	85·08	78·67	6·408	7·53	2·620	3·08	4·98	5·85
Store or Lean Pig	39·70	37·03	2·67	6·73	2·20	5·54	23·32	58·74
Fat Pig	54·74	53·09	1·65	3·01	1·75	3·19	42·20	77·09
Increase in Live Weight	71·83	71·39	0·436	0·61	1·33	1·85	63·44	88·32

We may briefly explain, that, for the purposes of this experiment, two pigs were selected resembling each other as nearly as possible both in weight and in every other respect. One of these was killed at once, and its composition determined by methods which we shall fully describe on some future occasion. The other pig, after it had been put up to fatten for a period of eight weeks upon weighed quantities of the foods, the composition of which is given in the upper lines of the table, and its *increase* in weight determined, was also killed, and submitted to the same methods of preparation and analysis as the former one. The composition of the two pigs—the one in the store and the other in the fat condition—thus being ascertained, that of the *increase in weight* was, as will be readily understood, simply a matter of calculation.

We learn from this table (VIII.), that rather less than 40 per cent. of the Store or Lean Pig was dry substance; of which about $2\frac{2}{3}$rds were mineral matter. Of the remaining 37 per cent. of dry substance, 2·2 were nitrogen, equal to about 14 only of proteine compounds. There is, however, of absolute or dry *fat* in this Store or Lean Pig, about $23\frac{1}{2}$ per cent.; or nearly twice as much as of dry nitrogenous compounds.

In the Fat Pig, on the other hand, there is about 55, instead of about 40 per cent. of dry substance; of which only $1\frac{2}{3}$rds, instead of $2\frac{2}{3}$rds, are mineral matter. Of the remaining 53 per cent. of dry substance, only 1·75, instead of 2·2, is nitrogen; and this is equal, upon the entire animal, to only 11, instead of 14 per cent. of proteine compounds. We have, however, of *fat*, instead of $23\frac{1}{2}$ per cent., about $42\frac{1}{4}$ per cent. in this Fat Pig, or nearly double as much as in the Lean one; and nearly four times as much as of dry nitrogenous compounds.

With then only about 14 per cent. of nitrogenous substance in the Lean Pig, and nearly twice as much *fat*, we have, in the fattening process, conducted only for a few weeks, the per-centage of mineral matter, reduced by about one-third, and that of the nitrogenous substances by about one-fourth; that of the *fat*, on the other hand, which in the Store Pig even, was in so much the larger proportion, is nearly doubled in the Fat one. Thus, the increase in weight during the fattening process was found to contain as much as 72 per cent. of dry substance, of which only 0·436 is mineral matter, and only 1·33 nitrogen, equal to about 8½ of proteine or gelatinous compounds. There is, however, about 63½ per cent. of fat, or nearly eight times as much as of dry nitrogenous compounds. Indeed, it is seen in the table, that 88 per cent., or about eight-ninths of the entire dry increase of this Fat Pig, was pure fat.

M. Boussingault, in his 'Rural Economy,' estimates that the Ox, the Sheep, and the Pig, contain from 3½ to 4 per cent. of nitrogen; and more recently in his paper on the Formation of Fat in the Animal Body (*Ann. de Chémie*, vol. xiv. p. 444), he supposes 4 as the probable per-centage in the Pig. He also states (Rural Economy), that M. Payen estimates the *increase* of the fattening pig to contain about 16 per cent. of nitrogenous compounds, equal to about 2½ per cent. of nitrogen. It will be observed, however, that only about half of these amounts of nitrogen were found in the direct experiments of our own which we have quoted; and it should at the same time be remarked, that the Fat Pig in our experiment was by no means so fat as is usual, at least in this country.

It is doubtless true, that other animals, as fed for the butcher, will generally contain more flesh and less fat than the pig. In a very fat sheep, however, fed for Christmas, and which was indeed too fat, we found a larger per-centage of fat, and as little nitrogenous substance, as in the moderately fat pig, whose composition has been given above. Among our experiments on this subject, it was only in the case of a lean ox, that we found the nitrogen to exceed 2½ per cent. of the entire animal; whilst in all the cases of store or lean animals, the per-centage of dry fat was much greater than that of the dry nitrogenous compounds.

The fact that fat is in so much a larger proportion than lean in the animals fed for the butcher, would seem not only to be consistent with the results of our experiments as to the great influence of the non-nitrogenous constituents of the food of these animals in the production of increase during the fattening process—but it indicates also the predominance of this non-nitrogenous character in that description of human food (butcher's meat), which is generally spoken of as the most nitrogenous, and therefore the most nutritive.

That the *fatty matter of the food* is not the only source of the fat stored up in the body of the fattening animal, is illustrated by a further consideration of the circumstances and results of this same experiment with pigs. Thus, in the following table are shown the amounts of Gross Dry Substance—of Mineral Matter—of Dry Organic Matter—of Total *Non*-nitrogenous constituents—of Nitrogenous constituents—and of fatty matter, stored up in the Fat Pig, for 100 lbs. of each of them consumed as food.

Table IX.

Showing the proportion of certain constituents stored up in the Fattening Pig for 100 of each of them consumed as food.

Constituents.	Consumed as Food.	Stored up in the Animal.	Expired, Perspired, or Voided.
Gross dry substance	100	15·04	84·96
Mineral matter	100	2·19	97·81
Total dry organic matter......	100	15·59	84·41
Non-nitrogenous constituents	100	17·74	82·26
Nitrogenous constituents ...	100	8·35	91·65
Fatty matter	100	407·00	

It may be observed, that in the case of the experiment with this single pig, the amounts of nitrogenous and non-nitrogenous constituents required to produce a given amount of increase—though nearly the same as the *averages* of the 24 pens, as given at the foot of Table VII.—were greater, than in many of the cases with the better foods. Hence, the quantities of the various constituents, represented in Table IX. as stored up in this pig for 100 of each of them consumed, are less than they would be in many of the other experiments. We believe, however, that the figures in the Table (IX.) may be trusted in their general indications; and attention may therefore be called in passing to the fact, that for 100 of each consumed, there is of the total dry substance little more than 15 stored up in the animal; of the mineral matter, little more than 2 per cent.; and of the nitrogenous constituents, about 8⅓rd per cent.

Again, a glance at the Table shows how very much larger is that proportion of every constituent of the food—excepting *fatty matter*—which was expired, perspired or voided, *i. e.* which was expended in merely keeping in working order the living mechanism, than that which is stored up in the animal as increase. Of *fat*, however, it appears that there was nearly four times as much stored up in the animal, as there was of fatty matter ready formed in the food. There was then, in this experiment, a considerable *formation* of fat in the animal body.

As is seen in the Table (IX.), for every 100 lbs. of gross dry substance consumed as food, only about 15 lbs. were stored up in the animal; and about 85 lbs. expired, perspired or voided. It may be convenient here to show in a tabular form, the composition of this 15·04 of total dry increase obtained by the consumption of 100 of total dry matter as food.

Table X.

Mineral matter	0·09
Nitrogenous substance	1·67
Non-nitrogenous substance (fat)	13·28
Total increase	15·04
Expired, perspired or voided	84·96
Total dry matter consumed	100·00

It must not be concluded, however, that only 15 per cent. of the dry substance of the food was employed in the production of the 15 parts stored up in the fat pig. Thus, in Table X. we see, that, of the 15·04 of gross dry increase produced from 100 of gross dry food consumed, 13·3 were *fat*; and from Table IX. we learn, that only one-fourth of this fat could have been derived from fatty matter already formed in the food. As then only one-fourth, or about 3·3 parts of the 13·3 of pure fat, was already formed in the food, about 10 parts out of the 15 of dry animal substance produced, would be *fat formed in the body from some other constituents.* We may perhaps safely reckon, that at least 2½ parts of starch, or the other *non*-nitrogenous compounds of food, would be required for the formation of one part of fat. It is true, that less than 2½ of starch, &c. would *contain* all the constituents of one part of fat; but when we consider, that in the conversion of the starch series of compounds into fat a large quantity of oxygen is eliminated, which we may assume would not leave the body except in combination with matters that would otherwise serve the respiratory process, it would seem probable, that more than 2½ parts of other constituents of food would be expended in the direct production in the animal body of one part of fat. At any rate, we are safe in assuming this amount for our present purpose, in the absence of more exact knowledge than is at command on the nature of the intermediate changes to which the constituents of food are subject in their passage through the body. If, then, we suppose, that the starch series—rather than the proteine compounds—of the food, served for the formation of the fat in the animal body, it follows, that about 25 parts of these were expended in the formation of the 10 parts of *produced* fat. If now we add to this amount of the non-nitrogenous constituents of the food not fat, the $3\frac{1}{3}$rd parts which were fatty matter already formed, and also the $1\frac{2}{3}$rds of the increase which was not fat, it would appear, that at least 30 parts of the 100 of dry substance consumed, must have been directly employed in the production of the 15 only of dry animal increase. It is obvious, too, from the nature of the chemical change by which fat would be formed from the starch series of compounds, that the extra 15 of the 30 parts of the dry substance of the food, which were expended in the direct production of the 15 of dry increase, would not serve any useful purpose in the respiratory process of the fattening animal. And, unless indeed, we were to assume—that in the more direct use of the starch series of compounds as respiratory matter, their oxygen was eliminated only in combination with respiratory material—and that when employed in the production of *fat* it was not so—it would appear, that not only must this produced fat have been obtained at the cost of respiratory material expended by the fattening animal which produced it—but that it is, at any rate, not in the *amount* of respiratory material thus obtained, that there can be any gain in this conversion by the fattening animal of a given amount of compounds of *lower* respiratory and fat-forming capacity, into fat to serve as human food, of which it is the most concentrated of the respiratory constituents.

If, then, as we have seen, so large a proportion as nearly $\frac{1}{3}$rd of the dry substance of the food of the fattening pig may be employed in the direct production of increase—and we have reason to suppose that frequently more than this is so employed—we think that the deviations from uniformity in the amounts of non-nitrogenous constituents consumed by a given weight of animal, within a given time, as shown in our tables, will be admitted to be even less than might have been expected in so extensive and varied a series of experiments—and to be, by no means such, as to raise any question as to whether or not, it was the supplies of the respiratory and fat-forming, rather than the flesh-forming constituents of the foods, which determined the amounts consumed.

But to recur to the question of the *formation* of fat in the animal body. We believe that such a formation, even to a considerable, and practically important extent, is demonstrated by the results of the experiments with pigs last given; and there is every reason to believe, that it is the starch and other non-nitrogenous constituents of the food that contribute mainly, if not entirely, to this formation.

At one time MM. Dumas and Boussingault maintained that the formation of fat in the animal body was improbable; and others have done so more recently. Since that time, however, both M. Boussingault and M. Persoz have instituted direct experiments in reference to this question. In the course of these experiments they found a decided *formation* of fat; and most probably from the starch series of compounds.

M. Boussingault made numerous experiments of a somewhat artificial kind with ducks; from which it appeared, that fat might be formed in the body from other non-nitrogenous constituents of food, and probably from nitrogenous compounds also. He also experimented with pigs, in a manner somewhat similar to that adopted by ourselves; and it is a curious circumstance, that his *store*, or *lean* pig, contained almost identically the same per-centage of fat as our own. The foods he employed were, however, far inferior in fattening quality. Hence, though his experiments extended over a much longer period of time, the per-centage of fat in his *fat* pig was scarcely 5 per cent. higher than in his lean one; whilst almost the whole of this *increased* fat had been supplied by fatty matter in the food. It was indeed mainly upon a calculation of the fat which had been supplied in the food of the *store* pig, that he found the evidence of the formation of fat in his experiments with pigs. M. Boussingault is disposed to believe, that the nitrogenous constituents of food probably have some considerable influence in the *formation* of fat in the animal body. We have ourselves called attention to the fact, that a large supply of the nitrogenous constituents of the food would seem to replace a relative deficiency of other constituents. The amount of increase is found, however, to bear a rapidly decreasing ratio to the amount of nitrogen in the food when this exceeds a somewhat narrow limit; whilst the composition of such increase would appear to contain a less proportion of fat. Whether therefore any effect of an excess of nitrogenous compounds in the production of increase be due merely to the amounts they contain of certain non-nitrogenous elements, or to the influence of the nitrogenous compounds themselves as such, in increasing the activity of some of the vital processes, and thus aiding the production of fat, or whether any increase due to the nitrogenous constituents in the food is more generally not fat at all, may be considered to be an open question.

In the experiments made by M. Persoz, geese were the animals he operated upon, and maize the food employed. He found a decided *formation* of fat; and apparently from the starch series of compounds.

We repeat, then, that we believe that the *formation of fat in the animal body*, even to a considerable and practically important extent, and most probably from the starch series of compounds, may now be considered to be clearly proved. It would appear, therefore, that the theoretical opinions of Baron Liebig on this point are fully borne out.

We have thus far only alluded to the feeding of fattening animals; and we think that the results which have been brought forward clearly indicate, that with them at least, as our current food-stuffs go, both the *amount consumed*, and the *increase produced*, are regulated more by the supplies of the more peculiarly respiratory and fat-forming constituents, than of the flesh-forming or nitrogenous ones. We have, however, calculated many human dietaries; and this branch of the subject we hope to enter upon more fully on some future occasion. We may, however, remark in passing, that from the results of this inquiry, as well as from a consideration of the management of the animal body undergoing somewhat excessive labour, as for instance, the hunting horse, the racer, the cab-horse, and the fox-hound, and also pugilists and runners, we are led to believe, that in the cases, at least of ordinary exercise of force, the exigences of the respiratory system keep pace more nearly with the demand for nitrogenous constituents of food than is usually supposed; and in fact, that the exigences of the animal body are much more correctly stated in the following sentences by Professor Liebig, than in those wherein he has attached so much more of importance to the amounts of the nitrogenous constituents, as the measure of the comparative value of foods.

At page 314 of the 3rd edition of his Chemical Letters, he says:—

"* * * It is evident that the amount of nourishment required by an animal for its support must be in a direct ratio with the quantity of oxygen taken into its system."

And again at page 322:—

"But the waste of matter, or the force exerted, always stands in a certain relation to the consumption of oxygen in respiration; and the quantity of oxygen taken up in a given time determines in all seasons, and in all climates, the amount of food necessary to restore the equilibrium."

A somewhat concentrated supply of nitrogen does, however, in some cases, seem to be required when the system is overtaxed; as for instance, when day by day, more labour is demanded of the animal body than it is competent without deterioration to keep up; and perhaps also, in the human body, when under excitement or excessive mental exercise. It must be remembered, however, that it is in butcher's meat, to which is attributed such high flesh-forming capacity, that we have also, in the fat which it contains, a large proportion of respiratory material of the most concentrated kind. It is found too, that of the dry substance of the *egg*, 40 per cent. is pure fat.

A consideration of the habits of those of the labouring classes who are under- rather than over-fed, will show, that they first have recourse to fat meat, such as pork, rather than to those which are leaner and more nitrogenous; thus perhaps indicating, that the first instinctive call is for an increase of the respiratory constituents of food. It cannot be doubted, however, that the higher classes do consume a larger proportion of the leaner meats; though it is probable, as we have said, that even with these as well as pork, more *fat*, possessing a higher respiratory capacity than any other constituent of food, is taken into the system than is generally imagined. Fat and butter, indeed, may be said to have about twice and a half the respiratory capacity of starch, sugar, &c. It should be remembered, too, that the classes which consume most of the leaner meats, are also those which consume the most butter, sugar, and in many cases, alcoholic drinks also.

It is further worthy of remark, that wherever labour is expended in the manufacture of staple articles of food, it has generally for its object the concentration of the *non*-nitrogenous, or more peculiarly respiratory constituents. Sugar, butter, and alcoholic drinks are notable instances of this. Cheese, which at first sight might appear an exception, is in reality not so; for those cheeses which bring the highest price are always those which contain the most butter; whilst butter itself is always dearer than cheese.

In conclusion, it must by no means be understood that we would in any way depreciate the value of even a somewhat liberal amount of nitrogen in food. We believe, however, that on the current views too high a relative importance is attached to it; and that it would conduce to further progress in this most important field of inquiry if the prevailing opinions on the subject were somewhat modified.

NOTICES AND ABSTRACTS

OF

MISCELLANEOUS COMMUNICATIONS TO THE SECTIONS.

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MATHEMATICS AND PHYSICS.

Mathematics.

The Rev. Dr. Bryce gave an Account of a Treatise on Arithmetic in the Chinese Language, by the Rev. Dr. Moncrieff, late of St. Paul's College, Hong Kong.

The Chinese have for ages had a character (called Ling) corresponding in part to our *zero,* but used by them only to fill a vacant place, not to give local value. Thus they came one step nearer the Arabic notation than the Greeks did. One step however remained, which Dr. Moncrieff has taken. The Jesuit missionaries to China had printed Vlacq's Logarithmic Tables in a simplified character, and it has been said that a copy of their work was presented to the Royal Society about the year 1750. Dr. Moncrieff's letter requesting him to make the present communication, had only reached Dr. Bryce on the first day after the present meeting; and having been pretty constant in his attendance on the Sections, he had not had time to investigate the matter particularly: however, he had examined all the records of the Royal Society within his reach, but could find no notice of the work of those reverend gentlemen. He was therefore unable to say whether they had attempted to introduce the admirable device of local value, which is the distinctive characteristic of the Arabic notation. If they had, Dr. Moncrieff evidently knew nothing of their having done so; which is not wonderful, inasmuch as Dr. Peacock, in his learned and elaborate history of the science (Encyclopædia Metropolitana), makes no mention of their work, from which we may infer that it was unknown even to him. At all events, Dr. Moncrieff found the actual arithmetic of China in the same clumsy condition in which it has been for ages, their notation quite unfit for making calculations on paper as we do, in consequence of which they were obliged to perform all arithmetical operations on the Abacus*.

Finding the circle used for another purpose in the written language of China, Dr. Moncrieff used a triangle for his *ling* or *zero,* and employed it to convert the characters representing simple *units,* into symbols for *tens, hundreds,* &c., exactly as in the Arabic notation. He also introduced our marks of addition, subtraction, multiplication, division, involution, evolution, &c., modifying some of them to distinguish them from characters already in use for other purposes.

The work comprises the common rules,—fractions, common and decimal,—involution and evolution; in short, the general scientific principles of arithmetic. He

* Two different figures of the Chinese Abacus are given in the Phil. Trans. for 1686, and in Du Halde's History of China.

did not attempt a commercial arithmetic, as that would have required a fuller knowledge of their weights, measures, &c. than he found it convenient to acquire; but as these are all decimal, it will be easy for any one to do what remains. His main object was to make arithmetic an instrument of that intellectual culture, which, in common with all missionaries, he deemed of so much importance. With this view he has given the reasons of all the rules, except that for finding the greatest common measure of two numbers. and that of Mr. Horner for extracting any root of a number, which are obviously too difficult for the pupils for whom his book was intended.

Dr. Moncrieff's attempt has already had such a measure of success as to encourage a hope that the stream of European improvement may, with less difficulty than we have hitherto supposed, be made to flow into the stagnant waters of Chinese science and literature.

On Criteria for real and imaginary Roots of Biquadratic Equations. By W. GARTLAND.

This is an extension and simplification of Sturm's method, but does not admit of being given in an abstract.

On Biquaternions. By Sir WILLIAM R. HAMILTON, *LL.D., M.R.I.A.*

The author briefly explained the term which he had been obliged to introduce into this new system; showed the simplicity and the reasons for the leading operations in it; and by a few very simple experiments on the rotation of planes round axes inclined to each other, explained the simple interpretation of some of those results which appeared at first to be inconsistent with the principles of the ordinary analysis.

On the Gradient of Density in saturated Vapours, and its Development as a Physical Relation between Bodies of definite Chemical Constitution. By J. J. WATERSTON.

The object of the present communication was to give a short notice of certain developments of a general law of density in saturated vapours, which the author had lately, in a paper laid before the Royal Society, collected evidence from observation to support. Density is, by him, taken to signify, not specific gravity, but the quotient of the pressure of the vapour by its temperature, reckoned from the zero of gaseous tension; the standard of temperature being that of the air-thermometer. The general law is, that the temperature and sixth root of the density of a saturated vapour form the co-ordinates of a straight line. In other words, at the same temperature, or at the same interval of temperature, any two vapours in contact with their generating liquids, have densities that are either equal, or that have a constant proportion to each other. The author gave diagrams illustrative of the application of this law to several vapours. The point of convergence of the right lines he calls nodes. He gave twenty-four distinct examples of its application to steam, alcohol, æther, and several other vapours, laid down the formulæ by which the computations could be conducted, and pointed out the method of determining the value of the constants.

LIGHT, HEAT, ELECTRICITY, MAGNETISM.

Notice of a Tree struck by Lightning in Clandeboye Park. By Sir DAVID BREWSTER, *K.H., D.C.L., F.R.S., & V.P.R.S. Edinb.*

During one of the thunder-storms which passed over the county of Down in August last, a birch-tree of considerable magnitude was struck by lightning. The tree stood in a thick mass of wood, and was not the tallest of the group. The lightning-bolt struck it laterally about 15 feet above the ground, exactly at the cleft where the two principal branches of the tree rose from the trunk. A large part of the bark and a piece of the solid wood were driven to some distance, and the electric fluid passed down the trunk into the ground, splitting the tree in two by a rent throughout the whole of its thickness. Lord Dufferin was so good as to have the tree cut down for examination. From a section of the upper branches it was obvious that the lightning had not entered at the top and passed through the branches into the trunk. Several workmen, indeed, in the neighbourhood saw the lightning-bolt moving horizontally before it struck the tree, a fact entirely confirmed by the effect which it produced. The force of the bolt must have been great, as it was expended in tearing off the piece of the trunk already mentioned, and in rending the tree in two, without separating the two halves.

The track of the lightning was marked, from its point of entrance to its passage into the earth, by a *darkish brown band,* about 2 or 3 inches broad. A portion of the wood thus marked will be sent by Lord Dufferin to Dr. Andrews, who will ascertain if the colouring matter contains any of those mineral substances which M. Fusinieri, an Italian philosopher, has found to exist in those parts of bodies over which lightning has passed.

The fact contained in this notice, that an object may be struck by lightning in a locality where there are numerous conducting points more elevated than itself, shows that a lightning-bolt cannot be diverted from its course by conductors, and that the protection of a building from this species of meteor can only be effected by conductors stretching out in all directions.

Account of a Case of Vision without Retina. *By* Sir David Brewster, *K.H., D.C.L., F.R.S. & V.P.R.S. Edinb.*

In the course of last summer I met with a gentleman who had a peculiarity of vision of a very remarkable kind, and one of which I believe there is no other example. While hunting he fell from his horse, and received such a severe blow upon his head as to deprive him entirely of the sight of *one* eye, and to a great extent of the sight of the other. Neither of the eyes had suffered the slightest local injury from the blow, and therefore the total blindness in one eye and the partial blindness in the *other* arose from the insensibility of the retina caused by the disorganization of the part of the brain more immediately connected with the origin of the optic nerves.

The degree of vision which remained in one eye was such as to enable its possessor to recognise any friend at the distance of 400 or 500 yards, or more generally speaking, at a considerable distance; but in society he could not recognise his most intimate acquaintances. He could see only the nose, the eye, or the mouth of his friend; and he was not able to obtain, from the duration of the impression of light, and the rapid transference of his eye from one feature to another, such a combination of the separate impressions as to give the likeness which they composed.

In order to explain this singular result, I must recall the attention of the Section to a notice printed in the Reports of a former meeting of the Association, 'On the Visual Impressions on the Foramen Centrale of the Retina*.'

From these facts it is obvious that the limited vision which we have described, was performed entirely on the *choroid coat* and through the *foramen centrale* of the retina.

In order to ascertain the *area* of distinct vision, I requested the patient to tell me the number of letters he could read distinctly, and found that the angle which these letters subtended at the retina was as nearly as could be ascertained about 4½ degrees, the angle subtended by the foramen as deduced from the previous experiments which I have mentioned.

The use of the RETINA is to give *sensitiveness,* and of the CHOROID, *distinctness.*

On the Form of Images produced by Lenses and Mirrors of different sizes. *By* Sir David Brewster, *K.H., D.C.L., F.R.S., & V.P.R.S. Edinb.*

The shape of the images of objects as formed by lenses and mirrors with spherical surfaces, has been treated of by various optical writers†; but I am not aware that

* See Reports of the Association for 1848.

† Smith's "Complete System of Optics," vol. i. chap. xii. p. 238, and vol. ii. Remarks, p. 83.

any author has treated of the shape of images as affected only by the size of the lenses or mirrors by which they are formed. This subject is of fundamental importance in the new art of Photography, when the images delineated by the solar rays are formed by lenses, and sometimes, too, by mirrors of a larger size.

The images of objects formed upon a plane surface differ from the objects themselves, from many causes which it is unnecessary here to enumerate. The most skilful opticians have striven, and to a great extent successfully, to make the most perfect lenses for photographic purposes; but the photographer himself has overlooked the greatest imperfection to which his art is subject, arising solely from the size of the lenses in his camera.

According to the geometrical principles of perspective, the correct representation of any body or object whatever, upon a plane surface, is obtained by drawing lines from the point of sight, through every point of the body or object, to that plane. As the pupil of the human eye is little more than two-tenths of an inch in diameter, we may regard the picture on the retina as a correct representation of external objects, in so far, at least, as its correctness depends upon the size of the lens which forms the picture. In like manner we may consider the image of objects formed by a lens the size of the pupil of the eye as a correct representation of the object.

Now if in perspective we take a new point of sight two-tenths of an inch distant from the first, the perspective representation of the object on a plane will be changed, and the magnitude of the change will increase with the distance between the two points of sight. In like manner, if we look at an object from two different points, which are two-tenths of an inch distant, we shall obtain two views of that object equally dissimilar.

Following out this principle, let us suppose that a lens *four* inches square is employed to produce upon a plane surface the image of any object, and that the size of the pupil of the eye is two-tenths of an inch; then, as there will be several hundred areas equal to that of the pupil in the lens, the image given by the lens will be a compound image consisting of several hundred perspective views of the object taken from several hundred different points of sight, each distant two-tenths of an inch from its neighbour, and all those on the margin of the lens distant three inches and eight-tenths from those opposite to them. Such a jumble of images cannot, under any circumstances, be a true representation of the object. This view of the question, as one of *perspective*, will be more intelligible if we consider the subject *optically*.

Let LL be either the horizontal or the vertical section of a lens, by means of which an image or picture of the object ABCDE is to be taken either on a plane surface, or suspended in the air, and made visible to an eye behind the lens. The solid object ABE consists of a cylindrical portion ABDC, whose termination AB is a circle, and of a conical portion CDE. If we continue the lines EC, ED, and CA, DB, they will meet the lens in the points *c, a, d, b*. If we now cover all the lens except the central portion *ab*, the image of the object ABE will be merely a circle, as shown at *ab*, fig. 1, because not a single ray from the cylindrical surface ABDC, nor from the conical surface CDE, can reach the lens *ab*. In like manner, if we cover all the lens except *cd*, the image of the object ABE will be, as shown in fig. 2, at *cd*, its circular termination, and the cylindrical part of it only being seen, because not a single ray from its conical part CDE can fall upon the lens *cd*. But when the whole area LL of the lens is exposed, the whole object will be seen suspended in the air, as at LL, fig. 2.

Fig. 1.

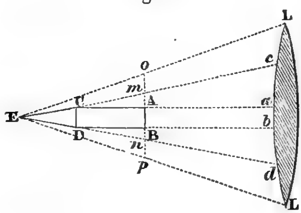
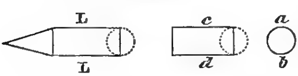


Fig. 2.



If the image is received upon a plane surface behind the lens, the cylindrical part will be represented by a halo or circle of light surrounding the circle *ab*, and corresponding in size to the section *mn*, fig. 1, of the cone of rays C*cd*D; and the conical part CDE will be represented by another halo or circle, round the halo *mn*, and corresponding to the section *op* of the cone of rays ELL.

Results demonstrating the truth of these views have been obtained photographically by my friend Mr. Buckle of Peterborough, whose beautiful Talbotypes obtained a Council Medal at the Great Exhibition. The acting diameter of his lens was $3\frac{1}{8}$ inches, and the effect of the combination of the marginal pictures is most distinctly exhibited.

Let us now apply these results to the photographical pictures of the human bust as taken in a camera. The human face and head consist superficially of various surfaces, some vertical, some horizontal, and many inclined at all angles to the axis of the lens by which they are to be represented on a plane surface. A true perspective representation of the human head placed at AB, will be that which is given by a lens *ab* whose diameter is equal to that of the pupil of the eye, or as formed by lines passing from the centre of the pupil to different points of the head. From such a portrait, all surfaces, such as AC, BD, EC, ED will be excluded; but if we use the whole lens LL, all these surfaces, and all those of an intermediate inclination between AC and EC, BD and DE, will be introduced into the portrait. If, for example, LL is a horizontal section of the lens, the right hand marginal parts of the lens, between *a* and L, may introduce into the portrait the left eye, or the left ear, or the left side of the nose, and all other parts of a certain inclination to the axis; thus enlarging all such parts and widening the picture. If LL be a vertical section of the lens, the lower part of the nose, the interior of the nostrils, the lower part of the upper lip, and the lower part of the chin will be introduced into the portrait by the lower marginal parts *b*L of the lens; while the top of the head, the upper parts of the lip and the eyelids, will be introduced by the upper marginal parts *a*L of the lens. The same is true of all other sections of the lens, and a monstrous portrait of the human bust is thus obtained by the photographer, the monstrosity increasing with the size of the lens. The nature and character of the portrait will thus vary with the superficial form of the lens, which may be circular, oval, square, rectangular, triangular, or of any irregular form; and in this way remarkable modifications of photographic portraits may be produced merely by varying the shape of the lens.

The amount of the deformity introduced into portraits by a lens three or four inches in diameter may be readily estimated by the fact, that when a portrait is taken from two points two and a half inches distant, such as those taken as seen by each eye separately, the difference between the two is so well marked that it can be pointed out by a child. A portrait, therefore, consisting of a combination of portraits as seen from every point of a lens three or four inches in diameter, must give a form and expression to the human countenance very wide of the truth.

The hideousness of photographic portraits is universally admitted, and has been ascribed to the imperfection of the lenses employed, the unsteadiness of the sitter, and the necessary constraint of features and of limb under which he submits to the operation. The true cause, modified doubtless by others, is the size of the lens, even if the lens is optically perfect.

The photographer, therefore, who has a genuine interest in the perfection of his art, will receive these truths with gratitude; and by accelerating the photographic processes, with the aid of more sensitive materials, he will be able to make use of lenses of very small aperture, and thus place his art in a higher position than that which it has yet attained. The photographer, on the contrary, whose sordid interests bribe him to forswear even the truths of science, will continue to deform the youth and beauty that may in ignorance repair to his studio, adding scowls and wrinkles to the noble forms of manhood, and giving to a fresh and vigorous age the aspects of departing or departed life.

But while small apertures possess such a peculiar advantage as that of giving a true perspective representation of the object or scene to be delineated, a *small* lens possesses still greater advantages. In large lenses much light is lost by the absorption of rays in passing through a great thickness of glass, and also by reflexion from the *four* or *eight* surfaces of the achromatic lens or lenses employed. In such lenses, too, neither the chromatic nor the spherical aberrations, which increase with the aperture, are completely corrected, and no attempt even is made to remove the influence of the secondary spectrum. With small apertures, too, objects, or parts of objects, at different distances, will be delineated with nearly the same distinctness, and a picture produced as nearly resembling the original as it can be made in the present state of practical optics.

The same observations, with the exception of those which relate to the achromatism and the thickness of the refracting medium, are applicable to the images produced by mirrors of different sizes.

On the Stereoscopometer. By A. CLAUDET.

This was a simple instrument, by which the relative positions of the two cameras and the placing of the object could be accurately determined in taking the pictures for the binocular stereoscope.

On a Manifold Binocular Camera. By A. CLAUDET.

The author exhibited a Double Camera for taking the two stereoscopic Daguerreotypes of groups or individuals, and by which four double pictures could be successively taken with such rapidity as to be exact representations of the same circumstances. It would be impossible to make all the mechanical arrangements of this instrument intelligible without drawings.

On the Laws of Magnetism and Diamagnetism, in a Letter to Dr. Faraday. *By* Professor MATTEUCCI.

Pisa, August 15, 1852.

MY DEAR FARADAY,—With much regret, and at the last moment, I am compelled to renounce the pleasure of assisting at the Meeting of the British Association and of conversing with you and other friends on scientific subjects. I beg you to present my cordial thanks to Col. Sabine for the invitation he so kindly sent me. I ask your permission to address to you an *extract* of my researches on magnetism and diamagnetism, which have occupied me for several years: if you think that this communication can offer any interest to the members of the Association, you can, if you please, read it to the meeting, as I should be glad in any way to prove my gratitude to that respectable body.

I have studied, in the first place, the influence of temperature and mechanic action on magnetic and diamagnetic substances. Thus, I operated on iron in a state of fusion obtained by the flame of oxyhydrogen gas. In this experiment a small iron globule is placed in a cavity at the extremity of a horizontal bar of copper wire or caustic lime, suspended by a cocoon silk in the magnetic field between the conical poles of a very powerful electro-magnet. Iron in a state of fusion, partially oxidated, *is always attracted by the magnet*; the diminution of magnetic attraction produced by fusion in iron is immensely great: in one experiment, which I think was sufficiently exact, I found that attraction became at least 15 *million* times less, passing from the ordinary temperature to the state of fusion. All the compounds of iron, and all natural substances containing a portion of metallic iron, suffer a diminution by heat; hence it is that the natural or artificial compounds of magnetic and diamagnetic substances, such as certain coals and charcoal, clay, impure metals, gold, copper, zinc, &c., which are attracted at the ordinary temperature, appear to be temporarily repelled when strongly heated. Passing to diamagnetic substances, I have found that their repulsive action suffers a very slight diminution by fusion in phosphorus and sulphur. But this is not the case with bismuth in fusion, upon which I have verified and completed the observation of Plücker.

The following experiment is simple, and sure to succeed at the first attempt. Take a bar of pure caustic lime and suspend it in the magnetic field in the manner described; when the magnetic power is developed, the bar is repelled; and when the bar is strongly heated, the repulsion is certainly not less great. Touching lightly the small cavity in the bar of lime with a piece of paper besmeared with oxide of iron, one can easily arrange so that the bar is attracted; and when the quantity of oxide is sufficient, the bar continues to be attracted even when strongly heated. Fill the cavity with bismuth, 1 gramme, for instance, and the bar will be again repelled when the magnetism is developed. But if, before passing the current, the bismuth is fused, the bar will be attracted, and will attach itself to the extremity of the pole when the magnetism is produced. At the instant that the bismuth becomes solid, the bar detaches itself abruptly from the pole, and the diamagnetic repulsion of the bismuth prevails.

It now remained for me to ascertain whether bismuth in a state of fusion was indifferent to magnetic action, or whether, on the contrary, it became magnetic. For this purpose, I measured by the number of oscillations the diamagnetic force of a cylinder of bismuth contained in a corresponding cavity formed in a bar of lime suspended by a glass hook to a cocoon silk. Operating with the necessary precautions, which are too long to be described here, I have found that the bar of lime, with its cylinder of bismuth in a state of fusion, made the same number of oscillations as when without bismuth. The lime being constantly diamagnetic, this might have masked the change of the bismuth transformed into a magnetic body by fusion. I therefore suspended between the poles of the electro-magnet a bar of lime, formed somewhat like a salt-spoon, in order to increase greatly the quantity of bismuth in fusion compared with that of the lime. In one experiment I employed as much as 57 grammes of fused bismuth, and nevertheless the repulsion continued. Thus, then, the diamagnetic power of bismuth diminishes suddenly at the point of fusion, and during the state of fusion the bismuth remains indifferent, without being apparently changed into a magnetic body.

I have studied the influence of mechanic action on diamagnetism. By means of a copper box provided with a screw, I was able to compress a pure bismuth cylinder, 3 millims. in diameter and 34 millims. in length, so as to reduce it to 28 millims. I then made two cylinders of bismuth precisely of the same dimensions, the one compressed, the other in its natural state, and I found that the compressed cylinder had a diamagnetic power *distinctly superior* to that of natural bismuth. I think it advisable here to call your attention to the fact which Coulomb, and more recently Plücker, have discovered respecting feebly magnetic substances; namely, that all cylinders of bismuth have the same oscillation independently of their weight, or in other words, that the diamagnetic power is proportionate to the weight of the cylinders. Cylinders of bismuth, varying in weight from 0·576 gr. to 18·600 gr., give the same oscillation. I studied afterwards, at some length, the influence of a powerful electro-magnet upon chemical affinity and cohesion. You have proved that gases, and even the most magnetic of the gases, do not suffer any variation in density by magnetic action. I have repeated the same experiments on gases, employing a glass tube closed or open, such as that of a spirit-level, filled with gas and different liquids. The gaseous bubble placed between the two polar extremities suffers considerable contraction and elongation, according to the nature of the liquid and gas. I think I have proved that these appearances are owing to a simple change of form in the bubble without variation of density produced by the differential action of the magnet on the gas and on the liquid. I made a great number of experiments in order to measure the electrolyzation of acidulated water in a very powerful magnetic field, or independently of this influence. Several precautions, not generally followed, are absolutely necessary to obtain a uniform result in the use of the voltameter. These experiments led me to conclude that the most powerful magnetic action has no influence whatever on the electrolyzation of water. There is however a phænomenon which I do not think has been observed hitherto, and on which I must say a word. In electrolyzing water in a powerful electro-magnetic field, and if the experiment is properly arranged, the streams of gas bubbles which rise from the two electrodes are violently carried away in certain directions when the magnetism is put in activity. I think this movement is communicated by the liquid currents discovered by Davy. By employing a saturated solution of sulphate of copper for electrolyte, and by blowing into that liquid through a glass capillary tube a stream of atmospheric bubbles instead of those formed by electrolyzation in water, I could easily convince myself that the phænomenon is independent of any peculiar state of the gas supposed to be derived from electrolyzation. By a proper application of Nobili's beautiful experiment of colours obtained by electrolyzation, I was enabled to demonstrate, that an axis of great magnetic power has no sensible influence in disturbing the distribution or propagation of the electrical currents, nor the physical or chemical composition of the body traversed by them. Make a rectangular box, the longer sides of which are formed of perfectly clean plates of platina. Fill this box with a solution of chloride of iron, or acetate of lead, or other metallic salts, and place it between the poles of a very powerful electro-magnet. The coloration of these plates, produced by the shortest passage of a very feeble current, is found to *be exactly the same at all points*, that is, on the line of the magnetic poles, as at the distance of 150 or 200 millimetres from that line. The magnetic power therefore does not change either the composition of the liquid subject to its action, nor the distribution of the electricity which traverses it. I remember having found formerly that the laws of the derived currents on a plate of tin and of the isodynamic lines, were not disturbed by the influence of a very strong electro-magnet. I have also studied the influence of the magnetic power of the elements on that of the body resulting from their combination. Although there are some examples of magnetic compounds, the elements of which are diamagnetic, such as protochloride of copper, one finds in general that the magnetical character of the compound results from that of its elements. Pure copper, which, independently of inductive currents, is decidedly diamagnetic, produces protoxide, which is indifferent or scarcely diamagnetic, and a peroxide which is decidedly magnetic. The same may be said of silver; the protoxide is diamagnetic, and the binoxide, obtained by the pile, is decidedly magnetic. Operating on the various oxides of bismuth and antimony, I measured the variations in the magnetic power induced by different quantities of oxygen contained in these oxides.

I have made a great number of conclusive and elegant experiments on the laws of equilibrium of diamagnetic bodies in the magnetic field, and on the reciprocal action of diamagnetic bodies. I have employed in these experiments a solution of chloride of iron in concentrated alcohol, so as to have the same density as olive oil, which is a diamagnetic body. I could thus fill the magnetic field with this ferruginous solution, in which floats a drop of oil, more or less large, or I could reverse the arrangement. At the moment in which the electro-magnet is set in action, the two liquids are set in movement and place themselves in equilibrium, occupying distinct places in the magnetic field. By adopting the proper arrangements, one can easily determine the form of the curved surfaces of separation of the two liquids. This method is delicate, and fitted for discovering the slightest difference in the force of the two poles, or in their relative distance from the centre of the magnetic field. If the magnetic field is uniform, as one obtains it with plane polar surfaces of great extent, a small piece of bismuth suspended to a cocoon silk, in the manner employed also by yourself, is in equilibrium in the centre of the magnetic field and in the greater part of the equatorial line. When the magnetic field is formed by the ferruginous solution, a piece of bismuth or drop of oil floating within the liquid does not remain in equilibrium in the centre of the field, but flies off to the side following the equatorial line. The drop changes in form, and is prolonged in axial or equatorial direction according to its being magnetic or diamagnetic. The constant motion of the diamagnetic drop from the centre towards the side along the equatorial line and this, even when floating not at the surface but in the middle of the liquid mass, is not in evident accord with the beautiful experiments of Reich and Tyndall. I have remarked on the fact, that the motion takes place when the drop is even in the midst of the liquid, in order to prove that this motion is independent of the remarkable elevation undergone by the ferruginous liquid along the line of the poles. With this method I could easily examine the mutual action of diamagnetic bodies. For this purpose the base of the square box placed in the magnetic field was formed one half of marble or wood, the other of bismuth. This base was covered with a thin stratum of ferruginous liquid, and of oil three millimetres in thickness. The line of junction of the marble and bismuth was alternately axial and equatorial. I was never able to discern the slightest dissymmetry in the form of the surfaces of separation of the two liquids, which might be attributed to the influence of the two very different substances, marble and bismuth, as regards their magnetic power. In the same way, I have never been able to discover any mutual action at the moment when the electro-magnet was in activity, between two drops of oil suspended in the midst of the ferruginous liquid, or between a piece of bismuth and one of these drops. I have therefore reason to doubt whether such movements, which have been considered as proving the mutual action of diamagnetic bodies, are not rather owing to the movement of the entire liquid mass of which we have spoken. Although it is extremely probable that the mutual action of diamagnetic bodies does exist, and, according to the laws admitted also by yourself, still it must be allowed that this action is very feeble, and it is much to be desired that an experiment should be made by which it might be clearly demonstrated.

I pass over in this extract, which is already too long, my experiments upon the different inductive power of various metals, on the time of induction in the different metals, &c.; but I must finally call your attention to the part of these researches which I believe to be the most important, and which relates to an experimental theory of diamagnetic phænomena.

A mass composed of very fine powder of perfectly pure silver or copper, the conductibility of which is destroyed by the interposition of a thin film of oil of turpentine, duly suspended in proximity of the polar surface, is repelled at the instant of the passage of the current, and continues to oscillate like a mass of bismuth. If one composes other similar suspended matter in which the quantity of metal and conductibility gradually increases, one sees the silver or copper pendulums first repelled from the pole, then come to a stop after a constantly decreasing number of oscillations, until at last they present the phænomenon which you have called *revulsion*, due to the production of induced currents. In the same way a small copper or silver disc, fixed to the extremity of a straw lever suspended by a cocoon silk near to a pole, is repelled or attracted at the beginning or end of the current without being subject to any movement of oscillation: if this disc is cut so as to destroy its continuity as much as possible, to prevent the development of the inductive current, it then exhibits the phænomenon of oscillation like bismuth. These phænomena, and several others which you have described, and which it is unnecessary to adduce here, have led you and Weber, with much reason, to admit the hypothesis of a diamagnetic polarity in reverse direction of that acquired by magnetic bodies. I hasten to add, that my experiments do not lead me to reject this hypothesis, as you, and more recently M. Verdet, have done; and that, on the contrary, it seems to me in conformity with physical analogy to admit that diamagnetic substances, when subjected to magnetic force, assume a polarity the same in kind as, but reverse in direction of, that acquired by iron, which polarity has a duration varying according to the nature and conductibility of the substance, and which, according to these circumstances, tends to transform itself into an inductive instantaneous current. I abstain from entering here into a minute development of these theoretical views, which every one can do for himself, and proceed at once to speak experimentally. It is perfectly true that you, and more recently M. Verdet, have demonstrated that the phænomenon discovered by Weber in bismuth can be explained by simply referring to the inductive currents, and without having recourse to diamagnetic polarity; but the same experiments have not proved the non-existence of diamagnetic polarity. In the first place, I recollect that oxide of copper is strongly magnetic; consequently a mass of copper filings with oxidated superficies cannot, when it acts on the electro-magnet, develope inductive phænomena similar to those of bismuth or pure copper. In fact, I found with my inductive apparatus, which is certainly the most powerful and delicate hitherto constructed, that a mass of copper filings oxidated at the superficies, such as used in organic analysis, gives inductive currents as if it were a magnetic body. In order to prove by our experimental method that diamagnetic polarity does not exist, one must prove that no induced currents are obtained in the direction demanded by that supposed polarity, when one makes an electro-magnet act on a diamagnetic body, incapable of conducting induced currents, and in quantity sufficient to induce sensible effects on our apparatus. To show the superiority of my apparatus, I have only to mention, that a stratum of 500 grammes of colcothar brought near, but not in contact with the electro-magnet, and consequently without any apparatus of rotation, produced an induced current of 10° to 15° and more, according to the strength of the battery. With this same apparatus and a rotating machine, I obtained very distinct phænomena of induction by the action of a bundle of *varnished bismuth or copper wires.* I have already observed that the experiment can be decisive only when one acts on the electro-magnet with a sufficient quantity of the diamagnetic substance. In fact, it seems reasonable to admit that the effects of induction, magnetic or diamagnetic, ought to be in proportion with the corresponding effects of attraction or repulsion. Now I am not very far from the truth in admitting that 1 *gramme* of bismuth is repelled by an electro-magnet with the same force as 11 *milligrammes* of colcothar is attracted by the same magnet; that 1 gramme of sugar or stearic acid makes equilibrium to 5 or 6 *milligrammes* of colcothar, and 1 gramme of sulphur to 2 or 3 *milligrammes* of colcothar. I have already said that the inductive action of 500 *grammes* of colcothar gives me 10° to 15° of induced current: therefore, to obtain a similar effect by bismuth (if diamagnetic polarity exists), one must employ a quantity of that metal, which is at least *a hundred times* 500 *grammes,* or 50 *kilogrammes.* By similar reasoning one sees what an enormous quantity of phosphorus, sugar and sulphur would have to be employed in order to obtain a sensible inductive effect, and how far we have hitherto been from employing the necessary quantity. It is only by the method of rotation of inductive bodies in presence of the electro-magnet, that one can obtain sensible effects from small quantities of diamagnetic substances. Using the method of rotation, as Verdet has done, with an electro-magnet and inductive coil more powerful than any which have been hitherto employed, I have succeeded in obtaining distinct signs of induction from *a mass composed of fragments of varnished bismuth.* I continue to vary and extend my experiments in this way; therefore, for the present, though I should be grateful to you if you would communicate this note to the British Association, I wish to be able to arrange these researches myself before publishing them.

On placing Compasses on Board Iron Ships. By Captain E. J. Johnson, *R.N., F.R.S., Superintendent of the Compass Admiralty Department of the Royal Navy. (In a Letter to the President.)*

It was my intention to have been present at the Meeting of the British Association at Belfast, but I have been prevented by my official duties on board some of H.M. steam-ships which could not be delayed. One of these was the iron steam-vessel "Trident," and I think it worth while to notice to you a circumstance which occurred relating to the compass observations.

As a member of the Compass Committee, you are aware that the system adopted in H.M. service on board iron ships, is to elevate the compass considerably—to ascertain the deviations and allow for them, and to persevere in a continual series of observations to ascertain the change of deviation according to the change of the ship's geographical position, as described in the "Practical Rules" which have been issued to all H.M. ships since 1842;—the said plan being considered safer than the application of iron or magnets for the reduction of the amount of deviation.

In placing the compasses of H.M. ships, I have, of course, adhered to the recommendations of the Committee, taking care by a few preliminary observations to fix upon a position where the deviations were lessened; but the circumstance to which I wish to draw your attention at present is this:—While the "Trident" was in the basin at Woolwich, it occurred to me to try whether a position could be discovered where the influences of the ship's iron upon the compass were so equalized as to render the amount of deviation so small as to be of no practical importance.

The correct magnetic direction of the ship's head having been determined by a compass on the shore, and that proving to be near to one of the points of maximum deviation (the standard compass on the quarter-deck there indicating 20° *westerly* deviation), I moved the standard compass several feet further *forward* in the centre line of the ship, and there found the *westerly* deviation increased to 29°. I now commenced to move the compass aft 6 or 7 feet at a time, observing the deviation at each position, and found the *westerly* deviation *decreased*; and on placing the tripod of the compass directly over the rudder-head, *easterly* deviation was produced; and hence it followed that there must be a position somewhere between the two last places of observation where there would be no deviation while the ship's head remained in the same direction.

This position I practically discovered by moving the compass a few inches at a time, till it indicated the correct magnetic direction of the ship's head.

The question which now remained to be proved, was, to what extent the deviations of the said compass had been lessened (or what they actually were) when the ship's head was placed upon different points, and I was gratified to find that after swinging the vessel and observing upon the eight principal points, the compass, placed as before described, proved to be correct within $\frac{1}{4}$ of a point.

It is necessary to mention that the "Trident" has wooden beams under the quarter-deck, and therefore it remains to be seen to what extent such observations may be useful in vessels which have iron beams.

It will also be requisite to ascertain by actual observation how far a position so selected shall prove advantageous when the ship changes her geographical position; and as the "Trident" is about to proceed to the southern hemisphere, and is amply provided with instructions and the means of ascertaining such changes, and as I shall swing her again at Greenhithe on every point before she leaves, we may hope for much useful information on this important subject.

In sending you these remarks, I must observe, that it may not always be practicable to find the position of no-deviation, or where the influences of the iron in the ship upon the magnetic needle are equalized, because such a point might be found in a most inconvenient position, or be too near moveable iron work, machinery, &c.; but if we succeed in approximating towards it, and thereby reduce the deviations within moderate limits, a point of great practical importance will be gained in navigation.

On a peculiarity of Vision. By Professor Powell, *F.R.S.*

The peculiarity to which I refer affects both my own eyes, but more especially the left eye. They have always been long-sighted, but I never used glasses till about seven years ago. About that time I had, I fear, injured my eye-sight generally by optical experiments, and have in consequence thought it prudent to desist from them in a great degree. I then perceived a general indistinctness of vision, which is however completely removed by the use of convex glasses of long focus; but I have not till lately been aware of the precise nature of this indistinctness. I have now found that it is produced by the image of every small object, as for instance, a fine dark line on a white ground appearing TRIPLE. I do not find any difference from varying the distance of the object from the eye, nor in placing the line in different azimuths round the axis of the eye; the appearance is presented whether I use one eye or both, but is somewhat less marked with the right eye. Conjectures may easily be started as to the change of form in the lens which might produce such an appearance, but I will not at present do more than simply mention the fact, as it may perhaps elicit other statements of a similar kind which may tend to throw light on the question as to its nature.

On Luminous Beams. Communicated by Professor Powell, *F.R.S.*

Appearances of luminous beams in the sky, of a peculiar kind, agreeing neither with the characteristics of aurora, nor of the zodiacal light, have been occasionally recorded. A remarkable instance of this kind was observed by Mr. G. A. Rowell, at Oxford, July 11, 1850:—"When the sun was just setting, or set, but hidden by clouds, he saw a bright beam with *parallel sides* extending vertically upwards from the place of the sun to an altitude estimated at 15° or 20°." Again, on July 6, 1852, Mr. Rowell saw a similar phænomenon which he describes thus:—"About 10 o'clock P.M., I observed two extraordinary rays of light in the N.N.W., each extending from the horizon to upwards of half-way towards the pole star, and apparently proceeding from the sun's place below the horizon, in a direct line towards that star. I watched this phænomenon till 10^h 30^m, and I believe it could not have been caused by an aurora borealis, the direction and appearance of the rays being very different from any aurora I have ever seen; there was no change to be observed in them, and they kept their place with regard to the stars. At 11 o'clock they had disappeared."

On Converging Sun-beams. Communicated by Professor POWELL, *F.R.S.*

A peculiarly brilliant instance of the phænomenon of the solar rays converging by the effect of perspective to a point opposite the sun immediately after sunset, was observed by several persons in and near Oxford, on July 6, 1852, about 8·35 P.M., and lasted about twenty minutes. Mr. G. A. Rowell collected the accounts of different observers, illustrated by sketches, given unknown to each other, and apparently without their being aware of the real nature of the phænomenon. He states that—"All agree as to the general appearance being that of five or seven principal rays of bright light arising from (converging to) a point in the S.E. horizon, just opposite to where the sun had set. Each ray extended about 65° or 70°, and was widest at the upper end; the middle ray being perpendicular. There is a difference in the statements as to whether there were smaller rays between the principal ones....... The observer on Shotover Hill had a clear view of the N.W. horizon, and remarked that there was not at the time the slightest appearance of rays where the sun had gone down."

On the Re-concentration of the Mechanical Energy of the Universe. By W. J. MACQUORN RANKINE, *C.E., F.R.S.E.*

Mr. Rankine observed that it has long been conjectured, and is now being established by experiment, that all forms of physical energy, whether visible motion, heat, light, magnetism, electricity, chemical action, or other forms not yet understood, are mutually convertible; that the total amount of physical energy in the universe is unchangeable, and varies merely its condition and locality, by conversion from one form to another, or by transference from one portion of matter to another.

Professor William Thomson has pointed out, that in the present condition of the known world there is a preponderating tendency to the conversion of all the other forms of energy into heat, and to the equable diffusion of all heat; a tendency which seems to lead towards the cessation of all phænomena.

The author of the present paper points out, that all heat tends ultimately to assume the radiant form; and that if the medium which surrounds the stars and transmits radiation between them be supposed to have bounds encircling the visible world, beyond which is empty space, then at these bounds the radiant heat will be totally reflected, and will ultimately be re-concentrated into foci; at one of which, if an extinct star arrives, it will be resolved into its elements, and a store of energy reproduced.

On an Improved Form of Reflecting Instrument for Use at Sea. By Professor C. PIAZZI SMYTH, *F.R.A.S.*

The peculiar circumstances of an observer at sea, caused chiefly by the rolling of the vessel, preclude the use of any of the ordinary instruments employed on land for measuring altitudes, depending as they do on levels or plumb lines for their zero points; recourse must be had to the principle of double images by two reflectors, the method invented by Hadley and Newton. This one necessary principle has been carried out in a variety of different forms, in the sextant, quadrant, quintant or reflecting circle, some more or less accurate or more or less convenient than others; but all of them, under whatever names they are known, are merely different forms of essentially the same instrument.

Great ingenuity has been shown in many of these forms, but still the greatest degree of efficiency has not yet been arrived at, or the highest degree of convenience attained for all the various occasions required in practice.

The naval officers, who know what these difficult circumstances are, unfortunately are not in a position to remedy the defects of their instruments; while the makers thereof, living at home at ease, cannot fully appreciate all the difficulties actually met with in real practice at sea. This has left room for a person like the author, who has had some practice at sea and some experience in instrument-making, to effect several minor improvements of a practical character.

The ordinary form of the reflecting instrument at present in use is the sextant, in which will generally be found, even as made by the best makers, more or less of the following little practical drawbacks upon the speedy and accurate employment of it.

It is packed in its box in a way difficult to be got out, the handle, by which it ought only to be touched, being below: also it cannot be laid down anywhere without a changing of the hands and the incurring of risk in handling parts which should be sacred from the touch.

Next there are several loose parts, as the telescope, plain tube, dark glasses, &c., which have to be screwed on before an observation can be taken, and time is lost thereby; even then too it may be often found with faint stars at night, that the object-glass of the telescope is prejudicially small, and the reflectors insufficiently bright, as well as erroneous at extreme angles, on account of the impossibility of procuring perfect glass, besides giving the nuisance of images from each surface, &c.

Then, supposing the observation taken, there is such a needless difficulty in reading off the divisions, a difficulty not felt by beginners alone, but equally by practised naval officers, who give that as a reason why the very important class of observations of stars by night is so little practised at sea.

Finally, the observation when read off at last is taken merely upon a sextant or part of a circle, and is therefore liable to errors of excentricity and motion of the centre, and this to an unknown extent, and not constantly, as they may be influenced by accidental causes unknown to the observer. It is essential to the accuracy and the honesty as it were of observations, that they should be taken with some form of circle with opposite readings; many such have been brought forward in England and France, but owing apparently to their greater complexity, size and weight, they have not obtained a footing amongst practical men.

The author then exhibited a reflecting instrument which he had had constructed by Messrs. Adie of Edinburgh, and which appeared to supply all the desiderata, for it was in the shape of a circle, small, light, and simple, with the delicate parts protected from injury under all circumstances: the usual *loose* telescope and plain tubes were avoided by making them cross through each other and work on a pivot, thus admitting of instant alteration from one to the other; the illuminating apparatus was improved and rendered powerfully effective even with a faint light; and a small apparatus was added, which, without sensibly cumbering the instrument, gave, either by night or by day, a convenient horizontal referring point, visible in the field of view.

Some Remarks on the Red Prominences seen during the Total Solar Eclipse. *By* Professor C. Piazzi Smyth, *F.R.A.S.*

When the Members of the Association separated last year at Ipswich, it was under circumstances of peculiar astronomical import, viz. the impending occurrence of the total solar eclipse in a neighbouring region: many astronomers started to observe the phænomenon to the utmost, and more especially everything having relation to, or tending to throw any light on the physical characteristics of the sun; amongst which the "red prominences" were considered the most promising and important.

The author was amongst the number of observers who started with these objects in view, but was totally defeated by the occurrence of clouds. Having been prevented then himself from seeing the red prominences, he thought it proper to defer to the opinions of those observers who had been more fortunate, and who seem in all cases to have come to the conclusion that these apparent bodies were really attached to, and connected with, the sun, and were no less than masses of light-giving matter, 30,000 or 40,000 miles in length, and playing of course a most important part in the mystery of the nature and the source of solar light, and the whole œconomy of that mighty orb.

But if we are never to see these bodies but during the rare occasion of a solar eclipse, and then only for the too short space of three minutes, ages upon ages may pass away before we ascertain anything very precise upon the subject. In this case it becomes of the greatest importance to contrive some method of making the red prominences visible on ordinary occasions; and a method having been proposed by Mr. J. Nasmyth of Manchester, which at least promised well, the author lost no time in putting it into execution.

The method consisted in receiving the image of the sun and field of view, formed by a telescope in a dark room, on a white board, in which was a hole just large enough to let the sun pass through, and be absorbed on the inside of a black bag beyond; the image of the field, and therefore of the sky in the immediate neighbourhood of the sun, could then be examined with the greatest nicety, and free from the prejudicial effect of the glaring solar image; while any faint ray of light extending from that luminary into the space beyond could be much more easily appreciated than before. But although the experiment was carefully tried on all the best days of last summer as well as the present, not the slightest appearance of red prominences could be detected. The author however would not presume to say that they did not therefore exist; for although the experiment in itself was extremely successful, inasmuch as during the very time that the sun was being received into the black bag the room itself was much darker than the atmosphere at the solar eclipse, yet the lightness of the sky, by reason of the reflective power of the air *outside* the room, was so extreme, that nothing so faint as the red prominences are reputed to be, could well be seen on so bright a background. This is a difficulty which can only be got over by ascending to a great height in the atmosphere, and it would be well worth while to repeat the experiment on the top of a high mountain.

Having given this experiment, founded on the opinions of observers, full trial, the author then thought himself justified in taking up an opposite idea, and supposing that the red prominences might be some spurious effects of diffraction of the sun's light at the edge of lunar mountains. He therefore produced an artificial eclipse by introducing a small opake ball into the telescope, near the focus of the object-glass, when directed on the sun. The results were, that pink light, similar to that of the prominences, was thrown off from the edge of the eclipsing ball, in greater quantity as the polish of the surface was increased, and was broken up into more distinct portions the more irregular the surface. Prominences most similar, nay, precisely like those of the eclipse, in shape and colour, were produced by an opal glass ball, scratched and cut on the edge with a diamond.

There was however still the important failing, that the artificial prominences were connected with the eclipsing ball as a centre, and not with the sun, as in the case of the real prominences. In the latter instance, however, the sun's rays fall on the moon in a *parallel* direction, while in the former they *converge* on the eclipsing ball. To arrive therefore more nearly at this particular, the author placed a large tin disc, with spherically curved tangential rim, on the top of the Nelson monument, and examined the appearance from below, when the sun was eclipsed behind the disc, with a small hand telescope. The result was that orange and red light were thrown off the edge; and in greater abundance, according to the greater proximity of the sun behind to any particular side of the disc, and also according to the greater purity of the atmosphere. This certainly seems to point out the great probability of a spurious origin for the red prominences at this surface of the lunar mountains; but this experiment should also be tried on a high mountain, in an atmosphere a little more nearly approaching that of the moon in rarity and purity.

On the Optical Properties of a recently discovered Salt of Quinine. By Professor Stokes, *M.A, F.R.S.*

This salt is described by Dr. Herapath in the Philosophical Magazine for March 1852, and is easily formed in the way there recommended, namely, by dissolving disulphate of quinine in warm acetic acid, adding a few drops of a solution of iodine in alcohol, and allowing the liquid to cool, when the salt crystallizes in thin scales reflecting (while immersed in the fluid) a green light with a metallic lustre. When taken out of the fluid the crystals are yellowish-green by reflected light, with a metallic aspect. The following observations were made with small crystals formed in this manner; and an oral account of them was given at a meeting of the Cambridge Philosophical Society, shortly after the appearance of Dr. Herapath's paper.

The crystals possess in an eminent degree the property of polarizing light, so that Dr. Herapath proposed to employ them instead of tourmalines, for which they would form an admirable substitute, could they be obtained in sufficient size. They appear to belong to the prismatic system; at any rate they are symmetrical (so far as relates to their optical properties and to the directions of their lateral faces) with respect to two rectangular planes perpendicular to the scales. These planes will here be called respectively the *principal plane of the length* and the *principal plane of the breadth*, the crystals being usually longest in the direction of the former plane.

When the crystals are viewed by light directly transmitted, which is either polarized before incidence or analysed after transmission, so as to retain only light polarized in one of the principal planes, it is found that with respect to light polarized in the principal plane of the length the crystals are transparent, and nearly colourless, at least when they are as thin as those which are usually formed by the method above mentioned. But with respect to light polarized in the principal plane of the breadth, the thicker crystals are perfectly black, the thinner ones only transmitting light, which is of a deep red colour.

When the crystals are examined by light reflected at the smallest angle with which the observation is practicable, and the reflected light is analysed, so as to retain, first, light polarized in the principal plane of the length, and secondly, light polarized in the other principal plane, it is found that in the first case the crystals have a vitreous lustre, and the reflected light is colourless; while in the second case the light is yellowish-green, and the crystals have a metallic lustre. When the plane of incidence is the principal plane of the length, and the angle of incidence is increased from 0° to 90°, the part of the reflected pencil which is polarized in the plane of incidence undergoes no remarkable change, except perhaps that the lustre becomes somewhat metallic. When the part which is polarized in a plane perpendicular to the former is examined, it is found that the crystals have no angle of polarization, the reflected light never vanishing, but only changing its colour, passing from yellowish-green, which it was at first, to a deep steel-blue, which colour it assumes at a considerable angle of incidence. When the light reflected in the principal plane of the breadth is examined in a similar manner, the pencil which is polarized in the plane of incidence undergoes no remarkable change, continuing to have the appearance of being reflected from a metal, while the other or colourless pencil vanishes at a certain angle, and afterwards reappears, so that in this plane the crystals have a polarizing angle.

If, then, for distinction's sake, we call the two pencils which the crystals, as belonging to a doubly refracting medium, transmit independently of each other, *ordinary* and *extraordinary*, the former being that which is transmitted with little loss, we may say, speaking approximately, that the medium is transparent with respect to the ordinary ray and opake with respect to the extraordinary, while, as regards reflexion, the crystals have the properties of a transparent medium or of a metal, according as the refracted ray is the ordinary or the extraordinary. If common light merely be used, both refracted pencils are produced, and the corresponding reflected pencils are viewed together; but by analysing the reflected light by means of a Nicol's prism, the reflected pencils may be viewed separately, at least when the observations are confined to the principal planes. The crystals are no doubt biaxal, and the pencils here called ordinary and extraordinary are those which in the language of theory correspond to different sheets of the wave surface. The reflecting properties of the crystals may be embraced in one view by regarding the medium as not only doubly refracting and doubly absorbing, but *doubly metallic*. The *metallicity*, so to speak, of the medium of course alters continuously with the point of the wave surface to which the pencil considered belongs, and doubtless is not mathematically null even for the ordinary ray.

If the reflexion be really of a metallic nature, it ought to produce a relative change in the phases of vibration of light polarized in and perpendicularly to the plane of incidence. This conclusion the author has verified by means of the effect produced on the rings of calcareous spar. Since the crystals were too small for individual examination in this experiment, the observation was made with a mass of scales deposited on a flat black surface, and arranged at random as regards the azimuth of their principal planes. The direction of the change is the same as in the case of a metal, and accordingly the reverse of that which is observed in total internal reflexion.

In the case of the extraordinary pencil the crystals are least opake with respect to red light, and accordingly they are less metallic with respect to red light than to light of higher refrangibility. This is shown by the green colour of the reflected light when the crystals are immersed in fluid, so that the reflexion which they exhibit as a transparent medium is in a good measure destroyed.

The author has examined the crystals for a change of refrangibility, and found that they do not exhibit it. Safflower-red, which possesses metallic optical properties, does change the refrangibility of a portion of the incident light; but the yellowish-green light which this substance reflects is really due to its metallicity and not to the change of refrangibility, for the light emitted from the latter cause is red, besides which it is totally different in other respects from regularly reflected light.

In conclusion, the author observed that the general fact of the reflexion of coloured polarized pencils had been discovered by Sir David Brewster in the case of chrysammate of potash*, and in a subsequent communication he had noticed, in the case of other crystals, the difference of effect depending upon the azimuth of the plane of incidence†. Accordingly, the object of the present communication was merely to point out the intimate connexion which exists (at least in the case of the salt of quinine) between the coloured reflexion, the double absorption, and the metallic properties of the medium.

Note added during printing.—When the above communication was made to the Association, the author was not aware of M. Haidinger's papers on the subject of the coloured reflexion exhibited by certain crystals. The general phænomenon of the reflexion of oppositely polarized coloured pencils had in fact been discovered independently by M. Haidinger and by Sir David Brewster, in the instances, respectively, of the cyanide of platinum and magnesium, and of the chrysammate of potash. A brief notice of the optical properties of the former crystal will be found in Poggendorff's 'Annalen,' Bd. lxviii. (1846), S. 302, and further communications from M. Haidinger on the subject are contained in several of the subsequent volumes of that periodical. The relation of the coloured reflexion to the azimuth of the plane of incidence was noticed by M. Haidinger from the first.

On the Thermal Effects of Air rushing through small Apertures. *By* J. P. JOULE, *F.R.S. and* Professor W. THOMSON, *M.A., F.R.S.E.*‡

On the Sources of Heat generated by the Galvanic Battery. *By* Professor W. THOMSON, *M.A., F.R.S.E.*

It has been stated as an objection to the chemical theory of the galvanic battery, that the chemical action being the same in all elements consisting of zinc and any less oxidizable metal, their electromotive force ought according to that theory to be the same; which is contrary to experience, the electromotive force of a zinc and tin element in dilute sulphuric acid, for instance, being found by Poggendorff to be only

* Report of the Meeting of the British Association at Southampton, 1846, part ii. p. 7.
† Ibid. Edinburgh, 1847, p. 5.
‡ This paper has been published in the Philosophical Magazine for December 1852.

about half that of a zinc and platinum element in the same liquid. Mr. Joule in 1841 gave (in his paper on the heat of electrolysis) the key to the explanation of all such difficulties, by pointing out that the heat must be generated in *different* quantities by the electrical evolution of *equal* quantities of hydrogen at equal surfaces of *different* metals. The author of the present communication, reasoning on elementary mechanical and physical principles, from Faraday's experiments, which show that a zinc diaphragm in a trough of dilute sulphuric acid exercises no sensible resistance to the continued passage of a feeble electric current, demonstrated *that a feeble continued current, passing out of an electrolytic cell by a zinc electrode, must generate exactly as much more heat at the zinc surface than the same amount of current would develope in passing out of an electrolytic cell by a platinum electrode, as a zinc-platinum pair working against great external resistance would develope in the resistance wire by the same amount of current.* A series of experiments, commenced for illustrating this conclusion, were described and a few of the conclusions stated. It was found that in two equal and similar electrolytic cells in the same circuit, which differed from one another in one of them having its exit electrodes of zinc, and the other of platinum, very sensibly more heat was developed in the former than in the latter, verifying so far the conclusion stated. By separating the two electrodes by means of porous diaphragms, it was found that, at least with low strengths of current, more heat was developed at the negative than at the positive electrode, when both electrodes were of zinc; while when both were of platinum, much more heat was found at the positive electrode than was found at the negative, for all strengths of current, which gave sufficient thermal effects to be tested in this respect. The last-mentioned result, which had not been anticipated by the author, appears to be in accordance with experimental conclusions announced by De la Rive.

Many other results of a remarkable nature were obtained in a series of experiments on the heat evolved in different parts of various electrolytic and chemical electromotive arrangements, but much difficulty had been found in interpreting them correctly on account of initial irregularities depending on "polarization," which often appeared to last as long as the experiments could be continued without introducing other sources of disturbance, and which produced marked effects on the observed thermal phænomena.

This communication was brought forward principally for the purpose of calling attention to what may be done if experimenters can be induced to undertake researches on the evolution of heat in all parts of a galvanic battery or of any electro-thermal apparatus, but partly also on account of the novelty of some of the results which have been already obtained by the author.

On the Mutual Attraction between two electrified Spherical Conductors. By Professor W. Thomson, *M.A., F.R.S.L. & E.*

In a previous communication by the same author at the last Oxford Meeting of the Association, the attraction of a single electrified sphere, influenced by the presence of another, on any external electric point, was shown to be the same as that due to a converging infinite series of electric points in determinate positions within it, to which the name of "electrical images" was given. Hence it is concluded that the attraction of one sphere upon the other is equal to that of one infinite series of electrical images upon another, and is immediately expressible algebraically by a "double series." Another method by which a single series is obtained to express the required attraction, had been alluded to at the previous Cambridge Meeting, and worked out to numerical results, which were published in November 1845, in the first Number of the Cambridge and Dublin Mathematical Journal. It was not until 1849 that the author found a way of reducing the double series to a single one, and so succeeded in arriving at the same form of result by the two methods. Detailed accounts of both methods, with all the formulæ for completely working out the solution, including the case of contact for which the series is not convergent, were communicated by letter to M. Liouville in the month of July of that year, and, not having as yet been published, are now laid before the British Association. Similar methods are applicable to determine the whole force experienced by either of two electrified spheres placed near one another and subjected to the influence of an electrified point, whether in the line joining the centre of the spheres or not; but the formulæ expressing the details were not brought forward.

On certain Magnetic Curves; with applications to Problems in the Theories of Heat, Electricity, and Fluid Motion. By Professor W. THOMSON, *M.A., F.R.S.L. & E.*

A method, which had been given by the author in the Cambridge Mathematical Journal for integrating the differential equations of the lines of force in any case of symmetry about an axis, is applied in this communication to the case of an infinitely small magnet placed with its axis direct or reverse along the lines of force of a uniform magnetic field. Diagrams containing the curves drawn accurately, according to calculations founded on the result of this investigation, (corresponding to series of ten or twelve different values given to the constant of integration,) were exhibited to the Section. Certain parts of these curves were shown in a separate diagram, as constituting precisely the series of lines of electric force about an insulated spherical conductor under the influence of a distant electrified body; and the other parts, in a separate diagram, as constituting the lines of motion of a fluid mass in the neighbourhood of a fixed spherical solid, at considerable distances from which the fluid is moving uniformly in parallel lines so slowly as to cause no eddies round the obstacle. The circle representing the section of the spherical conductor, in the former of these diagrams, cuts the entire series of curves at right angles, with the exception of one curve, which it cuts through a double point at an angle of 45° to each branch. The circle representing the section of the spherical obstacle in the latter diagram, along with two infinite double branches consisting of the axial diameter produced externally in each direction, constitutes the limiting curve of the series shown, and is not intersected by any of them. A series of diagrams (deduced from the former of these by describing a circle of the same size as that shown in it, and drawing, on a smaller scale, as much of the curves as lies without this circle,) was shown as representing the disturbed lines of magnetic force about balls of ferromagnetic substance of different inductive capacities, placed in a uniform magnetic field; and another series, similarly derived from the latter, (that is, the one representing the lines of fluid motion about a spherical obstacle,) was shown as representing the disturbance caused by the presence of diamagnetic balls of different inductive capacities in a uniform magnetic field. These two series of diagrams are also accurate representations of the lines of motion of heat in a large homogeneous solid having heat uniformly conducted across it, as disturbed by spherical spaces occupied by solid matter of greater or less conducting power than the matter round them; the two principal diagrams from which they are derived being the corresponding representations for the cases of spherical spaces occupied respectively by matter of infinitely great and infinitely small conductivity. The author called attention to the remarkable resemblance which these diagrams bore to those which Mr. Faraday had shown recently at the Royal Institution to illustrate his views regarding the action of ferromagnetics and diamagnetics in influencing the field of force in which they are placed; and justified and illustrated the expression "conducting power for the lines of force," by referring to rigorous mathematical analogies presented by the theory of heat.

On the Equilibrium of elongated Masses of Ferromagnetic Substance in uniform and varied Fields of Force. By Professor W. THOMSON, *M.A., F.R.S.L. & E.*

The fact, first discovered experimentally by Gilbert, that a bar of soft iron, held by its centre of gravity in a uniform magnetic field, settles with its length parallel to the lines of force, is not explained correctly when it is said to be merely due to the property of magnetic induction in virtue of which the bar of soft iron becomes temporarily a magnet like a permanent magnet in its position of stable equilibrium. For exactly the same statement would be applicable to a row of soft iron balls rigidly connected by a non-magnetic frame; yet such an arrangement would not experience any directional tendency, (since no one of the balls in it would experience either a resultant force or a resultant couple from the force of the field,) unless in virtue of changes in the states of magnetization of the balls induced by their mutual actions. Hence the mutual action of the parts of a row of balls, and, as is easily shown, of a row of cubes, or of a bar of any kind, must be taken into account before a true theory of their directional tendencies can be obtained. The author of this communication, by elementary mechanical reasoning founded on what is known with certainty regarding magnetic induction and magnetic action generally, shows that an elongated mass, in a uniform magnetic field, tends to place its length parallel to the lines of force, whether its inductive capacity be ferromagnetic or diamagnetic, provided it be non-crystalline, because if ferromagnetic it becomes more, or if diamagnetic, less intensely magnetized, if placed in such a position, than if placed with its length across the lines of force. But for all substances, whether ferromagnetic or diamagnetic, possessing so little capacity for induction as any of the known diamagnetics, this tendency, depending as it does on the mutual action of the parts of the elongated mass, is, and probably will always remain, utterly imperceptible in experiment. All directional tendencies in bars of diamagnetic substance which have yet been, and probably all which can ever be discovered by experiment, are due either to some magnecrystallic property of their substances, or to the tendency of their ends or other moveable parts, *from places of stronger towards places of weaker force*, in varied magnetic fields, or to these two causes combined, and in no respect to the inductive effects of the mutual influence of their parts. To consider the effects of a want of uniformity of the force, in a varied field, on the equilibrium of a ferromagnetic bar, the author quoted Faraday's admirable statement of the law regarding the tendency of a ball or cube of diamagnetic substance, and referred to former papers, in which he had proved that, when applied to non-crystalline substances generally, with the proper modification for the case of ferromagnetics, it expresses with admirable simplicity the result of a mathematical investigation involving some of the most remarkable principles in the theory of attraction. From this it was shown, that if we conceive a ferromagnetic mass to be divided into very small cubes, each of these parts would, of itself, tend towards places of stronger force, and therefore that the bearing of the whole mass in a varied field will be produced partly by this tendency and partly by the tendency depending on the mutual inductive influence which alone exists when the field is uniform. The author then proceeded to illustrate these theoretical views by a series of experiments. In some of them a steel bar magnet was used, and small soft iron wires, fixed in various positions on light wooden arms, were shown to be sometimes urged on the whole from places of stronger to places of weaker force by their tendency to get into positions with their lengths along the lines of force. In others, a ring electro-magnet, consisting of insulated copper wire, rolled fifty times round as closely as possible to the circumference of a circle of the diameter stated, about 9 inches in diameter, fixed in a vertical plane at right angles to the magnetic meridian, was used, and a single cube of soft iron, placed in an excentric position on a long narrow pasteboard tray centrally suspended in the field of force by unspun silk, was attracted into the plane of the ring; but a row of three or four cubes placed touching one another in a line through the axis of suspension, settled as far from the plane as possible, in virtue of the tendency of an elongated mass to get its length along the lines of force. Two cubes placed in contact are found to be in stable equilibrium in the plane of the ring, or in oblique positions, or as far from the ring as possible, according to the greater or less distances at which they are placed in the tray, from the point of suspension. A number of equal and similar bars of a composition of wax and soft iron filings of different ferromagnetic strengths, suspended successively with their middle points in the centre of the magnet, settled in various positions. Those of them which were of greatest ferromagnetic capacity settled perpendicular to the plane of the ring or along the lines of force; others, with a smaller proportion of iron filings, had positions of stable equilibrium both *in* the plane of the ring and *perpendicular* to it; and others, with a still smaller proportion of iron filings, had their sole positions of stable equilibrium in the plane of the ring. The last-mentioned experiments illustrated very curiously the diminished proportion borne by the effects of mutual influence of the parts to those of a non-uniformity in the field of force, in similar bodies of smaller ferromagnetic capacity.

On an Instrument for exhibiting the Colours of Liquids by Transmitted Light. By R. W. TOWNSEND.

This consisted of a short portable trough for containing the liquids, at the ends of which parallel mirrors being placed, by the reflexion of the visual ray or of light backward and forward several times, the effect was produced of transmitting the ray proceeding from the eye (or a beam of light) virtually through considerable thicknesses of the liquid. The author had been led to construct this in order to test the common explanation of the deep blue colour of the waters of the Rhone, where they enter the Lake of Geneva, and in other places. But his experiment with the instrument did not lead to the conclusion that the natural colour of all pure water was blue. Pure spring or rain water when *perfectly clear* exhibited no colour when thus viewed; but a sunbeam transmitted thus through the water received a beautiful deep yellow-green colour. He verified the experiment by afterwards using a very long trough without mirrors, and found the results the same.

On Molecular Action. By JOHN TYNDALL, *Ph.D., F.R.S.*

In this investigation the author has examined the influence exerted by the peculiar structure of wood upon the transmission of heat through the substance. A sensitive thermoscope was found in a bismuth and antimony couple, and by means of cushions of mercury which pressed upon the bodies under examination, perfect and uniform contact was obtained. The bodies were reduced to the cubical form. Four faces of each cube were parallel to the fibre of the wood; one pair of these faces intersected the ligneous layers perpendicularly, and the other pair was parallel to the layers. The velocity of calorific transmission was examined in the above three directions, and the following law of action established by experiments on fifty-seven different kinds of wood, both English and foreign :—

"At all points not situate in the axis of the tree, wood possesses three rectangular axes of calorific conduction: the first and greatest axis is parallel to the fibre of the wood; the second and intermediate axis is perpendicular to the fibre and to the ligneous layers which mark the growth of the tree; while the third and least axis is perpendicular to the fibre and parallel to the layers."

Two other systems of axes were pointed out by the author as existing in wood; the axes of cohesion and those of fluid permeability. In order of magnitude and direction these axes coincide with the axes of calorific conduction, and all three systems coincide with the axes of elasticity discovered by Savart.

On Poisson's *Theoretic Anticipation of Magnecrystallic Action. By* JOHN TYNDALL, *Ph.D., F.R.S.*

Professor Wm. Thomson has drawn attention to the fact, that the discovery of magnecrystallic action by Plücker was anticipated in Poisson's Theory of Magnetism; and in a recent number of Liebig and Kopp's Annual Report, the author's investigations are referred to as particularly confirmatory of this view. Dr. Tyndall, however, conceives that the hypothesis of Poisson is by no means sufficient to account for magnecrystallic phænomena. Poisson supposed that in crystallized bodies the magnetic elements were possibly ellipsoidal; and conceiving the larger axes of these ellipsoids all to lie in the same direction, he inferred that a differential action, such as that first observed by Plücker, would be the result. But exactly the same results are obtained by *a peculiar arrangement* of the particles of *amorphous* bodies. A wax model of calcareous spar was exhibited by Dr. Tyndall, the deportment of which, as proved experimentally before the Section, was precisely the same as that of a calc-spar crystal of the same size and shape. Similar experiments were made with other substances, both magnetic and diamagnetic, and all went to establish the result—a result assented to by Prof. Thomson, who witnessed the experiments—that the phænomena in question are not due to the shape of the molecules, but *to their manner of arrangement.*

ASTRONOMY, METEORS, WAVES.

On the connexion between Geological Theories and the Theory of the Figure of the Earth. By HENRY HENNESSY, *M.R.I.A.*

As geology may be considered to embrace an examination of the form and structure of the earth, it follows that every correct geological theory must be capable of explaining the greater as well as the lesser inequalities in the figure of our planet. Certain geological theories being incompatible with the supposition that the earth was originally in a state of fluidity, attempts have been made to account for its spheroidal figure by the abrading action of the waters at its surface. It has been shown by Playfair and Sir John Herschel that the earth would from such causes ultimately tend to assume the form of an oblate spheroid; but neither of these eminent mathematicians have presented such numerical results as would enable us to compare the theory with observation satisfactorily. This the author has effected in a paper communicated to the Royal Irish Academy, in which he deduces for the polar compression, according to the theory in question, $\frac{1}{404}$. The compression given by measurements is $\frac{1}{300}$; consequently it seems that the theory of the earth's primitive solidity must be rejected in favour of that of its primitive fluidity, which perfectly agrees with observation.

The author also pointed out an inconsistency between the theory of the earth's primitive solidity and the theory of climates proposed by Sir Charles Lyell in order to account for the diminution of temperature at the earth's surface since early geological epochs. This theory would require a gradual transport of matter from the equator to the poles in order to account for a diminution of the heating surface of dry land at the equator. Consequently on this theory the earth would tend to become prolate instead of oblate. The author concluded by pointing out similar objections to the geological views known as the Neptunian theory and the chemical theory of volcanos.

Proposed Theory of the Origin of the Asteroids. By JAMES NASMYTH, *F.R.A.S.*

As the progress of science is frequently aided by advancing hypothetical views in explanation of the cause of certain phænomena, Mr. Nasmyth desires to hazard a suggestion as to the cause of the break-up of the original planet whose fragments, it has been conjectured, form that numerous and remarkable group of small planets revolving between the orbits of Mars and Jupiter, some peculiarities of whose path have led to the supposition that they must have parted company from a parent mass at the same time and place. In order to render his views on this subject more clear, he would refer to the well-known toy called a "Prince Rupert Drop," namely, a drop of glass which has been let fall while in a semifluid state into water, by which the surface of the glass-drop is caused to cool and consolidate with such rapidity that the subsequent consolidation and *contraction* of the interior mass induces so high a degree of tension between it and the exterior crust that the slightest vibration is sufficient to overcome the cohesion of the external crust, and by so letting free the state of tension cause the glass-drop to fly into thousands of fragments. Nor is this action confined to "Rupert's drop," as we have examples of the same action in our foundry operations in the case of masses of brittle metal, when the exterior of the casting, by consolidating (as it always does before the interior) the after contraction of the interior of the mass, induces a sort of "touch and go" state of tension, which frequently results in such castings flying into fragments in spite of their *apparent* strength, either *per se*, or on the application of some force otherwise totally inadequate to produce so destructive a result.

Now let us apply this action (which we find constant in the cooling of all masses of brittle material) to the case of the supposed parent planet of the asteroids.

It appears to Mr. Nasmyth that we shall find in such the elements of a very feasible if not *the true* explanation of the origin of this remarkable and numerous group of planets, namely, that the parent planet may have consisted of such materials as that by the rapid passing of its surface from the original molten condition to that of solidification, while the yet fluid or semifluid interior went on contracting by the comparatively gradual escape of its heat into space through the solid crust, a state of tension may thereby have been induced, such as that in the "Rupert drop," and that the crust may have at last given way with such violence as to cause the fragments to part company, and so pass whirling off into orbits slightly varying from each other, according to corresponding variations in the condition of each at the instant of rupture.

The remarkable fact that the orbits of these asteroids have one common node or point of coincidence causes us to look to some such explanation as has thus been hazarded, and which perhaps may be entitled, in the mean time, to fill up a gap until supplanted by a better explanation.

Drawings to illustrate Recent Observations on Nebulæ. By the EARL OF ROSSE. *With Remarks by* REV. DR. ROBINSON.

Dr. Robinson stated that he had examined the drawings, which contain careful delineations of several nebulæ not previously examined, and certainly the contemplation of them was well fitted to increase the obligations of the astronomical world to Lord Rosse, as well as to fill every mind with astonishment at the wondrous revelations of his matchless telescope. Each of them was a new proof of a former statement of his, that this instrument would probably disclose forms of stellar arrangement, indicating modes of dynamic action never before contemplated in celestial mechanics. He referred to the drawings of M. 51, in which the spiral or vorticose arrangement of the stars and unresolved nebulæ was first remarked in its simplest form; and to others already published, where it presents itself under conditions of greater complexity. He also referred to the important fact that the class of planetary nebulæ might now be fairly assumed to have no existence, as all of them which have been examined prove to be either annular or of a spiral character. Thus M. 97, which was considered by Sir J. Herschel the finest specimen of them, and seemed even in his 18-inch reflector a uniform disc, presents in the six-feet a most intricate group of spiral arcs, disposed round two starry centres, looking like the visage of a monkey. Among the new ones are H. 2241. It is a ring of stars with a faint nebula within, and a fine double star near its edge; H. 2075, of the same kind, but with a bright star almost exactly central, and nine others round it, evidently part of the same group. H. 450 is a most extraordinary object; the ring exactly circular, its light mottled and flickering, and within it what is evidently a globular cluster. Scarcely less surprising, but more magnificent from its association, is the planetary at the edge of M. 46, which he had seen, though in a night not so favourable as that must have been when the drawing was made. It is a resolvable double ring, rather spiral, with a central star; and from the improbability of two objects so rare as a splendid cluster, and one of these compound rings being *casually* connected, it seems reasonable to think they constitute one system. The double star, ι Orionis, belongs also to this class, and he called attention to the absolute darkness of the aperture in the nebula round the two stars, and that the larger of them was at its edge instead of being central. He argued, from the remarkable difference between these objects as seen in the telescopes of Lord Rosse (even the three-feet) and those of previous observers, how desirable it was that a complete review of the nebulæ should be made without loss of time. Even now much labour and talent were expended in theorizing on the imperfect data given by instruments, which though matchless in their time have now been surpassed. Among others he directed the notice of the Section to H. 604, where the two clusters and the associated spirals are projected into ellipses; and to H. 2205, in which the long-resolved ray, being the most intense, was alone seen by Herschel, but the magnificent spirals and their central stars escaped him. M. 65, H. 857, appear to be helices seen obliquely. But the most curious one is M. 33, of which the centre is a triple star disposed as an equilateral triangle among a mass of smaller, from which proceed eight or nine spirals; and round all is an enormous nebula, in which however no spiral character had yet been traced.

There were several examples of another singular system, nebulæ streaked with dark bands, such as Bond discovered in the great nebula of Andromeda. H. 399, a wisp; H. 1393, a long ray of most marvellous appearance; H. 218, an oblique with sixteen or seventeen dark transverse stripes; and H. 315, having in the nebula a cluster nearly insulated by offsets from the broad curved dark band, are among the most surprising. But the number of these curious objects was so great that time would only permit him to invite attention to H. 1052 and 1053, where the cause of spirality had been interrupted by some other forces that bent the system at a right angle and drew the nebula into a straight ray; to H. 444, a double resolved nebula inclosed in a large and faint oval ring; and above all to M. 27, the "Dumb Bell" nebula as shown by the six-feet, with its brilliant two clusters of comparatively large stars, its dark bands and the faint rings which surround it differing even more from the picture of the three-feet than that does from the figure of Herschel.

In the name of the Section he thanked Lord Rosse, not merely for the pleasure which they received from the sight of these wonders, but for the unremitted and precious gifts which he was conferring on astronomy. Would he also increase their gratitude by mentioning any improvements which he might have lately made in the methods of suspending these large speculæ in their tubes or in the process of polishing, the latter with reference to the possibility of its being practised with success by persons who had not the long experience and mechanical knowledge of his Lordship?

Lord Rosse adverted to the peculiar conditions of equilibrium which must prevail in these systems, or rather to the forces which are required to produce the peculiar constitution which they indicate, and pointed out the difficulties of such an investigation. It could however not be undertaken with advantage till we possess a much more extended collection of data, to which he would contribute to the utmost of his power. These drawings were based on measures carefully taken with a bar-micrometer (the only one available in such cases), and he believed they might be trusted. He had already described the improvement effected by supporting the speculum on its lever by eighty-one balls, and mentioned the striking fact, that with a speculum weighing 3½ tons a slight pressure of the hand would deform for a time the image of a star. He had since effected a further improvement by supporting the edge of the speculum in a hoop mounted in jimmals. As to polishing, he had recently made many experiments with 3-feet specula in reference to the object of Dr. Robinson's question, and in particular had found, that, by increasing the speed of the second excentric in his machine, the process was rendered so much more certain, that desiring one of his workmen, a smith, to perform the whole process *without any superintendence* on his part, he produced a speculum, not perhaps absolutely perfect, but capable of doing excellent work. He had no doubt that any person of ordinary mechanical capacity would be able to do as much with a little instruction, and he would be most willing to give that instruction to any observer that might be placed in charge of a large reflector.

METEOROLOGY.

Account of a remarkable Case of Mirage. By Sir DAVID BREWSTER, *K.H., D.C.L., F.R.S., & V.P.R.S. Edinb.*

On the 21st of August, 1851, Miss F. E. went out on a drive with Mrs. and Miss H., and leaving them in the carriage, climbed to the top of the Mynydd, a high and steep hill, rising about 500 feet above the valley of New Radnor, the summit round and bare, the ground firm.

It was about half-past 2 P.M., and there was a bright hot sun.

After picking some flowers on the top of the hill, she went to a spot whence she could see the road, the carriage and the ladies, and waved to them her "*victorine*," which she held in her hand. Then, turning, she suddenly perceived a figure at the distance of a few yards from her. It was standing on a wet spot, where there was a little thin mist (probably steam) rising, and wavered a little, never remaining still; for which reason she did not think it was a real figure, though she says it had "a great deal of bulk." It was on a level with herself, and formed a species of triangle with herself and the sun, F. looking *towards* the sun, but not directly to it. She thought at first that the figure might be a delusion; it stood exactly facing her, and she first discovered it to be her own image by perceiving that, like herself, it held a "victorine" and bunch of flowers in its hand. She moved the hand with the nosegay, and the figure did the same. The dress and the flowers were precisely similar to her own, and the colours as vivid as in the reality. She could see the colouring and the flesh; it was like looking at herself in a looking-glass.

She stood looking at and examining it for two or three minutes; then, becoming frightened, turned away from the figure and ran straight down the side of the hill (which, though covered with turf, is of almost perpendicular steepness) without looking behind her, to Mrs. and Miss H., to whom she said that she had "had such a strange companion on the hill—herself." There was no mist around her when she saw the figure; it hung only over the one spot.

Miss H. said, that she and her sister-in-law had remained in the carriage. Looking up, she saw two figures on the top of the hill against the sky, at a few yards' distance from each other. Being short-sighted, and the distance considerable, she could distinguish nothing but this fact, and merely observed, that she wondered what companion F. had met with. She then turned to talk to her companion, and thought no more about the matter, until F. came running to them, considerably alarmed, to tell them what she had seen. Mrs. H. saw the two figures as well as her sister-in-law.

A little servant-boy who was with the carriage, saw F. run down the hill, falling repeatedly, and appearing much frightened.

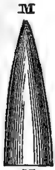
Miss F. E. returned a few days after to the same spot to see whether the appearance would be renewed, but has never seen it again.

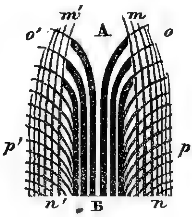
The figure of Miss E., thus distinctly seen by herself and others, was obviously produced by reflexion from the mass of vapour rising from the wet ground on which she stood. Sir David Brewster stated, on the authority of direct experiment, that when the particles of vapour are sufficiently small, such as that produced by breathing on a glass surface of nearly the same temperature as the breath, the surface of the vapour reflects as distinct a picture as if it were the surface of water. The vapour surface must have been considerably extended in the direction of Mrs. H.'s carriage in order that the reflected rays might reach it.

On certain Phænomena of Diffraction. By Sir DAVID BREWSTER, *K.H., D.C.L., F.R.S., & V.P.R.S. Edinb.*

In this communication the author pointed out some new and interesting phænomena which he had observed. The diffracting body tapers like the point of a very fine needle, which will be understood from the figure, which very imperfectly represents the internal and external fringes as produced by a needle-point like MN. The *ex-*

ternal fringes are represented by *mn*, *m'n'*, and are convex outwards, or parallel to the sides of the point MN. The *internal* fringes, as seen by Grimaldi and Dr. Young, are shown by the deep black lines between A and B. These *internal* fringes, however, I have observed extending far beyond the shadow in fine hyperbolic curves, as shown between *o* and *p*, and *o'* and *p'*. They intersect the *external* ones, and give them the appearance of *screws* or *twisted cords*. In homogeneous light, where the fringes are alternately dark and coloured, the dark fringes are dark at their intersections, and the coloured ones coloured.





When the needle-point is illuminated by the spectrum, and the fringes viewed by a lens, which is necessary to see them, we require to approach the lens to the fringes *m'n'* on the *violet* side of the spectrum, and to withdraw it on the *red* side, in order to see them distinctly. When this experiment is made with great care, I have counted *twenty* external fringes on each side of the shadow, which may always be seen most distinctly by looking through the margin of the lens.

When the diffracting body is an exceedingly small *wire* with parallel sides, the *internal* fringes extend far beyond the shadow, mingling with the external ones, and completely altering their colours and forms.

The *internal* fringes beyond the shadow, like those in it, disappear by intercepting the light with a screen on the opposite side of the diffracting body.

In former notices on certain dark bands in the spectrum, the author noticed that they resembled *screws* or *twisted lines*; and he infers from the preceding experiments, that these bands may have a similar origin, that is, that they may be produced by the intersection of two systems of bands, or by portions of bands produced by the ragged or uneven edge of the diffracting body.

In this communication Sir David stated that the bands which in former notices he had considered as indicating an *apparent polarity of light*, were merely the *internal diffraction fringes* produced by the edge of the plate, displaced, according to M. Arago's discovery, by the retarding action of the plate itself, and rendered visible through the action of the prism in one position of the edge more than another. He had seen the fringes under various circumstances, whether the diffracting edge was towards the *red* or *blue* side of the spectrum, never having any dependence on the aperture of the pupil or of the object-glass.

On four simultaneous Experiments in the Island of Bombay to determine the Fall of Rain at different Heights below 200 *feet. By* Dr. G. Buist. *Communicated by* Col. Sykes.

Dr. Buist gave the details of the means which he adopted to ensure accurate results. No satisfactory conclusion could be drawn, because the gauges at the several heights below and at 200 feet did not give uniform results; sometimes the most elevated gauges having the greatest fall of rain, and at other times the lower gauges having the greatest quantity. Nor did gauges at similar heights receive the same quantity of rain.

On Atmospheric Daily and Yearly Fluctuations. By Dr. G. Buist.

The object of the author was to show from the annual and daily oscillations of the barometer south of latitude 44° N., that the usually received opinion, that "the annual range of the barometer *increased* and that the daily fluctuations *decreased* as the equator was receded from," was met by so many instances to the contrary as to go far to invalidate the rule. Dr. Buist supplies a list of twenty-five stations from lat. 43° 39′ N. to lat. 42° 52′ S., in which the annual and daily ranges of the barometer are given for the year, and for the summer and winter months. With the exception, however, of Aden, Toronto, St. Helena, and Hobart Town, the stations are confined to the continent of India and within 22½ degrees of latitude north of the equator; and many of the stations are at very different elevations, which it is known affects both the annual and the daily oscillations. Dr. Buist in his paper discusses the exceptional cases to the supposed rule, and recommends them for scientific consideration.

Communication from the Smithsonian Institution 'on the Plan adopted for investigating the Meteorology of North America.'

Col. Sabine read a letter from Prof. Henry, of the Smithsonian Institution. Accompanying the letter was a set of charts to illustrate the plan adopted by the Institution. They gave the atmospheric changes in pressure, temperature, and wind during a storm which commenced at the close of January 1851. The principal object of this communication was to cause the British Association to procure the establishment of a series of observations in the British possessions on that continent which may serve as an extension of those proceeding under the direction of the Smithsonian Institution. The general plan is that originally proposed by Prof. Mitchell of North Carolina, and used successfully by Prof. Loomis in the study of two storms which occurred some years since. It consists in ascertaining the changes of the several meteorological elements from the mean of the month in which the storm occurs, and delineating on a series of charts all the phases and movements of the atmosphere from the beginning of the disturbance to its end. As many of the instruments used had not been compared and were not of the most improved construction, it had been feared that no reliable results could be obtained. But this is not the case: though the absolute mean temperature and pressure are not obtained, yet facts of equal, if not greater interest, are deducible, namely, the *changes* from a normal state. Thus the average (say for a month) can be deduced with sufficient precision to afford important practical deductions. Though the zero-points may be in error several divisions of the respective scales, they may give with sufficient accuracy the changes which occur at a given time, and thus furnish reliable data for determining the dynamic phænomena of the atmosphere, though inadequate to furnish statistical meteorological elements. The whole number of observers immediately under the direction of this Institution is about two hundred; and a hope was expressed that the British Association and the Royal Society would aid by their cooperation in extending the system by establishing corresponding observations in Her Majesty's possessions in America.

On the Aurora. By Lieut. W. H. H. Hooper.

The author believes the aurora borealis to be moisture in some shape (whether dew or vapour, liquid or frozen), illumined by the heavenly bodies, either directly or reflecting their rays from the frozen masses around the pole, or even from the immediately proximate snow-clad earth. This opinion he endeavoured to support by facts and argument.

Notes on the Meteorology of Ireland, deduced from the Observations made at the Coast-guard Stations under the direction of the Royal Irish Academy. By the Rev. H. Lloyd, *D.D., F.R.S.*

In the year 1850 an application was made by the Royal Irish Academy to the Government, requesting that meteorological and tidal observations should be made by the officers of the Coast-guard Service, according to a prearranged plan, at certain selected stations on the coasts of Ireland, the Academy undertaking to furnish the instruments and the instructions for their use. This application was promptly acceded to by the Government; and in the course of the same year meteorological instruments, previously compared with the standards belonging to the Dublin Magnetical Observatory, were conveyed to the several stations, and tide-gauges of a new construction were erected. All the stations were subsequently visited by Members of the Council of the Royal Irish Academy, who undertook the task of placing and adjusting the instruments, and of training the observers in their use. At the same time an application was made to the Board of Trinity College, and to the Heads of the Queen's Colleges of Belfast, Cork and Galway, requesting their cooperation in the meteorological observations; and a similar application was addressed to Dr. Robinson and Mr. Cooper, and to several private individuals who were known to be interested in meteorological inquiries. These applications were, for the most part, cheerfully acceded to, and the observations, upon the plan laid down by the Academy, were commenced everywhere before the close of the year.

Dr. Lloyd having been requested by the Council of the Academy to superintend the reduction of the meteorological observations, some of the principal results to which he has been conducted are given in the present communication.

The first point to which he invited the attention of the Section was the distribution of *mean temperature* in Ireland at the different seasons of the year. On an examination of the mean monthly temperatures at the several stations, it was found that those of the inland stations (Armagh, Markree, Portarlington and Athy) were *in defect*, as compared with the corresponding coast stations; the defect being (as might be expected) least in summer and greatest in winter. The *daily and yearly ranges* of temperature are, of course, greater at the inland than at the coast stations.

Upon examination of the results at the coast stations, it is found that there is a decrease of mean yearly temperature, in proceeding northward, amounting to 3°·5; the mean temperature at Castletownsend being 52°·2, and that of Buncrana 48°·7. The rate of decrease is about 1° in 80 geographical miles.

Again, there is a decrease of mean yearly temperature, although not so rapid, in proceeding eastward. Thus from Westport to Dublin, places nearly in the same parallel of latitude, the decrease of temperature is 1°·3; the mean rate of decrease in proceeding eastward being about 1° in 130 geographical miles. In consequence of this variation, the mean temperature of the western coast of the island exceeds that of the eastern by about 2°.

The following are the angles which the isothermal lines form with the meridian at the several seasons of the year:—

Spring...........	S. 63° E.
Summer	N. 77° E.
Autumn	S. 27° E.
Winter	S. 47° E.

It thus appears that the direction of the isothermals makes a wide oscillation in the course of the year, viz. through an angle of about 80°, their mean direction for the entire year being S. 57° E. It appears, further, that their two extreme positions are in the *consecutive* seasons of summer and autumn.

The latter conclusion, startling as it is at first sight, is completely explained by the form and annual movement of the isothermal lines, as shown in Dove's maps. In fact, there is a rapid flexure of these lines in the neighbourhood of the British islands in the autumn and winter months, the lines (as we follow them eastward) first tending to the N.E., and then, after a sudden bend, taking a S.E. course. Now this flexure, which is due to the influence of the Gulf-stream, begins to manifest itself in the month of September, and the maximum advances westward with the advance of the season; so that the ascending and descending branches of the curve pass through Ireland at a short interval. It is to this flexure that we owe, in this country, the mildness of our winter climate.

The next point connected with the meteorology of Ireland referred to by Dr. Lloyd, was the mean *elasticity of vapour* and the mean *humidity*. The maximum elastic force of vapour occurs, as might have been expected, at the southern stations, Cahirciveen and Castletownsend; and the minimum at the northern, Buncrana and Armagh. The mean elastic force of vapour in Ireland, during the year 1851, was ·314 of an inch of mercury; and the extreme variation depending on position was ·046.

If we divide the actual elasticity of vapour by the maximum elastic force corresponding to the temperature, we obtain the measure of the *humidity*. The humidity is, as we know, very great in Ireland; its mean yearly value for the whole of Ireland being ·86. The driest stations are, as might be expected, on the eastern coast, and the most humid on the western.

The total amount of *rain*, at the several stations, for the year 1851, is as follows:—

	Station.	Rain in inches.
20—25	Portarlington	21·2
	Killough	23·2
25—30	Dublin	26·4
	Athy	26·7
	Donaghadee	27·9
	Courtown	29·6
30—35	Kilrush	32·6
	Armagh	33·1
	Killybegs	33·2
	Dunmore	33·5
35—40	Portrush	37·2
	Buncrana	39·3
40—45	Markree	40·3
	Castletownsend	42·5
45—50	Westport	45·9
50—60	Cahirciveen	59·4

It will be seen from the foregoing table—

1. That there is great diversity in the yearly amount of rain at the different stations, all of which (excepting four) are but a few feet above the sea-level; the greatest rain (at Cahirciveen) being nearly three times as great as the least (at Portarlington).

2. That the stations of least rain are either inland or on the eastern coast; while those of greatest rain are at or near the western coast.

3. That the amount of rain is greatly dependent on the proximity of a mountain chain or group, being always considerable in such neighbourhood, unless the station lie to the N.E. of the same.

The author illustrated this last position by reference to the map prepared by Captain Larcom, at the instance of the Land-tenure Commissioners, in which degrees of elevation, differing by 250 feet, are distinguished by different shades of colour. Thus, Portarlington lies to the N.E. of Slieve-bloom, Killough N.E. of the Mourne range, Dublin N.E. of the Dublin and Wicklow range, and so on. On the other hand, the stations of greatest rain, Cahirciveen, Castletownsend, Westport, &c. are in the vicinity of high mountains, but on a different side.

If we assume the proportion of rain at the different stations to be constant, or nearly so, the preceding numbers may all be reduced to their *mean values* by multiplying by the factor, which expresses the relation of the rain of 1851 to the mean at any one station. The following table gives the yearly fall of rain in Dublin for the last eleven years:—

Year.	Rain in inches.	Year.	Rain in inches.
1841.	27·05	1847.	25·80
1842.	28·08	1848.	34·11
1843.	27·71	1849.	29·80
1844.	28·38	1850.	24·16
1845.	31·49	1851.	26·40
1846.	36·09		
		Mean....	29·01

On this assumption, therefore, the mean yearly rain at any station will be found by multiplying the number of inches which fell in 1851 by 1·1 $\left(=\frac{29{\cdot}01}{26{\cdot}40}\right)$. The greatest mean monthly fall of rain in Dublin occurs in October, and its amount is 3·34 inches; the least mean monthly rain is in February, its amount being 1·74 inches.

The last point adverted to by Dr. Lloyd, as deduced from these observations, was the evidence which they afford of the frequent occurrence of cyclonic movements in the atmosphere. The observations being simultaneous at all the stations, such movements are at once detected by a comparison of the directions of the wind at the same moment at the different stations; and it thus appears that the rotatory movement of the air, which constitutes a cyclone, is by no means confined to the more violent currents, but may be traced even in the gentlest breeze. The author concluded with some remarks on the physical characters of these aërial movements; and he showed in what manner the results of observation should be combined by the method of least squares, so as to deduce the direction and velocity of the centre of the vortex.

Monthly Amount of Rain from the Register, Armagh Observatory.

Anno.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Days on which rain fell.	Sum of rain.
	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.		
1840.	4·935	2·751	0·463	0·760	3·025	2·501	3·154	2·656	2·424	1·256	3·448	2·818	161	30·192
1841.	2·004	2·265	3·649	1·699	1·549	2·597	2·353	2·896	2·314	4·001	3·024	3·503	196	31·858
1842.	2·794	2·726	4·226	0·032	4·076	2·419	3·009	2·976	2·850	1·977	4·706	3·005	191	34·800
1843.	2·245	1·269	1·930	2·929	3·944	3·344	4·160	3·841	1·223	3·995	3·188	2·243	183	34·311
1844.	2·636	3·239	2·888	1·669	0·042	4·472	2·360	3·067	2·226	4·351	3·002	0·532	180	30·487
1845.	4·985	1·326	1·622	3·156	0·391	5·566	3·628	1·877	2·829	4·841	4·755	5·256	189	41·232
1846.	4·579	1·864	3·793	2·848	1·684	2·104	3·854	3·551	3·353	4·931	3·297	1·632	186	37·967
1847.	3·027	1·974	1·461	3·147	2·482	1·912	1·083	1·096	2·665	3·778	3·775	5·856	210	32·258
1848.	1·867	6·754	3·769	3·320	1·239	2·733	3·920	3·476	2·379	3·147	3·698	3·011	221	39·313
1849.	6·302	2·507	1·483	2·091	3·004	0·870	3·977	2·891	3·554	4·387	2·726	3·256	230	37·048
1850.	4·083	5·035	1·235	3·507	2·414	2·371	3·142	2·720	2·711	2·240	3·214	2·462	238	35·134
1851.	5·528	2·827	2·547	1·538	1·915	3·452	3·655	2·809	2·438	2·898	1·405	2·113	233	33·125
Mean.	3·749	2·879	2·422	2·225	2·230	2·862	3·191	2·821	2·580	3·484	3·353	2·974		

On the Fata Morgana of Ireland. *By* Mr. M'Farland.

These singular illusions are termed in the Irish language *Duna Feadhreagh*, or Fairy Castles. As proof that the Morgana had appeared as an island, either resting or floating on the sea prior to 1185, Mr. M'Farland read a passage from the topographical history of that country, by Giraldus Cambrensis (lib. ii. c. 12). He then referred to the "*Miranda loca*, quæ vidit St. Brandanus in Oceano," to which Usher alludes in his 'De Hiberniâ' (p. 813), and quoted an unpublished History of Ireland, composed about 1636 (and now remaining in MS. in the Library of the Royal Irish Academy at Dublin), that speaks of an "Iland which lyeth far att sea, on the west of Connaught, and sometimes is perceived by the inhabitants of the Owles and Iris; also from St. Helen Head, beyond the haven of Calbeggs (Killibegs, Donegal). Likewise, severall seamen have discovered it att sea as they have sailed on the western coasts of Ireland." Mr. M'Farland also read from the Chronographical Description of Connaught, written in 1684, by Roderick O'Flagherty, and published by the Irish Archæological Society, in which it is recorded (p. 68), that, "From the Isles of Arran and the West continent, often appears visible that enchanted island, called O'Branil, and in Irish Beg-ara, or the Sessen Arran, set down in cards of navigation. * * There is, westward of Arran, in sight of the next continent, Skerde, a wild island of huge rocks; these sometimes appear to be a great city far off, full of houses, castles, towers, and chimneys; sometimes full of blazing flames, smoke, and people running to and fro. Another day you would see nothing but a number of ships, with their sailes and riggings; then so many great stakes or reekes of corn and turf." Mr. M'Farland next cited the 'History of the Parish of Ramoan (Ballycastle),' by the Rev. Wm. Conolly (1812), in which it is stated, that the author had received a minute description of the Fata Morgana from several persons who saw it, on different summer evenings, along the shore of the Giant's Causeway; shadows resembling castles, ruins and tall spires darted rapidly across the surface of the sea, which were instantly lengthened into considerable height; they moved to the eastern part of the horizon, and at sunset totally disappeared. This work makes mention of an earlier one (of 1748), by a gentleman who resided near the Causeway, and which presented a long account of an enchanted island, annually seen floating along the coast of Antrim. Reference was afterwards made to 'Plumptree's Narrative' (of 1817), as showing that, at Rathlin—a considerable island opposite to Ballycastle—a belief then prevailed, that a green island rose every seventh year, out of the sea, between it and the promontory of Bengore; the inhabitants asserting that many of them had distinctly seen it, crowded with people selling yarn, and engaged in various other occupations common to a fair. The notes to the second book of Dr. Drummond's poem on the 'Causeway' were also glanced at, as containing an account of other cases of the Fata Morgana, by the Bushfoot Strand and Tor-point. So, a person still living (and whose name, &c. were given) conceived that he had a sight of the floating isle off Fair-Head; that it seemed to be well-wooded; and that he could distinguish upon it the forms of buildings, and a woman laying out clothes. Mr. M'Farland then mentioned that, in June 1833, he himself and a party of friends, when standing on a rock at Portbalintrea, perceived a small roundish island as if in the act of emerging from the deep, at a distance of a mile from the shore; at first it appeared but as a green field, afterwards it became fringed with red, yellow and blue; whilst the forms of trees, men and cattle rose upon it slowly and successively; and these continued for about a quarter of an hour, distinct in their outlines, shape and colour; the figures, too, seemed to walk across it, or wandered among the trees, the ocean bathed it around, the sun shone upon it from above; and all was fresh, fair, and beautiful, till the sward assumed a shadowy form, and its various objects, mingling into one confused whole, passed away as strangely as they came. Further, Morgana had occasionally assumed the semblance of a beautiful bridge that spanned the Sound between the Skerry rocks and the strand at Portrush, and having people passing and repassing over it. A particular instance of this was stated, as well as of the appearance of the sea, at Ballintoy, of what resembled a city with its streets, houses, spires, &c. Two occasions were then specified, in which the Fata had been seen in the sky—the one in the summer of 1847, over the Ferry at Lough Foyle, and the other on the 14th of December 1850, near to the Bannmouth; and in the course of which the images of troops, ships, &c. were reflected on the clouds. Four other cases of the Aërial Morgana were adduced, as witnessed about the town and coast of Waterford in 1644, and at the close of the last and commencement of the present centuries, and taken from the 'Voyages and Observations' of M. le Gown, Brewer's "Beauties of Ireland" (vol. ii. p. 307, n.), and the 13th volume of the Phil. Mag., Old Series. Mr. M'Farland considered that these various exhibitions of the Fata Morgana might all be accounted for by applying to those parts of the coast on which they had been displayed, the theories of Minasi and M. Honel, as advanced by them in explanation of similar phænomena seen on and about the Strait of Messina. The Northern Channel of Ireland presents, to a very great degree, the same data as regards shape, indentations, currents, and bitumen, as that strait does, and on which their theories rest; and he believed that, to some extent at least, so did the sea in the neighbourhood of the isles of Arran and town of Waterford. Where the Marine Morgana was found, the Aërial might be expected, and the Prismatic was a mere corollary to the first.

On the Causes of the Excess of the Mean Temperature of Rivers above that of the Atmosphere, recently observed by M. Renou. *By* W. J. Macquorn Rankine, *C.E., F.R.S.E.*

M. Renou having for four years observed the temperature of the River Loir at Vendôme, as compared with that of the atmosphere, has found that the mean temperature of the river invariably exceeds that of the air, by an amount varying from $1\frac{1}{3}$ to 3 Centigrade degrees, and averaging $2^{\circ}\cdot24$ Centigrade; and a similar result has been deduced from observations made by M. Oscar Valin on the Loire at Tours. M. Renou and M. Babinet account for this fact by the re-radiation from the bed of the river of solar heat previously absorbed by it.

Mr. Rankine thinks this supposition inadequate to account for the facts; because the excess of temperature of the river over the air was considerably above its mean amount in November, and very near its maximum in December; and because the mean diurnal variation of temperature of the river was much less than that of the air. He considers that friction is probably one cause of this elevation of temperature; for if water descends in a uniform channel, with a uniform velocity, from a higher level to a lower, the whole power due to its descent is expended in overcoming friction; that is to say, is converted into heat, as the experiments of Mr. Joule have proved. This must cause an elevation of temperature, which will go on until the loss of heat by radiation, conduction, and evaporation balances the gain by friction, and at this point the temperature of the river will remain stationary.

Meteorological Summary for 1851, *at Huggate, near Pocklington. By the* Rev. T. Rankin.

This, as usual, contained a summary for the year of the thermometer, barometer, hygrometer, rain-gauge, atmospheric waves, winds, auroræ, and meteors observed at Huggate. It also contained a brief notice of eclipses.

On an Aurora observed at Huggate. By the Rev. T. Rankin.

On the Aurora Borealis. By Rear-Admiral Sir John Ross.

This explanation of auroras is the same as that which was formerly given by Sir John Ross at the Dublin Meeting in 1835.

On the Formula for the Wet-bulb Thermometer. By Capt. Strachey.

The author stated objections to the principle on which Dr. Apjohn's formula had been investigated; affirmed that this formula was found not applicable to the high temperatures and dew-points observed in India, and proposed a correction in that part of the process which involves the difference of the number of degrees of the dry and wet bulbs.

On Tropical Hurricanes. By Dr. J. Taylor.

The author began by stating the observed facts as to these hurricanes. They begin from 10° to 20° from the equator, but are not observed at it. A hot, sultry and calm state of the atmosphere, with a low barometric pressure, indicates their occurrence, or immediately precedes them. The force of the wind increases as the centre of the area over which the action of the hurricane extends is approached. The author then pointed out the inconsistency of the theory of Mr. Espy and other American philosophers with the facts observed, and particularly that a ship situated in a storm of the structure which that theory supposed would find the wind to bear in either direction indifferently in the northern or the southern hemisphere, which is contrary to experience; for the direction of the whirl in the northern hemisphere is always contrary to the motion of the hands of a watch; while in the southern it was as constantly in the same direction for the true cyclone. He stated his conviction that the opinion which is alone consistent with all the facts is, that the movement of the air is one of revolution round a central space which is itself in a state of progressive motion; and that the direction of the rotatory movement is invariable in the same hemisphere. The author then sketched the causes which might give rise to such a rotatory movement; particularising the hypothesis of Dove and others, viz. that of contending currents, and showing its utter incompetence; and proceeded to give the theory which he proposed of them, viz. that the partial vacuum indicated by the low state of the barometer over the area of the storm, and particularly towards the vortex, is not the effect of centrifugal force, but the original cause of the movement, by inducing a translation of air from beyond the boundary of the partial vacuum inward towards its centre,—a motion which would occur in directly converging right lines were the earth and air at rest; but the earth being in motion, and therefore the area of the hurricane turning round with regard to its own centre, the velocity of such movement being greater for a particle of air at a distance from that centre than for one nearer, as the particles approach it, they retain their greater velocities, and thus move not in radial lines, but in diminishing circles or spirals round the centre, which would be the case were the particles of air only to retain their primitive velocity of rotation; but by the principle of the conservation of areas, the velocity would increase more and more as the centre of the vortex was approached.

The author then traced the consequences of such combined motions, by supposing the disturbance to commence first around one of the poles of the earth, and then by tracing the change of circumstances which must take place in other latitudes; and asserted, that by calculating by these suppositions, using as data the well-ascertained dimensions of the area over which cyclones extended, a relative movement of the air over the earth, even greater than any that had ever been observed in violent hurricanes, might result. He concluded by showing how an experiment which he had prepared might be performed, so as to exhibit the more striking effects of a hurricane in water, by giving a whirling motion to a wide vessel of water furnished with a valve in the bottom, at a distance from the axis, which could be withdrawn. He also stated his conviction, that the phænomena of sea and land breezes would yet be found to partake of the rotatory character.

Aurora Borealis observed at St. Ives, Hunts. By J. K. Watts.

This is a record of four displays of the aurora on the 26th of March, 1851, and on the 19th and 21st of February, and the 21st of March, 1852.

Miscellaneous.

On an Instrument for Drawing. By Henry Twining.

The use of the instrument is to assist in obtaining correct representations of objects from nature, by pointing out the different angles at which they present themselves to the eye, and by finding out the vanishing points of their retiring sides.

The instrument consists of a graduated semicircular plate placed horizontally on the top of a rod or pillar, so as to be raised or lowered at pleasure. Above this plate or dial is placed another having a vertical position, in connexion with which there is an index or needle, moving vertically on a pivot, and which serves to mark the elevation and the depression of any point above or below the horizon. Also connected with the *horizontal* plate or dial is another index, consisting of three branches or wires placed at right angles, and which is susceptible of a horizontal motion. Its position is immediately above the horizontal graduated plate. The straight side of this plate is placed parallel with the picture, the angular dimensions of which are marked on the graduated semicircle opposite. The cross wire of the index above the plate is then so directed, that, to the observer's eye, it will correspond exactly with a given line of any object in nature of which it is wished to obtain the direction, or, in other words, the inclination with reference to the plane of the picture. A plan recommended by Varley for attaining this purpose, is to give to one of the limbs of a jointed rule the inclination which any receding line in nature may appear to have to the eye; but with the instrument now described we reverse the method, as it were, for we adjust the direction of a wire which is level, so as to correspond with the horizontal line of any retiring object, and then we find out, on the graduated plate connected with the wire, the exact position of the vanishing points of these objects, that is to say, those points to which their various horizontal lines converge. Thus the true inclination of all horizontal lines is obtained by finding out, in the first place according to a simple method, but which cannot here be fully detailed, the vanishing points of all level lines of objects.

The advantages of this instrument may be considered to consist in accustoming the student to view the perspective of objects theoretically, and in a manner calculated to impress its principles on the mind; the horizontal plate and index serving to convey clear and precise notions of the relations of the vertical surfaces of objects to the plane of the canvas, whilst the vertical plate and needle serve to give the angular elevation and depression of objects, or their extension above or below the horizon; a correct representation of nature, under various circumstances, requiring a perfect familiarity with both these principles.

CHEMISTRY.

On the Discovery of Minute Quantities of Soda by the Action of Polarized Light. By Professor Thomas Andrews, *M.D., M.R.I.A., F.R.S., V.P. Queen's College, Belfast.*

The double chloride of potassium and platinum crystallizing in regular octahedrons, exercises, when placed in the dark field of the polariscope, no depolarizing action; and the same remark applies to the bichloride of platinum in consequence of its imperfect crystallization. On the other hand, the chloride of sodium and platinum in thin crystalline plates is remarkable for its depolarizing power, and a trace of this salt, which is invisible to the naked eye, may be at once detected by the brilliant display of prismatic colours which it exhibits under the action of polarized light. The author applies this property to the detection of soda in the following way. The other bases having been removed by the ordinary methods, and the alkalies converted into chlorides, a drop of the solution is placed on a glass slide, and a very small quantity of a dilute solution of the bichloride of platinum added, avoiding as far as possible an excess of that reagent. The drop is then evaporated by a gentle heat till it begins to crystallize, and afterwards placed in the field of a microscope furnished with a good polarizing apparatus. On turning the analyser till the field becomes perfectly dark, and excluding carefully the entrance of light laterally, the crystals remain quite invisible if either potash alone or no alkali whatever be present; while the presence of the slightest trace of soda is at once indicated by the depolarizing action of its platinum compound. With a drop of solution of chloride of sodium, weighing 0·0015 gramme, and containing $\frac{1}{10,000}$ of its weight of chloride of sodium, a very distinct effect was obtained. The quantity of soda thus detected was only $\frac{1}{13,000,000}$ of a gramme, or about $\frac{1}{1,000,000}$ of a grain.

On the Atomic Weights of Platinum and Barium. By Professor T. Andrews, *M.D., M.R.I.A., F.R.S.*

No determination of the atomic weight of platinum having been made since the recent revision of atomic weights, and the number adopted by chemists for that metal resting on the authority of a single experiment of Berzelius, the author considered it of importance, on practical as well as theoretical grounds, to institute some new experiments on the subject. The salt of platinum selected was the double chloride of potassium and platinum, which, after being dried *in vacuo* at a temperature of 105° C., was decomposed by digestion with metallic zinc and a small quantity of water, the action being assisted by the application of heat towards the end of the process. After the complete precipitation of the platinum and the formation of chloride of zinc from the decomposition of the double salt, the excess of zinc was removed by the addition, first of acetic and subsequently of nitric acid. The precipitated platinum was then removed by means of a small and carefully washed filter, and the amount of chlorine in the solution of chloride of zinc ascertained by Gay-Lussac's process, which has been of late so successfully applied by Pelouze to the determination of several other atomic weights. The double chloride of potassium and platinum was found to retain $\frac{5·5}{100,000}$dths of its weight of moisture, even when dried at a temperature considerably superior to the boiling-point of water. In three experiments performed by this process, the numbers obtained were 98·93, 98·84, and 99·06; the mean number 98·94 expresses therefore the atomic weight of platinum.

For the atomic weight of barium, the author obtained from two closely-accordant experiments the number 68·789, and concluded with some general observations as to the importance of a systematic series of experiments to settle, if possible, definitively, whether the law of Prout, that the atomic weights of all bodies are multiples of that of hydrogen, be universally true. He concluded by reading an interesting extract from a letter which he received from Baron Liebig:—"It is not certain that Prout's law may not be true for oxygen, nitrogen and carbon, without it being necessary to assume, as a consequence, that other bodies behave similarly; that is, their atomic weight must be exactly multiples by whole numbers of the atomic weight of hydrogen. The law is certainly not true of all bodies, but it may be true of certain groups, whose members, in respect to atomic weight, stand in a simple numerical relation to each other. The atomic weights of silicium, cobalt, strontium, tin, arsenic and lead, are in the same ratio as the numbers 1 : 2 : 3 : 4 : 5 : 7. We do not see the necessity of this relation, but only the possibility. Why should fractional numbers only occur, and not whole numbers also? I consider these relations only as facts; the law of the numbers themselves is quite unknown to us—as unknown as the absolute weights of the atoms."

On the Microscopic Structure of certain Basaltic and Metamorphic Rocks, and the Occurrence of Metallic Iron in them. By Professor T. ANDREWS, *M.D., M.R.I.A., F.R.S.*

If a thin splinter of basalt is viewed by reflected light in the field of a good microscope, it is seen to consist of a semitransparent granular mass, containing occasionally opake crystals of the magnetic oxide of iron and of iron pyrites. The former are easily recognized by their dark colour, metallic lustre, and the triangular and striated facets of the regular octahedron; the latter, by their yellow colour and cubical form. The semitransparent portion which forms the great mass of the stone evidently consists of two distinct minerals; one having a resinous lustre, and in microscopic characters closely resembling crystallized augite; the other, colourless and with a glassy lustre, might be referred to certain varieties of felspar or of zeolite. These remarks apply to the compact varieties of basalt.

The metamorphic rock of Portrush—an indurated clay-slate containing the characteristic fossils of the lias formation, and in external characters closely resembling Lydian stone—exhibits under the microscope a very different appearance. It is formed, in fact, of a semitransparent paste of homogeneous structure, everywhere thickly studded with innumerable microscopic cubes of iron pyrites. These crystals are very perfectly formed, but so minute that twenty of them may frequently be counted in the space of $\frac{1}{100}$dth part of a square inch, the sides of the crystals being on an average not more than $\frac{1}{2000}$dth of an inch in length. If a portion of any of these rocks be reduced, in a porcelain mortar, to a tolerably finer but not impalpable powder, and a magnet be passed several times through the powder, magnetic particles will be found adhering to the magnet, in greater or less abundance, according to the nature of the rock. On removing these magnetic particles and placing them in the field of the microscope, they exhibit distinct polarity and all the other characters of the magnetic oxide of iron. This mineral may be separated by the above simple process, not only from basalt, but from granite, clay-slate, primitive limestone, hardened chalk, magnesian limestone, and many metamorphic rocks. In short, it is one of the most widely-diffused minerals in nature, occurring in almost every rock which exhibits evidence of igneous action. The author was only able however to discover a doubtful trace in roofing-slate, serpentine and marble.

After referring to the few instances in which metallic iron, not of meteoric origin, is alleged to have been observed, the author proceeded to describe the process by which he has succeeded in showing that native iron is by no means an uncommon constituent of basaltic rocks. The stone is first reduced to powder in a porcelain mortar, the use of metallic tools being carefully avoided in every part of the operation. The magnetic portions are then removed, as in the process for separating the oxide of iron, and placed in the field of the microscope. While in the field, they are moistened with an acid solution of sulphate of copper, which produces no change on the oxide, but immediately indicates the presence of the slightest trace of metallic iron by a deposition of metallic copper. On making this experiment, a deposit of copper occasionally occurred in irregular crystalline bunches, perfectly opake, and with the characteristic colour and lustre of that metal. With neutral solutions of the copper salt this deposit very rarely occurred, indicating either that the iron is covered with a film of oxide, or that it is analogous in properties to the meteoric alloy which precipitates copper from acid, but not from neutral solutions. If instead of the copper solution dilute sulphuric acid be added to the magnetic particles, a slight effervescence at particular points frequently indicates the presence of the metallic iron; and on adding solution of copper while the disengagement of gas continues, the latter is suddenly arrested, and a bright deposit of metallic copper appears at the same points. The largest deposit of copper obtained was about $\frac{1}{50}$th of an inch in diameter. The most abundant indications of metallic iron were obtained from a coarse-grained variety of basalt, which forms the hill of Slieve Mish in Antrim, and also occurs at the Maiden Rocks and other localities. Indications of its presence in the basalt of the Giant's

Causeway, the lias slate of Portrush, and the trachyte of Auvergne have also been obtained.

This experiment is liable to the ambiguity that nickel and cobalt, in a state of very fine subdivision, also precipitate copper, and would also be extracted from a powder containing them by passing a magnet through it. The extreme improbability of either of these metals being present is such, that the author considers it scarcely to weaken the conclusions at which he has arrived.

On the Results of Analysis of a Substance resembling the Pigotite of Professor Johnston. *By* Professor JAMES APJOHN, *M.D., M.R.I.A.*

Is the Mechanical Power capable of being obtained by a given Amount of Caloric employed in the production of Vapour independent of the Nature of the Liquids? By Professor JAMES APJOHN, *M.D., M.R.I.A.*

On Glynn *and* Appel's *Patent Paper for the prevention of Piracy and Forgery by the Anastatic Process. By* SAMUEL BATESON.

On Irish-bog Butter. By JAMES S. BRAZIER, *F.C.S.*

The substance bearing this name is found accidentally in the various boggy districts of Ireland, sometimes also in Scotland, and is usually preserved in small kegs, in which the matter had most probably been originally deposited. Nothing appears to be known as to what this substance formerly was, or the time of its deposit. The specimen supplying the materials for Mr. Brazier's experiments was found in the neighbourhood of Belfast. In Berzelius' Rapport for 1847, is found an examination of another specimen of this substance by M. Luck, under the name of "*Bogic Acid*," who describes it as whitish, of low specific gravity, and of a peculiar odour. He fixes the fusing-point of the purified body at 51° Cent. (124° Fahr.). He mentions also that its reaction to litmus paper is acid, and gives for the formula of the acid $C_{33}\ H_{33}\ O_4$.

The specimen examined by Mr. Brazier was of a yellowish-white colour, the slight tinge of yellow being due to the presence of a very small quantity of a yellow oil pervading the whole mass: its external surface was somewhat friable, but portions from the interior of the specimen might have been selected having an unctuous feel, and possessing a most peculiar urinous odour. It is nearly insoluble in cold water, somewhat soluble in hot, but very soluble in alcohol and æther, especially on boiling, from either of which fluids it is deposited in white granular crystals. The alcohol or æther separated from the crystalline deposit, which was usually done by expression, was of a deep yellow colour, and containing apparently a small quantity of the yellow oleaginous matter above mentioned in solution, and imbibing more powerfully the urinous odour of the interior of the mass.

A clear portion of the substance taken directly from the keg gave a fusing-point of 45° Cent. (113° Fahr.), but after repeated purification and crystallization, by means of alcohol and æther, to free it from all oleaginous matter, the fusing-point was raised to 53° (127°·5 Fahr.). This means of purification was repeated several times, the fusing-point of the body remaining constantly the same, the substance itself resembling after fusion ordinary stearic acid. Before subjecting the substance to analysis, I thought it more advantageous to submit the body to a more rigorous method of purification, and adopted that of saponification. With potassa this body forms a beautifully clear transparent soap, and with the exception of the small portion of yellow oil mixed with it, is readily soluble in water; by means of solution therefore the oil and other accidental impurities may easily be separated. By the addition of hydrochloric acid to the aqueous solution of the soap, the fatty acid is set free; this has to be well washed with large quantities of water and subjected several times to a considerable pressure. In this state the fusing-point was found to be 127°·5 Fahr., and the same portion of acid having undergone the same routine of purification a second time, the fusing-point remained constant. An analysis of the body thus purified furnished numbers corresponding to the formula $C_{32}\ H_{32}\ O_4$, and for which the name of *Butyro-limnodic Acid* is proposed. The acid was subsequently recrystallized from alcohol and æther, when it was obtained in crystals of a beautifully white-satiny appearance, resembling benzoic acid.

We have now three fatty acids, isomeric in composition, and differing only by a few degrees in their points of fusion, viz.

	C.	H.	O.	Fusing-point.
Palmitic acid	32	32	4	58° Cent.
Cetylic acid	32	32	4	55° ,,
Butyro-limnodic acid	32	32	4	53° ,,

On the Principle of the Endosmose of Liquids. By Professor T. GRAHAM, *M.A., F.R.S.*

On the Phosphatic Nodules of the Greensand of the North of Ireland. By Professor JOHN F. HODGES, *M.D., Queen's College, Belfast.*

Professor Hodges, of Queen's College, gave an account of his discovery of the existence, in the greensand of the north of Ireland, of nodules rich in phosphate of lime, the important fertilizing ingredient of bones. The beds of greensand, he remarked, occurred immediately under the chalk, and belonged to what was called the chalk formation. They extended from the neighbourhood of Moira to the Giant's Causeway, forming in some places a broad belt, and in other parts a narrow stripe, and presented various shades of colour, from yellowish green to a rich dark green colour. The nodules which he had analysed were found imbedded in the greensand, and possessed peculiar interest, as affording the agriculturist a native source of the phosphoric acid. The beds of greensand contained about 5 per cent. of the bone-earth phosphate, while the nodules afforded so much as from 30 to 50 per cent. He gave the analysis of a sample of the greensand from the neighbourhood of Kilroot, in Antrim :—

100 *parts were found to contain*—

Water	0·97
Organic matters	0·73
Potash	0·56
Soda	0·25
Lime	4·14
Magnesia	0·41
Oxide of iron	4·85
Alumina	2·41
Sulphuric acid	trace
Chlorine	0·04
Phosphoric acid, equal to 6·68 bone-earth phosphate	3·24
Silica, soluble in potash	6·41
Insoluble siliceous matters	74·88
Carbonic acid and loss	1·11
	100·00

One ton of the sand would, therefore, convey to the soil 149½ lbs. of bone-earth phosphate, worth, at ¾*d.* per lb., 9*s.* 3*d.*

Dr. Hodges also directed attention to the valuable discovery of phosphatic nodules in England, and of a mineral in America, rich in phosphate of lime; and gave an account of some successful experiments which had been made with greensand applied as a manure.

On the Effect of the Moon's Rays. By —— KNOX.

This paper described the effects of a large lens in fusing different substances, giving the effects produced upon silica and other bodies, noting the temperature of the day at the period of experimenting and the time occupied. By concentrating the moon's rays upon two individuals, sensation was excited.

On the Atomic Weight of Magnesium. By ALEX. MACDONNELL.

The results of experiments were stated, which induced the author to conclude that the atomic weight for magnesium was 11·95 or quam prox. 12, and the atomic weight of magnesia as 19·95 or quam proxime 20, instead of 12·7 and 20·7, numbers that have usually been assigned in chemical works.

On the Estimation of Iodine. By Professor FREDERICK PENNY, *Ph.D. Andersonian University, Glasgow.*

Among the many applications that may be made of bichromate of potash to the purposes of centigrade analysis, there is none more convenient or useful than its employment for the estimation of the amount of iodine in samples of commercial iodine and of iodide of potassium. In Glasgow especially, which is the principal focus of the manufacture of potash-salts and iodine from kelp, and where the problems referred to are frequently presented for solution, an expeditious and exact method for the determination of iodine becomes truly valuable.

According to the statements of a party well qualified to judge, it appears, that, in the kelp season of 1851, the total quantity of kelp brought to Glasgow was about 6000 tons (22½ cwt. to the ton), which may be considered a fair average of ordinary seasons. On account of the greatly increased demand for potash-salts, the arrivals in 1850 amounted to nearly 10,000 tons, which is considerably higher than for several previous years*. The manufacture however is not confined to Glasgow; there are iodine works at Borrowstowness, Greenock, and Falkirk, in Scotland, at Ramelton in Ireland, and at Cherbourg and Brest in France.

The centigrade process, here to be described, for the estimation of iodine, is based upon the fact, that chromic acid in presence of hydrochloric acid causes the complete decomposition of soluble metallic iodides, the chloride of chromium and the chloride of the other metal being produced, while the iodine is thrown down in the solid state. Bichromate of potash is taken as the most convenient and stable form of chromic acid. The reaction with iodide of potassium is exhibited in the following equation:—

$$3KI + KO, 2CrO^3 + 7HCl = I^3 + 4KCl + Cr^2Cl^3 + 7HO.$$

The action is immediate, and provided that the solutions are kept cool, no secondary result is formed. The precipitated iodine speedily subsides, leaving the supernatant liquid quite clear, though slightly coloured, with a few floating particles of iodine on the surface. When the solution of the bichromate is overdosed with the iodide, it becomes dark red, from a portion of the iodine being dissolved by the excess of the iodide. This change of colour is useful as indicating when the addition of the iodide has been carried too far.

Iodide of Potassium.—The process for iodide of potassium is conducted as follows:—

10 grs. of bichromate of potash are dissolved in half an ounce of cold water, and half an ounce by measure of hydrochloric acid is afterwards poured in. An alkalimeter of 100 measures is then made up in the usual manner with 50 grs. of the iodide of potassium dissolved in water, and the solution is added to that of the bichromate of potash until the chromic acid is completely decomposed. To hit the exact point at which the action is complete, a white plate is spotted with a solution containing a mixture of pure protosulphate of iron and sulphocyanide of potassium, slightly acidified with hydrochloric acid, and by means of a glass rod a small quantity of the bichromate liquor is brought into contact with the mixture on the plate. So long as a red colour, or even dark tinge, is communicated to the spots by the application of this test, the presence of chromic acid is indicated; but when no dark shade is produced, the action is complete, and the operation is finished. The number of measures used is accurately read off, and the per-centage quantity of iodine in the sample subjected to trial is found by dividing 5080 by this number, 10 grs. of bichromate being equal (as will presently be shown) to 25·4 of iodine, and to 33·3 of iodide of potassium.

Throughout the process the liquid should be kept quite cool, and towards the conclusion the iodide solution in the alkalimeter should be added very slowly, in order to give ample time for the mutual action of the iodide and chromic acid, which should likewise be assisted by repeated and brisk stirring.

* *Kelp Imports in Glasgow. July to July.*

1841–42	2565 tons.
1842–43	1887 „
1843–44	1965 „
1844–45	3263 „
1845–46	6086 „
1846–47	3627 „

Mr. Glassford's *Kelp Manufacture.*

The mode of preparing the mixture of protosulphate of iron and sulphocyanide of potassium, as well as its extreme delicacy in detecting minute quantities of bichromate of potash, I have fully explained in a paper published in the Quarterly Journal of the Chemical Society of London, vol. iv. p. 244. It should be made very weak, and in using it the precaution should be observed of not spotting it on the plate until the moment of its being required. The spots moreover should be large, and thinly spread on the surface of the plate, and care should be taken to bring the drop of the liquor to be tested into contact with the centre of the spot, which it is allowed merely to touch, without any stirring or agitation. The colour or tinge is produced instantaneously if any chromic acid be present. It is not always easy to procure protosulphate of iron perfectly free from peroxide, and then the mixture prepared with such impure sulphate has a pinkish colour. This is of no moment when the tinge is light, as it becomes extremely pale and scarcely perceptible on the mixture being spread upon the plate. In the case of the mixture, however, being dark-coloured from the impurity of the sulphate of iron, it is better to dissolve a small piece of iron wire in dilute hydrochloric acid, and to add a portion of the clear solution at once to the sulphocyanide of potassium previously dissolved in water.

When minute accuracy is required, it will be advisable to add 30 grs. of the iodide, dissolved in a small quantity of water, at once to the bichromate solution; then to make up the alkalimeter with 10 or 20 grs. of the iodide, and to proceed with the operation as before directed. By using in this way a very weak solution of the iodide, it is perfectly easy to bring the result within a tenth of a grain of the proper quantity.

I have tried this process repeatedly upon carefully-purified iodide of potassium, both in large and small quantities. The results, which never differed more than a tenth of a grain from each other, show that 100 parts of bichromate of potash are equal to 333 of iodide of potassium, and to 254 of iodine; and accordingly 10 grs. of bichromate are equivalent to 25·4 grs. of iodine.

The following are some of the results obtained by subjecting different specimens of commercial iodide of potassium to trial by this process:—

Samples.	Iodide of potassium.
No. 1.	99·8 per cent.
2.	99·5 „
3.	93·6 „
4.	88·8 „
5.	79·3 „
6.	30·2 „

The last sample consisted chiefly of carbonate of potash.

Iodine.—When iodine is the subject of examination, it must be first converted into a soluble iodide. The iodide of zinc appears to be best adapted for the purpose, from its stability and the readiness with which it may be prepared. 50 grs. of the iodine to be tested are put into a small flask with some fragments of pure zinc and half an ounce of water. The mixture is agitated till the iodine becomes completely converted into iodide of zinc, which is indicated by the solution losing the dark red colour that it first acquires, and becoming nearly colourless. The solution is then decanted into an alkalimeter, which is made up to 0 with rinsings from the excess of zinc.

10 grs. of bichromate of potash are next dissolved in a small basin with half an ounce of water, and half an ounce of hydrochloric acid is subsequently added.

The remaining operations are precisely similar to those directed for iodide of potassium. The iodide solution is dropped into that of the bichromate till no coloration is produced with the sulphocyanide mixture; then 5080, divided by the number of measures consumed, gives the amount of iodine per cent. in the sample.

This process is obviously incompatible with proto-compounds of iron, arsenious acid, and substances having similar chemical relations; but their presence would be immediately disclosed and their influence easily prevented.

Kelp and Kelp-liquor.—The direct application of the present process to kelp and kelp-liquors is evidently inadmissible, in consequence of the sulphides, sulphites, hyposulphites and sulphocyanides, which they invariably contain. All these ingredients act readily upon bichromate of potash, in presence of hydrochloric acid. They may however be effectually removed by cautiously treating the solution from the kelp with hydrochloric acid, and evaporating to dryness, repeating the operations if necessary, or till the above ingredients are decomposed. In the case of kelp, the following is an outline of the mode of procedure:—A known weight is exhausted with water in the usual manner, and the several liquors, being mixed, are concentrated by evaporation, and set aside to crystallize. The mother-liquor is decanted and slightly supersaturated with hydrochloric acid, boiled and filtered. The filtrate is then evaporated completely to dryness, a little carbonate of soda being added towards the conclusion, if it be found that the hydrochloric acid is in such excess as to affect the iodide. This will be indicated by the liberation of iodine, and by the solution acquiring a dark colour. The dry residue is digested in a small quantity of cold water and filtered. The solution is then tested for the presence of the substances before named, when, if pure, it is transferred (wholly or in part, according to the quantity of kelp operated upon) to the alkalimeter, and subsequently dropped into the prepared solution of bichromate of potash and hydrochloric acid, as previously described. If however it should still contain any sulphite, hyposulphite, &c., the treatment with hydrochloric acid is repeated. It has been found that the extraction of the iodide from the residue by means of alcohol answers very well when the removal of the incompatible matters is attended with difficulty. The quantity of iodine in kelp is proportionately small, and of course subject to extensive variation. The amount extracted on the large scale from "drift-weed kelp" varies from 5 to 12 lbs. per ton, though larger quantities are said to have been obtained. From cut-weed kelp not more than 2 to 3 lbs. per ton have been extracted; and it is easy to conceive that the produce will be variable when these two kinds of kelp are mixed together. Not less therefore than 2 lbs. of drift-weed kelp should be operated upon, and in the case of cut-weed kelp, it will be advisable to use only 5 grs. of bichromate of potash in place of 10 grs.

The method of testing kelp-liquors is evident from the above outline of the mode of operating upon kelp itself.

On the Oil of the Sun-Fish. By Professor E. Ronalds, *Ph.D., F.C.S.*

On the application of certain Optical Phænomena to Chemistry. By Professor G. G. Stokes, *M.A., F.R.S.*

On the Koh-i-Noor Diamond. By Professor Tennant, *F.G.S.*

At the last Meeting of the British Association, Dr. Beke read a paper on the diamond slab supposed to have been cut from the Koh-i-Noor, and stated, that "at the capture of Coochan, there was found among the jewels of the harem of Reeza Kooli Khan, the chief of that place, a large diamond slab, supposed to have been cut from one side of the Koh-i-Noor, the great Indian diamond now in the possession of Her Majesty. It weighed about 130 carats, showed the marks of cutting on the flat and largest side, and appeared to correspond in size with the Koh-i-Noor." Professor Tennant was induced to record his opinion of the probability of this being correct. He had made models in fluor spar and afterwards broken them, and obtained specimens which would correspond in cleavage, weight and size with the Koh-i-Noor. By this means he was enabled to include the piece described by Dr. Beke, and probably the large Russian diamond, as forming altogether but portions of one large diamond. The diamond belongs to the tessular crystalline system; it yields readily to cleavage in four directions, parallel to the planes of the regular octahedron. Two of the largest planes of the Koh-i-Noor, when exhibited in the Crystal Palace, were cleavage planes; one of them had not been polished. This proved the specimen to be not a third of the weight of the original crystal, which he believed to have been a rhombic dodecahedron, and if slightly elongated, which is a common form of the diamond, would agree with Tavernier's description of it, bearing some resemblance to an egg.

On Chemical Combination; and on the Amount of Heat produced by the Combination of several Metals with Oxygen. By Thomas Woods, *M.D.*

The author endeavoured to show that in chemical combination no action different from that which takes place in simple bodies when expanding or contracting, when heated or cooled, exists. Every substance is an assemblage of particles between which a *definite* distance exists, as shown by every body having a *specific* gravity and bulk always the same for the same temperature; and therefore the *matter* and *space* of a body are related, or have some dependence on each other. Now if two bodies be brought together at an insensible distance (and this must always be the case before chemical action takes place), they form, as far as their particles are concerned, *one* body; and therefore these particles behave as though they were particles of a simple body, that is, the distance between them or the *space* is regulated by the matter. But as the matter of the compound body is not the same as the matter of either of those separately which compose it, the distance between the particles of the compound must be different from that of the elements. This distance cannot be greater, for then the particles would be nearer at a sensible than an insensible distance, and so could not mix at all; and being less, a particle of each of the elements must be joined to one of the other, for if not, the relation of the space to matter could not be carried out: hence what is called chemical combination. And, as where two simple bodies are brought together they unite, if the distance of the particles is less for the compound than the simple, so, if a simple and compound body are mixed, the former decomposes the latter if its particles lie closer to those of either of the elements of the former than those of the other elements do, for in every case the relation between *space* and *matter* must be carried out. But in other papers published in the Philosophical Magazine, Dr. Woods has endeavoured to show that the distance between particles cannot either be increased or diminished without an opposite and equal change simultaneously occurring in some other particles; hence, when in chemical combination the distance between the uniting particles is being diminished, other particles expand, and this expansion is the *heat* of chemical combination: and the necessity of this equal and opposite movement shows that it cannot be any power of matter, such as attraction, that causes particles to cohere, but the absence of expansion going on in other bodies; and the same law also proves that the idea of *repulsion* is equally unnecessary. Now, according to this theory, bodies which have the greatest affinity for each other should also lie the closest together, and as the more closely they lie the greater the distance their particles move together when combining, so the heat or accompanying expansion, which is equal although opposite, might be taken as a measure of the affinity of bodies for each other.

To prove whether this idea were correct, the author investigated the "amount of heat produced by the combination of several metals with oxygen." The method of finding the amount of heat is new. Instead of burning the metals in oxygen, as formerly, Dr. Woods dissolved them in water (potassium, sodium), or sulphuric or nitric acid, and noted the effect on the thermometer. To the number of degrees indicated was then added the quantity of heat absorbed by the decomposition of the dissolving menstruum; for Dr. Woods has proved in the October Number of the Philosophical Magazine, 1851, that "decomposition of a compound body absorbs as much heat as the combination of the elements originally produced." In the following table are the results:—

Name of metal.	Amount of heat produced by the combination of an equivalent of each with 1 grain of oxygen in 60 grains of water.
Sodium	284·0° Fahr.
Potassium	256·5 ,,
Zinc	159·8 ,,
Tin	129·6 ,,
Iron	126·4 ,,
Lead	99·4 ,,
Bismuth	74·5 ,,
Copper	72·6 ,,
Mercury	40·4 ,,
Silver	38·9 ,,

On the Combination of Metals with Oxygen. By T. Wood, *M.D.*

GEOLOGY AND PHYSICAL GEOGRAPHY.

On a New Variety of Magnetic Iron Ore; with Remarks upon the Application of Bicarbonate of Baryta to Quantitative Analyses. By Professor T. Andrews, *M.D., F.R.S., M.R.I.A.*

This mineral occurs in the schist rocks of the Mourne Mountains, near their junction with the granite. In external characters it resembles somewhat the common magnetic oxide; but its lustre is inferior. It occurs both in the amorphous state and in imperfectly-formed octahedrons. Its composition was found to be,—

Sesquioxide of iron	71·41
Protoxide of iron	21·59
Magnesia	6·45

The formula of this mineral is evidently $Fe_2O_3 + (FeO, MgO)$, a part of the protoxide of iron being replaced by magnesia. Although not mentioned in any of the published analyses of magnetic oxide of iron, magnesia appears to be a constant constituent of this mineral. The author gave the results of analyses of magnetic oxide in which 2·00, 0·71, and 0·09 per cent. of magnesia had respectively replaced an equivalent amount of the protoxide of iron. It is remarkable that not a trace of lime could ever be detected in any specimen of magnetic oxide. Oxide of manganese is usually also present, but in minute quantity. In this analysis a solution of the bicarbonate of baryta was employed to separate the sesquioxide of iron from the magnesia. A solution of this compound, which is readily prepared by passing a current of carbonic acid into water containing recently-precipitated carbonate of baryta in suspension, the author finds to effect a very complete separation of the sesquioxide of iron from the oxide of manganese and from magnesia, and considers that it may be very usefully employed in quantitative analyses for effecting the separation of the bases just mentioned, presenting many advantages over the insoluble carbonate of baryta, as well as over the other reagents usually employed for the same purpose.

On the Sources of Common Salt. By W. Bollaert.

Observations on the Diamond. By Sir David Brewster, *K.H., F.R.S.*

In the course of last spring I was requested by H.R.H. Prince Albert to give my opinion respecting different forms into which it was proposed to reduce the Koh-i-Noor diamond, in order to make it an ornamental gem. In the state in which it then was, it exhibited an inferior display of colours to its glass model, and it was only by surrounding it with a number of vivid lights that its coloured refractions could be developed. Having had occasion to observe some remarkable phænomena in small portions of *diamond*, an account of which was published in the Transactions of the Geological Society for 1836, I was desirous of examining so large a mass of diamond as the Koh-i-Noor before it was reduced in size, and covered with facets which would not permit it to be examined. His Royal Highness readily granted my request, and I had thus an opportunity of submitting it to the scrutiny of polarized light. In place of producing no action upon this species of light, as might have been expected from its octahedral structure, it exhibited streaks of polarized tints, generally parallel to one another, but in some places of an irregular form, and rising to the *yellow* of the *first order* of colours. These tints and portions of polarized light were exactly the same as those which I had long ago found in many other diamonds, and figured in the Edinburgh Transactions for 1815 and 1816. In placing the Koh-i-Noor under a microscope of considerable power, I observed in it, and also in each of the two small diamonds which accompanied it, *several* minute and irregular cavities, surrounded with sectors of polarized light, which could only have been produced by the expansive action of a compressed gas or fluid that had existed in the cavities when the diamond was in a soft state. In an external cavity, shown in the model, and which had been used for fixing the gold setting, I observed, with common light, a portion of yellow light, indicating a yellow substance. Mr. Garrard and others considered it as gold rubbed off the gold setting; but as gold is never *yellow* by transmitted light, I considered the colour as produced by a yellow solid substance of unknown origin. Sir Henry De la Beche having suggested to me that it would be desirable to make a general examination of the principal diamonds in London, I went next day to the British Museum, and found there an interesting specimen, which threw some light on the yellow solid to which I have referred. This specimen was a piece of colourless diamond, uncut, and without any crystalline faces, about three or four tenths of an inch broad, and about the twelfth of an inch thick, and on its surface there lay a crystal of yellow diamond, with the four planes of semi-octahedron. This singular fact was illustrated by a large model placed beside it. Upon examining the original, I noticed a pretty large cavity in the thickness of the specimen, with the extremity of which the yellow octahedron was connected; and finding a portion of amorphous yellow diamond in the other end of the cavity, I had no doubt that the yellow crystal had emerged, in a fluid state, from the cavity when it was accidentally opened, and had immediately crystallized on the surface of cleavage. I am well aware that such an opinion makes a good demand upon the faith of the mineralogist; but to those who have seen, as I have done, the contents of fluid cavities in crystal solidifying and even crystallizing on the face of cleavage, while another portion of the contents of the cavity escaped in gas—to those who have seen in topaz cavities numbers of regularly formed crystals, some of which, after being fused by heat, instantly recrystallized—the conclusion I have drawn will be stripped of much of its apparent extravagance. In examining a number of diamonds in the museum of the East India Company, to which Col. Sykes kindly obtained me access, and about *forty* or *fifty* in the possession of Messrs. Hunt and Roskill, I found many containing large and irregular cavities of the most fantastic shapes, and all of them surrounded with irregular patches of polarized light, of high tints, produced undoubtedly by a pressure from within the cavities, and modified by their form. Among these specimens I found one or two *black* diamonds, not *black* from a dark colouring matter, like that in smoky quartz, but black from the immense number of cavities which they contained. Tavernier has described a large and curious diamond which throws some light on the subject of this notice. It contained, in its very centre, a large black cavity. The diamond merchants refused to purchase it. At last a Dutchman bought it, and by cutting it in two, obtained *two* very fine diamonds. The black cavity through which he cut was found to contain *eight* or *nine* carats of what Tavernier calls *black vegetable mud!*

Geological Structure of the Counties of Down and Antrim. By JAMES BRYCE, *jun., M.A., F.G.S.*

The author began by stating that the valley of the Lagan, on which the town of Belfast is situated, is a great depression on either side of which formations of different ages are confluent. On the southern side of the valley the strata belong to the older formations; on the northern side they are the newest that occur in Ireland. Each of the counties of Down and Antrim is thus almost exclusively occupied with rocks peculiar to itself; those in the one county not including those in the other. The author then proceeded to describe the leading geological features of the County of Down. It contains two granitic tracts, which seem to have been elevated at different epochs. They are separated from one another, and each is wholly enclosed by a thick band of metamorphic slate, gneissose in its lower part, and passing upwards into flinty and common clay-slate. Superimposed conformably on these are other slates of a less crystalline type, whose aggregate thickness is enormous, and whose upper portions have yielded a few imperfect fossils, which seem to make them referable to the lower Silurian group; but as yet no definite lines have been made out to justify a classification. Over the slates, but unconformable to them, there occurs in the N.E. part of the county many strata abounding in fossils, which the author is inclined to refer to the Carboniferous and Permian systems. Among these no traces of coal have yet been found; which is remarkable, seeing that the system is otherwise so fully developed.

The formations of Antrim were next described. These consist of triassic beds, lias, and the cretaceous system, including greensand and chalk; the whole overlaid by vast accumulations of igneous rocks presenting many varieties,—basalts, greenstones, greystones, porphyries, tufts, and ashes with lignites; which the author endeavoured to separate into distinct flows from certain foci of submarine volcanic action. Many new phænomena connected with the Giant's Causeway were also described; and a tertiary pliocene formation at Belfast which has yielded a greater variety of fossil species than all the other similar beds in Ireland taken together. In conclusion, the recent discovery of extensive beds of rock-salt near Carrickfergus was briefly alluded to.

On the Disposition of Granite Blocks in Argyllshire. By JAMES BRYCE, *jun., F.G.S.*

On the Alps in the Vicinity of Mont Blanc. By Major CHARTERS, *F.G.S.*

An Account of the Changes occasioned during the Cooling of the Granite of Mont Blanc. By M. ACHILLE DELESSE.

On the Rocks of the Upper Punjaub. By Dr. ANDREW FLEMING, *of the East India Company's Service.*

Sir Roderick I. Murchison briefly explained the nature and value of the last researches of Dr. A. Fleming, to whom the Indian government had assigned the task of exploring (as Director) the salt mines of the Upper Punjaub. The chief results are, that the salt range is composed, in descending order, of a mass of nummulite limestone, which, forming its peaks, throws off younger and pebbly deposits, and is underlaid first by secondary rocks of Jurassic (Oxfordian) age, and next by limestone, laden with well-known species of Producti of the carboniferous or mountain limestone; the whole being supported by inferior masses of red shale, sandstone and conglomerate, to which the salt is subordinate. After a pointed allusion to the great importance of these discoveries, Sir R. I. Murchison informed the Section that he had acquainted the author that some of the salt of Russia occupied the same position, or that of the Devonian or Old Red Rocks.

On the Fossils of the Yellow Sandstone of the South of Ireland. By Professor E. FORBES, *F.R.S.*

During the course of the labours of the Geological Survey of Ireland in 1851, strata referable to the "yellow sandstone," and consisting of compact flagstones of a very grey and creamy colour, at the hill of Knocktopher in Kilkenny, were found to abound in fossils of great beauty, and apparently entirely new. They consisted of remains of ferns and other plants in a beautiful state of preservation, and were accompanied by a large bivalve shell, which must provisionally be referred to the genus *Anodon*, and may receive the name of *Anodon Jukesii*. The ferns belong to the genus *Cyclopteris*, and to a group in that genus among which the aspect of *Neuropteris* is assumed. They differ materially from any of the members of this group hitherto described, not only specifically, but also in their general arrangements; and exhibit some peculiarities not hitherto noticed in fossil ferns. The most common of these (*Cyclopteris Hibernicus*) is often two feet in length of its bipinnate fronds. Along with these are species of *Lepidodendron* and *Stigmaria*; also curious cones, formed of loose groups of scales or bracts, each furnished with an exceedingly long mucro. All of these appear to be new. Great interest attaches to this assemblage:—1st, as an indication of fresh, or at least brackish, water conditions at the period of the depositions of the beds; and 2ndly, as, if we are correct in considering these strata Devonian, this is the most perfect illustration of the flora of that epoch yet discovered. Fish remains of the genus *Holoptychius*, and of the crustacean *Pterygotus* occur also in these beds.

On the Shells found in the Alluvial Deposits of Belfast. By JOHN GRAINGER, *Hon. Sec. of the Dublin University Zool. Assoc.*

The author, after referring to the incomplete character of what had been published on the subject, stated, that the alluvial deposits of Belfast occupied the greater part of the foundations of the town, and extended three or four miles into the bay, and that the shells had been found in various levels from four feet in vertical height above high-water mark to twenty-four feet below it. The deposits appeared to have the shells rather diffused throughout them than lying in regular beds. This, together with the fact that the same species were found at every depth, made it useless as well as impossible to observe levels to which the species should respectively belong. Besides, the shells were all of recent species, and thus fixed the formations of one geological age. The following is a summary of the remarks upon each species.

Teredo norvegica, Sprengler. A considerable number of tubes were found, tending to prove the indigenousness of the species. It is not now an inhabitant of the bay, nor indeed is there any habitat nearer than Portpatrick in Wigtonshire, a harbour presenting identically similar geological features to those of Belfast Bay.

Pholas dactylus, Linn. A single valve in the sand of the deposits. It exists at present in some numbers in the harbour.

P. parva, Penn. Was met with, and in the living state upon the surface.

P. crispata, Linn. Several huge examples $4\frac{1}{2}$ inches long. Not now common in the bay.

P. candida, Linn. A tolerable number of single valves, with a few perfect specimens, one three inches in length. At the present day abundant in the harbour.

Saxicava arctica, Linn. A few single valves. Still an inhabitant of the bay.

Mya truncata, Linn. Occurred plentifully. An extremely common species in the harbour.

M. arenaria, Linn. Was found everywhere in the deposits. Now a favourite food with the poor along the neighbouring shores.

Corbula nucleus, Lam. Was met with but sparingly. It still occurs in the bay.

Thracia phaseolina, Lam. A few specimens, but only with separated valves. Common enough in the harbour at present.

T. pubescens, Pult. One rather fine individual. Has been taken also in the living state in the neighbourhood.

T. convexa, Wood. A large number was obtained. Has not been taken in Belfast Bay.

Solen marginatus, Pult. Occurred rather frequently. Has been dredged in the dead state near the mouth of the harbour.

S. ensis, Linn. Represented by one or two poor examples of the var. *magna.* Both the typical form and the var. occur in the living state.

S. pellucidus, Penn. In small numbers, and rather local. Dredged commonly enough in the bay.

Solecurtus coarctatus, Gmel. A single rather fine example. Not in the harbour as a living species, but has been dredged in some of the neighbouring estuaries.

Psammobia vespertina, Chem. One valve only. Still an inhabitant.

P. Ferroensis, Chem. Rather scarce, and only in single valves. Now dredged in tolerable numbers alive.

Tellina tenuis, Da Cos. Was represented by rather fresh-looking specimens. Quite abundant as a living occupant.

T. solidula, Pult. Distributed everywhere throughout the beds. Still a common shell in the neighbourhood.

Syndosmya alba. Was well distributed, and occurred in large numbers in company. It is also an inhabitant in the recent state.

Scrobicularia piperata, Gmel. Left ample memorials of its former presence; and does not occupy suitable localities near Belfast. The best specimens found nearest to the course of the river.

Mactra elliptica, Brown. Occurred pretty often. Enumerated amongst the inhabitants of the harbour.

M. subtruncata, Da Cos. A large number of fine examples. Abundant in the bay in the living state.

Lutraria elliptica, Lam. Was imbedded everywhere. It is yet in the harbour a not unfrequent species.

Tapes decussata, Linn. Appeared pretty often. Dug living out of the sand near Belfast.

T. pullastra, Wood. The typical form was met with abundantly. Extremely numerous at the present day.

T. aurea, Gmel. Was locally abundant. In some parts of the bay nothing could be more plentiful than this as a living species.

Venus striatula, Don. Three varieties occurred in some numbers, viz. *laminosa*, *gallina*, and a decidedly ventricose form. Still lives in the harbour.

Artemis lincta, Pult. Very sparingly in single valves. Not commonly met with in the living state in the bay.

Lucinopsis undata, Penn. Distributed in vast numbers. Thrown on the neighbouring shores in the recent state.

Cardium echinatum, Linn. Fine examples extremely numerous. Still living near its ancient station.

C. edule, Linn. Imbedded in vast numbers. On both sides of the harbour it is obtained for the market.

C. pygmæum, Don. Not unfrequent. Still to be met with living in the neighbourhood.

Lucina borealis, Linn. Was found finely developed, and in some numbers. Now dredged living in the harbour.

L. flexuosa, Mont. Fine examples in great numbers. One of the recent inhabitants.

Turtonia minuta, O. Fab. A few specimens of fine colour. Sometimes taken in great abundance in the living state.

Mytilus edulis, Linn. Several varieties in vast numbers. An individual measured $3\frac{1}{2}$ inches in length. As a living occupant it is extremely abundant.

Modiola tulipa, Lam. Pretty frequent in single valves of large size. Still inhabits the harbour.

Nucula nucleus, Linn. Somewhat frequent, and of large dimensions. Belongs to the fauna of the neighbourhood.

Leda caudata, Don. A single valve. Not found in the bay in the recent state.

Lima hians, Gmel. A number of detached valves. Dredged living also.

Pecten varius, Linn. Frequent. Now a well-known inhabitant.

P. maximus, Linn. Diffused abundantly, and present examples of all ages. Not unfrequently brought to market from the neighbourhood.

P. opercularis, Linn. In large numbers. Excellent examples dredged in the living state.

Ostrea edulis, Linn. In innumerable myriads, and several beautiful examples of the var. *parasitica*. The market is supplied by their descendants.

Anomia ephippium, Linn. Appeared abundantly. The bay still contains the species in numbers.

Patella vulgata, Linn. One specimen only. In suitable localities nothing could exceed the abundance of this mollusk at present.

Trochus cinerarius, Linn. Distributed in some numbers. The harbour still retains its presence in abundance.

T. magus, Linn. Occurred sparingly. Abundant as a living species.

Littorina littorea, Linn. Diffused in vast quantities. It still exists in the bay in countless myriads.

L. rudis, Don. Occurs but seldom. Lives in the harbour in abundance.

L. tenebrosa, Mont. Rather frequent. Enumerated in the fauna of the neighbourhood.

L. littoralis, Linn. Found pretty often. Extremely prolific in the bay.

Lacuna crassior, Mont. Distributed in some numbers. In the harbour it is still a living species.

Rissoa labiosa, Mont. Frequent, and in company with *Cerith. reticulatum*. In the harbour it still abounds.

R. ulvæ, Penn. Was common. Is thrown upon the shore in the living state in multitudes.

Turritella communis, Riss. Exceedingly abundant in the deposits. One specimen was $2\frac{3}{4}$ inches in length. It still lives in the harbour.

Aporrhais pes-pelecani, Linn. Was frequent. Still an inhabitant.

Cerithium reticulatum, Da Cos. Perhaps the most abundant shell in the beds. Still a member of the fauna of Belfast.

Scalaria Trevelyana, Leach. A tolerable number. Not present in the living state.

Eulima subulata (?). An individual of this genus was met with, but is now lost, and is doubtfully referred to the species *subulata*, which occurs at present in the neighbourhood.

Odostomia eulimoides, Hanl. Was met with sparingly, not at all corresponding to its present numbers.

Natica nitida, Don. Was found frequently. It is in the harbour as a living species.

Murex erinaceus, Linn. Was constantly met with. It occurs abundantly in the bay.

Purpura lapillus, Linn. In considerable numbers. It still lives there in great abundance.

Nassa reticulata, Linn. Fine examples very common. A prolific inhabitant at present.

N. incrassata, Müll. In exceeding abundance. Its presence still diffused through the bay.

Buccinum undatum, Linn. Very abundant. One specimen of the carinated var. Still an inhabitant.

Fusus antiquus, Linn. Occurred sometimes. Lives in the harbour.

Cypræa Europæa, Mont. A single imperfect example. Dwells now at the mouth of the bay.

Akera bullata, Müll. A specimen or two only. Sometimes thrown in now in vast numbers.

Scaphander lignarius, Linn. A portion of a full-grown shell. Still an occupant.

Philine aperta, Linn. Abundantly present. The harbour still retains it.

Helix rotundata, Müll. Was found once. In its usual abundance near the town.

H. nemoralis, Linn. Occurred once. Common all round Belfast.

Creusia verruca, Leach. Two or three specimens. Enumerated in the fauna of the locality.

Balanus. Two forms of this genus occurred. Both forms recent in the bay.

Pectinaria Belgica, Pall. Met with on one occasion. Common in the harbour.

Serpula triquetra, Linn. Was frequent. Constantly met with in the living state.

Eighty species in all, examples of nearly all of which are preserved in the author's cabinet. Those species which usually present colouring have preserved it in a striking degree. The great size generally attained is also remarkable. The shells which were in the greatest abundance were those of edible Mollusca, a fact which evidences such design as to suggest the beneficent Author of Nature as the Cause of it.

On the Lower Members of the Carboniferous Series of Ireland. *By* Richard Griffith, *M.R.I.A., F.G.S.*

Having briefly glanced at the carboniferous series, as it occurs in various parts of Ireland, he proceeded to describe the yellow sandstones and carboniferous slates, which, he said, are best developed in the north coast of the County Mayo, extending, in a western direction, to the undulating quartz rocks and mica-slate at Ballinderry, and in the north of Ireland, in the counties of Londonderry and Donegal. In the north, the series is altogether about 6000 feet thick, 3000 feet belonging to the carboniferous limestone, and 3000 to the slate and yellow sandstones, so that altogether the series is about 6000 feet in thickness. The first members of the series consist of beds of yellow sandstones, with occasional alternating layers of whitish and greenish coloured shales, red sandstones, and limestones. The beds contain a great number of fossils; and it is a remarkable fact, that fossils of the same character occur in each, and are found from top to bottom. The limestone alone contains upwards of 90 species, some remarkably curious specimens of which were shown by the author; and in the yellow sandstone there is a large number, including fish-beds and plants, such as were first discovered by Col. Portlock at Moyola in the County Londonderry. Mr. Griffith next directed attention to various sections in the County Dublin, in which he pointed out the carboniferous slate beds as having a stratification consisting of impure argillaceous limestone, and perfectly distinct in character from the lower limestone; and also to sections in the County Waterford, in which the old red sandstone is found resting unconformably on the Silurian rocks, with carboniferous slates and yellow sandstone below it. He conceived, that what he called the carboniferous slate and yellow sandstone might belong to the carboniferous limestone.

Notices of the Geology of Ireland. By RICHARD GRIFFITH, *F.G.S.*

Mr. Griffith directed attention to the map of the geology of Ireland, on which he had been so many years engaged, and to the improvements which he had been enabled to make on it since 1838, acknowledging with thanks the services rendered to him by Col. Fordyce, and Messrs. Bryce and M'Adam. On looking at the map, it will be found, he said, that the conformation of Ireland is peculiar, the coast being mountainous and the interior flat. Taking the line from Dublin to Galway, which is 120 miles, the summit level is seen to be only 160 feet above the level of the sea; hence it is that our canals and railways have been made at an expense so comparatively trifling. Lough Allan, which may be considered the source of the Shannon, is 160 feet above the level of the sea; while between Killaloe and the tide water at Limerick, a distance of about 12 miles, the fall is only 110 feet. The average fall is less than six inches to the mile, a circumstance to which we are to attribute so many sluggish rivers, and the existence of large tracts of country flooded during six or nine months in the year. The mountain ranges which indicate the strata of Ireland run in the north from north-west to south-east, and in the county of Cork from nearly east to west.

Beginning with the foundation and going to the top, it may be said that the mica slate, which forms the basis of all the sedimentary rocks of Ireland, occurs in abundance in the counties of Londonderry and Donegal, where it is found twisted and contorted in every direction by the protrusion of the granite. Mr. Griffith next alluded to the stratifications in the counties of Mayo and Galway, which, he remarked, were chiefly composed of mica-slate, granite rock, and limestone. Granite also occurs to the north of Galway Bay, where it is succeeded by metamorphic rocks and mica-slate. To the north of the grand boundary several granite rocks occur, protruding through the mica-slate and limestones. In this district there appears the green marble, which is only limestone metamorphosed by the action of the granite.

Passing northward, the mica-slate is found covered by Silurian rocks. These rocks contain numerous fossils belonging to the Silurian system, and are succeeded by enormous masses of conglomerate, containing large pebbles of grey granite, some of them nearly a ton in weight, and perfectly rounded. The granite thus observed is quite distinct in its character from the granite of the district, and clearly enough belongs to an older period. The thickness of the Silurian strata, including the conglomerate, may be set down at about 5000 feet. The speaker next alluded to the slates and Silurian ranges of the promontory at Dingle, in the county of Kerry, and described similar formations in the counties of Waterford, Wexford, and Wicklow. To the north of Dublin there is another slate district, similar in character to that of Wicklow and Wexford, and probably belonging to a lower Silurian series, though, as no fossils have been discovered in it except at the south portion, its exact age remains undetermined. This is accompanied with the granite at the Mourne Mountains, which Mr. Griffith conceives to be newer than the slate. One of the most interesting Silurian districts in Ireland occurs near Pomeroy, in the county of Tyrone.

Mr. Griffith next described the Old Red Sandstone, particularly alluding to the large district which occurs in the county of Tyrone, and which, apparently, has some relation to the Silurian district at Pomeroy; and then pointed out on the map several mountain ranges which are capped by the deposit, particularly the Galtees and Knockmeledown mountains, Slievenish, in the west of Kerry, and districts north of the county of Cork. Mr. Griffith remarked that the old red sandstone is succeeded by the great mountain limestone district of Ireland, which occupies two-thirds of the entire country. The carboniferous limestone series, he observed, is altogether about 6000 feet thick, 3000 feet of which belongs to the lower portion of the series, and 3000 to the upper.

He next described the several coal districts of Ireland, commencing with Ballycastle, at Fair Head, on the north coast of the county of Antrim. This district, which is of greater antiquity than any other in Ireland, had, he remarked, been worked to a considerable extent. The coal was worked by tunnels, and the beds, which were affected at different elevations by the protrusion of dykes of greenstone, have been nearly worked out, though at Murlough Bay, which contains bituminous coal, or stone coal, there are some beds, whether exhausted or not he had not information to enable him to say. The next coal district is that situated near Coalisland, in the county of Tyrone. It is very small, and the beds are now nearly all worked out. A third occurs in Leitrim, Cavan, and Roscommon, stretching to Lough Island, which contains only one bed, not exceeding two feet in thickness, though in this locality there is the site of the Arigna iron-works, which, though they are not worked at the present time, formerly attracted much attention in this country. The shale accompanies the coal with rich beds of argillaceous ironstone, some of it containing so much as 40 per cent. of iron; indeed, the iron that was made at Arigna was found to be of very superior quality.

Mr. Griffith next described the Kilkenny coal district, which contains, he said, an unflaming coal, or mineral charcoal alone. There are several beds in this district, two of which are three feet in thickness, one four feet, and two less than three feet. The upper beds have been long since worked out; the lower ones still remain, though they are so impure in quality, and contain so much sulphur, that they are not used except to burn limestone. The Munster coal district was next dwelt upon. It occupies a considerable portion of Clare, Limerick, Cork, and Kerry, and contains three beds, some of which are not more than six inches in thickness. The most valuable portion is found at the south, immediately to the north of the river Blackwater, where several excellent beds of anthracite occur.

Having remarked that he would not say that a valuable coal bed would not be found in Ireland, though he believed that no such coal would be had in the country as is to be found in England, Mr. Griffith proceeded to the New Red Sandstone. The new red sandstone, he said, is very sparingly developed in Ireland. The most southern locality in which it is found is at Carrickmacross, in the county of Monaghan, where, in sinking through it to obtain coal, a bed of gypsum, 40 feet in thickness, was discovered; and the districts in which it is found most extensively are in the counties of Tyrone and Antrim. In Tyrone, it adjoins the coal district, and rests upon it. It also occurs in the valleys of the river Lagan, in the counties of Down and Antrim, continues under Belfast, and again displays itself at Carrickfergus. The strata contain gypsum in thinner beds, however, than those mentioned as occurring at Carrickmacross. Some time ago, when sinking through it to obtain coal, a bed of salt was discovered.

The new red sandstone is covered by the lias, which is similar to that in England, and this again by the chalk, which in the north of Ireland is called white limestone, owing to being more dense than the chalk found in England. The chalk is covered by tabular trap, which occupies a large portion of the counties of Antrim and Derry.

Mr. Griffith next explained the position of the tertiary beds, remarking that an interesting tertiary district occurs in the south side of Lough Neagh, in the counties of Tyrone and Down. It is ten miles in length and four in breadth; a bore was made through it, to the depth of 300 feet, with a view to obtain coal, and the strata were found to consist of alternations of white ironstone and blue clay, with surlurbrand, or wood coal—a series similar to that at Bovey, in Devonshire. The level of the bore, which was situated not far from the coal-field, and adjoined the coal district, was about 70 feet above the level of the sea; and, as the boring itself was 300 feet deep, the depth of the series was 230 feet below the level of the sea, though even at this distance it was not penetrated. Mr. Griffith next alluded to the tertiary districts situated on the coasts of the counties of Wicklow, Wexford, and Waterford, and concluded by a view of the eskar hills and diluvial gravel which cover so large a portion of Ireland, and which appeared to him to have been produced by currents setting in from the north-west towards the south-east.

On the Fossil Remains of the Lower Silurians of the South of Scotland, and their Position. By ROBERT HARKNESS.

The occurrence of fossil remains amongst the deposits known to the earlier Scotch geologists by the name of transition, was a circumstance which excited considerable attention even in the days of Hutton and Playfair. The locality from whence these were procured was Wrae in Peeblesshire, and this spot for a long time was regarded as the only source which afforded organic remains amongst the Silurians of Scotland. Since these deposits have been discovered to be of the Lower Silurian age, they have furnished fossils in considerable abundance.

Prof. Nicol has, from the slate quarries of Greistone and Thornielee in Peebleshire and Selkirkshire, obtained Graptolites; Mr. Carrick Moore, at Cairnryan, has procured the same fossils; Prof. Sedgwick at Moffat also obtained Graptolites; and Sir Roderick Murchison, in the last year's volume of the Journal of the Geological Society, has given an elaborate account of the Silurians of the south-west of Ayrshire and their fossil contents. These Silurians, described by Sir R. Murchison, occupy a higher position than those which constitute the great Silurian mass traversing the South of Scotland from sea to sea.

In Ayrshire a deposit of limestone makes its appearance, which, both in lithological characters, and also in its fossil contents, shows an affinity to the limestone of Wrae, and above this limestone several deposits containing large quantities of fossils occur. The nature of the fossil contents of this limestone and that of Wrae indicate that they appertain to the Llandeilo flags. At Wrae this limestone is seen lying upon a breccia composed of fragments of slate, and at the same locality thick beds of the slate, from whence these fragments have been obtained, are also seen. This slate extends east-north-eastwards and west-south-westwards, and is seen at Stobo in Peeblesshire, and in the summit-cutting of the Caledonian railway, where it shows great thickness. From thence it extends westwards through Lanarkshire and the north-east of Dumfriesshire to Cairn Ryan in Wigtonshire; and in this black slate Mr. Carrick Moore found Graptolites and other fossils. To the south of the zone occupied by these black slates, beds of greywacke, sandstones and shales are found, having great thickness; and beneath these a band of gray slate is met with. In this gray slate are seen, in some localities, the graptolites described by Prof. Nicol, and this gray slate band runs nearly parallel with the black zone. Besides Graptolites, it affords annelid markings and fucoids, both of which are found in considerable abundance at Barlae quarry in Kirkcudbright. Southward of this gray slate the graywacke sandstones and shales again make their appearance, and in them there occurs a deposit of green and blue shales, which also contain annelid markings. Beneath these green and blue shales, after a considerable thickness of graywacke sandstone is passed through, beds of soft black shale are seen having abundance of Graptolites, of various species, and this graptolite-shale passes into anthracitic shale, in some localities consisting altogether of the latter mineral. Under the anthracite, graywacke sandstones and shales are again seen, and these appear to form the lowest beds of the lower Silurians, as they occur in the South of Scotland. In these low shales evidence of animal life is seen in the form of annelid impressions, and these are probably the lowest traces which have yet been obtained of animal existences. The lower beds of greywacke sandstones and shales, the anthracite band, and the accompanying graptolite beds, as well as some of the deposits which succeed them, are repeated three times in that portion of the area occupied by the Silurians, where they are best developed, viz. in Dumfriesshire. The gray shale, and the beds which succeed it, together with the higher black slates and breccia, do not appear to be repeated like the deposits which occur beneath them, consequently the order of sequence of the deposits in these lower Silurians is somewhat disturbed. However, between the Beatock station of the Caledonian railway and Elvanfoot a comparatively perfect sequence may be made out, by examining the sections on the line of railway and the brook courses which fall into the Evan, the stream which runs parallel to the Caledonian railway. At Ruttenside near Greskin, about four miles above the Beatock station, the anthracite is seen in the Evan water, and this can be traced E.N.E. to Hartfell, and from thence into Peeblesshire and Selkirkshire. North from Ruttenside the greywacke sandstones and shales, which lie above the anthracite, make their appearance; and at Rae-cleugh, near the line which separates Dumfriesshire from Lanarkshire, the gray slates were seen, which contain the Graptolites at Greistone, and the annelid markings and fucoids at Barlae. Following the railway northwards from Rae-cleugh, we come upon the greywacke sandstones and shales, which separate the gray slates from the black slates which occur above them; and these at the summit-cutting are succeeded by the black slates, which at Cairn Ryan afford Graptolites and other fossils. The hills of Crawford in Lanarkshire, which rise to the north of the black slate band, are composed of the breccia already alluded to; but the thickness of this breccia cannot be made out here, nor is it seen to be succeeded by the limestone containing Llandeilo flag fossils, as at Wrae in Peeblesshire. This section on the Caledonian railway is more than six miles long, and from the great inclination of the beds, which are rarely less than 70° N.N.W., it would seem to afford a series of deposits about 25,000 feet in thickness; and by taking the conglomerate which lies below the limestone, and the deposits which occur beneath the anthracite beds, it is probable that we may add 5000 feet more to the Silurians which occur below the limestones containing fossils similar to the Llandeilo flags, making in all a total thickness of 30,000 feet of strata through which four distinct bands of deposits containing fossil remains are scattered.

From the mineral character of these Silurians, and also from their occurrence below the limestone with lower Silurian fossils, it would seem that the great bulk of the Scotch Silurians are about the equivalents of the Longmynd beds of the governnment geologist, as shown in North Wales. But the Scotch deposits have, however, one feature which the Longmynd beds do not possess, viz. organic remains, and they are of such thickness as to indicate that in them are contained some of the lowest forms of life, not only as regards the relation of the fossils to animals generally, but likewise as respects geological position.

With regard to the fossil contents of these lower Silurian beds, these are remarkably simple, and at the same time very characteristic. Graptolites of various species are the almost exclusive fossils, and they abound more in the lower beds than in the higher strata. In the shales which lie above the anthracite they occur in great profusion, and are the exclusive fossils of this deposit. Here, too, the greatest amount of species is obtained, as well as the greatest abundance of individuals; and as respects the latter, I know of no deposit in the whole range of the geological formations which can be compared with these black shales, so far as quantity of fossils is concerned.

Although these low beds are characterized by this group of fossils, it is not sufficient to give to them a division distinct from the lower Silurians. Graptolites in some districts occur in considerable abundance, above beds which are marked by lower Silurian trilobites, as in Bohemia. Some species of Graptolites extend upwards into the upper Silurian, amongst which is the *Graptolites priodon*, Bronn; and this species is found in great quantities in the lower Silurians of Scotland, at Greistone, in the gray slates. But although I have examined many thousand specimens from the soft black shale above the anthracite, I have never been able to detect this common Graptolite.

On the occurrence of Graphite at Almorness Head, Kirkcudbrightshire. By Robert Harkness.

At Almorness, a headland which lies on the west side of the entrance of the estuary of the river Urr, in the stewartry of Kirkcudbright, graphite occurs. This headland consists principally of syenite and patches of metamorphic lower Silurians. The syenite is a portion of that which extends from Criffel, a mountain on the south-east of Galloway, along the southern margin of the county, and crossing the estuary of the Urr, makes its appearance on the western side. In this syenite the felspar is commonly of a white colour; but when the syenite approaches the Silurian rock, the felspar becomes reddish, giving the syenite a flesh-coloured tint. This is the case with that portion which forms the headland of Almorness, and through which veins of quartz traverse. In one of these, which occurs on the south-west side of the headland, the graphite is found. This vein, which is about 4 feet wide, has the graphite disseminated through it. It likewise appears on the syenite in contact with the quartz vein. It has been urged by some of the German chemists, that the presence of plumbago in igneous rocks is due to the decomposition of carburetted hydrogen, which, passing over matter through veins in a red-hot state, has been decomposed, the result being the deposition of the carbon, which, uniting with iron in the rocks, appears in the form of a carburet of iron. So far as regards the former occurrence of carburetted hydrogen in connexion with the rocks which have been elevated by the irruption of the syenite in this locality, this is a circumstance extremely probable. In the Silurians which occur to the north of the district occupied by this syenite, there are seen extensive beds of anthracite; and these beds of anthracite, when acted on by gneous matter previous to their becoming anthracitic, would afford abundance of hydrocarbons.

Amongst the Silurians which are contiguous to the syenitic district, and which are much metamorphosed and chloritic, there occur beds, which, from their structure and position, appear to have originally been anthracite, but which now contain no traces of carbon. Probably the action of the igneous rocks on these beds may have been the means by which the carburetted hydrogen was obtained, and the passage of this through red-hot veins may have produced the graphite at Almorness Head.

An Account of the Researches of German Geologists. By H. HENNESSY.

On Devonian Rocks in the South of Ireland. By J. BEETE JUKES, *F.G.S.*

The object of the following paper is, first of all, to bring before the Section the physical facts connected with some very remarkable fossils discovered by the Geological Survey of Ireland during the past year; and secondly, to take the opinion of the Section on a difficulty that has arisen as to the classification and nomenclature of the rocks.

For the first part of the paper, a description of the structure of the south-east part of the county of Kilkenny will suffice; for the second, the description must be extended from Kilkenny through Waterford into Cork.

[Mr. Jukes then described this portion of the southern part of Ireland from Mr. Griffith's map, of the general accuracy and admirable character of which he spoke in high terms, and from some enlarged sections copied from those constructed by the Geological Survey.]

In Kilkenny, the total thickness of the rocks between the mountain limestone and the Silurian and granite does not exceed 1000 feet. In the neighbourhood of Knocktopher, south of Thomastown, these rocks are principally composed of red slates and sandstones. The mountain limestone has some beds of dark shale interstratified with its lower parts, beneath which are some brown and yellow sandstones, containing casts of bivalve shells; these do not exceed 150 feet in thickness, and below them are about 300 feet of red slates, with a few yellow sandy beds occasionally, when we come to some alternations of red and green "slate-rock," a smooth fine-grained argillaceous sandstone without cleavage. In these greenish beds are some large slates containing ferns, and also casts of some large bivalve shells resembling *Anodon.* These fossils were discovered by Mr. Flanagan, fossil collector to the Survey, the country being mapped, and the details of its structure made out by Mr. Andrew Wyley, my able and zealous colleague on the Geological Survey, a native of Belfast, and who I regret is not able to be present on this occasion. These red and green beds are about 100 or 150 feet in thickness, and below them are about 350 feet of red slates and argillaceous sandstones, below which are 100 feet of coarse conglomerates, resting on the subjacent Silurian and granitic rocks.

Reckoning from the base of the mountain limestone to the latter, the beds containing these fossils are about in the middle of the included series:—

In the north part of the County of Waterford, near Carrick on Suir, for instance, we get below the mountain limestone,—

	Feet.
Thin-bedded yellow sandstones and greenish and yellow shales........	150
Alternations of yellow sandstone and hard red shale, often cleaved	350
Red shales and sandstones with conglomerates, fine at top, and getting coarser as we descend	1800
	2300

In other parts of Waterford further west, these beds thicken out to a total of 4500 feet, of which the upper, consisting of yellow sandstones alternating with red shales, is about 900 feet.

In the northern part of County Cork, about the south flank of the Galtee Mountains, and thence to Fermoy, we get a similar section, consisting of,—

	Feet.
Yellow sandstones alternating with red shales and slates	500
Red shales or slates, and red sandstones, with an occasional band of yellow sandstone	400
Red sandstones and slates passing downwards into thick red sandstones and conglomerates, resting unconformably on lower Silurian........	2500

In the central part of County Cork the lower part of the formation is not seen, but the rocks immediately below the mountain limestone still consist very largely of yellow sandstones, split up not only by red shales and slates, but also by blue and gray shales cleaved into slate. In these bluish slates are found casts of marine shells.

Hitherto, in North Cork, North Waterford, and Kilkenny fragments of plants have been the only things found in the yellow sandstone.

As we go south, the blue and gray slates increase in quantity at the expense of the yellow sandstones, till south of Cork, especially near Monkstown and Carrigaline, we get the following section:—

		Feet.
Dark gray shales and slates, with occasional bands of greenish-gray grit		400
Brown sandstone, sometimes calcareous, and containing casts of *Cucullæa*?		50
Dark gray shales and slates, weathering brown or yellowish, with occasional bands of hard sandstone, all more or less affected by slaty cleavage	from to	600 1000
Red and green slates alternating	about	300
Red slates, with an occasional band of yellow sandstone		500
Red slates, with gray or purple sandstones, without reaching the base of the formation		2000
		4850

We here lose the yellow sandstone altogether, and get below the mountain limestone, a great series of slate rocks with interstratified beds of sandstone, the prevailing colour of the upper portion being gray, and of the lower red, with alternating beds at their junction, marine fossils being found in the upper part, and no fossils at all in the lower.

Still further south, about Kinsale, these upper beds acquire a still larger development, being at the very least 6000 feet thick, without seeing anything like the base of them, and without any certainty of our having seen the top. Of this part, as we have not yet completed the survey, I cannot enter into details; I have however received a letter from my colleague, Mr. Wilson, in which he tells me that the following section is admirably seen in Courtmacsherry Bay:—

	Feet.
Blue calcareous shales, with occasional thin bands of limestone and blue slates, with a few grit beds	2100
Blue slates, with greenish-gray grits predominating below	1700
Yellow sandstones with shale partings	800
Red and green slates passing down into red slates and sandstones	1500
	6100

We here get the yellow sandstone coming in again just above the red rocks, having a vast series of blue and gray shales and slates above it, bearing out Mr. Griffith in his threefold division of carboniferous slate, yellow sandstone and old red. The difficulty we experience in the field is, that all these rocks are so blended at their junction by alternation one with another through several hundred feet of thickness, and are near their junction, and generally, except in particular spots, so devoid of fossils, that we cannot hit upon any characters to enable us to draw a clear boundary between them. Starting with the old red sandstone, and calling that Devonian, there are no physical characters whatever enabling us to draw a boundary until we come to the base of the mountain limestone. We have therefore hitherto found ourselves compelled merely to make a shaded outline, including the upper beds, namely, the carboniferous slate and yellow sandstone of Mr. Griffith, looking on them in the light of the upper portions of the old red sandstone. If we can so consider them, we get the following remarkable result; that on the east, where the old Devonian land lay, as proved by the conglomerates, the old beaches of that formation, we find remains of terrestrial plants and freshwater shells; while on the south and west, where the rocks get finer-grained, and where therefore the finer silts and muds were deposited further from the land, or in the deeper water of the sea, there we get marine shells coming in, and we find the whole formation gradually thickening in that direction, swelling out from 1000 to upwards of 6000 feet. This increase of thickness, though it seems great, is nothing remarkable, since to acquire it, it is only necessary to suppose that the old sea bottom deepened very gradually, its bed inclining at no greater angle than 1°, or 17 in 1000, or 89 feet (14 fathoms) in a mile, if we take the distance from Knocktopher in Kilkenny to Kinsale; or if we supposed that the thickness of the whole rocks doubled (from 3000 to 6000) between Cork and Kinsale, a distance of 20 miles, the slope of the bottom would not amount to 2° or 35 in 1000, or 184 feet (30 fathoms) in a mile.

On the Permian Fossils of Cultra. By Professor WM. KING, *Queen's Coll., Galway.*

Before noticing the fossils*, Prof. King made a few observations on the rocks forming the Permian system of the north of England. This system is so called from an extensive division of the Russian empire bearing the name of Perm, and situated on the western flanks of the Ural mountains. The name was originally proposed by Sir Roderick Murchison, who was the first to show that the rocks occurring in that region are of the same age as certain magnesian and fossiliferous deposits largely developed in the county of Durham. The name 'Permian' has consequently been applied to the last-named deposits, and on the same grounds it must also be applied to corresponding rocks wherever they may exist. The Professor proceeded to prove that the remarkable patch of magnesian limestone occurring at Cultra, on the shore of Belfast Lough, is a member of the Permian system, the fossils it contains being identical with the *Schizodus Schlotheimi, Pleurophorus costatus, Bakevellia antiqua*, and other species common to the Permian rocks of England and Germany.

On the Mines of Copiapo. By Colonel LLOYD.

Report on Crag Formations and Coprolites. In a Letter from Mr. LONG.

On the Fossiliferous Beds of the Counties of Antrim and Down. By JAMES MACADAM, *F.G.S.*

These beds were described in descending order. The town of Belfast is in a great measure placed upon deposits of sand and silt that have been formed in the estuaries of the rivers Lagan and Blackstaff. Great quantities of shells have been found in these beds, and a list of them was laid before Section D, at the present meeting of the Association, by Mr. John Grainger. They are all of species now existing, but some are not found at the present time living in the bay. These shells occur at levels, none of which seem to exceed that of present high water. Beds of shells, however, are found at various elevations. At the Kinnegar of Holywood, four miles down Belfast Lough, beds of shells similar to the above occur at elevations from 10 to 20 feet; and on the opposite side of the bay, below Carrickfergus, a shell-bed occurs in a like position. On both sides of the bay other beds may be observed from 60 to 80 feet above the water with similar contents; and they are found also at some distance inland, up the valley of the Lagan, and in the valley running from Belfast to Comber. In the latter valley there is a branch of the County Down Railway, and during its formation many shells were obtained from the cuttings. It is also worthy of being recorded, that in a cutting near Comber rolled lias and chalk fossils were found, the nearest beds containing such fossils being behind Belfast, and at a distance of ten miles. Beds still more remarkable occur at elevations from 100 to 150 feet. One of these, at the Belfast Water-works, on the Antrim side, was examined by Messrs. Hyndman and Bryce in 1842, and an account of it was copied into the Appendix to Col. Portlock's 'Geological Report on Londonderry.' Another bed, precisely similar, was discovered by Mr. MacAdam in 1850, at the Knock on the Down side. The most abundant shell in it is the *Nucula oblonga*, and the deposit may be perhaps considered as belonging to the newer pleiocene. Some years ago, Mr. Smith, of Jordan Hill, described a shell-bed occurring at Port Rush, ont he northern coast of Antrim; it occurs at an elevation of 10 feet, and contains a great variety of recent marine shells mixed with some land ones; a list of them is printed in Portlock's 'Report.'

In Belfast Lough there are deposits of submerged wood, in one of which, near Carrickfergus, hazel-nuts have been obtained, having their kernels replaced by carbonate of lime: this fact had been remarked by the late Dr. M'Donnell, and a note of it is entered in the 4th volume of the Geological Transactions. Throughout the

* The Cultra fossils were noticed by Dr. Griffith in a paper read at the Cork Meeting of the British Association (vide Report Brit. Assoc., 1843, part 2. pp. 45 and 46).

county of Antrim deposits of lignite frequently occur, as around the shores of Lough Neagh, at Carnaghliss, between that lake and Belfast, at Libbert near Glenarm, at Kiltymorris and at Ballintoy: associated with them is an impure fire-clay. At several of these places the lignite is covered with trap, proving that this trap is of tertiary or post-tertiary age, as the wood from which the lignite has been derived was in all likelihood coniferous. There is also lying under the trap in different parts of Antrim considerable beds of ochre, which sometimes contains thin seams of impure lignite. It has been long known that at Lough Neagh, in the alluvial covering that lies upon the lignite beds, there are found many pieces of silicified wood, sometimes of a considerable size. Between the trap and the subjacent chalk there is very generally a bed, varying from a few inches to a few feet, consisting in many places of iron-shot clay and loose flints, and in others of a grayish clay, like impure fire-clay; in this last case it sometimes contains lignite.

The Chalk of Antrim contains a number of fossils resembling in a great measure those obtained from the same formation in England. The upper beds of the Antrim chalk are not so prolific in organic remains as the under, which are mixed with particles of greensand; under these lower beds, and quite conformable to them, are beds resembling the Fire-stone of Surrey, and lowest of all is a soft bed of pure greensand. In the upper strata of pure chalk the prevailing fossils are some species of *Belemnites, Ammonites, Pleurotomaria, Terebratula* and *Turbo*; also several kinds of Echinodermata and Sponges, which fossils not unfrequently are found also in the imbedded flints. In the lower or chloritic chalk are remarked, in addition to the above, *Arca, Avicula, Inoceramus, Natica, Ostrea, Pecten, Pholadomya,* and *Trigonia*; and the same are observed even in greater abundance in the subjacent fire-stone. Some fine specimens of *Ostrea carinata* have been got in the fire-stone, to which rock this fossil seems to be confined; also the *Exogyra Columba* appears in it in great numbers, and rarely in the upper or lower beds. The *Exogyra lævigata* is very abundant in the lowest bed of soft greensand, where it is often the only fossil to be met with: in this lowest bed there is less variety of organic remains than in the others; from it however were procured some teeth and bones of Saurian animals by Mr. MacAdam; and in the Philosophical Magazine for 1831, there is an account of the discovery of saurian vertebræ near Belfast, in lias, by Mr. Bryce; but it has since been ascertained that they had been found in the soft greensand bed which immediately overlies lias. Teeth of the Shark family, sometimes very perfect, occur in all the beds from the upper chalk to the pure greensand, and some obscure remains of entire fishes of a small size; also portions of crustacea, and several zoophytes. In some places fucoids were got in the fire-stone, and small pieces of fossil wood in the soft greensand. These lower beds are apparently equivalents of the upper greensand of England.

Thin beds of lias underlie the greensand, but not everywhere, as they are wanting in various localities. This lias abounds in organic remains, almost identical with those of the same formation in England. In the beds near Belfast there are several ammonites, and great numbers of the *Cardium striatulum,* with a few other fossils. In the beds near Larne the same fossils are found, and a great variety of others, as the *Gryphea incurva* and *obliquata, Plagiostoma giganteum* and *punctatum, Pachyodon, Mya, Amphidesma, Pecten, Mytilus, Modiola, Arca, Lutraria, Avicula, Trochus, Turritella,* &c.; also numerous fragments of the *Pentacrinus.* At Larne a bed of oolitic structure rests upon lias, and in it are found *Avicula contorta* and *Lima Proboscidea,* with some others. At Ballintoy, on the north coast of Antrim, there is a lias deposit very rich in fossils, several of which are described in Portlock's 'Report:' several new ones have been obtained by Mr. MacAdam from that deposit, some of which seem not to have been as yet described. In the beds at Larne and Belfast several fish remains were obtained, and a few saurian vertebræ. The hardened lias of Port Rush has been often described; it contains many fossils, but they are not easy to determine from their obliteration; in all probability they are nearly the same as those found at Ballintoy.

Mr. MacAdam has discovered, resting immediately on the variegated saliferous marls of Woodburn, near Carrickfergus, a bed containing many fish remains, among which were recognized the *Gyrolepis Albertii* and *tenuistriatus* and others, which have been referred to the upper parts of the Trias. In the marls and subjacent sandstones no fossils have as yet been discovered.

On the south, or County Down side of Belfast Lough, at Cultra, there are small patches of magnesian limestone, in which are found some shells resembling *Schizodus*. Associated with this limestone are red sandstones, supposed to be equivalents of the rothe-todte-liegende, and containing vegetable remains, as *Calamites*, *Sigillaria*, &c., but often too obscure to determine specifically. Underlying these are soft calcareous shaly beds, in which are many fish remains, generally of *Holoptychus*, and a great number of *Modiola*, with a few other shells.

At Ballycastle and Murlough, in the north-eastern part of Antrim, there is the regular coal formation, from which Mr. MacAdam obtained a variety of fossil plants, but not differing from those of the English coal-fields. There are associated shales in which a *Lingula* is frequently found, and there is underlying carboniferous limestone with the usual fossils. In the County of Down at Castle Espie, near Comber, there is a small patch of carboniferous limestone, remarkable for the Orthoceratites it contains, and several other fossils. On the County Down side of Carlingford Bay there is a deposit of limestone, which in all probability is the same as that which occurs near the town of Carlingford on the south side in the county of Louth, but the fossils have not yet been examined.

No Silurian rocks have yet been discovered in Antrim or Down, but it is not improbable that the like may be detected on more minute examination.

On the Subdivisions of Leptæna. *By* Professor M'Coy.

On the Structure of certain Fossil Fishes found in the Old Red Sandstone of the North of Scotland. By Professor M'Coy.

The Professor exhibited specimens and plates; among others a large species of *Holoptychius*, which he named *H. Sedgwicki*, showing for the first time, the form, number, and position of the vertical fins of that genus. He also dwelt on the anatomical structure and peculiarities in the form of the tail, and the ossification of the vertebral column, which had been supposed to characterize the fishes found in the more ancient rocks, and which had been used by some recent writers in support of the doctrine of "Progressive Development." He pointed out that the structure of the fossils which he treated of disproved these notions, and strengthened the more ordinary geological laws. He described the peculiarities of two new genera, which united the two great groups of Saurodipteridæ and Cœlacanthi.

On the Mode of Succession of the Teeth in Cochliodus. *By* Professor M'Coy.

In this communication the fact was announced that the mountain limestone genera of fossil fishes called *Cochliodus* and *Pœcilodus* by Agassiz, and supposed by him and all succeeding writers to have manifested the most intimate relation to the living Australian shark, called *Cestracion*, had really a strong horny jaw for the support of the teeth, and that these latter succeeded each other vertically upwards, the young teeth appearing under the old ones; while in the living shark alluded to there was no horny jaw, and the young teeth followed the old ones laterally from behind forwards; so that there was no such reason, as generally supposed, for quoting the existence of the *Cestracions* in the Palæozoic rocks. The nearest analogy for the carboniferous fossils was the osseous genus *Placodus* of the Muschelkalk, though it differed in microscopic structure.

On the Structure of the South Silurian Mountains of Scotland. By Professor J. Nicol, *F.G.S.*

On the Occurrence of Glacier Moraines in Arran. By Prof. Nicol, *F.G.S.*

Notice of the Discovery of a new Talpina? *By* C. B. Rose, *F.G.S., Swaffham, Norfolk.*

In the course of last winter, I sent some fossil fish-scales from a species of *Beryx*, met with in the chalk strata, to a person in London, that they might be put up as microscopic objects; he succeeded in setting two: on their return to me, upon examination under the microscope with a power of ¼th, I found one of them extensively ornamented with elegantly ramifying figures, not much unlike coralloid bodies. After perusing Mr. Morris's paper, Ann. Nat. Hist., Aug. 1851, and comparing the figures on my fish-scale with those seen in many of the Belemnites from the chalk at Norwich, I feel persuaded that the figures on both are due to the operations of the same tribe of parasites, and I consider that the dissimilarity in their form is sufficient to warrant my concluding that they are the workings of different species.

Unlike the borings in the Belemnite, which run in straight lines, and frequently inosculate, those in the fish-scale proceed with a graceful curve to their extremities, terminating in a symmetrically-formed dilatation or cell, and they do not frequently inosculate.

I have with some care endeavoured to measure the calibre of the borings, and I believe that it ranges from a 3000th to a 4000th of an inch in diameter. Conceive, then, the infinitesimal tenuity of the organism that formed them. I propose calling this parasite *Talpina Squamæ*.

On the Lowest Fossiliferous Beds of North Wales.
By J. W. SALTER, *F.G.S., of the Geological Survey of Great Britain.*

The great interest always attaching to the search for the oldest types of animal life, has lately been revived by the zealous researches of M. Barrande of Prague, who has discovered and announced in various communications*, a succession of faunas in the Silurian region of that country. The earliest fauna is marked by the presence of peculiar genera of Trilobites, not found in any of the succeeding formations. Such are in Bohemia *Paradoxides, Conocephalus, Sao*; and several other genera of the *Olenoid* type, together with species of *Agnostus*.

A rare Orthis, a Pteropod, and two *Cystideæ*, are all the other forms this naturalist has discovered, after many years of patient labour, in his *region C*.

The publication by Angelin in the 'Palæontologia Suecica,' of a considerable number of Trilobites, confirms these views, and shows the same genera, *Paradoxides, Conocephalus*, and for the most part *Agnostus*, to be confined to the lowest members *A. B.* of the Swedish system, and with them are the long-known species of *Olenus* and the *Graptolites* of the lower alum slates.

In 1851, M. de Barrande paid a visit to this country for the express purpose of comparing the Bohemian fossils with many unpublished forms of this country. He recognised with great pleasure that the "*Lingula flag*" (discovered by Prof. Sedgwick to form the lowest fossiliferous zone in North Wales †) was a most satisfactory equivalent of this lowest stratum *C*.

Lingula Flags.—As all the fossils from these strata collected by the Geological Survey have now been examined, it is thought it will prove interesting to put them upon record, previously to their fuller publication in the Memoirs of the Survey.

The beds in question are largely developed in Merionethshire and Caernarvonshire, appearing sometimes in the form of fine thin-bedded sandstones, and at others of beds of black slates interstratified with coarse sandstone and conglomerate. In Merionethshire they appear at the base of a great igneous series, described by Messrs. Jukes and Selwyn as 15,000 feet thick, and the fossil beds alternate with these volcanic strata throughout their whole extent, at least the *Lingula Davisii*, which is the characteristic fossil, is found from the base nearly to the top.

In the lower part, or the true Lingula flags, the *Lingula Davisii* is associated with *Olenus micrurus*, a new crustacean *Hymenocaris* hereafter mentioned, and fucoids: higher up no fossils have been found except the *Lingula Davisii*; and at the top, but still distinctly in the igneous series, *Lingula* still occurs, probably of the same species, but associated with an *Asaphus*, a *Calymene*, and some *Graptolites*.

For the lower part of this series, which I feel sure M. de Barrande would alone con-

* The latest, and since this paper was read, is that published in Leonhard and Bronn's Neues Jahrb. 1852, p. 257, Transl. in Quart. Geol. Journ., vol. viii. pt. 2. p. 31.

† Quart. Geol. Journ., vol. iii. p. 139 *et seq.*

sider as belonging to the "Etage C," may be cited the following fossils and localities:—

PLANTS.

Species.		*Localities.*
Chondrites, — sp.	Records Mus. Pract. Geol., ined.	Carnedd Ffiliast, a mountain 5 m. S.E. of Bangor.
Cruziana semiplicata, n.sp.	Salter, ibid.	Ditto (specimens more than a foot long, abundant).

CRUSTACEA.

Olenus micrurus............	Salter, Decade 2. pl. 10. of Memoirs Geol. Survey.	Dolgelly; Trawsfynydd; Tremadoc; N. W. of Llanberis.
Hymenocaris vermicauda, new genus.	Salter, Records Mus. Pract. Geol., ined.	Dolgelly; Tremadoc; Pont Seiont, Caernarvon?

MOLLUSCA.

Lingula Davisii.	M'Coy, Ann. and Mag. Nat. Hist. vol. viii. 405.	Dolgelly; Tremadoc; N.W. of Llanberis; Carnedd Ffiliast; near St. Ann's Chapel, Bangor; &c.

One of the most interesting fossils is a large *Paradoxides*, probably *P. Forchhammeri*, Angelin; but most unfortunately the exact locality in North Wales has not been preserved, though there is great probability it comes from the 'Lingula Flags.'

In the higher beds, near the upper limit of the igneous series, Prof. Sedgwick and myself gathered in 1843 the following fossils.

Asaphus Selwynii, n. sp. .	Salter, Records Mus. Pract. Geol. ined.	Hengwrt uchaf, 4 m. N.E. of Dolgelly, a bed of slate in the volcanic ash.
Calymene parvifrons.	Salter, Append. to Prof. M'Coy's Palæozoic Foss. Woodw. Mus. pl. 1. F. f. 7.	Tai hirion, under the trap and volcanic ash-beds of Arenig bach.
Lingula Davisii?...........	M'Coy, *supra*.	Tai hirion; and Llyn-y-Dywarchen, to the west of it. The Geol. Surveyors have also found Lingulæ at Hengwrt uchaf.

Lastly, at Llanfaelrhys near Aberdaron, South Caernarvonshire, in beds which both by position and mineral character appear to be the 'Lingula Flags,' although separated by great dislocations and obscured by drift, the following fossils occur.

Asaphus Selwynii, n. sp., mentioned before.
Lingula attenuata?
———, *broader species.*
Didymograpsus Murchisonæ, and
Graptolites incisus? or a new species.

In all these, except the first list, some doubt may be entertained whether the strata may not more properly be classed with the second division, the 'etage D' of M. de Barrande. The genera *Asaphus* and *Calymene* certainly would indicate it. There is every reason to believe that the *Asaphus Selwynii* is the same species as one common in the lowest Llandeilo flags of Shelve in Shropshire, and as such it is considered.

Therefore, if the zoological demarcations, which are of so much value elsewhere, hold good in England, *it would be proper to draw the line between the fossils which occur at the base, and those near the top of the igneous series.*

Professor Phillips has described a formation of black shales occurring at the base of the Silurian series in the Malvern Hills, which is characterized only by small Trilobites, and these of the genera *Olenus* and *Agnostus*; they are *Olenus humilis*, Phill. Mem. Geol. Surv. vol. ii. pt. 1. p. 55. f. 4–6; *O. bisulcatus*, Ph. f. 1, 2; *O. scara-*

bæoides, Wahl.? f. 3 (*O. spinulosus* ?, Phill.), and *Agnostus pisiformis*, Wahl. Brongn. t. 4. f. 4.

It is quite possible therefore, as suggested by M. de Barrande himself, that these shales may be identical with the black slates of Sweden, and belong to the Etage C.

It should however be observed, in conclusion, that *Agnostus* in England is generally characteristic, not of the first, but of the second zone or true Llandeilo flags; we have at least three species; also that the true position of our *Paradoxides* is not known; that, in the probable equivalent of the 'Lingula Flags' in S. Caernarvonshire, an *Asaphus*, the *Didymograpsus Murchisonæ*, and perhaps *Lingula attenuata*, occur; that the genus *Cruziana*, the fucoid described below, is characteristic of beds in Normandy*, which lie nearly in the place of our *Caradoc sandstone*; and that *Hymenocaris*, the new genus here proposed, belongs to a group of Phyllopod Crustaceans not hitherto described from strata older than the Upper Silurian. Taking all these circumstances into account, it would, I think, be premature to pronounce as to the separate and distinct character of our own lowest fossiliferous zone; and it may perhaps be necessary hereafter to modify the conclusions drawn by so able and successful an observer as M. de Barrande as to the primordial and isolated character of his earliest fossil group; it may be a local, and not a general phænomenon.

It will be borne in mind that the lowest fossiliferous zone in England and Wales is not quite the oldest known. The purple and green schists of Wicklow in Ireland contain Zoophytes or Bryozoa (*Oldhamia antiqua* and *O. radiata*, Forbes), and they have been determined to occupy a similar place with the "Llanberis slates and Harlech grits" of Prof. Sedgwick, which underlie the 'Lingula flags,' and which in Wales and Shropshire are void of fossils.

Notes on the New Forms above mentioned.

I append a short description of the new genus *Hymenocaris*, and the new species of fucoid, *Cruziana*, from the 'Lingula Flags.'

Hymenocaris, new genus.

Carapace ample, semioval, narrowed towards the front, curved downward at the sides, but not angularly bent along the dorsal line; no external eyes; antennæ? of two pairs, short and not visibly jointed; abdomen as long or longer than the carapace, of 8 [or probably 9] transverse segments,—the last with short unequal appendages.

Species 1. *Hymenocaris vermicauda*, Salter, Records Mus. Pract. Geol. ined.

There are four, and may be more appendages to the last segment; for one crushed specimen shows two of them, a short and a long one on the dorsal part of the segment, and two others toward the ventral edge; and it is impossible to say how they may have been arranged.

The number of segments to the body is also not quite certain, though nearly as above stated. One specimen shows the 8 anterior, another the 4 or 5 posterior ones and the appendages. The antennæ? too, are 3 appendages, two longer than the third, proceeding from the front of the carapace: they show no trace of joints.

The genus is evidently related to the living *Nebalia*, and differs markedly from *Ceratiocaris*, M'Coy, by the entire convex carapace, not bent along the dorsal margin. It has, too, a neck furrow running all along the posterior edge. There are no traces of eyes on the exterior of the carapace. The crust was very thin.

Localities. Tremadoc; Dolgelly; North Wales.

Cruziana, D'Orbigny. *Fræna*, Marie Rouault.

C. semiplicata, sp. nov. *C. longa, plus pollice lata, linearis, integra, ad sulcum medianum crebriplicata, extùs lævigata: plicis obliquis, simplicibus aut irregulariter furcatis, ad marginem lævem latum abruptè terminatis.*

It appears to differ from all the published species, in the smooth border, against which the oblique folds terminate abruptly; they very rarely run out into it. The plaits are not always equal, and are sometimes branched and occasionally fasciculate.

Locality. Carnedd Ffiliast, near Bangor, North Wales; Stiper Stones, Shropshire.

* Marie Rouault, Bull. Soc. Géol. France, vol. vii. 1850, p. 725.

On a few Genera of Irish Silurian Fossils.
By J. W. SALTER, *F.G.S., of the Government School of Mines.*

CRUSTACEA.

Among the many new and interesting forms of Trilobites described by Colonel Portlock in his work on Londonderry and Tyrone, a small species of *Asaphus* was recorded from the Lower Silurian of Tyrone, which he named *A. latifrons,* distinguishing it from some other species by the breadth of front included within the curve of the facial suture. The species is very remarkable for the position of the eyes, which are placed very far backward and inward, so as to be close to the *base* of the small and narrow glabella. This peculiarity of habit is associated with some other characters which will remove the species from *Asaphus,* to which, nevertheless, it is closely allied. It has also some relations with *Illænus.*

Stygina, new genus.

GEN. CHAR. *Body ovate and rather flattened. Head and tail large and tolerably equal, body of 9 rings.* Eyes small, placed far backward and inward, near the base of the glabella, which is quite indistinct above, and much contracted below. Facial suture marginal along a wide space in front, and below the eyes curved outwards, and ending on the posterior margin. Angles of head mucronate. *No rostral shield.* Hypostome ? Axis of body narrow. *Pleuræ without a furrow.* Tail smooth with a moderately long axis.

The flattened oval form, long axis to the tail, and head spines, very much resemble *Asaphus* *, from which the 9 ungrooved pleuræ effectually distinguish it. In the obliteration of the glabella, number of body-rings and course of the facial suture, it is closely allied to *Illænus,* from which its habit differs so much; but there is enough of the under side preserved to show that there was no rostral shield, an essential character of *Illænus.*

Species 1. *Head spines short. S. latifrons. Asaph. latifrons,* Portlock, Geol. Rep., Tyrone, &c. pl. 7. figs. 5, 6. *A. marginatus,* ib. f. 7.—*Locality.* Desertcreat, Tyrone, in Llandeilo flags.

Species 2? *Head spines long. S.? Murchisonæ. Ogygia Murchisonæ,* Murchison, Sil. System, pl. 25. fig. 3. *Locality.* Mount Pleasant, Caermarthen, in Llandeilo flags.

The narrow axis and the smooth extremities of this species, as well as the apparent absence of eyes in the middle of the head, render it very probable that we have here a second species of the genus. The facial suture, too, as far as it can be traced, agrees with that of *Stygina.*

The Chair of Kildare, an interesting isolated patch of Llandeilo flags, discovered by Mr. Griffith, contains in some parts of the limestone swarms of a minute Trilobite belonging to the great group of the *Olenidæ,* but referable to no published type. It will soon be figured and described in Decade 7 of the Memoirs of the Geological Survey. In the meantime the characters may be defined as follows:—

Cyphoniscus, new genus.

GEN. CHAR. *Body oval and very convex;* head large and *gibbous; body of 7 segments; tail minute.* Head half-elliptical, the glabella occupying the greater part of it; glabella broadest in the middle, oval, and inflated, without lobes; neck-furrow distinct; cheeks bent steeply downwards, with nearly parallel sides, rather broadest below, the posterior angles square. *Eye-line marginal in front for a space equal to the breadth of the glabella, then running in an oblique line down the cheek, and cutting the exterior margin very obliquely some distance in advance of the posterior angle.* Eyes (minute linear?) very forward; free cheeks narrow and linear. Thorax convex, the axis prominent, and the fulcrum of the pleuræ near it. Pleuræ

* One species of *Asaphus,* described by Portlock, *A. rectifrons,* exactly resembles our genus in the wide marginal extent of the facial suture in front, and in the want of a vertical suture on the under side. But the eyes are in the usual position, and the blunt extremities and broad obscure axis show that this species is a true *Asaphus,* though probably not of the section *Isotelus.*

deeply furrowed, their ends rounded or truncate. Tail small, the axis short of 1 segment, the *sides without furrows*.

The position of the very minute eyes is indicated by a slight indentation opposite the front of the glabella; they must have been linear and small, for there is no visible elevation or appearance of an eye-lobe. In this respect there is some difference between the form under description and the North American genus *Triarthrus*, to which it is, nevertheless, most closely allied. In both genera the eye-line takes the remarkable course above described, viz. in an oblique and almost marginal line from the front to the outer edge of the narrow cheeks, and the furrow which runs along the posterior margin of the cheeks in both genera turns upward towards the termination of the facial suture. *Triarthrus*, too, has the ends of the thorax segments rounded or square, not pointed and recurved as in other Olenoid genera. But the present genus differs in the gibbous form and inflated glabella without lobes, as well as in the fewness of the segments of the thorax, 7 instead of 15 or 16.

Species 1. *C. socialis*, n. sp. Length about a quarter of an inch. *Locality.* Chair of Kildare, in Lower Silurian.

Acidaspis, Murchison.

Of this remarkable genus, one new Irish form has to be added to the list. It was formerly (Mem. Geol. Surv., vol. ii. p. 1. pl. 9. fig. 5) considered by me the same with *A. bispinosus*, M'Coy, a species distinguished by the possession of two spines on the neck. Many species are now found to have this character. The original one, described by Prof. M'Coy, is a minute species with a remarkably inflated glabella, and a sinuated front. It is from the Chair of Kildare.

The new species, of which good specimens occur in Waterford (Lower Silurian), has a wide and somewhat depressed head, with a straight front, and the glabella lobed, and not inflated. It will be figured and described in Decade 7 of the Memoirs of the Geological Survey as *A. Jamesii*.

Æglina, Barrande. *Cyclopyge*, Corda.

This genus, proposed by Barrande to replace the name *Ægle*, which he formerly bestowed on it, exhibits the greatest proportional development of the eyes known in the group of Trilobites. They occupy the entire side of the head to the exclusion of all other parts of the cheeks, and meet in front (as in the case of many insects, especially of the male sex). In this respect *Remopleurides* of Portlock is the only genus that can be compared with it; the genus under notice, however, has the eyes greatly more developed, and with large lenses quite visible to the naked eye; few body segments, and a rounded tail. The genus must for the present be placed near *Asaphus*. Two or three species are known in Bohemia, all Lower Silurian.

A new one, *Æ. mirabilis*, has been found at Portrane, Dublin; and the same, or an allied species, in Anglesea and South Wales. It will be figured shortly in Decade 7, Mem. Geol. Survey.

Remopleurides, Portlock.

As this has just been quoted, it may be well to say, that perfect specimens of *R. dorsospinifer*, Portlock, will also be figured with the above. The remarkable dorsal spine, detected by the discoverer of the genus, is very likely a character peculiar to the male sex, and it is more than probable that *R. Colbii* is the female of the same species. Such appendages characterize the male sex in *Sphæroma*.

In the *Remopl. dorsospinifer*, the possession of this spine, on the 8th segment, is accompanied by a general narrowness of form as compared with *R. Colbii*, but besides this, there is no available means of distinction. Col. Portlock had himself suggested, that two or more of these forms might prove to be varieties of one species, and in this, after careful examination, I fully concur. Again, except in the possession of the lateral appendages (which might be expected in the mature ovigerous female), and in a still greater breadth of form, *R. laterispinifer* does not differ from the two above mentioned. And hence these three forms may be respectively regarded, as the male, and the young and mature female forms of the same species. While suggesting this as probable, and supported by general analogy among the *Crustacea* and other articulate tribes, it would not be advisable to alter the names originally given.

Cyphaspis, Burmeister,

is another example of this dorsal appendage. Several of the species that have been described show something of it when perfect. A fine series of the *C. megalops*, M'Coy, from Dudley, in the collections of Messrs. Gray and Fletcher, have in each specimen a strong spine projecting from the 6th segment, which is the same segment in which they occur in the recent *Sphæroma*.

Encrinurus punctatus, a common Trilobite, has similar spines on the 7th and 10th thorax segments. *Brontes spinifer*, Barrande, and *Sao hirsuta*, ibid, have short spines on every segment.

MOLLUSCA.

The collections in Kildare have also yielded a new and very interesting Cephalopod, of a group common in North America, but not in this country. The genus *Lituites* in America contains a group of closely-coiled species, the whorls being thicker than broad (instead of broader than wide, as usual in the genus), the siphon internal, and the septa waved backwards on the peripheral margin. They are distinguished as the genus *Trocholites*. One of these species, the *Lituites* (T.) *planorbiformis*, Conrad, was found by Prof. Sedgwick and myself at Bala, North Wales. The septa in that have but a very slight backward curvature on the outer margin. A second species, from the Chair of Kildare, is different from either of the American ones. It is easily distinguished by the great depth of the backward curvature of the septa, forming a complete sinus. It may be called

Lituites hibernicus, sp. nov.

Diameter $\frac{7}{8}$ths of an inch, thickness nearly half an inch. Whorls 4 (or 5), their thickness much greater than the breadth. Umbilicus rather deep. The inner whorls much covered by the outer. Surface with faint lines of growth, nearly smooth. Septa rather approximate, and with a *deep* peripheral sinus.

Pterotheca, new genus.

I wish to propose the above name for a remarkable Pteropod mentioned in the Report of the last meeting of the Association as occurring in Canada, Ireland, and Wales. Of this beautiful fossil, originally described from a Tyrone specimen as a smooth Brachiopod, better specimens have been obtained in N. Wales, which show it to have been an animal closely allied to *Cleodora*, but distinguished from it and all allied forms now known by an extraordinary expansion of the sides or wings of the shell. The cavity for the animal is a compressed triangle, as in *Theca*, *Cleodora*, and others of the order; but the dorsal lamina is much elevated above the flat ventral one, and the sides are furnished with a wing-like expansion almost to the curved tip.

Species 1. *Pterotheca transversa*. Sides entire; ventral lamina flat. Syn. *Atrypa transversa*, Portl. Geol. Rep. p. 455: As *Cleodora transv.* Salter, Rep. Brit. Ass. 1851, p. 64.
Locality. Desertcreat, Tyrone.

Species 2. *P. corrugata*, n. sp. Sides lobed, ventral lamina somewhat keeled above.
Locality. Caernarvonshire.

On the supposed Action of Water in Geological Formations, and the Position of the Poles of the Earth. By W. D. SAULL, *F.G.S.*

On the Conditions under which Boulders occur in Scotland. By JAMES SMITH, *F.G.S., of Jordan Hill.*

On Certain Furrows and Smoothings on the Surface of Granite, caused by Drift Sand, at the Cape of Good Hope. By WILLIAM STANGER, *M.D.*

It appears by the observation of the author that rocks are polished by the sand driven by the winds, and exhibit on a smaller scale similar effects to the polishing by glacial action.

On some Peculiarities of Granite in Certain Points of the Pyrenees. By H. Twining.

Notice of a Skeleton of Mastodon angustidens *found near Montopoli. By* Dr. Vallini.

The country of Montopoli is situated on a group of small hills of the pleiocene deposit, which extends north-eastward beyond the Arno, toward the Val di Rievolè, and south-eastward connects itself with the meiocene tracts of the Val d'Elsa, Val d'Era, &c. The hills consist for the most part of masses of yellow sand, deeply excavated by the strong action of water. The sands are often rendered coherent by calcareous cement, and from point to point diversified by gravels of eocene origin. The shells of mollusca lie in different planes, and most plentifully in the lower part of the deposit.

The bones of the Mastodon were found by Dr. Vallini at the depth of about two feet, in the excavation for a drain, and levelling of a small hill in the south-east part of the country of Montopoli. In general they were found in the sands simply indurated, but from place to place in a species of conglomerate of sand and shells cemented by carbonate of lime. All were found on the bedding surface of a sandy bed, mostly arranged with reference to their anatomical relations, and surrounded by marine shells, such as *Pecten pleuronectes, Ostrea denticulata, O. lamellosa, Cardita pectinata, Venus lævis, V. islandicoides.*

The author described minutely the situation of a long chain of dorsal vertebræ in their natural order, directed from north-east to south-west, and connected with the bones of the pelvis; at the opposite extremity of the vertebral series, a large tusk, and near its base the lower maxillæ, one still retaining a molar, the other showing the alveolar cavity. Great part of the cranium was found lying a short distance to the east of the parts already described. To the north-west lay the right femur, and other bones of the leg of the same side; and, two metres removed from the western extremity of the tusk, the left scapula.

A minute description of the dimensions of the bones was appended. The tusk was in length 2·57 metres; its basal diameter 0·17, at the upper end 0·075. There were 20 ribs, mostly preserving their connexion to the vertebral column; the longest 0·88 long, and 0·035 broad. Antero-posterior length of scapula 0·33; its height 0·47. Length of the acromial spine 0·60; its height 0·14. Breadth of the acromial extremity 0·26; of the articular cavity 0·14. Length of the ulna 0·60. Diameter of its humeral extremity 0·28; of its carpal extremity 0·13. Length of radius 0·58. Length of femur 0·87. Breadth from the summit of the articular ball to the trochanter 0·32. Diameter of the articular ball 0·14; its height 0·10. Diameter of lower articulating extremity 0·28; in the middle 0·14. Length of tibia 0·50. Diameter of its femoral extremity 0·20; of its tarsal extremity 0·13.

On the Geological Structure of Spain. By M. De Verneuil.

On the Geology of a Portion of the Himalaya Mountains. By Major Vicary *of Wexford. Communicated by* Sir Roderick I. Murchison.

A coloured section from the plains in the neighbourhood of Umballa, towards the flanks of the Himalaya above Subathoo and near Simla, showed that all the formations, from the youngest tertiary of the tract to the crystalline rocks of the chain, are in highly dislocated positions, some of the younger deposits appearing to underlie others of prior date, probably through the occurrence of powerful faults. Some of the younger tertiary beds with pebbles and fossil bones (the Séwalik strata) are inclined with the older or nummulitic rocks, and are probably therefore of higher antiquity than was supposed. Sir R. I. Murchison passed a warm eulogium on the author, Major Vicary, a brave Irish officer, who, in the wars of Scinde and the Punjaub, had sometimes, even in face of the enemy, collected materials which had advanced geological science, and specially adverted to a most magnificent assemblage of nummulites and associated fossils, which were about to be described in a separate work by M. D'Archiac.

On the Geology of Saint Ives, Huntingdonshire, and its Neighbourhood. *By* J. KING WATTS.

The principal formations in the neighbourhood are the upper greensand, the gault, and the Oxford clay, with great quantities of drift gravel and sand in certain localities. The upper greensand is however but ill defined, being only occasionally met with, as near Woodhurst and at Needingworth, and then but to a small extent. The gault formation is well defined, and is in some places of great thickness. All the elevations and hills near this town are composed of it. The lower greensand is seen outcropping in patches a few miles distant, as between Elsworth and Hilton, and also between Over and Willingham. There is a beautiful outcrop and elevation of this formation at Haddenham some miles off on the road to Ely, being a further continuance of the line. The Oxford clay extends to a considerable distance southward, and a great part of the district towards Fenstanton, Hilton, and Conington is of this formation. The drift gravels and sand are found in many places immediately under the top soil; in some places very coarse, and at others as fine as quick-sand. In some of those drifts occurred good specimens of *Echinus*, many *Belemnites* and *Ostreæ*, much water-worn. The above-mentioned range of gault hills are well defined and interesting. At the westward end of the range near the town, the gault passes downward apparently to a great depth; and at this place many *Ammonites*, *Gryphææ*, *Belemnites*, *Hamites*, and *Terebratulæ* are found. The Ammonites occur of various sizes, some very small, and others weighing many pounds. Belemnites have been found upwards of a foot in length. This ridge trends eastward towards Somersham, and about 2 miles from St. Ives towards that place, is a district of rich land, called St. Ives Heath, which was formerly part of the royal forests, but disafforested in the reigns of Henry II. and III. This heath was in bygone times of celebrity, on account of its medicinal spring or spa, and an establishment formerly stood there for the use of invalids who resorted there for the waters. An interesting account of the water in the above-mentioned spring was published in the 56th volume of the Philosophical Transactions, by Drs. Layard and Morris. It is to be regretted that this spring should have been choked up and destroyed. Following the range of hill, which now turns eastward, we arrive at the cutting on the Wisbeach and St. Ives Railway, in the parish of Bluntisham. In this cutting iron pyrites were found in great abundance, a great quantity of selenite, and specimens of Ostrea and Belemnites. The elevation proceeds on to Holywell, and there breaks off, the river running below.

On the opposite side of the river, in the parish of Over (Cambridgeshire), is a continuance of this ridge of low hills, and the Cambridge and St. Ives railway cuts through the southern side thereof. In this cutting a great variety of fossils were found, many smooth nodules crystallized within, and large boulders of hard sandstone.

In this cutting, at a considerable depth, was found a large Ammonite, and 17 vertebræ, and a paddle of a species of Plesiosaurus; and also one vertebra of another Saurian, which were forwarded to Prof. Owen.

On the Eskers of the Central Part of Ireland. *By* R. YOUNG, *C.E.*

After having described the peculiar character of the country between Dublin and Galway, and the absence of mountain chains, the sluggish character of the streams, the immense tracts of bogs, the numerous gravel pits, and the enormous stretch of carboniferous or mountain limestone; the author went on specially to take up and discuss the phænomena invariably associated with the district—gravel, diluvium and bogs. Like Mr. Griffith, he attributed the growth of the bogs to the gravel hills and diluvium, which acted as barriers to the free discharge of the drainage from the land, and caused in some cases extensive lakes, of which we have many evidences in the marl beds and callow lands along the Shannon, Suck, Brusna, &c. He divided the diluvial ridges of the country under two distinctive forms:—1st, the gravel hills, which, he said, are sometimes confounded with eskers, from their bearing at times a resemblance to them in form and composition, though their character is distinct, and which seem to have been thrown down from agitated water, as there is little appearance of stratification; and 2ndly, the eskers proper—well defined, narrow ridges of pure gravel or blue-water gravel—which, when not washed through by pent-up waters, can be distinctly traced, many for 20 or 30 miles, and which, when they traverse a flat country, bear a striking resemblance to a railway embankment. They are invariably found to consist of water-worn limestone, gravel, associated with boulders both of limestone and sandstone, also much worn, and sand without clay. The larger boulders are generally arranged in a bed at the bottom of the ridge, the interstices often filled up with a marly stalagmite, the gravel and sand-beds lying above them. Mr. Young went on to describe some remarkable peculiarities with regard to the form and direction of the eskers, and concluded by stating it as his opinion, in common with others, that the drift had its origin in the sea currents and eddies, at the same time pointing out on a map which he has constructed the probable direction of the currents across the depressed tract between Galway and Dublin, when the country was submerged 500 feet.

BOTANY AND ZOOLOGY, INCLUDING PHYSIOLOGY.

BOTANY.

On the Development of Ferment Cells in the Warm-Water Flax Steeps. By Professor ALLMAN, *M.D., M.R.I.A.*

THE author described a peculiar cellular growth which invariably accompanies the process of flax-steeping by the warm-water or patent method of Mr. Schenk. It is strictly analogous to the cells which are developed during the alcoholic fermentation, and first shows itself in the flax-steeps a few hours after the commencement of the steeping process, in the form of isolated cells of a nearly spherical figure containing minute colourless granules, but without any decided indication of a nucleus. These cells rapidly multiply by a process of gemmation, and ultimately form dichotomously branched groups which collect on the surface of the steep in the form of a thick yeasty head. The very peculiar and characteristic odour which accompanies the process of flax-steeping, appears to be exactly coincident with the formation of the cells, and to go on increasing with their multiplication.

The cells appear by their presence to determine in the fluid a peculiar fermentation, and the consequent decomposition of the intercellular substance which holds together the fibre of the flax stem, a process which, however generally confounded with common putrefaction, must nevertheless be carefully distinguished from it.

On a Microscopic Alga as a Cause of the Phænomenon of the Coloration of large masses of Water. By Professor ALLMAN, *M.D., M.R.I.A.*

It appeared, in little conglomerated gelatinous-like masses, and, when submitted to the microscope, it was found to consist of a number of fronds. The younger fronds were nearly spherical, and consisted essentially of a central mass of transparent gelatinous matter, surrounded by a crust composed of minute cells, containing a green colouring substance. The crust being much slower in its growth than the internal nucleus, it soon burst, and the nucleus then, by an apparent spontaneous action, assumed a regular form, not unlike an hour-glass, which soon separated into two distinct fronds. Some of them being put into a glass tube, and placed in the window, were observed to arrange themselves in a mass on the side of the tube opposite to that exposed to the sun's rays—that side of the mass towards the light being formed into a beautiful concave curve, which might, he thought, when fully investigated, reveal some important facts as to the nature and influence of light.

Remarks on the Flora of the South and West of Ireland. By Professor BALFOUR, *M.D., Edinburgh.*

The communication on this subject contained the result of a three weeks' tour just completed with some of his pupils in the southern and western districts of Ireland, viz. in the counties of Cork, Kerry, Limerick, and Galway. The floras of these districts belong to Professor E. Forbes's Armorican and Lusitanian divisions;

the former containing plants resembling those of Cornwall and Devonshire, and the French coast at Normandy; the latter having plants resembling those of Portugal and of the Asturian division of Spain.

The mountains of the south and west of Ireland, although some of them attain an elevation of upwards of 3000 feet, were not found to exhibit an alpine or Scandinavian flora like the mountains of Scotland. The few alpine species seen were chiefly *Silene acaulis, Draba incana, Dryas octopetala, Saxifraga nivalis* and *stellaris, Saussurea alpina* and *Polystichum Lonchitis*. Some of these appear at much lower elevations than they do in the mountainous districts of Scotland. The flora resembles in many respects that of the western coasts and islands of Scotland. This is shown by the prevalence of such plants as *Cotyledon Umbilicus, Osmunda regalis, Hypericum elodes, Pinguicula lusitanica, Eufragia viscosa, Ulex nanus, Anthemis nobilis, Hymenophyllum Tunbridgense* and *H. Wilsoni*. But in addition to these, there are many peculiar species. The prevalence of *Saxifraga umbrosa*, with its varieties *serratifolia* and *punctata*, as well as *Saxifraga Geum, S. elegans, S. hirsuta, S. hirta*, and *S. affinis*, tend to give a marked character to the flora of the south-west; and in the Connemara district, *Erica mediterranea, E. Mackaiana* and *E. ciliaris*, along with *Dabœcia polifolia* and *Eriocaulon septangulare*, give a remarkable character to that flora.

The Cork flora has been fully given in a work published by Dr. Harvey at the time when the British Association met in that town. Dr. Balfour's party noticed on the sides of the Glanmire river, as well as at Aghada, a species of *Hypericum*, probably *Hypericum anglicum* of Fries, which had not previously been recorded in Ireland. The plant abounds in that part of the county of Cork, and appears to be in a wild state. At all events, if it has been introduced, it has become completely naturalized. On the roadside near Monkstown, Cork, there was observed profusion of *Petasites fragrans*, apparently wild. In Killarney, the prevalence of *Trichomanes radicans, Lastrea Thelypteris* and *Lastrea Fœnisecii*, was remarked, as well as *Pinguicula grandiflora, Arbutus Unedo*, and *Orobanche Hederæ*.

In the large island of Arran there was seen abundance of *Adiantum Capillus Veneris, Spiranthes autumnalis, Sesleria cærulea, Alsine verna*, and a peculiar form of *Saxifraga hypnoides*. On the limestone of that island were found many plants which are common in the trap districts of Scotland.

On the Distribution of the Marine Algæ on the British and Irish Coasts, with reference to the Influence of the Gulf-stream. By Professor DICKIE, *M.D.*

There are forms of marine Algæ generally admitted to be characteristic of our northern coasts, and others of the southern. The present remarks have reference to those generally deemed of southern type; that is, those usually more or less abundant in low latitudes, and on the other hand absent from high latitudes. Such species, natives of our coasts, may be classed under three heads:—first, those confined to the southern parts of Great Britain and Ireland; second, species of more extensive range, since they extend to the north of Ireland and south-west of Scotland; third, those found abundantly in the south of England, and ranging along the western coasts of both islands, as far as Orkney and Shetland; and the species comprehended under these three heads, and amounting to at least twenty, are, so far as known at present, absent from a certain part of the east coast of Scotland. A considerable proportion of them reappear in Shetland and Orkney. The marine vegetation in those northern islands in some respects resembles that of the north of Ireland, though there is a difference between them of from four to five degrees of latitude. The marine vegetation of some of the north-eastern counties of Scotland, intermediate in latitude, is of more boreal character.

The drifting of tropical fruits, &c. to the western and northern parts of Britain and Ireland, is a proof of the course and presence of the Gulf-stream; the development of southern forms of Algæ at the extreme northern parts is a proof of the same, and an indication of its influence in reference to temperature. Are we to consider their absence from certain parts of the east coast of North Britain as owing to a lower sea temperature than in localities where they exist? The portion of the coast in question is precisely that which, from the generally understood course of the Gulf-stream, may be least exposed to its influence. Investigations respecting the temperature of our seas are, however, still *desiderata*, and without such, an important modifying element has been overlooked having reference to the climate of the British islands.

Notice of a Monstrosity of Bellis perennis. *By* Professor Dickie, *M.D.*

Each capitulum was surrounded by an involucre of the usual form; the receptacle (as in a well-known variety of the plant) supported numerous secondary capitula, each having an involucre of three to five pieces, and enclosing generally three, five, or six imperfect flowers, most of which seemed reduced merely to open carpellary leaves, and attached to some of them there was an imperfect ovule. The secondary capitula were either sessile or stalked, and the same was true of the carpellary leaves. This variety presented therefore a remarkable example of arrest of development, the flowers being reduced to imperfect carpels with or without rudimentary ovules.

Remarks on the Altitudinal Ranges of Plants in the North of Ireland. By Professor Dickie, *M.D.*

The observations were made on Slieve Donard, in county Down, attaining an elevation of 2796 feet, Muckish and Erigal in county Donegal, the height of the former being 2190 feet, of the latter 2450 feet, and Nephin in the north-west of county Mayo, its elevation being 2639 feet. Neither of these mountains present the same richness of vegetation seen on many of those in North Britain. Only one of them, namely, Slieve Donard, comprehends the upper part of the Mid-Arctic zone of Mr. H. C. Watson, lying between 3000 and 2000 feet. Only six species attain the summit of Slieve Donard, three being Monocotyledons, and three Dicotyledons; six of the former and twelve of the latter were found on the summit of Muckish; Erigal has on its comparatively narrow summit four Monocotyledons and seven Dicotyledons; on the summit of Nephin were observed four of the former and eight of the latter; there are only two species common to all the summits, viz. *Festuca vivipara*, and *Vaccinium Myrtillus*.

The upper limits of 39 Dicotyledons and of 32 Monocotyledons were carefully measured. It might have been expected that in general the species noted would have the upper and lower limits of each respectively, obeying the usually understood law. Instead of which, it appears that their natural upper limits are, with a very few exceptions, lower in the North of Ireland than in North Britain.

The lowest limits of plants usually found at high elevations were next examined, and those of 20 species in Ireland compared with their recorded lowest limits in different parts of North Britain; from which comparison it appears that the lower limits in Ireland are generally much lower than in Britain. It may be stated, in other words, that in Ireland, with a climate generally mild, plants usually growing in the low grounds do not rise so high upon the mountains as in North Britain with a less favourable climate; and plants usually growing at high elevations, descend lower in Ireland than in many parts of North Britain.

On an Anomaly of the Trifolium repens (white clover), *in which the Pedicles of the Flowers were very much elongated, and the Petals and Pistil converted into Leaves. By the* Rev. Professor W. Hincks.

Morphological Analogy between the Disposition of the Branches of Exogenous Plants and the Venation of their Leaves. By the Rev. Professor M'Cosh, *M.A.*

The view which the Professor took of the morphology of the plant might be regarded as an extension, in the same direction, of the theory of Goethe. According to this theory, all the appendages of the axis of the plant, including leaves, bracts, sepals, petals, stamens, &c., are formed on a common plan, of which the leaf may be taken as the type. It had occurred to him (Dr. M'Cosh) that we may regard the branches of the plant and the whole plant as formed on the same plan. We may thus regard the plant as constructed on one model throughout. Speaking in this paper of reticulated leaved plants, he showed that there is a correspondence between the disposition of the branches along the axis and the distribution of the venation of the leaf.

(1.) In some plants the lateral branches are disposed pretty equally along the axis, whereas in others a number are gathered together at one point, and the plant becomes verticillate or whorled. Now, he found that wherever the branches are whorled, either the leaves of the plant, as in the rhododendron, *Alchemilla alpina*, common barberry, broom, laburnum, marsh trefoil, or the veins of the individual leaf, as in the common sycamore, *Alchemilla vulgaris*, currant, gooseberry, guelder rose, geranium, maple, are also whorled.

(2.) When a leaf has a petiole, the tree has its trunk unbranched at the base (as in the case of the sycamore, apple, &c.), and when the leaf has no petiole, the trunk is branched from the root, as in our common ornamental lawn shrubs—the bay laurel, holly, box, &c.

(3.) He proceeded to show further, that the angle at which the branches go off from the axis is the same as that at which the side veins go off from the main veins. His observations during the past summer had been chiefly directed to this point. He made the measurements by means of a graduated semicircle with a moveable index. In these measurements he took the angle formed by the main lateral branches with the axis, and by the main lateral veins with the midrib. The angle of the veins of the leaf is easily taken. It is more difficult to determine the natural angle of the branches, inasmuch as the direction of the branch may be altered by a variety of circumstances, as by winds, its own weight, &c. Still, there is evidently a normal angle for each species of plant, which may be ascertained by taking the average of a number of measurements of a freely growing branch. He had measured in all about 210 species of plants, and found the angle of the branch and of the vein to correspond. He produced a tabulated statement of these 210 plants, and called the special attention of the Section to several of them, as under the letter A.

Plants with Woody Structure.	Angle of vein and branch.
	° °
Alaternus, very short petiole and branched to near root	50
Alder, short petiole and short unbranched trunk	50
Andromeda speciosa	38
Apple, has petiole and unbranched trunk	45
Arbutus, very little petiole, or unbranched trunk	55
Azalea, no petiole, and no unbranched trunk, leaves and branches whorl	60
Native Herbaceous Plants.	
Achillea millefolium	35
Achillea ptarmica	35—40
Arctostaphylos Uva Ursi	35—38
Agrimonia eupatoria	35
Alchemilla vulgaris, main veins whorl, and leaves and branches whorl	37
Alchemilla alpina, leaflets whorl, and also flowerstalks, and leafstalks	25
Angelica sylvestris	40
Anthriscus sylvestris	40
Arctium lappa, angle decreases from base	48—40
Apargia autumnalis	50
Atriplex patula	45
Alisma plantago, has whorled veins and whorled leafstalks	60

(4.) He had also observed that the curve of the branch seems to be the same as the curve of the vein.

These observations seem to show that there is a morphological analogy between the ramification and venation of reticulated leaved plants. Though he could not enter on the subject at present, he believed that there was a similar unity running through linear-leaved and monocotyledonous plants. In conclusion, he remarked, that these views, if substantiated, would aid in giving us the true science of the morphology of the plant, and in particular show that there is a unity of design in the skeleton of the plant, similar to the unity of design which has been discovered in the skeleton of the animal frame. Possibly they might also help to determine the direction of the vital forces as operating in vegetable organisms; they would certainly make us better acquainted with what Humboldt would call the physiognomy of each species of plant, and furnish some additional marks to distinguish genera and species, and, what was to him especially interesting, enable the student of natural theology to make successful use of the plant, to illustrate the order which reigns in the universe.

On the Transmutation of Ægilops *into* Triticum. *By* Major Munro, *39th Regiment, F.L.S.*

The origin of all our domesticated animals is still considered by the most celebrated naturalists to be unknown, and this is the opinion very generally held with regard to our principal cereal grains also. The difficulty may possibly have arisen from looking for an animal or plant bearing too close a resemblance to their cultivated descendants. Mythology, hitherto considered an amusing dreamy account of early history, may come to our aid in this matter also, and lead us, in the fable of Ceres and Triptolemus, to Sicily as the birth-place of our much-valued grain, wheat. Certain it is that at different periods it has been believed that some species of *Ægilops* is the origin of our wheat, the produce of some of the numerous varieties of the cultivated *Triticum*. It has also been stated, that the inhabitants of the neighbourhood of Mount Ætna used to collect the seed of the *Ægilops ovata* which grows there wild, as food. It is a small insignificant-looking plant, but from a series of specimens produced to the meeting, it does not require any great stretch of imagination satisfactorily to trace the gradual alteration the plant assumes in its various advances towards the state which is commonly called Tonselle wheat. The still greater external change from bearded to smooth wheat, and the very extraordinary looking forms called Egyptian and Abyssinian wheats (*Triticum Polonicum* and *compositum*), take place under our own observation daily, especially in cultivating wheat in India from English and Egyptian grown seeds. M. Esprit Fabre seems most satisfactorily to have proved that both *Ægilops ovata* and *triaristata* pass accidentally into *Æ. triticoides*, and thence into *Triticum*. His experiments, as detailed and illustrated in a pamphlet edited by M. Felix Dunal, appeared to have been carried on most carefully and regularly for twelve years, commencing in 1838. For seven years the plants were raised in a garden surrounded by a wall, and for five years as a field crop, producing an average return with other wheats grown in the neighbourhood. M. Fabre had no favourite idea to illustrate and enlarge upon, and no object apparently in his experiments but the interests of science, and was so badly provided with books, that he had only one, and that certainly a very good one, Decandolle's *Flore Français*. He therefore details minutely the gradual change which took place after each successive sowing in this remarkable progress of *Ægilops ovata*, about six inches high, with its brittle head, shedding, as soon as ripe, its few, one to three, perfect hairy seeds, into good wheat three feet high, producing from each lasting head often 100 and upwards perfect, almost smooth seeds, remaining in the spikes till removed by the hand of man. In proof of the correctness of these observations, M. Dunal has forwarded a very interesting series of specimens to England. Still the fact, it is but right to state, is doubted by some botanists, and especially by him who is considered by almost every naturalist as *Botanicorum facile princeps*. The objections appear scarcely sufficiently strong, and the difficulty of procuring ripe seeds of *Ægilops* into England has hitherto prevented some minute inquiries into the internal structure of the seeds. In making conclusive experiments in cultivation, it will be necessary first to procure the shoot or varieties of *Ægilops ovata*, which is called *triticoides*, and not simply to cultivate the *Ægilops ovata*, which might go on for years reproducing itself without variation. All gardeners in seeking to produce double flowers carefully collect the seed from the best semi-double ones.

Fully persuaded, in conformity to the opinion of most botanists, that *Triticum* and *Ægilops* are identical as a genus, and that M. Fabre's experiments are fully to be depended upon, there is no reason to adopt the notion, that this really very curious but not unnatural change of *Ægilops* into *Triticum* proves the little value of modern genera, and leads us to expect that oats can be changed into rye, and wheat into barley. The latter has been asserted as a fact, and may possibly have taken its origin from the circumstance, that in 1817 *Hordeum trifurcatum* or *Ægicerus* was introduced as Nepal wheat; but it was soon found to be a real barley, and it may possibly have been thought that the climate had changed the wheat into barley.

It certainly is very difficult to define what is a genus, at the same time the beautiful order of God's works in general indicate that he has made some divisions or groups which naturalists and others call genera, within the wide range of which species may wander, but beyond which they cannot go. To three such different genera do wheat, barley and oats belong, and they never will be altered by cultivation from the one into the other.

It may be interesting to add, that the observations of a very large number of monstrosities in abnormal states in grasses (some quite as curious as the one the subject of this notice), plainly show that there is always a tendency in grasses to elongate their axis, and increase the number of the flowers in the spiculæ, and never to become fewer-flowered, which would be the case if wheat or oats ever became barley.

The Black and Green Teas of Commerce. By Professor Royle, *M.D., F.R.S.*

It was a remarkable fact, that the subject of the difference between the black and green teas had been, until recently, a matter of great uncertainty. The Jesuits, who had penetrated into China, and Mr. Pigou, were of opinion that both the black and green teas were produced from the same plant; while Mr. Reeve believed that they were manufactured from two distinct plants. Now, as regarded himself, he (Dr. Royle) had adopted the view that the best kinds of black and green tea were made from different plants; and examination of tea samples seemed to confirm that view, but a repetition of the experiment had not done so. Mr. Fortune, subsequent to the China war, having been sent out to China by the Horticultural Society of England, made inquiries on the subject. He there found the *Thea bohea* in the southern parts of China employed for making black tea; and in proceeding as far north as Shanghae, he found the *Thea viridis* used in making green tea near the districts where the best green tea was made. So far, therefore, the information obtained seemed to confirm the view of two different species of *Thea* being employed to make the two different kinds of tea; but Mr. Fortune, in visiting the district of Fokien, was surprised to find what he conceived to be the true *Thea viridis* employed in making *black* tea in districts near where the best black tea was made. He took plants with him from Fokien to Shanghae, and could find no difference between them. It was still, however, desirable to get specimens from the district where the black and green teas or commerce were actually made, and this had latterly been effected. In consequence of the great success which had attended the experimental culture of tea in the nurseries established in the Himalayas, Mr. Fortune was again sent to China by the East India Company. He proceeded to the northern parts of the country, in order to obtain tea seeds and plants of the best description, as the most likely to stand the Himalaya climate. Mr. Fortune procured seeds and plants in great numbers, and sent them to the Himalayas, where they had been since cultivated. When he had reached Calcutta, the tea manufacturers whom he had brought with him made from plants in the Botanic Gardens their black and green tea from the same specimens; so that it was evident it was the process of manufacture, and not the plant itself, that produced the green tea. All now who were acquainted with the difference between black and green teas, knew that they could be prepared from the same plant without the assistance of any extraneous materials, though it was a common thing for manufacturers to use indigo, prussian blue, turmeric, &c. in colouring the tea. Dr. Royle showed specimens of the Black Tea plant from the Woo-e-Shan, and of the Green Tea plant from the Hwuychou districts. No specific difference could be observed between the two specimens.

Zoology.

On a peculiar Annelidan Larva. By Prof. Allman, *M.D., M.R.I.A.*

The author described a minute Annelidan larva, which he obtained in abundance in a small towing-net in July last off the coast of the county of Cork. It is vermiform, and swam about with great activity, the locomotion being chiefly effected by the aid of ciliated discs, which are borne on the fourteen segments which immediately succeeded the head. Each disc carries a pencil of very long vibratile cilia; and four such discs are carried by each segment.

The disc-bearing segments are followed by about twenty others much smaller and destitute of discs. The terminal segment is encircled by a wreath of very long cilia. Dorsal and ventral oars are present on all the segments. The dorsal oars carry cirriform branchial appendages densely clothed with minute vibratile cilia. The setæ are largely developed; and in each pencil of setæ carried by the disc-bearing segments there are two stronger and longer than the others, denticulated and beautifully iridescent. A pencil of very large and beautifully iridescent setæ is borne by the head. A prominent ridge on the upper surface of the head is set with thread-cells. The mouth is situated on the inferior surface of the head. The alimentary canal is straight, dilated into a large sacculus in each of the fourteen large anterior segments; in the smaller posterior segments the canal presents but slight dilatations.

The little larvæ were preserved in a phial of sea-water, and after about a week were seen to be transformed into minute Annelides, nearly resembling *Nereis*. Their death shortly afterwards prevented all subsequent observation on their development.

On the Universality of a Medusoid Structure in the Reproductive Gemmæ of the Tubularian and Sertularian Polypes. By Professor Allman, *M.D., M.R.I.A.*

In this communication it was the author's object to show that the Medusoid structure was not confined to the free locomotive gemmæ of the Tubularian and Sertularian Polypes, but that a similar structure was also possessed by the fixed capsules of the *Tubularidæ*, and by certain fixed organs found in the ovarian vesicles of the *Sertularidæ*; that the Tubularian and Sertularian Polypes therefore produced, by a process of gemmation, fixed as well as free Medusæ, the real office of both being apparently the production of ova by a true sexual process.

In the marine *Tubularidæ*, the capsular bodies which contain the ova consist of a closed vesicle whose walls are composed of cells, and having a hollow peduncle projecting into it from the point of its attachment to the Polype-stem, the cavity of the peduncle being in direct communication with the general cavity of the polypary. The hollow peduncle here manifestly represents the stomach of a Medusa with the mouth permanently closed, and the vesicle only requires to be open anteriorly, to complete its resemblance to the bell-shaped disc. The system of gastro-vascular canals, which in the ordinary Medusæ radiate from the stomach towards the margin of the disc where they intercommunicate by means of a circular vessel, are, it is true, here wanting, and the absence of this part of the medusan organization may at first sight appear to invalidate the view here taken. That the absence of the radiating canals in the marine *Tubularidæ* however affords no real ground for objection, is proved by *Cordylophora*, their freshwater representative.

In this curious genus, the reproductive capsules, altogether homologous with those of *Tubularia* and its marine allies, present a well-developed system of branched tubes communicating with the base of the peduncle and extending forwards in the walls of the capsule. These tubes will easily be recognised as the true equivalents of the gastro-vascular canals of the Medusæ, and at once complete the series of homologies between the fixed sacs of the *Tubularidæ* and their locomotive medusoid gemmæ.

The contents of these sacs are either bodies presenting all the characters of true ova, with the germinal vesicle, and in many instances the germinal spot, and exhibiting the phænomenon of yelk-cleavage and the subsequent steps in the development of the embryo, or else they present no appearance of ova and are merely composed of a multitude of minute corpuscles, endowed in some cases with independent motion, and which are most probably spermatozoa. The ova-like bodies are therefore true ova, and the bodies developed from them (sometimes polypoid embryos, but most frequently resembling the "Planulæ" of Sir J. G. Dalyell) are the product of a true sexual process, and not, as has been asserted, mere gemmæ or bulbillæ.

In the *Sertularidæ* medusoid bodies have been witnessed by many observers to escape from the "ovarian vesicles" of *Campanularia*, and swim freely away; while Loven and Lister have observed similar though less completely developed medusoids expand at the mouth of the vesicles of this genus, discharge their ova, and then wither away without ever becoming free. Besides these gemmæ of obvious medusoid organization, certain more or less globular bodies are commonly seen in the interior of the vesicle clustering round the fleshy axis, and described by various observers as eggs. In these so-called eggs of the *Campanulariæ*, however, the author has detected a medusoid structure quite as manifest as in *Tubularia*. Each of them is in fact a fixed Medusa, either developing within it true ova which present a distinct germinal vesicle and germinal spot, and undergo the process of yelk-cleavage, when they finally escape as "Planulæ;" or else, as it would appear in some cases (though this will require further observations for its confirmation), containing spermatozoa.

Among the *Sertularinæ* no case had hitherto been observed of the production of anything resembling Medusa-buds, The author has however found the axis developed in the interior of the "ovarian vesicle" of *Sertularia argentea* into a medusoid body, which, though permanently fixed, presented medusoid structure more highly developed than in the fixed sacs of the *Campanulariæ* and *Tubularidæ*; the peduncle of this Medusa terminated by an open mouth, and the disc was also open; the gastro-vascular canals were present; the ova appeared to be developed in the walls of the peduncle.

The facts recorded in the present communication were believed by the author to be the only ones wanting to harmonise the singularly discrepant observations of the several trustworthy zoologists who have made these polypes their special study.

By a careful collation of these facts, and those already established by independent observers, the following conclusions may be obtained:—

1. That the Tubularian and Sertularian Polypes are in their young state either "Planulæ" or solitary naked polypoid larvæ ("Actinulæ").

2. That both "Planulæ" and "Actinulæ" are embryos proceeding from real ova, the result of a true sexual process.

3. That these ova are produced in all cases by a proper medusan structure, however masked this structure may be under the form of a fixed ovisac.

4. That the free medusoids are not embryos, but buds, and that they are destined, probably in *all* cases, as we know them to be in *some*, to produce ova by a true sexual process in a manner similar to what takes place in the fixed sacs.

5. That every ? species of the *Tubularidæ* and *Sertularidæ* therefore produces by gemmation two kinds of polypes, one *hydroid* and destined for nutrition, the other *medusoid* and destined for sexual reproduction.

6. That the medusoid polypes are either fixed or free, the fixed with a more or less masked medusoid structure discharging their ova in the immediate vicinity of the parent stock; and the free with a highly developed medusoid structure and furnished with active powers of locomotion, by which they are enabled to carry their ova to a distance, and thus provide for the diffusion of the species.

On the Signification of the Ovigerous Vesicles in the Hydroid Polypes. By Professor Allman, *M.D.*

On a singular Locality chosen for its Nest by the Black Red-Start (Sylvia Tithys). *By* Martin Barry, *M.D., F.R.S.*

At the railway station in Giessen, Hesse Darmstadt, in May 1852, it was found that a bird had built its nest on the collision spring of a third-class carriage which had remained for some time out of use. The bird was the Black Red-start (*Sylvia Tithys*); and the nest contained five eggs. The discovery was made by the "Wagenmeister," Jacob Stephanij, who humanely desired his men to avoid as long as possible the running of that carriage. At length, when it could no longer be dispensed with, the carriage was attached to a train, and sent to Frankfort-on-the-Maine, distant between thirty and forty English miles. At Frankfort it remained for six-and-thirty hours, and was then brought back to Giessen; from whence it went to Löllar, distant four or five English miles, and subsequently again came back to Giessen, having been kept awhile at Löllar; so that four days and three nights elapsed between the bringing of the carriage into its use and its last return to Giessen. Stephanij, now finding the nest not to have been abandoned by the parent birds, and to contain young ones, which he describes as feathered, removed it from the carriage to a secure place of rest which he had prepared, saw the parent birds visit it, and visited it from time to time himself, until at first three and then the other two young birds had flown; none remaining at the end of four or five days. Now, while the carriage was travelling, where were the parent birds? It will hardly be said that they remained at Giessen awaiting its return, having to examine by night as well as by day hundreds of passing carriages in order to recognise it; the young birds in their nests quietly awaiting food (!) There seems little doubt that, adhering to the nest, one, at least, of the parent birds *travelled with the train.* Nor, when it is remembered how gently and how slowly an enormous railway carriage is pushed into connection with a train,—how gradually a train is brought into full speed, and how equable the movements are upon a railway,—will it appear incredible that at such a time a parent bird should continue with its nest, that nest being quite concealed, and containing young. Not until after the above was written did the author of this communication become acquainted with the important fact, that while the carriage in question was at Frankfort, as well as during its short stay at Friedeberg, on the way to Frankfort, the conductor of the train saw a red-tailed bird constantly flying from and to the part where the nest was situated in that particular carriage. Is further evidence required that a parent bird did indeed travel with the train?

Zoological Notices. By the PRINCE OF CANINO.

The Prince exhibited a Ray which would have tempted many a naturalist of our day to constitute a new genus, and perhaps even a new family; yet it is only a monstrosity of the common *Trygon pastinaca,* or to speak more properly, a specimen in which the transitorial forms of the embryo have become *permanent.* A teratologist would claim the analogy of this our monstrosity to the *bifida spina,* or to the *leporine lip,* which are nothing but normal and transitorial conditions in course of formation.

It would be easy with the fish before him, for the anatomist to prove,—1, the embryonal changes of the Trygon and the Raiidæ; 2, their similarity and consequent superiority in the scale to the *Squalidæ,* the proof of which has been a *desideratum* in our science; whilst the greater development of the nervous system proves these cartilaginous fishes higher organized than the osseous ones generally placed ahead of them.

The Prince of Canino also drew attention to three species of *Bulweria* to be mentioned: *B. columbina,* a second Smithian species from the Cape, and a new one from the Isle of Bourbon; he also noticed a new *Thalassidroma,* which he calls *Procellaria thetis,* from the Gallapagos, similar to *pelagica,* but even smaller, without the whitish alar band, and with upper tail-coverts white to the tips, as in *Pr. Wilsonii* and others, not black-tipped as in the *pelagica.*

Remarks on the Distribution and Habits of Echinus lividus. *By* Professor DICKIE, *M.D.*

This interesting species is well known on the west coast of Ireland; Bundoran is the most northern locality recorded in Professor E. Forbes's work on the Echinodermata; it has, however, a more extensive range. Mr. Hyndman observed it at Tory Island; it has been found by the Rev. Mr. Gallagher in the Bay of Dunfanaghy, and in July last I saw it at Malin Head, county Donegal. It may possibly occur on the east coast of Ireland, since I found a specimen cast up at Carrickfergus, Belfast Bay. This species has the power of forming nest-like cavities in rocks of moderate hardness; these are sufficiently deep to protect about two-thirds of the animal. There appears to be some relation between the structure and composition of the spines and the habits of this species; they are generally well-developed in proportion to its size, and sections of them, viewed under the microscope, present appearances of greater strength and density than similar preparations of the spines of *Echinus sphæra,* though a much larger species. The following are the results of a chemical examination made, at my request, by Mr. J. W. Smyth, assistant in the laboratory of Queen's College.

	Echinus sphæra.	*Echinus lividus.*
Specific gravity	2·49	2·55
Inorganic matter	82·03 per cent.	82·26 per cent.
Organic matter	17·97 per cent.	15·74 per cent.
Ash	Chiefly carb. of lime.	Chiefly carb. of lime.
Silica	0·05 per cent.	0·41 per cent.
Iron	none.	a trace.

The smaller proportion of organic matter, and greater amount of inorganic generally, and of silica in particular, appear to indicate some relation between the spines of *Echinus lividus* and its burrowing powers. The spines on the sides and lower surface of the animal are generally abraded, particularly in immature individuals; when it has attained full size, and the cavity completed, the spines are often, if not always reproduced. By actual experiment, I have proved that the spines are capable of abrading rock of moderate hardness.

On a New Map of the Geological Distribution of Marine Life, and on the Homoiozoic Belts. By Professor EDWARD FORBES, *F.R.S.*

On this map the provinces under which animals and vegetables are assembled, are delineated so as to show their peculiarities, relations, and contrasts. The character of each is marked by the entire assemblage of organized beings constituting its population; a considerable portion in most cases being peculiar, and a still larger number of species having their areas of maximum development within it. The several provinces vary greatly in extent, some being very small, some very large. But though not equally important in a geographical point of view, their inequality of extension is not opposed to their being of equal natural history importance. The author showed that the northern and southern limits of each province correspond with the boundaries of a latitudinal belt, to which, on account of the similarity of organic features presented throughout its extension, the name of *Homoiozoic* is proposed to be applied. Nine of these belts are distinguished; of which one is unique, central, and equatorial, and four in the northern hemisphere represent as many in the southern. The boundaries of these belts on land appear to correspond with the isotherm of the months in which there is the greatest vivacity of animal and vegetable life. The homoiozoic belts are not of equal breadth in all parts; and whilst the Polar belts include only a single province in each, the others severally include many provinces. On the same map, the comparative distribution of marine life in zones of depth in different and distant regions is also laid down, and a nomenclature applicable to all seas is proposed for them.

Remarks on a species of Sepiola *new to Britain, and first procured in the Neighbourhood of Belfast. By* Professor EDWARD FORBES, *F.R.S.*

One species only has hitherto been recognised in the British seas, and this has always been identified by our naturalists with the common Sepiola of the Mediterranean. Gervais and Van Beneden, in 1838, maintained that the Sepiola of the Atlantic coasts of Europe was different from that inhabiting the Mediterranean. The distinctions indicated by them, however, were quite insufficient to warrant the inference drawn by these observers. M. A. D'Orbigny was the first to determine a true and important difference, but likewise committed the error of supposing that all the Atlantic individuals were of one type and the Mediterranean ones of another. He consequently referred all the figures and descriptions of British and Channel *Sepiolæ* to his *S. Atlantica* (those of Pennant, Bouchard, Gervais and Van Beneden, and Thompson), and those of Mediterranean individuals to *S. Rondeletii*. It will be seen that we have both these species in the British seas. Owing to the distinctive characters having been entirely overlooked, it is impossible now to say which kind was intended by British authors who quote this cuttle-fish under the names of *Loligo sepiola*, *Sepiola vulgaris*, and *S. Rondeletii*. Under these circumstances, we think it best to restrict our synonyms and not include doubtful references.—1. *S. Atlantica*, D'Orbigny.—Suckers becoming suddenly four-ranked, crowded, and very minute at the extremities of the lower pair of arms. Respecting this species, Mr. Alder writes as follows from the Menai Straits:—"Miss Hughes has supplied me with three specimens of different sizes. This is an odd fish, crouching generally at the bottom like a toad, with its great goggle-eyes half-closed, and sometimes crawling along by means of its suckers, puffing the water through the funnel all the time. When it does take to swimming it darts very quickly through the water and is difficult to catch. When taken out of the water and placed on the hand, it had recourse to an odd mode of progression, turning two or three somersaults in regular tumbler fashion; first laying hold with its arms, turning over, and laying hold again until it managed to get back into the water. In this species, too, the tentacular arms generally lie concealed within the others."—Dr. Johnston remarks of it, that "although kept alive in a basin of sea-water for about twelve hours, and repeatedly irritated, it never ejected any inky fluid, with which it is, nevertheless, amply provided." It is probable, as has already been remarked, that the majority of British localities of *Sepiola* relate to this species. Whether Pennant's *Sepia sepiola* from the coast of Flintshire was it, it is impossible now to say. We have taken it in the Irish Sea; in fifteen, eighteen, and twenty fathoms, among the Hebrides, and in seven fathoms in the Sound of Skye. Mr. Alder has found it on the coast of Northumberland, and in the Menai Straits; also at Torbay. The week before Mr. Thompson, of Belfast, died, he submitted to our examination two specimens of *Sepiolæ* as possibly distinct. His sagacity did not deceive him in this, any more than in many other similar instances; for one of these little cuttle-fishes taken at Bangor, in Ireland, in 1839, by Dr. Drummond, proved to be *S. Atlantica*, and the other was an Irish example of the true *Sepiola Rondeletii*. The statistics of the distribution of the two species have yet to be made out.—2. *S. Rondeletii*, Leach.—Suckers on the lower pair of arms similar to those on the others. I may remark respecting the British cuttle-fishes,—1. That the *Rossia Jacobi* has proved to be identical with *Rossia macrosoma*. 2. That among Dr. Ball's specimens of Irish cuttle-fishes, a form noted by him as probably distinct from *Loligo media* is apparently the *Loligo marmorea* of Verany. 3. That the true *Ommastrephes sagittatus* has been taken during the past winter at Brighton by the Marchioness of Hastings, and at Folkestone by Mr. Mackie. The specimens usually so named have been shown by Mr. Alder and Mr. Hancock to be the *Ommastrephes todarus*.

Catalogue of the Shells found in the Alluvial Deposits of Belfast. By JOHN GRAINGER.

The greater part of the town of Belfast is built upon alluvial deposits of sand and silt. These depositions extend far into the bay, and are extensively exposed at low water, reaching to Holywood upon the county Down side, and to Whiteabbey upon that of county Antrim. The localities which were most investigated were the embankments raised for the two railways which run along the sides of the bay, and the cuttings made during the progress of the harbour improvements. The embankments of which the railways consist are formed almost entirely of the sand and silt raised on the spot, and leaving numerous shallow excavations. The cuttings, however, made to afford a straight channel instead of the old tortuous course of the tidal river presented shells from much deeper levels. They extended to the depth of nine feet from low-water mark, and eighteen from that of high water. It affords an example of the importance of seizing opportunities for prosecuting scientific researches, presented by the progress of altogether different operations, when we consider that these places will never again be accessible to inspection, the channel being now filled with water, and the railways traversed by continually passing trains. All these localities presented vast numbers of shells, which appeared rather scattered everywhere throughout them, than lying in regular beds. This, together with the fact that the same species were found at almost every depth, made it impossible to observe levels to which the species could be said respectively to belong. The shells, no matter at what depth found, were all of recent species; thus fixing the whole formation of one geological age. In addition to these localities may be mentioned the foundations of the town generally; the whole affording a range of about twenty feet in the vertical. Eighty species were enumerated. Of this number not one is extinct; five are not now living in the bay; seven occur so sparingly that they can scarcely be called inhabitants of the bay, but are rather occupiers of some very limited spot in it; while the great majority of the remaining seventy species dwell at the distance of several miles from their ancient stations, although the latter are still under water. Thus six per cent. of the former occupants of the harbour have left it, while nine per cent. appear in the fair way of doing so. The shells which occurred in the beds in the greatest numbers were those of the edible Mollusca.

Dr. Mathie Hamilton read a paper "On the Lobos Islands."—Along the seaboard of Peru and Bolivia, within the Tropic of Capricorn, countless numbers of aquatic fowls exist, which live on fish, and whose excretions are exceedingly fertilising. In some localities, the number of guanos is enormous, so that when alarmed by discharges of fire-arms, or otherwise, they rise from their nestling places in such masses as cannot be supposed by those who have never seen these birds darkening the air like a cloud. Guano producers change their habitation when continuously disturbed, but they do not permanently leave a locality which has long been frequented by them, in consequence of a temporary alarm; for, in such a case, they soon return to their old haunts, and totally abandon them only when teased by lasting annoyances. The ocean on the west coast of South America within the tropic, teems with fish, the quantity seeming exhaustless, and guanos equally abound; so that their egesta are gradually accumulating somewhere either on or off that desert land, and now have become an object sought after, not only by the Peruvian mountaineer, but by the merchant, shipowner, and statesman.

On a Peculiar Organ which occurs on some of the Marine Bryozoa, *and which appears to indicate a Difference of Sex. By the* Rev. Thomas Hincks, *B.A.*

Some of the marine Bryozoa are furnished with a curious intertentacular organ, first noticed by Dr. Farre in his paper on the *ciliobrachiata*. It consists of an oblong and somewhat "flask-shaped" body, which is placed between two of the arms, and attached to the tentacular ring. It has a wide orifice at the top, round which there is a play of cilia. The neck is somewhat constricted. The interior cavity is lined with cilia. The organ becomes narrow towards the base, and is closely united to the sides of the tentacles. It is constant in its position, and (in *Membranipora*) is always situated on the same side as the anal orifice. At times it is seen to be extended considerably, and to change its form.

It was observed by Dr. Farre on the *Membranipora pilosa* and *Alcyonidium gelatinosum* (Johnston), but he was unable to determine its function. I have also met with it on the *Cycloum papillosum* (Hassall), and I can find no record of its occurrence on any other species but the three which I have named. It is possible, however, that it may not be confined to these, for it is commonly present on very few individuals, and might readily escape observation. Dr. Farre states that he was unable to detect any flow of fluids through it, nor could he ascertain with what parts the cavity in its interior might communicate. At most times nothing is to be seen but the regular and constant play of cilia within it and around the orifice. But in spring I have met with individuals furnished with the appendage, in which *Spermatozoa* were present in immense quantities, and have witnessed their expulsion from the cell through the intertentacular organ. In one instance, when examining the *Membranipora*, I observed a mass of the *Spermatozoa* moving upward from the lower part of the visceral cavity. On reaching the base of the organ, which I have described, they were drawn into it, and carried through it by the action of the cilia lining the interior, and were then ejected and borne off by the tentacular currents. This expulsion went on for three or four minutes, during which time the active filaments were streaming up from the lower part of the cell. After awhile a single *spermatozoon* only made its appearance occasionally, and at last none were to be seen. *The ciliated intertentacular organ, then, communicates with the visceral cavity, and is at certain seasons the channel through which large quantities of Spermatozoa are ejected and diffused through the surrounding water.*

Similar observations were made on the *Cycloum*. I have never met with *Spermatozoa* in any individual which was not provided with the organ (and I have examined hundreds), while in those which possessed it, they were frequently present at the proper season in astonishing profusion. The organ occurs on comparatively few individuals. This has been ascertained by a careful examination of great numbers at different seasons of the year.

With the facts now related before us, there can be little doubt *that the intertentacular organ of the Membranipora, Alcyonidium, and Cycloum marks a difference of sex*. It characterizes the male individuals, and is a special provision for the expulsion of the *Spermatozoa*, which are produced in great profusion in a few of the cells, and being thence diffused through the surrounding water, are drawn in by the tentacular currents of other individuals (female), and so fertilize the *ova*.

A separation of the sexual organs has also been observed in some of the freshwater *Bryozoa*, but I am not aware that any of the latter are supplied with the intertentacular organ.

Researches into the Structure of the Ascidians. *By* Thomas H. Huxley, *F.R.S., Assist. Surgeon R.N.*

The author stated that he was desirous of laying before the Section an account of some investigations into the structure of the Ascidians which he had been led to make while endeavouring to form a catalogue of those contained in the collection of the British Museum.

The Ascidians, varied as they are in external appearance, present certain general anatomical uniformities, which are capable of being represented by a diagram. To such a hypothetical structure thus represented, the author gives the name of the Archetypal Ascidian. From this every actual form can be shown to be derived, by very simple laws of modification. The author particularly desired it to be understood that he attached no other meaning to the term Archetype than that thus defined.

It has been a matter of dispute which is the dorsal and which the ventral side of the Ascidians; there can be no question, however, that the heart is upon one side of the axis of the body, and that the nervous ganglion is upon the other; to avoid all ambiguity therefore, the author proposes to speak of the "hæmal" and of the "neural" sides, in accordance with the nomenclature proposed by him in a memoir 'Upon the Homologies of the Mollusca,' read before the Royal Society. The Ascidian Archetype differs from all others in the following points:

1. The intestine is always flexed towards the hæmal side. In the Polyzoa it is flexed towards the neural side, as pointed out by Professor Allman.

2. The tentacles are small, while the pharynx is very large, and serves as a respiratory cavity, its parietes becoming perforated. The author combated the view that the "branchial sac" of the Ascidian answers to the tentacles of the Polyzoon, or to the united gills of the Lamellibranchiate Mollusk; in opposition to the former view, he endeavoured to show that the tentacles of the Polyzoa are represented by the tentacles of the Ascidians; and against the latter, he urged, that the gills of the Bivalve Mollusk have no representative in the Ascidian. The "branchial sac" of the latter, represents not the gills of the Mollusk, but the perforated pharynx of Amphioxus; an analogy which has already been noticed by many observers.

The author brought forward the structure of the peculiar genus *Appendicularia*, as fatal to the view that the branchial sac of the Ascidian is homologous with the united tentacles of the Polyzoa.

Especial attention was directed to the formation of what the author termed the "Atrium," under which term he included the cloaca and the space between the branchial sac and the "third tunic" of writers. The author endeavoured to show that it answers to the mantle-cavity of ordinary mollusks; that its excessive development accounts for the presence of the "third tunic" in the Ascidian, and that Savigny's comparison of an Ascidian to an inverted Patella had very considerable justice.

The author next proceeded to detail many structural points of interest which he had made out in the genera examined. A minute account was given of the structure of the branchial sac in *Boltenia, Cynthia, Phallusia, Syntethys,* and other genera. The branchial meshes are always true apertures, generally more or less rectangular or oval in shape; but in one species described they were arcuated or semilunar, so as to give the appearance of spiral vessels in the branchial tissue.

The structure of the dorsal folds and of the "Endostyle," a structure first noticed as distinct by the author in his memoir upon the *Salpæ,* was minutely described; and the singular and characteristic variations in form of the peculiar organ of sense —the "tubercule antérieure" of Savigny—were pointed out.

The "Tubular System," described in the same memoir as a peculiar and unique organ in *Salpa* and *Pyrosoma,* was shown to be the form of hepatic organ proper to, and universal among the Ascidians.

The reproductive system exhibits remarkable and hitherto little noticed peculiarities, which have led the author to distinguish the simple Ascidians into Monothalamous and Dithalamous groups, the section Styela (Sav.) being the type of the latter. Owing to the discovery of a *Marsupial* Cynthia, that is, of one whose ova pass through all stages of their development in the Atrium of the parent, the author was enabled to lay some interesting embryological facts before the Section. The Cynthia in question has the appearance of a compound form; it does not, however, become multiplied by gemmation like the true compound forms, but the originally free, tailed larvæ, adhere and become firmly united before the withering away of their appendages. The mass is therefore an aggregation of distinct individuals, not one individual represented by many Zöoid forms.

The development of the muscular tissue of the tail was described, closely resembling that of the muscles of the tadpole as given by Kölliker.

With respect to the structure of the test of the Ascidians, the author stated that he had verified in many new cases the discovery of the presence of cellulose in large quantities therein made by Schmidt, and extended by Löwig and Kölliker, and by Schacht. In other points, the author's results differed somewhat from those of these writers; and after pointing out what he considered to be the true structure, he drew particular attention to the essential identity of the test of the Ascidian with true bone (if for the calcareous salts cellulose be substituted) on the one hand, and with vegetable tissue on the other. The physiological distinction between plants and animals, which authors have endeavoured to draw, upon the ground that the Ascidians do not *form* cellulose, but only take it from plants, seems incompatible with the circumstance made out by the author, that the Ascidian larvæ contain cellulose while they are yet a mere mass of cells contained within a structureless membrane, and totally without any organ, except the tail.

The author endeavoured to show that the Ascidians might be divided into natural groups, by considering:—

1st, The arrangement of the organs with regard to the axis, whence the animal may be symmetrical or asymmetrical, according to the relative development of the neural and hæmal regions, and of the branchial sac; and,

2ndly, The nature of the tentacles and of the reproductive organs.

In conclusion, the author stated that the Ascidian type appeared to be sharply defined from all others, nowhere exhibiting any transition forms.

On a New Species of Acaleph from Belfast Bay. By GEORGE C. HYNDMAN.

Dr. J. D. MARSHALL exhibited specimens of the "Bonaparte's Gull," "Sabine's Gull," "Little Auk," and some other fowl, all shot in the neighbourhood of Belfast. The specimen of "Bonaparte's Gull," he mentioned, had been called after the Prince of Canino; and is the only one hitherto shot in Europe, having been obtained in the Lagan in 1848. It is at present in the Belfast Museum.

On the Geographical Distribution of Animals in connection with the Progress of Human Civilization. By WILLIAM OGILBY, *F.L.S.*

The author treated his subject in a very popular manner, and pointed to the less civilized nations of the world, as being so from the absence of animals capable of domestication. America and Australia were the great types of this deficiency. The following conclusion of his paper will give an idea of the general argument and style. "Let us now examine the facilities which the natives of Europe, Asia, and Africa possessed for developing civilization compared with those of America and Australia. The former had those great *collaborateurs* in their social progress, they had the horse, the ass, and the camel, for beasts of burden; and they had the sheep, the ox, and the goat, for food and a thousand other useful purposes. The consequence of this was, that, at a very early period—at a period of which there are few authentic historical documents extant—the nations of Western Asia had advanced in civilization to an extent which is now only beginning to be thoroughly understood and appreciated. The researches of such eminent men as Dr. Layard into the antiquity of Assyria and Egypt, prove this beyond question; and show that those nations had advanced to a power which in modern times has scarcely been equalled, and that we are only now in the same state with regard to civilization that they were three or four thousand years ago; whilst the less fortunate inhabitants of America and Australia would be obliged, by the want of those facilities possessed by the former, to remain in their original condition for eternity."

On the Homologies of the Cranial Vertebræ. By Professor OWEN, *F.R.S.*

On some Fishes, Crustacea and Mollusca found at Peterhead. By C.W. PEACH.

The fish were Yarrell's blenny (*Blennius Yarrellii*) in considerable numbers, and Ray's bream (*Brama Raii*). A new species of *Hippolyte*, and several specimens of *Limapontia nigra*, constituted the contributions to the Fauna of Peterhead.

On the Character of the Sertularian Zoophytes. By WYVILLE T. C. THOMSON.

Mr. Thomson's remarks were confined to the pointing out of some of the most remarkable peculiarities in this very numerous class of zoophytes. He described their appearance and the circumstances under which they are found; and exhibited bottled specimens of most of the species found along the Aberdeenshire coast. With regard to the specific distinctions of those species, he conceived that the standard of classification hitherto adopted was by no means a safe one. As an instance of this he referred to the *Sertularia rosacea* and *Sertularia margarita*, which had been described by naturalists as belonging to separate species; but on recent and minute investigations it hasbeen found that there is no specific distinction between them, and that they belong to a third, *Sertularia pinasta*. He suggested that, instead of the ovigerous vesicles being regarded as the principle of comparison in determining the species, the stem and general skeleton should be adopted as being more fixed and invariable.

PHYSIOLOGY.

On the Part played by the Cavernous Sinus in the Circulation of the Brain. By Dr. J. BARKER.

On a New Effect produced on Muscles by the Electric Current. By Dr. E. DU BOIS-REYMOND.

Last spring, Dr. Bence Jones of London, whom I am proud to call my friend, published a short abstract of my Researches in Animal Electricity. To those who have perused this little volume, the name of the electrotonic state of the nerves will be familiar. I have ventured so to call the altered condition of the nerve which is induced by any electric current pervading any portion of it, however short, and which denotes its presence by a most striking change in the electromotive action of the nerve. The nerve, when in its natural state, produces electric currents according to the law of the antagonism of the longitudinal and transverse section, the former one being positive, the latter negative. The nerve, when in the electrotonic state, in addition to its usual electromotive action, produces electric currents according to the law of the voltaic pile. Every portion of nerve, however short, acquires an electromotive power such as to produce a current in the direction of the exciting current. This new condition of the nerve begins and ends as soon as the exciting current itself. I have endeavoured to account for it in the following way. The ordinary nervous current I consider as being produced by peripolar groups of dipolar electromotive molecules. According to Grotthuss's well-established theory, the exciting current may decompose these groups, so as to make all the dipolar molecules turn their positive poles in that direction in which the current goes. If it be admitted that this new arrangement extends with decreasing regularity over the whole length of the nerve, all the phænomena of the electrotonic state of the nerves could easily be explained.

In the second volume of my large book, I have stated that the muscles do not exhibit the phænomena of the electrotonic state. Indeed no change of the electromotive action of the muscle is perceived, when that portion of it which extends beyond the ends of the galvanometer is submitted to a constant electric current. Nevertheless, I have succeeded in discovering a mode of action of the electric current on the muscles, which undoubtedly corresponds to that action of the current on the nerves which I have called their electrotonic state.

If a muscle, while in the state of life, is submitted to a strong electric current, of any kind whatever, and if directly afterwards it be placed in the circuit of the galvanometer, the very portion of it which was comprised between the electrodes is found to have acquired a new electromotive power, such, indeed, as to produce a current in the direction in which it was pervaded by the extraneous current. This new electromotive power is the greater according to the intensity of the extraneous current. It rapidly decreases so as to become insensible after a certain lapse of time, the length of which, of course, depends on the original amount of the electromotive power induced, as well as on the sensitiveness of the galvanometer employed.

This new effect produced on muscles by the electric current is quite different from that which was discovered by Peltier, who found that muscles, when for a long time exposed to an electric current, acquire an electromotive power in the *contrary* direction to that in which they were pervaded by the current. These two effects, that observed by Peltier, and that now denoted by myself, both coexist, so as partly to counterbalance each other. But the contrary electromotive power, induced in muscles by electric currents, is analogous to that which is engendered by passing a current through metallic electrodes immersed in any electrolytic liquid. On the contrary, the electromotive power, which keeps the same direction as the current by which it was induced, owes its origin to the peripolar groups of dipolar electromotive molecules in the muscles being decomposed by the current, and the dipolar molecules having their positive poles turned with more or less regularity in that direction in which the current goes.

The electric current, therefore, acts in the same way on both nerves and muscles, viz. it decomposes the peripolar groups, and forces the dipolar molecules into a certain arrangement different from the natural one. In the nerves this preternatural arrangement extends on either side of the portion submitted to the current, and even, though with decreasing regularity, over the whole length of the nerve, but it vanishes as soon as the exciting current itself. In the muscles, on the contrary, the preternatural arrangement does not extend to any sensible degree beyond the portion immediately acted upon by the exciting current; but, instead of it, the arrangement continues to prevail a certain time after the exciting current has ceased. Hence it appears that the production of the new electromotive power in a nerve and that in a muscle, by means of an electric current passed through their substance, bear to each other a similar relation as the production of magnetism in a bar of perfectly soft iron and that in a bar of steel, by means of an electric current passed through a coil surrounding the bar. Suppose, indeed, that a current be passed through a coil surrounding a very short portion of a long bar of soft iron, the bar will directly prove magnetic in its whole length, only the intensity of its magnetic force will decrease from the coil to the two ends of the bar. As soon as the circuit of the coil has been broken, the bar would be found quite bare of any magnetic power, provided the iron be perfectly soft; in making the experiment, however, there will still be some magnetism left. Again, suppose that the same coil were placed in the same manner on a similar bar of steel, instead of soft iron, then its action would not extend over the whole length of the bar, only the very portion surrounded by the coil, and those placed in its immediate neighbourhood, would become magnetic; but in this case they would remain so even after the circuit of the coil had been broken.

This difference in the magnetic phænomena elicited in steel and iron by the electric current, philosophers are in the habit of ascribing to a coercitive force possessed by the former substance, by which force the magnetic fluids are prevented from moving freely so as to require a certain amount of force to be separated, and to remain so afterwards; or by which force, to speak in accordance with Ampère's theory, the molecules surrounded by currents, on which the magnetic phænomena are admitted to depend, are kept in the positions in which they once have been put by any previous action. It therefore may be concluded, that with respect to the mobility of their electromotive molecules, the muscles and nerves differ from each other in the same way as steel and soft iron; or that the muscles possess a coercitive force which prevents their electromotive molecules from moving as freely as they seem to do in the nerves.

This statement appears the more important, as I had hitherto not succeeded in pointing out any essential difference between the electrical phænomena of muscles and nerves. Yet such a difference ought to exist, if any relation be admissible between the electrical phænomena of muscles and nerves, and their other vital properties, which present such striking discrepancies.

On the Forces by which the Circulation of the Blood is carried on. *By* Professor T. Wharton Jones, *F.R.S.*

On the State of the Mind during Sleep. *By* Richard Fowler, *M.D., F.R.S.*

What is the state of the vital and mental forces during sleep, dreaming, trance, asphyxia, coma, compression of the brain, intoxication?

The body of an animal is its coil ("mortal coil"), and this, like a federative republic, of which the brain coil is the chief, is composed of a congeries of coils (organs of sense, glands, &c.), and, above all, of a muscular apparatus so adjustible as to enable the mental force to form it into coils for occasional purposes, for expression by speech and gesture, execution of works of art, &c.

In its waking state, the mental force has indirect perception of the adjustments of the muscles by the muscular sense, rendered more sensitive by the blood accompanying every retransmission to the muscular and nervous fibres.

The mental force has, in addition to perception and volition, a power to modify the adjustments induced by sensations and conceptions. It has its sense of buoyancy and fatigue from the different degrees of compression felt on the sentient extremities of the muscular nerves, hence the idea of power. Hume challenged the assertors of our having an idea of power to adduce the impression from which it may be inferred; and here is an adequate impression.

That mind and vitality are forces, is ascertained by the resistance they can oppose to all the physical forces, to those of gravitation and motion, by mounting a hill or swimming against a rapid stream, by the heavier weight sustained by a living than a dead muscle, and by the fracture of bones by falling, without the contact of hard substances. Dead fishes are disintegrated by being frozen; but Sir John Franklin's fish, at Fort Enterprize, were alive when thawed, after having remained frozen thirty-six hours. Men have resisted the effects of temperature which roasted and boiled butchers' meat.

To what source but to mind can we refer the existence and marks of intelligent contrivance on the earth, and in all we have learned of the universe?

It is an indispensable condition of all force to be latent to our faculties till a fit coil is present. We knew but little of motion, heat, light, gravitation, &c., before the watch, steam-engine, thermometer, barometer, &c., were invented; but the presence of the coil ensures the presence of the force, and the more perfect the coil the stronger the force (coil for atmospheric electricity)*.

When asleep, our coil is like a drum unbraced, or harp unstrung—unadjusted, whether for sensation or action. But what is its state when we dream? Then some of our organs retain such a state of tension as to be excited by impressions or conceptions, and impressions upon vital coils induce definite adjustments (probably by retransmission). If the lips of a comatose patient be rubbed with a spoon before its contents are put into the mouth, the adjustments of deglutition are so accurately made as not to risk suffocation. It is thus intelligible. How suggestive touches induce retransmissive adjustments, by which sleepers, the blind and deaf (feeling by the touch), are enabled to interpret the meaning of others; and questions to persons asleep are suggestive of the adjustments by which they are answered. This is analogous to the suggestive effects of questions in ordinary conversation, but still more palpably of leading questions in courts of justice.

The less the relaxation of tension (as in the morning) the more vivid the dream. Our belief in our dream (as in the diorama) is not contradicted by objects outside.

When conceptions are vivid, such as belong to the passions, they produce retransmissions to the parts to which the conceptions belong.

Again—That the adjustments required for sensation are the same as those by which conceptions are formed, is proved by various cases—by the experiment of Banks†—by the murderer, suffering from remorse, having always the image of his murdered child before him.

It is contrived by Benevolence, that like adjustments induce like conceptions. Many repetitions are required to form accurate conceptions. And we must *do* to know, for it is not till we have *done* that we get the conceptions which form the painter, sculptor, orator, singer, &c. Sir J. Reynolds says, that it was not till he had been at Rome a year, that he began to appreciate the works of Raphael.

We know how vibrations induce definite diagrams. Thus are also definite adjustments induced, and thus identity is recognised, by the likeness of this object to our previous conceptions of it.

Unadjust the coil, and the force disappears. This is the sleep of the coil, not of the force. In man, who is, as we have said, a congeries of coils, they do not *all* sleep.

Feeling in the body, and conception from abiding adjustments of past sensations, are the instructive interpreters of new sensations. Thus the conception of a ship near to us, interprets the perspective appearance of a distant sail. Every known part is suggestive of its whole. A conception already in the mind retransmits such adjustments to the ear, that it interprets the sound of the words sung in music. (Men "walking in darkness." Chant.)

Some persons seem to live in a dreaming state, unadjusted by attention. They do not observe what is passing; for we must look to see, listen to hear, &c. Their impressions and conceptions induce no definite adjustments, and adjustments are, to the perceptive mind, signs of thought.

In profound sleep, we are not aware of more than suspension of consciousness, and are without dreams. In what, then, does this differ from death but in time? "Sleep, the death of each day's life." "But in the sleep of death, what dreams

* The late Mr. Read of Knightsbridge had on the top of his house an electrical apparatus, so excitable that it indicated by bells the slightest change in the electric strata of the atmosphere.

† See Banks in Dr. Darwin's Zoonomia (his report on ocular spectra).

may come?" If my notion of this subject be physiologically correct, the mind is a force acting as physical forces do, each through the medium of its appropriate coil, and returning to a latent state when the coil is withdrawn. A force is not manifested when the coil is not, any more than thinking is, when the coil is disconnected with *mind force.* What then becomes of the mind? What becomes of any other force? Motion is individualized in a watch—gravitation in a pendulum—heat in a thermometer—and gravitation again in a barometer—magnetism in a natural or artificial magnet.

Endow appropriate coils with consciousness—as soon as an appropriate coil is presented, the force will, as we observe in all coils, enter it, as in the instance of the coil for atmospheric electricity.

Where, then, is mind, when its mortal coil is perishing in the grave? Where are the physical forces when the instruments which they actuated (the pendulum of a clock, a steam-engine, a voltaic trough, or a Leyden phial) are broken? Gravitation, motion, heat, and electricity do not cease to exist. They existed before their coils were invented, and will continue to exist when this earth and all material organized structures shall have ceased to exist; and that this will be the condition of the mind, we have abundant reason to expect. It is the mansion, not the tenant that is changed. Mind may still live as distinct from flesh and blood, which is sustained by food, as is the swimmer from the flood.

ETHNOLOGY AND GEOGRAPHY.

ETHNOLOGY.

Remarks on an Ethnological Collection, in illustration of the Ethnology of Java. By Dr. BIALLOBLOTZKI.

On the Misapplication of the terms Evolution and Development, as applied by Ethnographical Philologists to the Inflexions of a Language. By RICHARD CULL, *Fellow and Hon. Sec. of the Ethnological Society.*

THIS paper is more of a critical character than fraught with new facts, as indeed its title conveys. Philologists speak of a language developing its inflexions, or having its inflexions evolved. It appears to the author that Horne Tooke clearly pointed out the nature of the inflexions of languages, that the researches of all philologers have confirmed his view, and yet we continue to speak of evolving inflexions. Many persons attribute a vast mental superiority, at least in language, to certain nations of antiquity, for having developed inflexions in their language; and deem the descendants of those same nations to be inferior, because they have not only not developed any inflexions, but have been unable to maintain those which were developed by their ancestors. If the views of Horne Tooke be sound, the idea of developing, in the sense of opening or unfolding, is erroneous.

A change in the form of a word to express a different meaning is called an inflexion. The form of a word can be changed in two ways.

1. By adding one or more sounds, or even syllables to it, as *love, loved, loving.*

2. By a change *in* the word, as *speak, spoke*; and both methods of changing the form may occur in the same word, as *speak, spoken.*

The word *loved* differs both in form and sense from the word *love.* The word *spoke* also differs in both respects from the word *speak.* And the word *spoken* differs in both respects from *speak.*

What is expressed in one language by such a change, called an inflexion, may be expressed in another by a different method; thus the Latin *dominus,* a lord, besides its other changes of form, has one which gives it a feminine signification, *domina,* a lady; but the English word lord has no feminine inflexion. Thus while in Latin a part of the word only is changed, in English another word is adopted. The word lady is not an inflexion of the word lord. Languages differ greatly in regard to inflexion; some abound in inflexions, while others have but few. They are numerous in Sanscrit, Greek, Latin and the Sclavonic languages, less so in English, and at the lowest in Chinese.

We know how these inflexions were produced. They are not produced by any opening as a bud opens into a flower, but by the coalescence of another word, or fragment of a word, with the original word.

We can show in many languages the word whose fragment is coalesced. Now a junction of two things, even when well incorporated, together cannot with propriety be called a development or evolution.

In the Hebrew language the personal pronouns are termed separable and inseparable. The separable pronouns represent the person to be in the nominative case. The inseparable exhibit only some fragment of the separable pronoun combined with some word.

In the Malay the plural is formed by adding some word or words which signify *much, many,* or the like, or by repeating the same word, as *oran baniak* or *oran oran,* many man, or man-man.

In the Coptic the syllable *ni* or *na,* which is prefixed to form the plural, is, no doubt, says Professor Lee, the word *na* or *naa,* which means much, many or great. In Lee's Hebrew Grammar the subject of the coalescence of words with fragments of other words is treated in a masterly manner.

If we study human speech for ourselves, by closely observing what is going on, instead of merely reading books on the subject of grammar, we shall detect the process by which inflexions are formed. The formation of inflexions, like other changes in language, are not the result of a committee of learned men sitting in solemn council. There is no deliberation whatever in the matter. Learned men and grammarians do not make the changes. They only observe and record the changes that are taking place in the language of the mass of the people; and all these changes are made in the spoken language.

The two objects of language are—

1. To convey ideas, &c.
2. To do so rapidly.

In our common speech we are ever striving to convey our thoughts with rapidity, and in our efforts to do so, we involuntarily abbreviate many words and join those abbreviations or verbal fragments to other words. In this way we œconomise sounds, syllables, and sometimes words. The word *them* is commonly imperfectly uttered in the rapidity of familiar discourse. It is abbreviated by cutting off the theta in such phrases as, *I gave 'em* instead of *I gave them.* This was observed above a century ago, when an attempt was made to render the written language a transcript of the spoken by printing the abbreviation *'em* for *them.* The first edition of Lord Shaftesbury's Characteristics was so printed.

Again, in familiar talk we say *I aint* for *I am not*; *I wont* for *I will not*; *I shant* for *I shall not.* These examples, so far from being exhaustive, are merely instances from groups of such abbreviations. The act of subordinating an auxiliary verb to the principal verb of a sentence seems to crush the auxiliary into a mere fragment, as in the sentence *I have done,* which is in rapid talk broken down into *I'v done.* Such cases illustrate the formation of an inflexion, and is what is passing under our daily observation. A number of reasons prevent the transfer of these colloquialisms from being transferred to writing, but no one who has studied the subject will doubt, that if our language were an unwritten one and now about to become a written one, such forms of inflexion would be noted and written as a part of the language.

The author has observed similar phænomena in several European languages. Hence the causes that produce such phænomena in our own language are also operating with similar results in certain other living languages, and it is to such causes alone that we can refer the formation of inflexions in the Hebrew and other ancient languages. The formation of inflexions, then, is not by developing something out of a word, but by adding something to that word.

Notes on Blumenbach's *Classification of the Human Race. By* Richard Cull, *Hon. Sec. Eth. Soc.*

Description of a Samoied Family seen at Archangel, in a letter to Dr. Hodgkin. *By* John V. Giles.

During my late visit to Archangel I had an opportunity of observing a family of Samoieds, and beg to offer a description of them. They consisted of five individuals, the father, mother and their children, and my interest was chiefly enlisted in them by their exceedingly diminutive stature.

In beating about the coast of Lapland for some weeks and round the North Cape, I had accustomed myself to the low stature of the Laplanders, but the height of these poor wandering Samoieds approached dwarfishness.

The mother, who was about three inches taller than the man, was scarcely four feet high. The next most striking peculiarity I observed in them was a close resemblance in features to the Chinese, or to such of the Chinese people as I have seen about Lintin, Whampoa and Canton, who are, I believe, a race between the Chinese and Tartars. The chief point of resemblance was the oblique set of the eyes in the head, they being also small, dark and piercing; cheek bones high; hair long and black; complexion dark and swarthy. There appeared to be much labour expended upon their dress, which consisted of an infinite number of very small pieces of deer skins, cut into the shape of lozenges or diamonds, closely and rather neatly sewed together, the fur side of the skin turned inwards. Much pains seemed to be taken to ornament them, by plaiting and working up strips of skins into tassels.

The upper vestment resembled a strait jacket, having long sleeves closed at their extremities, which appeared to be used as a scrip, for when anything was given to them they released the arm through an opening made under the armpit, and then drew the arm in again, depositing the article in the nether extremity of the sleeve.

The lower part of their dress terminated in and was joined to a sort of mocassin, made also as the upper portion, of an infinite deal of patchwork. I imagined they had been in the habit of exhibiting themselves to English vessels, for they had learned a few words in our language, and could ask for tobacco, biscuit and beef. To my repeated inquiries as to where they came from, they pointed to the *north-east.*

They made me several visits during my stay, seemingly very much pleased with the gifts of tobacco and biscuits they received from me, but would never come on board the ship. Unlike the people around them, they would not drink raw spirits.

The youngest of the children I judged to be about three years of age. The man's features were regular and tolerably well-looking, but in the woman I discerned the marks of premature old age; she was wrinkled and had lost some teeth. Upon first seeing them I had taken them all for children from their size, until I came to look into the woman's face, when seeing the marks of age, and making inquiries as well as I could, they made one understand their relationship.

As they are a people not much known, I have imagined an account of them, however short, by one who had personally met with them, might contribute to your researches in ethnology.

Notes upon a Collection of Irish Crania. By John Grattan.

On placing this collection of ancient Irish crania before the Section, the author offered a few remarks as to whence they were obtained, and as to their probable antiquity. For some years Mr. Grattan had been associated with Mr. Getty in his examination of the round towers in Ulster, having for his special object to rescue from destruction any crania that might be brought to light during Mr. Getty's proceedings. Ten round towers were examined in which various osseous human remains were found, including eleven crania. In all the towers, except that at Trummery, upon removing a greater or less depth of heterogeneous materials,—evidently the slow accumulation of ages,—a flooring of lime, apparently the result of the accidental dropping of mortar during the building of the tower, was reached, from which downwards the offsets that constituted the foundations of the tower extended, the interior being filled up with soil similar in all respects except compactness to the virgin soil upon which the foundation rested, and *in this soil* and *under the lime floor, without any exception whatever,* the remains when present were found.

The skulls so obtained were with one exception in so frail and crumbling a condition that it was found impossible to remove them, except in almost hopeless fragments, but by carefully saturating them with glue and cementing them together, they were restored to the condition in which they then appeared (specimens were exhibited).

The ten towers examined were Drumbo, Trummery, Clones, Armoy, Drumlane, Rams' Island, Devenish, Island Mahee, Antrim and Torry. Five of these towers contained human osseous remains; one had been previously disturbed, and four exhibited no trace whatever of any. At Trummery, a tower of comparatively recent erection, according to Dr. Petrie, the osseous remains were found in a carefully constructed stone chamber.

Of the eleven skulls discovered within the Round Towers, *one* was found at *Drumbo*; *one* at *Trummery*; *six* at *Clones*; *two* at *Armoy*; and *one* at *Drumlane.*

The whole collection (including crania from various other sources) was thrown into four chronological groups, viz. the Prehistoric, the Remote historic, the Anglo-Irish and the modern periods. The eleven crania from the round towers were referred to the second or Remote historic group, which from Dr. Petrie's researches must belong to a period ranging between the fifth and thirteenth centuries. The tower of Drumbo not being of later erection than the sixth century, the cranium must have an antiquity of not less than twelve or thirteen hundred years. Drumlane tower being of nearly the same period, scarcely so old, its cranium therefore might be one thousand or eleven hundred years old.

The collection exhibited unquestionable evidence of the existence in Ireland at various epochs of strikingly contrasted varieties of the human family. But amongst the varieties of form attention was fixed upon one fact strongly shown, viz. the tenacity with which different types preserved their identity through periods of time which embraced no small portion of the history of mankind.

The crania of the second group, viz. those found in the round towers, it was suggested, might possibly represent the *magnates of their day.* The construction of an elaborate stone chamber under the tower of Trummery would scarcely have been undertaken unless the individual had been a person of some importance, probably the immediate progenitor of the erector of the tower; yet, although the interment took place within the tower, it was not to be assumed that the towers were built for such a purpose. The decapitation of a slain chieftain, either by friendly or hostile hands, was a matter of ordinary occurrence; now with the cranium from Armoy were found the three superior cervical vertebræ, *and no more,* precisely so much of the spinal column as would remain attached to the head when separated from the trunk. Hence the inference was not unreasonable that it was removed from some fallen chieftain to rescue it from indignity, and the tower in which it was found being probably then in the course of erection, was there interred, just as the head of Diarmid M'Fergus was buried at Clonmacnoise and his body at Connor, as recorded in the annals of the four masters A.D. 565.

A hope was expressed that the collection was but the commencement of one calculated one day to afford useful data to science; and the author concluded by expressing his own belief, that, though these interesting relics of dim and distant ages and their congeners of more modern times might present to the eye of the *ordinary observer* but few and barren facts, they would be found, nevertheless, when viewed through the medium of what appeared to some minds a deeper research and more exact knowledge, to stand forth, voiceless and unsuggestive as they seemed, enduring hieroglyphs of our race pregnant with meaning of *hidden* but *grave* import, and not, perhaps, of very difficult decipherment.

On the Ethnological Bearing of the Recent Discoveries in Connexion with the Assyrian Inscriptions. By the Rev. Edward Hincks, *D.D.*

Correct ethnological reasoning must be founded on facts, of the present or former existence of which we have satisfactory evidence; that is, statements in relation to them, reduced to writing while they still existed, and that by persons who must have been cognizant of the reality of what they recorded. Facts of this nature may be isolated, or reduced to a system by those who recorded them. Of such a system we have a good example in the Germania of Tacitus, Dr. Latham's recent edition of which was warmly commended. Other collections of facts of a somewhat similar character were alluded to; but all had the disadvantage of recording much as to which the collectors had only imperfect information, indiscriminately mixed up with what they knew; and again, all such collections have come down to us through many copyists, in passing through whose hands they have been much depraved.

In these respects they must yield to the collection of facts deducible from Egyptian or Assyrio-Babylonian records, of which we possess autographs, or at any rate copies made under the superintendence of the authors, while the facts were yet recent. Nor is danger to be apprehended from intentional misrepresenting. Facts connected with history, would, doubtless, be presented in a manner more favourable to the royal authors of the inscriptions than truth would warrant. But, in facts which most concern the ethnologist, there is in general no room for misrepresentation; they being facts which come out as it were accidentally, and as to which national vanity has no place.

The facts recorded in the Assyrian inscriptions are of more importance than those in the Egyptian, because they are not clouded as the latter are by ignorance in respect to their chronology or geography. The chronology of the period to which the most important Egyptian inscriptions and papyri belong is still a subject of controversy; while it was stated that the commencements of the reigns of Sargon and Sennacherib were as certain as those of any of the Lagidæ or of the Cæsars. Dr. Hincks had announced in a paper recently read before the Royal Irish Academy, that the twelve first years of Sargon corresponded with the twelve years assigned in the Canon of Ptolemy to Mardokempad, which name is a corruption of that of Marduk Baladan. In the course of July, he had identified the three years of the Belibus of the Canon (Belib) with the second, third, and fourth of Sennacherib. It followed from this that the reign of Sargon lasted eighteen years, and that the first interregnum of the Canon, which occupied two years, is to be referred to the last year of Sargon, and the first of Sennacherib. Sargon's reign began in 721 B.C.; Sennacherib's in 703 B.C. Marduk Baladan was three times conquered; first by Sargon, in 710; secondly, by Sennacherib, in 703; and thirdly, by the same king, in 700. On the first occasion, Sargon added Mesopotamia to his kingdom; on the second, Sennacherib gave it to Belibus; and on the third, he made his son Assurnadin king of Mesopotamia and Chaldea, which last country had been left to Marduk Baladan on the two former occasions. Dr. Hincks identified this name with the Aparanadius, which is the name of the successor of Belibus in the best MS. of the Canon of Ptolemy, which is, however, not an ancient one; the Greek *p* being a mistake for *ss*, which might easily have been occasioned by the similarity of these letters.

Before Sargon we have Shalmaneser, Tiglath Pileser, and Pul. Col. Rawlinson, who had first recognised the name of Marduk Baladan, has recently discovered a series of annals of Tiglath Pileser. In a fragment of the annals of Pul, Dr. Hincks discovered the name of Menahem as a tributary, in the eighth year of his reign. This being fixed by 2 Kings vi. to about 770, his reign must have commenced about 777. Divanubar, the obelisk king, must have begun to reign about 900 B.C., as Hazael, the commencement of whose reign is known to be about 885, was king in his eighteenth year, but not in his fourteenth. Col. Rawlinson has found a series of annals of the father of this king, in which Ithobal, king of Tyre, is mentioned. It appears from the Tyrian annals, extracted by Menander, and preserved by Josephus, that he reigned from 936 to 904, which is in perfect harmony with the date of his son's reign.

Reasons were then given why the geography of the Assyrian inscriptions was capable of being better determined than of the hieroglyphic ones; namely, that the Egyptian could only go in one direction to Asiatic countries, whereas the Assyrians made expeditions in all directions; and the direction in which an unknown country lay could generally be determined by that of other countries noticed along with it, if, indeed, it was not expressly pointed out by the king's saying that he went to it over the Euphrates or the Zab.

The great ethnological fact respecting Assyria—its language—was then treated of. Dr. Hincks considered the Assyrian language to belong to a family akin to that of the Syro-Arabian languages hitherto known, rather than to that family itself. He first pointed out what it had in common with all these languages. It had verbal roots, which were normally triliteral, but of which some letters might be mutable or evanescent, whence arise different classes of irregular verbs. These roots admitted not only the simple conjugation, but others in which radical letters are doubled, other letters added, or both these modifications made at once. From these roots verbal nouns are formed, either by a simple change of the vowels, or by the addition of letters, such as are called in Hebrew Heemantic.

It agreed with the Arabian more closely than with any other Syro-Arabian language in three respects :—1st. In forming the conjugations, consonants are inserted among the radical letters, as well as prefixed to them. This takes place regularly in Arabic, but in Hebrew only where the first radical is a sibilant. 2nd. The termination of the aorist varies as in Arabic; different verbs taking different vowels between the second and third radicals, while the first radical sometimes terminates the verb; and sometimes takes after it *a* or *u*. 3rd. The forms of the plural vary, and the cases of nouns differ in a manner which resembles, in some measure, what takes place in Arabic.

The Assyrian language differed from all the Syro-Arabian languages known hitherto in the following respects :—1st. Where they have *h*, it has *s* in a variety of instances, and especially in the pronouns and pronominal affixes of the third person—*sû, sî, sunu*; *su, sa, si, sun* and *sin*, most of which resembles forms in other languages, if only *h* be substituted for *s*.

The same difference occurs in the characteristic of the causative conjugation. In these respects, but not by any means generally, the Assyrian agrees with the Egyptian, and through it with the modern Berber. 2nd. The Assyrian has no prefixes, such as *b* for *in*, *l* for *to*, which occur in all the Syro-Arabian languages. In place of these it has separate prepositions; and to avoid the awkwardness of joining these to the prenominal affixes, and perhaps for greater clearness, nouns are inserted, forming compound prepositions, as *ina kirbisu* "in its midst" for "in it." Compound prepositions may be used also before other nouns, as *ina kirib biti*, "in the midst of the house" for *ina biti*. Sometimes the Assyrian uses affixes as substitutes for prepositions. Instead of *ana*, to or for, before a noun, *ish* may be added. Thus "for a spoil" is expressed indifferently by *ana shallati* and *shallatish*. This last form has much of the nature of an adverb and has some resemblance to the Hebrew noun with *He* locative*. 3rd. The Syro-Arabian languages made frequent use of a preterite, in which the distinctions of number and person are confined to the end of the root; but the Assyrian rejects it, or at least uses it in an exceedingly sparing manner. On this account Dr. Hincks proposed to consider the Benoni participle, masculine, singular, *in regimen* as the root. 4. The varieties in the termination of the future are not connected with any particles that may precede them, but of themselves indicate different tenses. The termination in *u* is certainly a pluperfect. Thus where mention is made of "that Marduk Baladan whom I *had defeated* in my former campaign," the verb is *askunu*; but whenever "I defeated" occurs in the simple narration *askun*, *askuna*, or in a different conjugation, *astakan* is used. This law has been fully established. The addition of *a* seems not to change the sense; it is added to every verb when what it governs follows it, and to some verbs even where it precedes it. These are chiefly such as denote locomotion.

The resemblance of the most common Assyrian prepositions and of the pronouns to Indo-European forms is curious, and points to a common though remote origin.

The Babylonian inscriptions are in the same language as the Assyrian. This was probably the court language at Babylon; but the common people most probably used the Chaldean language, in which some parts of the books of Ezra and Daniel are written.

* Since this was written Dr. Hincks has been led to alter his views as to the final *ma*, which is not connected with the pronominal affix, but with the verb that precedes it, of which it modifies the sense; thus *addin-su-ma* is not "I gave to him," but "when I had given to him," or "having given to him."—(June 1853.)

On the Forms of the Personal Pronouns of the Two First Persons in the Indian, European, Syro-Arabic, and Egyptian Languages. By the Rev. Edward Hincks, *D.D.*

Dr. Hincks began by saying that he now only threw out suggestions, which might be followed up by others. The question, of which he took a novel view, could not be settled by considering the pronominal forms exclusively. Many other points would have to be considered; and whether the conclusions which appeared to him to follow with a high degree of probability from these forms, would be confirmed or proved to be erroneous by the examination of other forms, was what he could not now say. He only wished to set persons to think. It appeared to him that a certain theory had been taken for granted, and he wished that it should be subjected to examination.

The affinity of the personal pronouns in all the Indo-European languages was not to be disputed; nor did Dr. Hincks mean to challenge any reasonable opinion respecting the absolute antiquity of the Sanskrit. What he called in question was its antiquity relative to the European languages akin to it. The case with respect to the pronouns of the two first persons might be briefly stated. The Asiatic members of this family have a final *am* which is wanting in the European numbers. Was this *am* omitted by the Europeans, or added by the Asiatics? The former is the received opinion; the latter seems more probable to Dr. Hincks. Examples of both processes are common. The English pronoun *we* is nearly the same with that in many languages of Northern Europe. It is admitted by all philologists that this has been shortened from a more ancient form, *wir* or *wis*. This abbreviation has been made in Swedish within the historic period. In other languages it was made in the prehistoric period; that is, we have no written documents of an age before it was made. Philologists are, however, agreed that the *s* or *r* at the end of this form was an addition, and that there must have been an older form without it; and the received opinion is that this form *wi* or *vi* was an abbreviation of the Sanskrit *viyam*. Dr. Hincks considered this to be a false view. He assumed a form *anwis* or *anus* (and that *wi* and *u* pass into one another appears from a vast number of instances; as the Latin termination *vis*, where the Greek and Sanskrit have *us*; the Semitic copulative conjunction, &c., &c.), from which *wis* and *nus* (*nos*) would both arise. This *anus* was the Semitic pronoun *anu*, which was common to the Indo-Europeans and Semitic races before their separation, in the same manner as *anaku* and *anta* or *antu*; and the Indo-Europeans added *s* under a false impression that a plural termination was necessary, the fact being that *anu* was itself plural. As it is not likely that this mistake would be made simultaneously by unconnected nations, Dr. Hincks argued that the addition of *s* must have taken place while the Indo-Europeans were *one people*; and hence the necessity of assuming an ancient form which would account for both *weis* and *nos*. It was observed that *n* was peculiarly liable to be attached to words beginning with a vowel. The Irish names of Newry and of the river Nore, the English noun *newt*, in which the *n* has etymologically no place, and the abbreviations, *nan*, *ned*, *nol*, are proofs of this.

At first, it was assumed that the pronoun of the first person singular in the European languages showed traces of the Indian *am*. The *o* in *ego* might be for *om*, as the *o* in *lego* certainly was. A trace of this *o* remained in Sclavonic, and its omission in Lithuanian and Gothic was evidently a degradation. Dr. Hincks maintained, however, that this *o* might be otherwise accounted for, the Assyrian form of the pronoun being *an-aku*. According to this view, the Indian pronouns *aham* and *viyam* are so far from being the original forms that they are obtained from late European forms; not from the more ancient *aku* and *vis*, but from the abbreviated *ak* and *vi*.

If this philological view be correct, it tends to an ethnological view, which resembles what has been advanced by Dr. Latham. The Indo-European race proceeded westward through Asia Minor, and over the Hellespont and Bosphorus. They then dispersed through Europe, and at length an offset from the Sclavonic branch returned to Asia between the Caspian and Black Seas, overrunning some countries eastward of Assyria and at length penetrating to India.

The Semitic and Indo-European pronouns of the second person plural are distinct, having been developed in different manners after these races separated.

The Egyptian pronouns of all these persons take that *an* at their commencement which the Semitic pronouns of the first two persons have.

The Origin, Characteristics, and Dialect of the People in the Counties of Down and Antrim. By the Rev. A. Hume, *D.C.L., LL.D., F.S.A.*

The district comprising the counties of Down and Antrim, of which Belfast is the natural centre, is one which has exercised a most important influence on the destinies of the human race in these islands. In Down, the patron saint made his first convert, and there his ashes repose; in Antrim, the real Ossianic poems are supposed to have existed. In Down was the ancient Ulidia, from which the extended name Ulster is derived; in Antrim was the ancient Dalradia, the name of which was applied to a large portion of modern Scotland. Ireland was originally known as Scotia, or Scotia Major; and, when the name was superseded at home, it was retained by our enterprising colonists to Argyle and Lorn, and afterwards extended to all North Britain, after the conquest by Kenneth in the ninth century. The line of kings descended from Fergus the son of Erc, not only mingled its blood with the Saxon and Norman royal lines of England, but afterwards inherited the sovereignty of Great Britain; so that Queen Victoria traces an authentic descent from the petty chieftains of this neighbourhood in the fifth century.

More than a thousand years afterwards, the debt of colonization was repaid, at the time of the Plantation of Ulster. The Anglo-Saxon population had been so long separated into two branches, the English and Scotch—differing in country, laws, religion, manners, prejudices, &c.—that they must be regarded as two peoples, and not one. If to these we add the remnant of the native Irish, there are three distinct elements, from the composition of which, in different quantities and situations, the inhabitants of the two counties are derived.

These localities are the following:—the Irish, in the hilly districts, as in the "Glynnes" [glens] of Antrim; and the Irish-speaking population in the neighbourhood of Cushendall. There are a few in almost every parish, and several in the great towns. In Down, few occur north of Downpatrick and Ballynahinch; they then converge to the mountains of Mourne, by the parish of Loughin-island. In the past generation, Irish was frequently spoken in the markets of Downpatrick, Castlewellan, Dromara, and Ballynahinch; now it is rarely used as a separate mode of communication. In the districts of the Celts they preserve their traditional antipathies, though they assimilate in language; and the terms "Irish," "Scotch," and "English," are used currently by the nearest neighbours in reference to ancestral origin.

The Scottish immigration followed two natural routes—by the Mull of Cantyre to the County Antrim, near the Causeway; and by the Mull of Galloway to the County Down, by Donaghadee. From the earliest time, coracle skiff and coaster must have passed in this way, and the two distinct streams ran right across the counties. In Down, the Scotch current is traceable by Comber, Killileagh, Saintfield, and Annahilt, nearly to Hillsborough; also, by Castlereagh and Purdysburn, to near Belfast. In the County Antrim, the course is by Ballymoney and Ballymena, up to the town of Antrim, and over the back of Devis and the Cave-hill.

The English settlers occupied mainly the low countries, such as the basins of the Lagan and Bann, and the banks of Lough Neagh. Belfast was originally an English town, but its external increase has been mainly from the two Scottish districts. Lisburn was a small English and Welsh colony; it is now practically an English town. In one barony of Antrim, of 128 townlands, the population is all of English origin; and Aghalee, Ballinderry, &c., look like parts of England.

At various points the different races meet, but refuse to mingle. There are English, Irish, and Scotch quarters in several towns, such as Downpatrick and Carrickfergus; and the Lagan, near Lisburn, separates the two races. In one half of the parish of Hillsborough the people are all Scotch, in the other they are all English. A hill near Ballynahinch separates the two races; and the island of Rathlin has its two promontories occupied, one by the Irish, the other by the English and Scotch.

The religion, habits, customs, &c., may all be deduced from this distribution. In religion, for instance, the rule is, that the English are Episcopalians; the Scotch, Presbyterians; and the Irish, Roman Catholics. The lines of Scottish population may be marked on the map by a double chain of Presbyterian meeting-houses, while in the English districts they are rare or unknown. In fourteen Presbyteries of the General Assembly, seven of which are in each county, there are upwards of 200 congregations. If to these we add other Presbyterian congregations not connected with the Assembly, we shall find that fully one-half of all the congregations in Ireland are situated in these two counties, or connected with Presbyteries that centralize in them. More than one-half of these are in rural districts, unconnected with towns or villages, and called by the names of townlands; showing that the Scotch were in general agriculturists, and less settled in towns than the English. In the English districts the church-and-king feeling is strong, but, from the magnitude of the parishes and the distance of churches from particular points, the people are less attentive than they should be to their religious duties. In the Irish districts the Roman Catholic congregations are large, and those of the two branches of the Protestant Church are small. In the English and Scotch districts, several parishes are united to form one in the Roman Catholic arrangements; and again, Drumgooland, where Protestants are few in number, is divided into two Roman Catholic parishes. This is in the neighbourhood of Dolly's Brae, and it is said that in two townlands of Backaderry and Magheramayo, as well as in several others, there are scarcely any Protestant families.

The habits of the people, as well as their creed, indicate their origin. In the English districts there is more comfort and tidiness than we find elsewhere; for the man of Scottish ancestry does not enjoy life so well, though he may be actually richer. The Scotchman is often more intelligent than his English neighbour, but he rarely excels him in weight of character. In the English districts the farms are large, and there is a better kind of house, furniture, stock, food, clothing, &c. The man of English origin will live and let live. In the markets of Lurgan, Lisburn, Moira, and Portadown, the Down farmer is known from the Antrim one, or rather the Scotchman from the English, by his hardness in driving a bargain. The old English sports and pastimes were kept up till recently at Lambeg; the May-pole is still known in Holywood, and tradition leads us to believe that certain mystery plays have been performed in the district. The custom of hiring servants at stated fairs is followed in Antrim, as is the case in many other towns and places of England; and while those who attend for the purpose at Carlisle carry a straw in the mouth, those at Antrim carry a little white rod in the hand. The settlers on the Marquis of Hertford's estate were in general natives of the shires adjoining the Bristol Channel, and as their ancestral district is the apple district of England, so the barony of Upper Massareene is the apple district of Ireland. After the lapse of 250 years, the ancient custom is preserved as if it were of yesterday. The superstitions of May-eve and Hallow-e'en are still practised, and not one of the ceremonies in Burns's poem is neglected, even by those to whom the poem is utterly unknown.

The names of persons and of places are also highly illustrative of the people. In the English districts, we meet with such names as Turner, Standfield, Hull, Moore, Shields; in the Scottish, Dunbar, Edgar, Livingstone, Kennedy, Douglas, and sometimes they undergo curious transformations. In the Irish districts, a few names are used with distinctive terms and epithets, and sometimes Irish names are translated into English or Anglicised; M'Shane becomes Johnston, and Ginnif, Sands, while M'Gurnaghan is altered to the more euphonious Gordon. Names of places are often derived from those of persons, as Hill-town, Hill-hall, and Hills-borough, from the Downshire family; Gill-hall and Gilford from the M'Gills; and similarly Warings-town, Ross-trevor, Echlin-ville, Mount-stewart. Grooms-port is Graemes'-port, and Ballymcarrett the village of M'Art. Many names are less distinctly known, as Bryan's-ford, Lyle-hill, Randals-town; others allude to the original possessors, as Acre M'Cricket, Taggart's-land, Douglas-land, Dobbin's-land, Bally-copeland, Bally-french, Bally-gilbert.

Dr. Hume concluded his remarks with a *vivâ voce* description of the Hyberno-English dialect in these two counties, and showed, by various quotations, its local characteristics, and also its usefulness. From the fusion of many peculiarities and the mingling of provincialisms from various parts of the United Kingdom, it is particularly useful in the illustration of our old English literature.

Heads of a Paper "On the present state of Medo-Persic Philology." *By* Professor MacDouall, *M.A., Queen's College, Belfast.*

Tendencies have been lately exhibited, in works treating of comparative philology, to disturb, whether by contraction or by enlargement, the relations which profound researchs was upposed to have definitively settled between the Indo-European languages and those of other families, and also to question, on various points, the principles on which the present arrangement of the members composing the Indo-European class itself reposes. In particular, the position usually assigned to the Medo-Persic element has been assailed; and not merely has the registry of its functions and claims been thought to demand revision, but a disposition has been evinced to jostle it altogether out of its existing connexion. Although it was not to have been expected that such theories as those formerly advocated by Othmar Frank on one side, and Col. Vans Kennedy on another, would be reproduced after the natural history of languages had been traced by Schlegel, Humboldt, and their coadjutors, yet that the present attitude of Medo-Persic philology is a retrograde one, might be inferred from such surmises as those which, having been propounded by an authority like Dr. Latham, drew upon him unmeasured censure in a recent number of the Edinburgh Review. If it be not certain, after all, that the Irānian speech is cognate with the Sanskrita,—if it be still possible that the organisation of any of its dialects may pass for Seriform,—then it is certainly high time that the notions generally current in reference to it should be reviewed, and, if requisite, corrected. A *resumé* of the progress already made may be useful as a preliminary to prospective steps in this direction.

The Languages spoken by the subjects of the Achæmenian Kings—preserved through past ages on rocks, bricks, and slabs of stone, in the Cuneiform Inscriptions—are now partially resuscitated. One of these—generally known as "the third"—is admitted by all decipherers, with the (probably) solitary exception of Grotefend, to come under the Semitic category, like those of the Inscriptions of Assyria and Babylonia. The "second" type has not yet been so definitely classified: the designation at first given to it, "Pahlavī," has been given up, and that of "Median" has been substituted provisionally; but, while some consider it Aramaic, others are at a loss whether to treat it as Arian, or as Tūrānian,—and in either case disguised by foreign accessions,—or as a hybrid offspring, and one of uncertain parentage. Only the "first" of these monumental languages is admitted by all to be Arian, and by nearly all to represent the "Old Persic." Not only its orthography, but its lexical and grammatical constitution, has been already to a great extent elucidated; and,—what it is here of importance to observe,—it has been shown to resemble very closely the Old Sanskrita,—that of the *Vēdas*.

Distinct from the Languages just noticed, and likewise from each other, are those preserved in the Sacred Books of the Pārsīs—whether those of the Sipāsī heretics, or those of the orthodox Zoroastrians or Mazdayaçnīs. It is true, that not only the antiquity and genuineness of those books has been questioned by European criticism, but that the very languages, both of that oracle of the Sipāsīs—the *Dasātīr*, and of those Zoroastrian books which are represented as the oldest and as the prototypes of the rest, have been regarded as fictitious products,—travesties of real but recent tongues, or else as mere gibberish. Whether, however, that in which the so-called version of the *Dasātīr* is composed represents the vernacular of Persia about the time of the Moslem conquest, or is some centuries later,—and whether that of the so-called original, the *Asmānī Zabān*, be such a fabrication as the *Balai-Bōlnā* of the Sūfīs or the Formosan of Psalmanazar, or after all be, as suggested by Von Hammer and Troyer, the relic of some old local dialect,—are points which, on the one hand, cannot be regarded as finally decided, and, on the other hand, do not furnish available *data* in the present inquiry. But it has come to be generally acknowledged, in respect to the Mazdayaçnian Books, that they in reality belong to three distinct epochs:—the originals being fragments of the revelations attributed to the undated Seer, Zarathustra;—the proximate versions or imitations of these, with some commentaries on them, being of the Sāsānian age;—and the versions of those versions, with other pieces founded upon and referring to them, coming down as far as—and in some instances even below—the era of Yazdajird. And the history of the three Languages, in which these three classes of Books are composed, requires now to be traced with the utmost attainable accuracy.

I. The *First* of them has been variously designated the Language of the "*Mānathar*" (="Invocations"), or "of the *Avestā*" (="Text, Discourse," or perhaps primarily "Appointment, Decree"), or "of the *Zend*" (="Book," or perhaps "*Gnōsis*, Science"), from the documents in which it has been preserved. The third of these names is the one most usually employed; though Spiegel and some other scholars have lately questioned its propriety, conceiving it to designate the more recent version, in an Aramaising idiom, which will be noticed under the next head. So long as this language could be studied only in the specimens exhibited by Anquetil Duperron, its character and rank were very imperfectly apprehended; but now, that its genuine physiognomy has been portrayed by the happy ingenuity of Rask, its framework rebuilt and reanimated by the master-hand of Burnouf, and its relations elicited by the comprehensive analytics of Bopp, it has assumed its rightful stand-point as one of the primary members of the Indo-European family. As yet, however, opinions remain divided in reference to its original locality,—its growth, progress, and decline,—the age, authenticity, and mutual relations of its literary muniments.—The idea of Anquetil, Kleuker, and Herder, that the Zend-books were composed under Darius the son of Hystaspes and succeeding kings of the Achæmenian house, has been advocated by Adelung, Rask, Malcolm, and Klaproth: Wahl likewise concurred,—although he held that their language was merely a hieratic vehicle, gradually refined from the one in popular use by the sacerdotal caste: and the late Dr. Prichard adhered to the same chronology, without pronouncing decidedly for Wahl's theory, but evidently well inclined to it. Foucher and Tychsen, however, believed the groundwork of the liturgy to date from the reign of the Mede Cyaxares I., above 600 years B.C.; while they allowed that expositions of various parts, with additional prayers and tracts, composed under the Achæmenids, must have been incorporated with antique fragments in the existing compilation so lately as under the Sāsānian dynasty. Rhode and Heeren went still farther back, making the age of Zarathustra anterior to the Median empire; and this hypothesis has been stamped with the sanction of Burnouf, Lassen, and Pott.—For the locality of "the Zend-folk," the older inquirers had pitched upon the North-West provinces of Irān, between the Caspian and Black Seas, and supposed the vocabulary to have been that of Northern Media: philological affinities were therefore sought, by Anquetil, Kleuker, and Wahl, in the subsisting dialects of Armenia and Georgia; but—more discreetly—by Klaproth and Rask, in the speech of the Caucasian Irōn or Osī, whose descent from the old Medes had been traced through the Alans of the middle ages. An antagonist theory points to the North-Eastern provinces, those bounded by the Caspian and the Hīmālayan range; and, styling the speech of the *Avestā* "Sogdo-Bactrian," makes it intermediate, as to local habitation not less than age, between the "Medo-Persic" of the Achæmenian Inscriptions and the Sanskrita of the *Vēdas*. And this latter theory,—first suggested by Foucher and Tychsen, afterwards maintained by Rhode and Heeren,—is now commended by Burnouf, Lassen, Pott, Spiegel, and Westergaard; while Prichard, after a show of resistance, has virtually capitulated in its favour.—The definite conclusions of Westergaard on other points have not yet been announced; but, in 1843, he proposed to keep in view, throughout his forthcoming Grammar and Dictionary, certain ideas,—previously thrown out by Mr. Erskine of Bombay,—viz. that in the extant *rifacciamento* of the Pārsī books but a small *residuum* of the old Bactrian oracles can be detected, and that their language is in a condition of decrepitude and semibarbarism. Col. Rawlinson, in different papers, oscillates between Erskine's notion and that of Wahl; but his latest statement, in 1846, is opposed to the belief that these books conserve any tongue which was spoken under the ancient monarchy. Finally, Spiegel's acute criticism has not only dissevered the relics of most hoar antiquity from the recent Sāsānian accessions,—has not only detached from both extremes various specimens of the literature which partially bridged over the wide gap between,—but has disparted the "Old Zend" itself into two distinct dialects, and referred to each of these such of the extant documents as exhibit their respective peculiarities. What if this distinction,—which Westergaard homologates,—was one of locality rather than of age? What if one-half of the book *Yaçna* was composed on the Western or Median side of the Caspian Lake, and the other on its Eastern or Bactrian border? If so, we may amicably close all controversy about "Media" or "Bactria," as the home of the Zend speech—which must thus have been "Medo-Bactrian," and as the cradle of the Zend people—in whose sagas the spiritual and secular powers were symbolised, respectively, by Zarathustra, the Seer born in Urumīyā, and Vishtāçpā, the Monarch enthroned in Balkh.

II. Under the early Sāsānian kings the *First* Book-language had become obsolete, and the *Second*,—called by the Pārsīs "the speech of *Huzvāresh*" (=" Auspicious Heroism," as it used to be rendered, or rather, as it is now understood, " Acceptable Sacrifice"),—became the hieratic vehicle. In this appeared both versions of the old revelations, and also some new works designed to facilitate the restoration of Magian worship, such as the *Virāf Nāmah*, the *Bun-Dehesh*, the *Minō-Khirad*, the *Dīn-Kard*, &c. That any secular works were composed in it, or indeed existed at that epoch, there is no evidence. In it, however, are expressed the legends upon the fire-altar-coins struck by the early Sāsānids, and also the vernacular portions of bilingual inscriptions upon various monuments at Naqsh-e-Rustam, Naqsh-e-Rajab, and Karmān-Shāh, belonging to the same period. This fact was discovered, as is well known, by the illustrious Silvestre de Sacy. The labours of successive numismatists and decipherers have gradually, though still but imperfectly, elicited the laws and characteristics of the language: they have been most clearly expounded in an essay of Joseph Müller, and the publications of Spiegel and Westergaard are now rendering them at once more definite and more widely known. All inquirers continue to agree that it is isolated, among the Arian kin-tongues, by a copious Aramaic infusion, neither inherited from its predecessor nor transmitted to its successor, which has imparted to it a hybrid and abnormal aspect, and which at the same time assures us that this is the "language of Zardusht" described by Abū-'l-Faraj as an admixture of Old Persic with Nabathæan or Assyrio-Chaldaic.—Now, these circumstances all harmonise with—if they do not absolutely require—the hypothesis, that the Huzvāresh speech must have originated in the Western provinces of the empire, where the maniform intercourse of Arian and Semitic tribes would naturally produce a mongrel phraseology. While compatible with Anquetil's view of its being indigenous in Lower Media, in the region between Māzandarān and Farsistān, they rather favour that for which the cogent arguments of Erskine, Müller, Mohl, Lassen and Knobel have secured a general reception—viz. that it was formed in the Border-land along the Tigris, including at first Khūzistān and Irāq-Ajamī, and subsequently also the Northern districts about Hamadān and Kirmānshāh. They decisively preclude the fancy of Quatremère and Pott, that this language was vernacular East of the Caspian, among the Parthians,—was successfully propagated towards the West and South by the dominant Arsacids,—and only relapsed into obscurity after several reigns of the native Sāsānians. For, in this case, it should have been distinguished by a Tūrānian, not an Aramaic, infusion; its monumental inscriptions should have been found to the East, not the West, of the Great Salt Desert; its coin-legends should have belonged to the "Phil-hellenic" Arsacids,—whose mintage however is purely Grecian,—not to their Sāsānian successors, whose policy would naturally have discouraged its use. Equally inadmissible is the idea of Anquetil and his immediate followers, that this dialect so early and so extensively encroached upon the domain of others, as to have been adopted, under the Kaiānian dynasty, as the speech of the court and the empire, and to have maintained that rank at least 900 years, including the most brilliant and palmy period of Persian ascendency, and reaching down almost to the Moslem invasion. It is sufficient to remark,—without mentioning the historical and geographical difficulties which hence arise,—first, that it is not *this* language which supplies the words adduced by Greek and Latin writers as exemplifying the classical Persic of their day; and, secondly, that *its* structure does not accord with the intimations of Firdausī, Nizāmī, and other Moslem authors, that the speech of the ancient monarchy had survived the revolution, and had come down to themselves so far exempt from any material change that they had no difficulty in consulting the chronicles preserved in it.

III. In respect to the *Third* Book-language, the prevalent—and, as would appear, well-founded—belief now is, that *it* was the one referred to by Firdausī and Nizāmī; that it had been the vernacular idiom of Farsistān, which, under the later kings of the Sāsānian line, became fashionable and literary; that it ranked as the *Darī* or "Court-speech" during two centuries, but shrank into the obscurity of a book-language after A.D. 641, when it ceded its title of *Darī* by resisting that influx of Arabic terms and phrases which began thenceforward to colour the vehicle of ordinary conversation and business. Its analytical character, intermediate between the still complex—though doubtless partially relaxed—tissue of Huzvāresh and the consummated disintegration of Neo-Persic, warrants the philological soundness of this belief. Its name, "*Pārsī*," at once recals its original locality, and identifies it as the distant descendant of the language which occupies the first place in the Achæmenian Inscriptions—although, of course, the resemblance between these two has been seriously impaired by diversified influences in the wide chasm of time by which they are separated. Since in it various holy Oracles were translated from Huzvāresh,—if not, in rare cases, even from the older hieratic tongue,—and since expositions and devotional pieces by revered Mōbeds were preserved in it by those who adhered to the old faith after the triumph of Islām, it is now found to be largely saturated with the spirit of those uncongenial idioms,—especially the latter of them, with which it was in more immediate contact. Hence too it has been designated the speech of "*Pā-Zend*" = "the Commentary," and of "*Buzurgān-e-Dīn*" = "the Doctors of Religion." But, though the literary memorials now extant in it are, probably without exception, religious, others, now lost, are recorded to have been composed in it on secular subjects;—such as the *Zafar-Nāmah*="Book of Victory," by Būzūr, the Vazīr of Nūshirvān,—the far older *Kār-Nāmah* = "Journal," of uncertain authorship,—and a work on Morals by Ardshīr Bābagān. Further, it must be this same Pārsī or Old Darī which Mohammedan writers term "*Pahlavī*," while stating that in it, under the patronage of Nūshirvān and his successors, were composed the *Bāstān-Nāmah* = "Old Hero-book," and also sundry versions as well of Sanskrita collections of apologues as of treatises by Plato and Aristoteles.

Although, in the present abstract of a long paper *, the disputed appellations *Avestā, Zend, Darī*, have been passed without discussion, yet it is necessary concisely to review the history and circumscribe the import of the name just mentioned,—*Pahlavī*,—because it has been bandied about, in reference to unconnected and alien objects, with such latitude as to have involved the whole field of Medo-Persic philology in a perplexity truly tantalising.

From the time of Hyde and Anquetil, European writers, with the sanction and concurrence (as would appear) of the Pārsīs themselves, have designated the *Second* Book-language "*Pahlavī*." And, in accordance with the different views which they have taken of the origin and history of that language, they have espoused different derivations of this name. Some have deduced it from *pahlū* = "vigour," or *pahlau* = "strong, hero," as if it were strictly synonymous with *Hu-zvāresh* (according to the etymology put upon the latter term until lately), and representative of the speech in which the *Pahlawān-e-Jahān*—those Paladins who upheld Irān, while its sway was most extended—embodied their conceptions;—others, from *Pahlava* as applied to the Parthian tribes, or from *Pehlev* as indicating the old battle-ground of Rustam and Afrāsiāb;—others, from *Pahlū*, as restricted to the Border-land between the purely Persian and the Arabo-Chaldaic territories. But *Pahlavī* is defined by some Moslem authorities as simply = "ancient *Pārsī*;" and by all of them this is employed as the ordinary designation of the tongue which they describe as having been the national one down to the Saracen conquest, or even later. Numerous words noticed by Firdausī as *Pahlavī* are purely Irānian—not of Semitic parentage, as many of them at least must have been, if really *Huzvāresh*; and it has been observed likewise, that that poet commutes *Pahlavī* and *Pārsī* as epithets distinctive of his own phrāseology. The truth then is, that, in Moslem usage, *Pahlavī* suggests the *Third* Book-language—the one above discussed under the titles *Pā-Zend* and *Pārsī*; occasionally comprehending also the *Darī*, in which the third language came to be absorbed—just as the names *Darī* and *Pārsī* likewise have been sometimes treated as interchangeable. Before this state of the case was clearly demonstrated by Joseph Müller, the name *Pahlavī* had been construed, in *all* Oriental works alike, as referring to *one* language,—and that the *Huzvāresh*; but the unhappy result had been the perpetuation of such philological and historical hypotheses, incongruous and untenable alikē, as have previously passed under our review.

Since, now, the name in question has been ascertained to denote, in one set of writers, the *Second* Book-language—one strongly tinged with Aramaism, but, in another set, the *Third* Book-language—one of more purely Irānian organisation, it

* In it the later "*Darī phasis*" of the language, the modern *Farsī*, and various Arian dialects pure and mixed, were also reviewed, but not in a way that readily admits condensation or abridgement.

may be inquired, whether either of its applications favour any of the three etymologies, which, as was above mentioned, have been proposed for it, or rather a fourth must be resorted to for it in one or other—or both—of those applications. Now, a retrospect at the conditions of the problem evinces that two of the etyma must be summarily set aside. The third, viz. *Pahlū* = "Border-land," is suitable to *Pahlavī* as denoting the hybrid speech of Khūzistān; but, manifestly, it is not at all appropriate in reference to the language of Farsistān and Kōhistān, of which the Darī employed by Tabarī and Firdausī was the offspring; and hence it becomes desirable to find one which may lie at the root of and explain both applications. Various reasons recommend *pahalam* = *par' uwam* = *pārum*, &c., a word which means both "excellent" and "ancient," and which moreover—what it is especially important to observe—is sometimes contrasted in usage with the later "*Parsī*," and synonymous with "*Zabān-e-Bāstānī*" = "the ancient tongue." It will thus appear probable, that the *Pahlavas* and *Pahalwān* are so designated as being "the ancient tribe," and the *Pahlavī* as being "the ancient speech." If so, one may collate the *Pelasgoi* and the *Graioi* or *Græci* in relation to the *Hellēnes*, as also the *Prisci* and the *Casci* in relation to the *Latini*; and this, whether or not "ancient" be likewise the radical sense of—that much-tortured appellative—*Pelasgoi*, as well as of *Casci*, of *Prisci* = *pristini*, and of *Graioi*—an abridgement of *geraioi* which is illustrated by *graia* and *graus*. It were needless to embarrass this analogy by suggesting further, that *Pelasgoi*,—if strengthened from *Pelagoi*, a sister-form of *Palaioi*,—might not even serve as an etymological link between *Prisci* (coll. *prius, primum, prin, paros, perusi, palai*, &c.) and *Pahlava* or *Palhava*, through a series of letter-changes, which separately would be easy, although cumulatively they might appear improbable.

Geography.

An Attempt to account for numerous appearances of sudden and violent drainage seen on the sides of the basin of the Dead Sea. By Capt. W. Allen, *R.N., F.R.S., F.R.G.S.*

The Dead Sea, the lake Asphaltites of the ancients, is now generally understood to have a depression of more than 1300 feet below the level of the Mediterranean; yet hitherto no satisfactory theory has been given of the cause of the phænomenon. If Capt. Allen ventures to offer one, it is because he thinks it right to record impressions forced on his mind, by certain features which arrested attention on approaching its mysterious shores, by the road of Jericho.

These features were:—

1. Some indications of lines of alluvial deposit on the sides of the mountains, a little below the level of the sea; especially observable on the eastern declivities.

2. A succession of sand-cliffs on both sides of the Jordan.

3. Some parallel lines of pebbles, about 50 feet wide, near the Dead Sea, perfectly resembling its actual beach, which is composed principally of flat pieces of bituminous shale, with fragments of Lydian stone. These lines of pebbles are remarkable, because previously not a stone had been seen for several miles; while between and beyond them the soil is a very soft alluvium.

4. The precipitous mountains rising from this sea are rent with ravines, and their innumerable peaks have a tendency to group themselves in a succession of plateaux.

5. Near the N.W. angle of the sea are some conical hills, with flat summits and steep furrowed sides. These had all the appearance of sedimentary formation, which, however, was gradually less observable in ascending the mountain; and at last the horizontality of the strata could only be detected in a general sense.

Similar appearances in terraces and cliffs have been noticed in the Southern as well as in the Northern Ghor, which both slope downwards to the Dead Sea.

Now, if these remains of sedimentary deposit be admitted as evidences of occasional subsidence of the waters of the Dead Sea, its surface may be traced by them to its original level with the Gulf of Akabah, to which it would then have been joined by a narrow strait, similar to that of Tirāhn, by which this gulf communicates with the Red Sea. The actual condition of this strait, Tiràhn, would give countenance to the idea, that it is in process of closing; for by the chart it will be found that a well-defined bank or shoal is advancing from the nearest opposite points, between which the channel is unfathomable and is less than half a mile wide.

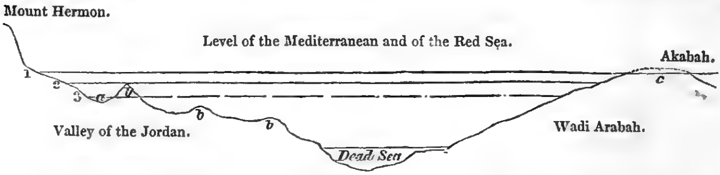
The growth of coral reefs *, deposits of sand and gravel, &c., cast up by the sea, may have, in the same way, closed up the hypothetical strait at Akabah, and cut off the communication between the two gulfs †. Then the upper basin being of great extent, evaporation from its surface would exceed the supplies poured into it from the river Jordan, and other small streams, and would therefore cause it to fall, as well as to contract its limits.

If this effect of evaporation had not been modified by other circumstances, it would have left the whole dry bed of the basin with a uniform covering of alluvial deposit. But the lines of silt seen at different elevations, the terraces, the sand-cliffs, the flat-topped hills and the parallel beaches, concur in showing that the subsidence of the surface was not always gradual, but that it has been subject to occasional and sudden changes of level, of which these are the monumental records.

On these assumptions, the lake Asphaltites in its original state was the upper end of a long and narrow arm of the ocean, extending from the base of Mount Hermon, or Anti-Libanus, nearly 2000 miles, and gradually increasing in breadth from a few yards at the north end to about 200 miles at the other extremity.

The undulations in the bed of this fissure divided it by narrow straits into several basins.

In the same way the upper basin, or the portion cut off from the Gulf of Akabah, would have had also its undulations in the bed, in other words, irregularities in depth.



a. Lake Tiberias. *b, b, b*. Barrier. *c*. Dried-up Strait.
1. First line. 2. Second line. 3. Third line.

The prodigious evaporation from so large a surface would have brought it down, soon after the separation, from the upper line in the diagram, to the first irregularity or barrier on the second line; where the further process of evaporation would cause a division of the waters into two basins, of which the upper, having the Jordan running through it, would preserve for a time its level at the second line, while the lower basin, being still so much larger in proportion to the supply, would continue to fall.

Suppose it to have fallen to the third line; and then, the upper basin being still at the level of the second line, if the weight of water, or the action of the current of the Jordan on a soft bed, or their combined effect, forced the barrier, the water of the upper would have been transferred to the lower basin, with a violence that would have torn up and scoured the sides of its former bed, leaving marks of its action in rugged ravines, and traces of its ancient level round the margin.

But if the lower strata of the barrier had been of rock so solid as to resist the action of the waters at a certain point, then a part of them would have been retained in the depression, forming a freshwater lake, as the lake Tiberias.

The process would have been repeated, dividing at the barriers, or shallowest parts, successively, which having also been forced by the same action, the same effects would be produced by the violently retreating waters, leaving vestiges, such as the monticules or conical hills, with their crowning attestations of former levels, the sand cliffs of the banks of the Jordan, and the more recently formed parallel beaches near the Dead Sea.

As the only solid barrier was at the lower end of the lake Tiberias, this is the only

* See Rüppell. † Or the separation might have been caused by a slight upheaving of the land by volcanic agency.

reservoir of fresh water that has remained; and the Jordan winds its rapid course through the Ghor to the last deep central basin, where the excessive saltness of the water will now be naturally accounted for, since it is a condensation of that, which having been a part of the ocean, was salt *ab origine*.

The process of evaporation and depression would continue, till the Dead Sea should be reduced to such an area, as would just balance the water discharged into it; and then the only variations would be in the oscillations of that balance, caused by extraordinary floods or droughts.

From a fact observed by travellers in three consecutive years, namely, that a salient part of the northern shore is sometimes an island, and sometimes a peninsula, it would appear as if the point of equilibrium has been already attained. Whether this be the case or no, could be ascertained by careful observation on this fact, or by comparing fresh lines of soundings with those taken by Lieut. Lynch, U.S.N., in the southern portion of the sea, which is extremely shallow.

A proposed new line for a Ship Canal to the East Indies through the Dead Sea. By Capt. W. ALLEN, *R.N., F.R.S., F.R.G.S.*

Referring to the communication immediately preceding, the author observes that the extent or elevation of the *filled-up strait*, the water-shed, in fact, between the Dead Sea and the Gulf of Akabah, remains still undetermined. The depression is bounded on either side by mountain ranges several thousand feet above the level of the sea. Those on the east are continuous from Mount Hermon, or Anti-Libanus, to the Red Sea. Those on the west are broken only between the Lesser Hermon and Mount Gilboa, by the low plain of Esdraëlon; which is watered by the brook Kishon, having its principal sources in the neighbourhood of Mount Tabor in the N.E., and in the mountains of Gilboa to the S.E. They unite near the middle of the plain, and flow N.W. between a shoulder of Mount Carmel and a spur of the Nazareth range of hills, to a little estuary in the most sheltered part of the bay of Acre.

The swelling of the plain is so gentle, that no precise part can be pointed out as the watershed; but it is doubtless near the forks of the river at the village of Afûli. Its elevation is perhaps less than 200 feet above the Mediterranean Sea on the west, and about 900 feet above the Jordan, with a rapid slope to the east.

Thus Nature has furnished a stupendous "cutting" of 200 miles in length, separated from a sea at either end, by a very slight barrier, which might be cut through, at the north end at least, with very little trouble and expense, for the plain of Esdraëlon appears to be an alluvium of great thickness, with no obstructions of rock.

The required length of canal here would perhaps be about 25 miles, the greater part in the already deeply cut bed of the Kishon.

By damming up the head waters of the Kishon in reservoirs near the junction of the principal affluents, they might be used to sluice out trenches previously prepared by loosening the soil with mines of gunpowder, &c., so as to work east and west at the same time, as there is a fall both ways. When these trenches shall have been cut to a sufficient depth below the level of the sea, its floods being let in, would, it is imagined, with the aid of gunpowder, soon force a channel wide and deep enough for navigation.

Likewise, if the hypothesis of the "dried-up strait" at Akabah should prove to be correct, the difficulties of removing the barrier at that end may also be inconsiderable. Of this at present the data are more uncertain, as they depend on observations of travellers, not made for such an object. But similar aid might be afforded by the force of a current from the Gulf of Akabah, backed by the Indian Ocean, to clear the canal.

These barriers being removed, the *now* Dead Sea would be restored to its ancient level, and would be converted into the active channel of communication between Europe and Asia.

Such operations would, it is true, involve the submergence of a territory, a city, and some Arab villages belonging to the Sultan. But the territory is useless, the city is in ruins, the villages are but mud huts or tents, and it is presumed that His Highness and his subjects would be amply remunerated for the loss of these, by great revenues arising from transit dues, from the increased value of adjacent and fertile, but rebellious and neglected territories, and lastly, from the facilities the canal would afford to the pilgrims, who now have a toilsome and dangerous march of more than six weeks in the desert, between Damascus and Mecca.

On the Antiquities of the Island Ruad, the ancient Aradus, and on the ancient Harbour of Seleucia in Pieria. By Capt. W. Allen, *R.N., F.R.S., F.R.G.S.*

Travellers, to whom the maritime renown of the Phœnicians is familiar, cannot fail to be struck by the disproportion of the means by which it was attained. The island of Tyre, little more than half a mile long, situated near the dangerous coast of Syria, formed their principal harbour. A colony from Sidon took advantage of similar circumstances at a more northern part of the coast, in the little island of Aradus, the modern Ruad, which is still smaller; yet it soon became so flourishing as to be the parent of colonies, and Strabo describes it as full of inhabitants and lofty houses. The vestiges which remain show that he did not overrate its prosperity. It is situated in lat. 34° 48′ N. and long. 35° 51′ E.; the extreme length is about 800 yards, lying N.W. and S.E.; so that the side towards the coast presents tolerable protection from the prevalent S.W. wind.

Considering that this little island may again become a place of shelter for ships in the increasing trade of Syria, and especially as a convenient coal depôt for steamers, Capt. W. Allen, R.N., made a survey of it in the spring of the year 1851*.

The whole N.E. side of the island is converted into two little ports by three piers, which all more or less show their ancient construction: the most northern is quite in ruins; that to the southward still answers its purpose, but is occupied by a mosque, and therefore could not be examined; but the middle pier is almost perfect. It is constructed with massive blocks of sandstone, 16 feet long by nearly 7 in depth and breadth, placed transversely; with large bollards at the extremity of the pier. On either side are quays of concrete, now "a wash." The length of the pier from the present waterline is 224 feet. In both ports are also traces of similar quays. From the base of the northern pier is a fine bed of concrete, stretching across the island, about 150 yards long by 125 yards wide, very nearly level, the slight inclination being towards the port, where its margin forms the quay. Pococke, with great reason, supposed that this was used for drawing up the smaller shipping for shelter. The concrete round by the west is about 30 yards wide, increasing on the south side. Its probable purpose here was to increase artificially the dimensions of the island, which having in its natural state been surrounded on the exposed side by numerous rocks and islets, the summits of these were leveled, and the interstices filled with the fragments and squared stones, imbedded in concrete as hard as the rock itself, which it perfectly resembles. Along the three outer sides of the island are gigantic remains of the ancient walls, which in two places have still five or six courses of stones, 15 to 18 feet in length, lying transversely and forming the thickness of the wall. On the west side, however, the wall, for about 10 feet high, is of the solid rock, which to seaward, at this part only, is cut in the form of a moat and glacis. The purpose of this, doubtless was to break the fury of the waves in S.W. gales. A small culvert, leading from the "moat," through the wall and the concrete, towards the port, led to the conjecture that the water from the waves rushing up the glacis being received in the moat at a higher level, might have been conducted by this culvert to the port for the purpose of cleansing it.

The central or natural portion of the island is covered by the modern town, which has wonderfully increased during the last century. Pococke in 1738 found very few houses, except in the castles, which were defended by cannon against corsairs. Fifty years later Volney says, "there does not remain a single wall of that crowd of houses, which, according to Strabo, were built with more stones than those of Rome itself." Now, according to the report of an old man, there are 500. When he was a child there were very few, and he had heard that 100 years ago, there were only 5 houses.

The present inhabitants retain some of the spirit of the ancient Arcadians, as they

* The hydrography has since been more completely done by Mr. Hooper, of H.M.B. Frolic under Commander Vansittart.

are all engaged in maritime affairs, and shipbuilding is carried on with considerable energy. There is no room for cultivation on this confined spot, so that all supplies are drawn from the mainland, little more than a mile distant. They depend for water on cisterns, and do not appear to be cognizant of the submarine fountain described by Strabo.

With the same view to the probable requirements of increasing commerce of these rich countries, Capt. Allen made a little survey of the ancient harbour of Seleucia in Pieria, situated still further to the north, in the bay of Antioch, near the mouth of the Orontes, in lat. 36° 8′ N. and long. 35° 55′ 30″ E. This noble work consists of an inland basin, connected with a small sea-port by a canal, and of a magnificent culvert cut through a mountain for the purpose of feeding the one and cleansing the other, as well as to avert the destructive effects of the mountain torrents.

The sea-port, noticed in the Acts of the Apostles as the place whence St. Paul embarked, is formed by two massive moles, about 200 yards apart. That to the north is quite a ruin; the other has its inner part nearly perfect, constructed with large blocks of stone placed transversely, some of which measured 25 feet, and one, broken, 29 feet 4 inches. This port, though small, was probably sufficient for the reception of ships preparatory to their entering the basin, and for the purpose of refuge in bad weather.

The inner harbour or basin was probably an excavation, with a strong wall fronting the sea. It is *retort-shaped,* communicating with the sea-port by the neckpart, a canal about a thousand feet in length, and was possibly at a higher level than the sea, and entered by locks, as Colonel Chesney saw the remains of hinges of gates. The basin is about 700 yards long by 450 wide. It is now a swamp, through which a little stream passes to the sea by a gap in the wall. The great culvert is nearly 1200 yards long, terminating near the sea-port. Its commencement is at the turning of a little valley, across which an enormous wall was built for the purpose of directing the torrents towards it. This wall has a great portion of it still standing; the dilapidated part being in the middle, where probably there were sluicegates to feed the basin. The culvert is for the greater part an "open cutting," in one place not less than 150 feet deep in the solid rock.

There are two tunnels of 24 feet aperture, with a channel for the water in the middle; which arrangement was doubtless intended to facilitate the removal of fragments of rock that might have been carried thither by torrents. There is also a conduit at the side to supply the marine suburb of the city with water.

Some Greek and Latin inscriptions are to be seen in the culvert, but too much defaced by time to be legible.

The principal object Capt. Allen has in view in describing this ancient and splendid work, which had been previously examined by other travellers, and especially by Colonel Chesney, R.A., is to show the facility with which it could be again rendered available for the reception of shipping: for, although each of the three members of it is dilapidated to a certain extent, enough remains to justify the belief that its restoration could be accomplished without much labour or expense.

Both Col. Chesney and Capt. Allen, by independent calculations, estimated the cost of cleaning the inner harbour, by manual labour entirely, at about £30,000; but Capt. Allen considers that by making use of the appliances left by the ancients to aid in the operations of nature, the greater part of both expense and labour would be reduced.

To this end, whether anciently it was a basin above the level of the sea, and entered by locks or no, he would now propose to make it so, by raising and strengthening the west wall, which is the only part of the circuit of the basin not bounded by rising ground, so that any depth required might thus be had, as there is a perennial stream running through it.

When full, the immense volume of the basin, a surface of about 47 acres, might be used as a "backwater" to clear the canal and the sea-port. The piers of this would have to be repaired and carried further out seaward, which would be the principal part of the expense. The culvert and the great wall with its sluice-gates might be easily repaired.

The examination of the ruins of this once-flourishing city not being the principal object, Capt. Allen did not devote much time to them, but he visited some magnificent sepulchres, excavated in the mountain through which the culvert is cut. From their dimensions it is probable that they were of the Seleucidæ, especially as the natives call them the "Cave of the Despot." They consist of two large chambers, ornamented with arches, pillars and sculptured scrolls, &c., containing two principal isolated tombs, with numerous *loculi* in the walls and in the floor. All have been rifled and stripped of their ornaments. In the neighbourhood of the city are many sarcophagi, and some vaulted chambers in the face of the cliffs.

In conclusion, it is hoped that this fine harbour may again become the outlet of the unrivalled fertility of the neighbouring countries, and be the fitting terminus to Col. Chesney's projected communication with our possessions in the East Indies by the river Euphrates.

On a Railroad through Asia Minor. By W. F. Ainsworth.

The paper, after describing the route intended to be taken, and remarking on the engineering difficulties and facilities on the way, proposed to connect Constantinople with its Asiatic suburbs by means of a floating viaduct, or tunnel, such as they have in Wales at present. The author considered that, in the event of this great undertaking being attempted to be carried out, the better route through Asia Minor would be along the coast of the Sea of Marmora, rather than, as some scientific gentlemen had recommended, through the mountains of the interior of Anatolia, which Mr. Ainsworth considers it would be next to impossible to surmount. The Turks, who just now are very much alive to the great importance of commerce, are engaged in opening a great commercial road from a port on the Black Sea to Sivaze, a town in the centre of Asia Minor; and Mr. Ainsworth considered that the completion of this undertaking would be one of the greatest inducements to the commencement of the projected railway. Throughout the land route, only in one instance was it necessary to allude to a tunnel, and that was where the Fawnes mountain crossed the route, and this, there was reason to hope, could be passed without a tunnel. Taking the matter all in all, the author pronounced it difficult to imagine any country better adapted for colonization or improvement. At present, the country could not be said to be safe from the predatory Arabs, but the Turks and agricultural Arabs were well-disposed. The road from London to Bombay is 5500 miles; for 2600 miles of this distance there is already a railway, and works could be carried on cheaply in Asia Minor from the facility of procuring labour. The capital required he calculated at twenty-two millions.

On the Distribution of Common Salt, and other Saline Bodies, with a view to show their Primary Origin and subsequent Formations. By William Bollaert, *F.R.G.S.*

The attention of the author of this communication was first drawn to the subject whilst chemical assistant in the laboratory of the Royal Institution about 1824, and when in Peru shortly afterwards, the occurrence of so much salt from the level of the sea to great elevations in the Andes was noticed by him. Subsequently, being in the north part of Mexico, opportunities offered of making other researches.

Mr. Bollaert, in a paper to the Royal Geographical Society in 1851, on "Southern Peru," in noticing the existence of salts bordering the Pacific Ocean, in the mountain-range of the coast, in the great plains beyond, as well as in the Andes, said that such a disposition of things would lead one to surmise, that the salt and other saline matters may derive their origin from other sources than the ocean, viz. volcanic, and the decomposition of rocks.

Dr. Daubeny was one of the first to draw attention to the fact, that salt and muriatic acid are among some of the most abundant compounds thrown out by volcanos; and his researches fortified Mr. Bollaert's opinion, formed in Peru in 1826, that the greater part of salt found from the Andes to the coast may claim a direct volcanic origin.

With reference to the author's own observations made in Peru and other places, as well as those of others in various parts of the world, and omitting here geographical, geological, chemical, climatalogical and other details, he offers the following *resumé* as to the origin of common salt and other saline bodies, adverting only to the more salient points.

I. Bay-salt, deposited entirely by solar evaporation from sea-water, particularly in warm latitudes; in Greenland, however, the heat of the few summer days is so great as to evaporate the water left by the tide among the rocks, and to reduce it to a fine salt. There is an important commercial fact connected with bay-salt, inasmuch as it has been found, particularly at Buenos Ayres, to be much better suited to the salting of meat (which appears to be owing to its containing the deliquescent chlorides) than the salt procured from the salt-lakes and plains of Patagonia, the latter being nearly a pure chloride of sodium; thus the following conclusions may be arrived at, that the superficial saline deposits in Patagonia and other inland plains in various parts of the world are not beholden to the ocean for such deposits.

II. Bay-salt, as procured from sea-water by allowing it to run into shallow reservoirs on the surface of the ground, where it is partially evaporated by the sun's heat, and then by artificial means; a purer chloride of sodium is thus obtained, in consequence of the separation of the bittern from it.

III. Another and a harder species of bay-salt is found near the level of the ocean, a few feet above the sea, particularly on the coast of Peru; here it has been but recently uplifted above the sea.

IV. Salt is produced in Russia by the freezing of sea-water, and then evaporating the brine. One effect of the low temperature is to decompose a portion of the salt, and convert the sulphate of magnesia of the brine into sulphate of soda and chloride of magnesium.

The formation of sulphate of soda in this way may be the principal cause of its existence in Peru and other places, that is to say, the saline lakes in the Andean and other mountainous regions, would in winter be reduced to a low temperature, when the chemical change would be produced; as summer approached, the snows above the lakes would melt, and rains would run into the lakes; these in time would overflow, causing streams; some of these waters would find their way into rivers and then into the ocean, whilst others would run into hollows, low lands and plains; and in such arid countries as Peru, Mexico, Patagonia, parts of Asia and Africa, and perhaps in Australia, would yield layers of saline materials, the principal one being common salt. In Saxony, Sardinia, and some other localities, water from brine-springs is evaporated by passing over and through "Thorn Houses."

V. Salt, having risen with the vapour of sea-water or with the spray of the ocean; also with the vapour arising from saline inland lakes, as in Asiatic Russia in particular.

VI. *Rock or Fossil Salt* is found constituting portions of mountain ranges; in the Carpathians in Europe; in the Sulemien mountains in Asia; also in Thibet, here in company with borax and muriate of ammonia; and doubtless the many brine-springs in the interior of China have their origin from masses of rock salt. As so much salt is found in the arid parts of Africa, it is reasonable to conclude that the mountains also contain it. We know that in the mountains of Morocco there is rock salt. To the east of this section much carbonate of soda (Trona) is found.

The inland waters of Australia are brackish, and its plains covered with saline materials; hence we may suppose that in the interior of that large mass of land there may be rock salt.

In North and South America there is abundance of rock salt. In the north, among other ranges affording it, is the Wha-sacht, which is above the Great Salt Lake of Utah or of the Mormons; in South America, from the Andean region to the coast, on either side it is found, and in company with many other curious saline bodies.

From the small per-centage of saline matter in sea-water, not 4 *per cent.*, we can hardly look to the ocean as the origin of *so much pure or almost pure* chloride of sodium existing in mountain regions, but rather to sources of a volcanic character at different epochs; sub-marine as well as sub-aërial volcanos yielding it. During volcanic eruptions, with vast quantities of sulphur and other volatile bodies, the vapour of muriatic acid escapes, and salt has been found sublimed about craters as well as muriate of ammonia. Sea-water may find its way into the igneous interior of the earth; however, the formation of salt in all probability is mainly due to the direct union of chlorine and sodium; salt thus formed from its elements in the bowels of the earth, then ejected through volcanic vents, at times with steam and water as a hot saturated solution, at times with earthy matters, the salt afterwards forming masses, or in those peculiar orbicular layers, as seen in Cheshire and elsewhere, and such operations having gone on at various periods and under different circumstances and elevations, may account for rock or fossil salt being now found below the level of the sea, above it, and at great elevations on the surface of the globe. Having now arrived at the supposed origin of rock salt, the next division is proceeded with, viz.

VII. *Saline Lakes* situated in the elevated regions of India, Thibet, and other parts of Asia, as well as at lower levels, including the Dead Sea, which is below the ocean; the saline lakes of North and South America. In these cases, as already mentioned, the waters of melting snows and rain would dissolve the salt formed in high regions, washing it down into hollows, and then salt lakes would be formed at all elevations, and when these waters became saturated salt would be deposited; in summer some would dry up, leaving a cake of the substance.

VIII. *Brine Springs* are met with all over the world; such being formed by water percolating through the earth, first at high levels, then coming into contact with depositions of salt, producing springs, lakes and streams, from which the saline matters are found in some cases to remain in hollows and plains, forming large tracts of surface-salt.

IX. The saline matters found in the Steppes of Asia, Deserts of Africa, Pampas of Patagonia, and other places to the north, in the Desert of Atacama, and along the west coast of America; and lastly, in the great saline deserts of Mexico, California, and the United States. In these cases the salt has been brought down by streams and springs from higher regions to a lower.

X. Saline bodies formed by the decomposition of volcanic and other rocks; the albites or soda granites, so common in the New World; the red granites, yielding potash, as in India, giving rise to nitrate of potash; such decomposition would go on at all elevations, and, by the aid of water, the soluble parts would find their way into lower regions, and ultimately into the ocean.

Mr. Bollaert then describes the section of country from Buenos Ayres to Potosi and Lima, also another in South Peru, from Iquique in the province of Tarapaca, lat. 20° 12′ S., long. 70° 14′ W. to Potosi, the latter in particular, as being interesting in regard to the subject of his observations.

The now important port of Iquique is in the centre of a region where it seldom or never rains. No water is found on the coast, except where a rivulet may come from the Andes; such water-courses being very scarce, and often salt. Under the Incas, Iquique was a fishing-place, and guano was collected there. There is no vegetation whatever to be seen, and in early times water had to be brought from the interior. When the celebrated silver mines of Huantajaya were discovered in 1556, a few miles inland from Iquique, then this port was supplied with water from the ravine of Pisagua, which is to the north; but of late years, and since nitrate of soda has been shipped from thence, stills have been employed for the distillation of fresh- from sea-water, supplying 1000 to 1200 people as well as animals. In some of the plains near the coast, bay-salt is met with 15 to 20 feet above the sea, the land having been recently uplifted from it.

From the sea-shore in many places there is an abrupt rise of 2000 to 3000 feet, at which level are plains, hollows and undulations; and rising out of them ranges of porphyritic and argillaceous mountains 3000 feet higher. Veins of metallic matters are abundant, gold, copper, lead, arsenic, &c., the silver mines of Huantajaya having yielded from 1726 to 1826 more than 15 millions sterling. In the hollows, plains and undulations are extensive superficial collections of salt, containing a little chloride of calcium. This coast-range is 30 miles wide, and, having passed it, the Great Plain of Tamarugal is entered, which is 3000 to 3500 feet above the sea, and some 30 miles wide. In the south is the brackish river Loa, with salt streams running into it; in the north there are other saline streams. Where water from the Andes gets into this plain, and it often runs over its surface, and that water not very salt, there a few Tamarugos (Mimosa) grow; and buried under the soil there is much apparently of the same species of tree undergoing a saline fossilization. The author is strongly inclined to think, that we must look to this surface-water as the vehicle that has brought down from great elevations the saline matters, such as are found all over this plain, as well as those in the Desert of Atacama. A curious point about the greater portion of the water obtained from the wells in this plain is, that although there is so much saline material on the surface, there is little or none of it in the water. It is in this plain, where there is so great an abundance of salt, nitrate of soda, sulphate of soda (Glauberite), carbonate of soda (Trona), sulphate and muriate of lime, and a newly-discovered salt of borax (Hayesine or Hydro-boro-calcite), this valuable salt is found with and under the beds of nitrate of soda, and often in company with Glauberite *. With the nitrate of soda, in particular, there are iodic salts †, and probably bromic. In the hills, on either side of this plain, are large quantities of native alum or Pickeringite.

The formation of nitrate of potash in India, and nitrate of soda in South America, is difficult to explain. It was formerly supposed that the nitrogen required to produce the nitrate of potash in India came from the decomposition of organic matters; but as the greater portion of nitrate of potash was found in situations affording none, this opinion was abandoned, and the nitrogen of the atmosphere was resorted to. With regard to the formation of nitrate of soda in South America, at least in South Peru, there are no organic matters whatever in the soil from the Andes to the sea-shore; for the whole country is, and has been for ages, arid, rocky, sandy, and marly saliferous deserts. The nitrogen and oxygen of the air may possibly yield, in some way or other, nitric acid, when assisted by tropical heat, the chemical rays of the sun and moisture; still, if we have to look to volcanic sources for the formation of salt and other chlorides, why not recur there also for the origin of the nitrates, sulphates, borates, iodates, &c.?

A short remark on the probable cause of the South Peruvian deserts may not be out of place here. The S.S.E. wind, having been deprived of much of its humidity in traversing the continent of America, arrives in the frozen regions of the Andes, so dry as not to be in a position to deposit any moisture of consequence; and this dry or S.S.E. wind blowing across the lands of the west coast, appears to be the main cause of its present desert character.

The nitrate of soda has as yet only been met with on the western side of the Pampa de Tamarugal, and the deposits of it have interruptions or spaces covered with salt. The nitrate grounds vary in breadth, but are of great length, and in places 7 to 8 feet thick, sometimes quite pure.

The *Caliche*, or rough nitrate of soda, is boiled in water, the nitrate is held in solution, whilst the salt and earthy parts fall to the bottom of the boiler: the saturated solution is run into troughs to crystallize, and is then ready for sale.

The principal occupation of the Province of Tarapaca is in the nitrate of soda trade, the article being shipped from Iquique to Europe, where it is used as a fertilizer in the manufacture of nitric and sulphuric acids, &c.

There is sufficient nitrate for the consumption of Europe for ages to come. The supply, however, at present for export cannot be much augmented over 30,000 tons annually, in consequence of the scarcity of beasts of burden in this desert country to convey it from the oficinas or works to the port of Iquique. Since 1830 to 1851, the exports have been about 240,000 tons, one of the principal exporters being Mr. G. Smith, to whom the Province is greatly indebted for his perseverance in establishing this new branch of trade.

Having traversed the Pampa de Tamarugal, ranges of sandstone mountains present

* The boracic acid of Tuscany and borax from India is almost monopolized by one party in England; the price for British refined being in November, 1852, £4 to £4 4*s.* per cwt. Now it would be important if supplies of the boro-calcite from Tarapaca could be obtained. Mr. Smith fears it only exists in small quantities there, but in which opinion I do not quite concur. According to his views as to the origin of salt and many other saline bodies being volcanic, the author would recommend a search for nitrates, borates, iodates, &c., in those dry and desert saline districts, the more particularly where there are evidences of volcanic influences.

† Hayes found in a sample of nitrate of soda, 0·63 iodic salts, composed of iodate of soda and chloro-iodate of magnesia.

In November, 1851, dry iodine sold for 6½*d.* to 7*d.* per oz., but at the same period, 1852, it had risen from 1*s.* 3*d.* to 1*s.* 6*d.* Thus in these salts from Tarapaca we have another source of iodine.

themselves, at the base of which there is much sulphate of soda and some carbonate, and a little higher up large quantities of gypsum. Ascending, a broken mountainous country is attained, where, on account of it receiving some rain, coarse pastures, Cacti and some brushwood are met with; here saline matters would be found, but that the rains wash them into the lower country. In this district there are gold and copper veins in abundance; and on examination, it is thought that Lavadero or grain-gold will be met with: and there are extensive plains in the Andes, at 14,000 and 15,000 feet, out of which rise ridges and knots of mountains; that of Lirima is supposed to be 24,000 to 25,000 feet above the sea.

In this Andean volcanic region there is among others a great salt deposit known as the Pampa de Sal: it is a few miles to the east of the volcano and town of Isluga. The volcano is in 19° 12′ S., 68° 50′ W. The volcano and salt plain was first made known in Europe by Messrs. Bollaert and Smith in 1827; and it was on beholding so large a collection of salt in the elevated position of nearly 15,000 feet, that so strongly impressed Mr. Bollaert with the idea that we ought to look for the origin of the greater portions of saline materials to direct volcanic sources.

This Pampa de Sal extends to near Potosi, varying in breadth from 3 to 8 leagues, the saline matters being 8 to 10 inches thick. In this elevated region there are many lakes, some containing fish. Many of these lakes are salt; how can they be otherwise, when saline bodies exist in more elevated regions, ejected in all probability from craters and fissures, the whole country being pre-eminently volcanic? In this way we may reasonably account for the large quantities of fossil salt in the mountains of Chili, Peru, Mexico, and in those of the United States; also in the more elevated portions of Europe, Asia and Africa; and the melting of snows and rains would wash much of this soluble material into the sea.

Observations on the Euphrates Line of Communication with India. By Colonel Chesney, *R.A., D.C.L., F.R.S.*

In compliance with the request of a distinguished member of the British Association, Dr. Robinson, whose continued interest in the subject of the Euphrates line of communication with India is a source of extreme gratification to me, I have put together a few observations for the purpose of showing,—1st, what was the past state of the overland communication with India; and 2ndly, what may be done to *accelerate* if not to *perfect* this intercourse.

Had not the want of the means promised by Government prevented the appearance of the remainder of my work, it would have been unnecessary for me now to enter upon the subject of our communication with the East, since the succeeding volumes would have contained all the details of the Expedition.

The use of the overland route dates almost from the *discovery* of India itself. We find that the far-seeing Elizabeth maintained a fleet at Bír to facilitate trade along the Euphrates, which being then the high road to India, was constantly made use of by Balbi, Fitch, and others, who had occasion to pass by that line with merchandize. The route from Europe was by Alexandretta and Aleppo to Bír on the Euphrates, whence the goods were carried by boats, partly for the use of the inhabitants of the country, and partly for India, whither the products of Europe were conveyed at this period, by way of the Persian Gulf.

Space and time will not permit us to discuss the latter subject, but I may remind you that in the time of Herodotus, Mesopotamia was the most productive country in the world; and as it still retained a portion of its commercial wealth at the period of which we have just been speaking, this route was but the continuation, or rather the remains of the trade, of Tyre, Sidon, Egypt, &c., *and not*, as has been frequently imagined, the adoption by the Levant Company, of a new and shorter line than that by the Cape of Good Hope.

Up to the time when the East India Company ceased to trade, Bushire, Bassorah, and Baghdad, were productive seats of commerce. But although their value to England has greatly diminished in consequence of the cessation of the commercial intercourse which previously existed, I may just observe, that it appears from official returns (which are given in my work), that the trade between India and the Persian Gulf is still about two millions annually.

The line of the Euphrates, however, had, as it still continues to have, another advantage for England. The direct line from London passes by Vienna, Constantinople, and Asia Minor, to Aleppo, from whence, by the desert of Arabia, it reaches Bassorah.

Messengers in Europe, and Tartars in Arabia, used to accomplish this journey in from twenty-five to thirty-six days; and fast-sailing schooners carried the despatches along the Persian Gulf to Bombay in about twelve days more.

The route by the Red Sea had been used in the same manner, but being less speedy by a great deal, the regular transit was continued through Arabia up to the peace of 1815; and it was considered of such importance, that, on examining in the archives of Bombay the result of the intercourse by this route in 1836, I found that instead of trusting to the Secretaries, the communications on this subject were from the pen of Lord Wellesley himself.

My acquaintance with Mesopotamia commenced in this way:—

Purposing to assist in the defence of Turkey against the Russians in 1829, I proceeded to Constantinople in that year; but arrived, as it proved, almost at the close of the war, and I consequently undertook a journey into Asia with the object of examining the proposed lines of communication with India. Public anxiety on this subject led to a series of queries being drawn up by Mr. Peacock of the India House, which fell into my hands, and decided me to attempt the examination of these routes; for I was one of those who began to see, in part at least, what might be done by steam.

In a lecture at which I was present in 1802, Mr. Walker, in noticing the embryo power of steam, made this remarkable prophetic observation:—"The day," said he, "will arrive, when, instead of changing horses, we shall only require to light a coal." Already this grand idea has been realized almost to the letter, and I may live to see it equally carried out, by means of a railroad and electric telegraph between England and India.

But to return from this digression. Provided with Mr. Peacock's queries, I examined the route by Cosseir and the Nile, as well as that across the isthmus of Suez, and a detailed report was made to Government through the Right Hon. Sir Robert Gordon, allowing twenty-two days between Bombay and Alexandria.

This, I believe, was the first proposal, at least the first founded on examination, for opening a steam communication by way of the Red Sea. It is not therefore surprising, steam by sea being *then* in its *very infancy*, that the Earl of Clare, in commenting on my paper, should have said, in allusion to the time allowed, "The misfortune is that Capt. Chesney endeavours to make out a case." I need scarcely add, that the energy and activity of Waghorn has performed in fifteen, and even twelve days, that transit for which I had allowed twenty-two.

In proceeding from Egypt towards the Euphrates, which was my next object, difficulties and impediments occurred in consequence of my having been carried off by the Arabs for some time, and over a considerable tract of country. I must not, however, occupy your time by describing a journey which I still remember with the deepest interest.

On regaining my freedom, I continued my journey across the great desert, and succeeded in reaching the Euphrates.

The line taken from Damascus was that by Palmyra; the country was not sandy, but part of it had a hard pebbly surface, while the rest was undulating, and covered with sheep grass, not unlike the Dorsetshire downs. A slight illness so far disarmed the suspicions of the Arabs, as to offer an excuse for my going by the river; and having taken leave of my camels, I caused a raft to be constructed of hurdles supported on thirty-three inflated sheep-skins, on which, accompanied by three Arabs, I was fairly launched on the great river Euphrates.

The compass gave me the bearings, and the depth of the river was ascertained by means of a pole going down from the bottom of the raft, by which means I avoided the suspicions that would have been raised by the ordinary method of sounding. The raft was kept mid-stream during the day, and was secured to a bank by night, and thus made its way to Felujah opposite Baghdad, not however without some difficulties and even dangers, such as being fired at by the Arabs from the banks, and being three times robbed of my money under the name of a tax. The condition of an isolated individual deprived of all resources when at such a distance from Europe, may appear to have been almost desperate; but, strange to say, I succeeded, through the influence of the English name, in borrowing funds from the very individuals who had previously robbed me, and the descent by Babylon to Bassorah, and ultimately across the Persian Gulf, was happily accomplished.

I must not attempt more than a very general description of the Euphrates, but I may observe that I found it deserved even more than its celebrated name as the fourth river of Paradise.

It is wide, deep, and highly picturesque, flowing between ancient aqueducts and irrigating mills, some of which are of modern construction also, with frequent villages and occasional towns, sometimes seated on islands, at others on the banks of the river, amidst luxuriant groves of date-trees, and occasionally, as in the neighbourhood of Babylon, surrounded by the richest wheat cultivation.

I now laid down and sent home, a map of that part of the river which had been examined; and recollecting that my temporary captivity had deprived me of the opportunity of visiting the country between Seleucia and the river Euphrates, above and below Bír, I traversed about 1700 miles of Persia, passing through Ispahan and several other great cities of that kingdom, to the sources of the Euphrates, and also travelled over some 1800 miles through Asia Minor, which enabled me to examine the country between the Mediterranean and the upper part of the river.

These explorations occupied three years and a quarter; their result was a printed report to Government, submitting at the same time, that a steam communication with India should be opened alternately by the Persian Gulf and the Red Sea. I believed then, as I do now, that our great kingdom requires a second line, even if we were free from all chance of interruption; and even irrespectively of the mercantile and other advantages which belong to the route through Arabia.

This report had scarcely appeared, when I was summoned to St. James's, and after going into the question in much detail, the King (William the Fourth) took a lively interest in the comparative merits of the Red Sea and River Euphrates lines, observing, that as a sailor, he considered that about one-half the distance of open sea gave a manifest advantage to the latter.

The subject was next taken up by Lord Palmerston, Lord Ripon, the Marquis of Lansdowne, and Mr. Grant, now Lord Glenelg, and after a lengthened examination by a Committee of the House of Commons, £20,000 were voted for an Expedition to the Euphrates and Tigris, in the command of which I sailed early in the year 1835.

It consisted of two flat-bottomed iron steamers, the fifth and sixth of the kind that had been built, with a competent staff of scientific and other officers, together with detachments of artillery and sappers, all of whom, having been originally boiler-makers, mill-wrights, &c., were prepared to assist in putting up the vessels, which we carried out in pieces.

The upper Euphrates near Bír was the place selected for this purpose, as we considered we should there be less likely to meet with opposition from the Arabs, than if we had landed with this object at the mouth of the river; moreover there are two cities, Antioch and Aleppo, on this line, and many villages which offered great facilities in men, animals, &c.

Accordingly the Expedition landed at the mouth of the Orontes, where, contrary to previous promises and arrangements, we found ourselves stopped by the Pasha of Egypt, who was then in authority.

In this dilemma, I determined, instead of sailing away to go round to India, to disembark the steamers and their equipments, and having formed a camp, about 400 tons of materials were deposited on the banks of the Orontes, and the Columbine sloop of war and transport which had brought them, took their departure, by way of proving to Mohammed Ali that the Expedition was not to be stopped. Open impediments ceased after a time, but underhand opposition still met us in every quarter, when we had roads to make, waggons to construct, and men as well as animals to collect. The delays consequent upon this state of things brought us to the ordinary impediments of the rainy season; but at length all difficulties were overcome, the diving-bell was rolled under the surface of the water to be carried onward, and the last piece of boiler, weighing seven tons, and drawn by 104 bullocks, entered Port William under a triumphal arch, and thus the extraordinary energy and perseverance of the officers and men of the Expedition accomplished, what a French writer termed *"the gigantic operation"* of transporting this and the other heavy weights a distance of 147 miles, frequently over difficult country, from the Orontes to Port William on the Euphrates.

This operation consumed all the funds of the Expedition, and having been told by Government that no more would be given, I was forced either to stop, or to find the funds myself. I felt that if I decided on the former course, it would lead to the belief that we had failed, and I therefore ventured to draw on my friends at home for upwards of £2000, and as a compensation for this unpleasant alternative, we had the pleasure of seeing two steamers floated, one 108 feet long, and both completely armed and equipped for the intended service, with ample supplies of provision and fuel. The latter is found abundantly of two kinds, viz. mineral pitch, and plenty of Tamarisk wood, which gave nearly a knot an hour more speed than coal.

The descent and survey of the river now commenced. For the latter purpose two boats preceded the vessels day by day, sounding and taking bearings, and the officer in charge of this party became the pilot of the steamers next day for so much of the river as he had thus explored.

In this way our operations were peaceably and successfully carried on, till on one portentous morning, we discovered a cloud, like a man's hand, coming towards us with fatal speed. All efforts were made to secure the vessels in time, and the lesser one, the Tigris, even reached the bank, but the whirlwind of the desert had reached her at the same instant, and though still in its infancy, such was its violence, that that unfortunate vessel recoiled from the bank, and was held as if in a vice, heeling over. The storm soon attained its greatest power. The Euphrates was backed at this moment to avoid a collision with the unfortunate Tigris, and at 1 p.m. we floated past as a mere log, in the midst of darkness deeper than that of night, immense waves breaking over and into the ill-fated vessel, till she was carried to the bottom in seven fathoms water, the helmsman and all others remaining firmly at their posts. So fearful and so violent had been the effects of this whirlwind from the desert, which would have blown a frigate out of the water, that portions of the paddle-boxes were in the fields before I and seven others reached the shore. Twenty of my brave companions had scarcely found a watery grave when a calm succeeded the hurricane, which had run its whole course in fifteen minutes. Had it lasted eight or ten minutes more, the Euphrates, though secured to the bank with chain cables and large jumpers driven into the earth, must have gone to the bottom also. The Arabs, however, showed the greatest kindness; for instead of taking advantage of our condition, as is unhappily frequently the case in our more civilized country, they gave us every possible assistance by collecting the remains of the goods, &c. Our loss however was very, very great; 1100 drawings, and all the accounts of the Expedition, all the money, with a large quantity of stores, &c., went to the bottom.

This catastrophe happened at Werdi, about half-way between the Mediterranean and Persian Gulf, or nearly 500 miles from either; at the very spot where I first came upon the river, and also near the place where the apostate Julian lost the greater part of his fleet from a similar storm. The Arabs told us they had often witnessed storms, but never one such as this had been.

I had been saved, and therefore I could not despair, though half the river still remained to be navigated. I had now the painful task of communicating what I had hitherto concealed from the officers and men, the orders to break up the Expedition as soon as it should reach the Persian Gulf. I announced that I considered the late calamity would justify a departure from these orders, and being nobly seconded by the officers, who gave up their pay to lessen the expenses, we happily continued our survey and descent by Babylon to Bassorah, where we fired seventy-two guns, one for every year of our warm-hearted monarch King William.

The expected supplies had not yet reached the Persian Gulf from India, but they were received at a later period, and we renewed our operations by ascending more than 300 miles of the river Tigris, to the city of the Kaliphs, Baghdad. The steamer everywhere created surprise if not amazement. On one occasion, an Arab, placing his head between his knees, was heard to exclaim, "Has God only made one such creation"? The Arabs had a kind of prophecy that when iron should swim on the water, their dominion was to end, and they came in consequence hundreds of miles to ascertain the fact that it really did swim.

On descending again to Bassorah, we found the Hugh Lindsay with a mail and passengers from Bombay. We took both on board, and immediately commenced the ascent of the Euphrates. But when we had reached the distance of nearly 200 miles, the cross-head of the engine snapped, and it became necessary to drop down to Bassorah, and to send the mail by land to England.

The officer who took charge of it is now Captain FitzJames, one of those Arctic voyagers, to ascertain whose fate England is now making such meritorious, and let us trust they will prove successful exertions.

I now proceeded to India to urge the continuance of the enterprise, and the engine having been repaired, Colonel Estcourt, who was left in charge, ascended to Baghdad, after exploring the river Karun, &c. Fresh orders were however received to break up the Expedition, and the party returned to England by land, while I followed taking from Bombay important despatches. With these documents I made a desert journey of nearly 1000 miles from sea to sea. My party consisted of two Arabs with four camels. The compass guided our steps by day and the stars by night, and thus the journey to Damascus was accomplished in nineteen days. We occasionally halted in Arab tents, when I heard them speaking of Chesney Beg, who having shaved off his beard was not recognized by them.

On reaching England, I received a communication from Prince Metternich, expressing his readiness, his earnest desire indeed, to meet the supposed Indian line at Scanderoon; but the British Government did not enter into the question at all, beyond turning it over to the East India Company. Three river steamers were however afterwards floated by the Company on the Mesopotamian rivers, and Captain Campbell of the Indian Navy successfully ascended the Euphrates as high as Beles. Captain Lynch of the Indian Navy (who was one of the officers of the Expedition), in his descent of the river, crossed by one of the ancient canals flowing from the Euphrates to the Tigris, into the latter river. The necessities of the service during the Affghan war, caused these vessels to be taken to the river Indus, and the question of their navigation remained in abeyance till last autumn. The Turkish Government then took the matter up, and after some reference to me, two steam-vessels of suitable dimensions have been constructed by Messrs. Laird of Birkenhead, and will speedily be launched on the rivers of Mesopotamia. I feel, however, no small anxiety lest a great undertaking should fall to the ground from want of competent management, such as might be found by British enterprise, either on this or any other line.

Of late the Eastern Steam Navigation Company, in competing with the Peninsular and Oriental Company, appears to have come to the conclusion that long and powerful steamers, using both the screw and paddles, might reach India by the Cape in about thirty-two days, and it is understood that vessels of this description are now being built. Admitting that the most complete success should attend this great undertaking, and that a distance of 10,790 miles should be accomplished within the specified time, it is quite clear that this line will have to compete with vessels of similar power on the shorter lines, namely, the one of about 5238 miles by the Red Sea, and that of 4823 miles by the Euphrates.

Of another line, that by America, which is to be brought before this Section, I know little or nothing, but it seems clear to me that either of the other two must have manifest advantages. As the communication by the Red Sea has for a long time been as regular *as can be desired*, it only remains to notice the facilities belonging to the line through Asiatic Turkey and Persia, and again by the same line of country, partly by railroad and partly by steam-vessels.

A railway already exists from London to Hungary, and ere long it may reach Constantinople, either by crossing the Balkan partly by means of stationary engines, or coasting the sea-shore by way of Varna, in order to turn this chain, and thus reach Constantinople with facility. The great chains of Asia Minor present, as I know, and as you have seen by Mr. Ainsworth's paper, very serious impediments, but not such as *might* not be overcome by the science of the present day; and having once attained the valley of the Mesopotamian rivers, the line might be continued along the southern shores of Persia and the coast of Mekkran to India.

But, although practically attainable, the enormous expense on the one hand, and the unsettled state of this part of the country on the other, render such a line of communication only likely to be successfully attempted at some distant period. We may therefore postpone the consideration of all that is eastward of the Euphrates, and confine the question to a railway through Arabia, having a steamer to India from one extremity, and another to Trieste from the other. The line supposed is to quit the Mediterranean at the Bay of Antioch, and pass from thence by ancient Aleppo to the Euphrates at Jáber, and so along the right bank of the river to its estuary, a distance of 715 miles. Were this completed, with the assistance of powerful steamers at each extremity, letters might reach Bombay from London in eighteen or nineteen days, and messages, partly by electric telegraph, in ten days.

Seven hundred and fifteen miles of a single line of railway on the American plan, might be executed for about £5,720,000, or with two powerful steamers on the Arabian, and as many on the European side, for about £6,000,000 sterling, including the necessary port in the Bay of Antioch.

Instead, however, of engaging in the first instance in such a serious outlay, temporary, and by no means costly arrangements can be made. There is, as we all know, a railway open to Trieste, from whence the Austrian Lloyd's Company vessels would carry the mails and passengers to Scanderoon, which, as a *temporary* harbour, requires no outlay whatever. From thence by the Bír-line, it is but 110 miles to Beles on the Euphrates, between which place and Bassorah small steamers might be used:

	Days.	Hours.
London to Trieste	3	12
Trieste to Scanderoon	2	12
Scanderoon to Jáber	1	10
Jáber to Bassorah	5	10
Bassorah to Bombay	4	12
Delays	1	10
	18	18

and if partially using the electric telegraph, ten days.

Such an opening as this *as a commencement,* might be accomplished with a *bonâ fide* capital of £50,000, or at the outside, £80,000; and if the undertaking were conducted by practical men, I should have no fears as to its result. For the temporary land journey, either camels might be used, with frequent relays, or the carriages of the country, called Tack-i-van, which are carriages slung between two camels or horses; and the necessary protection from place to place being connected with the hire of the animals, this would give large employment to the Arabs, and their interest would go hand in hand with the undertaking.

During our extensive intercourse with them, the Arabs showed the most favourable disposition towards us; and they were not only glad to be employed, but proved remarkably faithful, not only in transporting goods and stores, but in money also. All our stores, and upwards of £6000 were safely carried in small sums from time to time by Arab messengers, without any loss whatever, and the existence of commercial intercourse for centuries in Arabia, is the best proof that no great difficulty can attend more extended relations with this people.

As the fertility of Mesopotamia greatly exceeds that of Egypt, being capable of growing indigo, cotton, sugar, grain, and wool to any amount, this country opens a vast field for agricultural and commercial enterprise, with the safe and productive investment of capital. Besides the advantages of a postal communication with India, alternately with that by the Red Sea, a ready intercourse with Southern Persia, Arabia, Mesopotamia, and Kurdistan, must greatly extend the outlets for our manufactures, and would probably afford at the same time desirable localities for colonization.

The climate is healthy, and it could be easily shown by calculation, that there would be ample returns for the capital of any company that may be judiciously organized. One of my officers, Mr. Hector, remained on the Euphrates, and commencing from nothing, has realized a small independence by the occasional freightage of a ship from England with cotton and other goods. The natives, both of Arabia and Asia Minor, are anxious for European manufactures, which, when I was in Mesopotamia, were chiefly obtained from Russia, and of an inferior quality. These goods were retailed by the native merchants at an enormous price, their profit being generally cent. per cent. It is however necessary to consult the taste of the natives in cottons, muslins, and other manufactures, to ensure success. The Russians have done this judiciously, and have secured popularity for their goods.

Much more might be said on the subject of commerce; but setting aside all these considerations, let us reflect for a moment on the vast field that would be opened to scientific research and observation, in countries so rich in remains of early civilization, so deeply interesting to the antiquarian and the historian, so fertile in productions for the naturalist and botanist. To the ethnologist, geologist, and geographer also, the opening of this line of route would be of inestimable value, while to be the means of re-introducing Christianity and civilization to regions hallowed by the most sacred associations is surely an object worthy of the best efforts of the British people. The Mesopotamian rivers should not be allowed to remain almost useless to mankind, and I cannot relinquish the hope that I shall yet see this long-cherished desire, fully and judiciously realized.

To carry out the whole project of a railway through Arabia, only £1,205,000 would be required, and the annual cost would be about £140,000. The greater object of a railway to India all the way, would require about £33,800,000. But my proposal only requires for a beginning £50,000 or £80,000, to be gradually increased as success crowns our efforts to a capital of £1,205,000; and we may leave the question of the £33,000,000 for our sons or our grandsons.

Expedition under Mr. F. Galton, *to the East of Walfisch Bay.*

Climatological Notes on Pisa and Lucca. By Dr. J. Gason *of Dublin.*

Recent Survey for a Ship Canal through the Isthmus of Central America. By Messrs. Lionel Gisborne *and* Forde. *Communicated through the Royal Geographical Society, by the Foreign Office.*

On a Recent Journey across Africa from Zanzibar to Angola, as communicated from Her Majesty's Foreign Office to the Royal Geographical Society.

On certain Ancient Mines. By the Rev. Edward Hincks, *D.D.*

There are two places in the Cuneatic inscriptions in which mines or quarries are mentioned. The first is on the obelisk, brought from Nimrûd, where the following passage occurs. It is Divanubar, king of Assyria, who speaks:—"In my twenty-second year (about 878 B.C.), I crossed the Euphrates for the twenty-first time, I went down to Tabal. I received their tributes from twenty-four kings of Tabal. I went to the mines of silver, of salt, and of gypsum." The last-named substance is identified by its being that of which certain colossal bulls are said to have been made. The country where these mines existed must be a part of Cappadocia; and, from the number of its kings, it is evident that it was of considerable extent. It appears, from the inscriptions, that it bordered on *Khelakku*, which Colonel Rawlinson has identified with Cilicia. Its name is probably preserved, in a slightly corrupted form, in *Tavros*, the name given by the Greeks to the mountain chain which lay in the south of it. So *Wararadh*, or Ararat, was properly the name of a country, but is now applied to a mountain in the east of this country. As a more familiar instance, *Mourne* is properly the name of a barony, but is best known as that of a mountain chain which lies in it. In this country, Mr. Ainsworth has mentioned two salt mines, one near Kankari, and the other at Tuz Koi, near Neu Shehr. The latter is described as an immense bed of salt, in which a pit was originally dug, round which shafts are now sunk. Gypsum quarries are found in abundance in this district, as is also marble; but of this substance it appears that no bulls have yet been found. No mines of native silver exist in the country; such a mine may have existed formerly, and have been exhausted; but it is more probable that the mine was of argentiferous galena, the reduction of which is less difficult than of copper ore; and we know that the mode of reducing this was known many centuries before the date of this inscription. Such a mine exists at Denek Tagh, about eighty miles north of the salt mine. [M. de Tchihatchef mentioned another silver mine, lying between this and Sivas, which he thought more likely to have been visited by the Assyrian king.] The other passage in an Assyrian inscription is in the annals of Sargon. In Botta's pl. 83, l. 9, under the 11th year (711 B.C.), when he took Ashdud, the king of which fled to Egypt, there occur the words, "Baal Zephon (*Bahil Zapuna*) the great mine of copper." The preceding and following words are lost. The earliest known copper mines are those in the peninsula of Mount Sinai. A place called *Surâbat El Khadem* attracted much attention some years ago. It was believed to be an Egyptian place of pilgrimage. Some pillars were found there, containing dates in the reigns of many Egyptian kings, and these were believed to be tombstones. At length Lepsius visited the place, and ascertained that it was a great copper mine; and that the pillars contained records of its being worked at the times mentioned, and invocations of Hathor, the Egyptian Venus, who presided over the country. This connexion of Venus with copper, in the worship of both this country and Cyprus, and in the fancies of the alchemists, was noticed as a curious coincidence that required explanation. On the Nimrûd obelisk are the tributes of five nations, the first and fifth of which offer copper; and this was, no doubt, a production of their countries. The name of the first nation is *Gilzan*, probably the Gozan of scripture. The name probably signifies the country of the Gelæ, whom Strabo places on the shore of the Caspian sea. It is the modern Ghilan. Here is the celebrated copper mine of *Shichterabad*, which Colonel Monteith says is probably not exceeded by any in existence for richness and facility of working. It is near a river which is called at this day Ozan. The second tribute is that of Jehu, king of Israel. The third is of a country formerly supposed to be Egypt, the name of which very closely resembled its name; but it is the hilly country to the east of Nineveh, and not very far from it. The fourth tribute is supposed to be that of a nation on the west of the Persian Gulf. The fifth is, according to Colonel Chesney, that of the people on the opposite coast of the Gulf where copper is found. The mode of reading this name is uncertain, the first character having different values. Dr. Hincks was disposed to read it *Shirutinay*, identifying it with the *Sharutana* of the Egyptian inscriptions, or the people of Cyprus; but the appearance of the people was, according to Colonel Chesney, so decidedly Persian that he would not press this point. He, however, went on to state his reasons for believing the *Sharutana* to be from Cyprus, as it led to some interesting conclusions. They are called "the Sharutana of the sea," and this is analogous to a phrase "of the middle of the sea," which, in the Cuneatic inscriptions, is added to certain names implying insular position. This is one of the few points on which Dr. Hincks and Colonel Rawlinson differ. A series of names of people are mentioned on a great slab at Nimrûd, as paying tribute to the father of Divanubar. This list begins with the Tyrians and ends with the people of Arwad. Then comes this phrase, which Colonel Rawlinson supposed to apply to all the people, and to mean that they lived on the sea coast; but Dr. Hincks supposes it to belong to the last people only, and to imply that they lived in an island. The same phrase is appended to two other names; and this difference as to its interpretation has led to very different views of what these names apply to. We have the *Yavnay*, who arementioned in several places, and particularly as being employed by Sennacherib to navigate his vessels, along with Tyrians and Sidonians. Colonel Rawlinson makes them to be the people of Jabneh, in Palestine, but Dr. Hincks believes them to be the Ionians, or people of the Grecian islands. But what is more interesting is, that Luli, the king of Sidon, is said to have fled from Tyre to a place named, according to Colonel Rawlinson, *Yatnan*, and supposed by him to be Rhinocolura, on the frontiers of Egypt. He evidently believes that Luli fled by land. Dr. Hincks reads the name *Yavan*, and believes it to be the country to which the *Yavnay* belonged, or the Grecian islands, including perhaps Crete. He observed that, in the Khorsabad inscriptions, an invasion of seven kings of this country is mentioned, and they are said to have been seven days on their voyage. This implies that they came from Crete, or from beyond it. What makes this matter most interesting is, that the flight of the Tyrians to Yavan, which is represented in the seventy-first plate of Mr. Layard's Monuments of Nineveh, seems to be the fulfilment of the prophecy in Isaiah xxiii. 12. Tyre, the daughter of Sidon, is here passing over to Chittim. Commentators have looked to the time of Nebuchadnezzar for the fulfilment of this prophecy; but here is a more direct fulfilment than could have occurred then, more than 100 years earlier, and not above fifteen years after the prophecy was delivered. The sculpture evidently refers to a flight, not to a warlike expedition, as women and unarmed persons are represented in the ships; and an adjoining slab represented the castle of Tyre on the sea shore, and a woman, who had embarked, receiving a child from a man on the shore. After this digression, the identity of "Baal Zephon, the great copper mine," with the place of that name, before or over against which Pihahiroth was situated, was maintained. Baal Zephon was supposed to be Surâbat el Khadem; and it was maintained that Pihahiroth must be on the part of the coast which fronted this mine; a position which agreed with that of the coast south of *Râs 'Atâkah*, but by no means with any part of the coast north of it. This was considered to refute the opinion which so many have adopted of late years, that the Israelites crossed the sea in the neighbourhood of Suez. Dr. Hincks observed, in conclusion, that the truth of the narrative in the book of Exodus was one for the theologian and not for the geographer. The position of Pihahiroth, whether close by Suez or to the south of Râs 'Atâkah, was a geographical question. If the former opinion prevailed, another geographical question arose, whether a multitude of people could cross the sea in that place, under any circumstances of wind or tide, without the laws of nature being suspended. But if the latter opinion be adopted, there is no room for this second question. Every one must admit, that, below the Cape, if the Israelites crossed at all, they must have crossed the broad and deep sea, when the water must have stood as a wall on their right hand and on their left, as the narrative expressly affirms that it did.

Latest Explorations in South Africa to the North of Lake N'gami. By Messrs. LIVINGSTON *and* OSWELL.

On the Expedition to the Interior of Central Australia in search of Dr. Leichardt.

On the Proposed Expedition to ascend the Niger to its Source. By Lieut. L. MACLEOD, *R.N.*

In the contract lately made by the Admiralty with Mr. M'Gregor Laird, for the conveyance of the mail to the west coast of Africa, there is a clause by which the contractor binds himself to supply a steam-vessel suitable for river work, for the purpose of geographical and scientific research, at the small cost of 4s. per mile. By taking advantage of this clause, Mr. Macleod proposes to open the Niger and the Chádda to the commerce of this country and continue researches as to the course and source or sources of that river.

Notes on the Distribution of Animal Life in the Arctic Regions. By A. PETERMANN, *F.R.G.S.*

The occurrence of animals in the arctic regions, and its bearing on the missing expedition under Sir John Franklin, is a subject which has of late excited a good deal of interest, and has given rise to the most conflicting opinions: some have maintained the existence of animals in the arctic regions in great numbers, affording abundance of food to man; others as stoutly insisted upon the extreme scarcity, if not total absence, of animals. Mr. Petermann then proceeded to state, that the views hitherto entertained regarding this subject were narrow, circumscribed, and consequently erroneous; that individual observations in particular localities, comprised within a small space on the American side, had been received as data upon which to build general statements regarding the entire arctic regions, though in such observations the whole Asiatic side of the polar basin had been altogether overlooked. Arguments were then adduced, from the geographical features, and natural history of those northern regions, to prove that the commonly received hypothesis, that with ascending latitudes there was a proportional descent of temperature, and a consequent decrease of animal and vegetable life, is a fallacious one. With regard to the bearing of these observations upon the Franklin expedition, Mr. Petermann further remarked:—The general opinion is that the missing vessels have been arrested somewhere between Wellington Channel and Behring's Straits, and the Siberian shores. Most probably their position is nearer to the latter than to the former points. As these three regions abound in animal life, we may fairly conclude that the intervening portion partakes of the same character; and, moreover, that the further Sir J. Franklin may have got from Wellington Channel, and the nearer he may have approached the north-eastern portion of Asia, the more he will have found the animals to increase in number. The direction of the isothermal lines corroborates this assumption, as they are indicative of a higher summer temperature in that region than in any other within the Polar basin. Those countries being probably uninhabited by man, the animals will have continued unthinned by the wholesale massacres by which myriads are destroyed for the sake of their skins or teeth. An interesting fact was mentioned by Lieut. Osborn, namely, that Captain Penny, in September 1850, had seen enormous numbers of whales running southwards from under the ice in Wellington Channel. We know this to be also the case in the Spitzbergen sea every spring, and that these animals are numerous along the Siberian coasts. This not only proves the existence of one, or perhaps two Polar seas, more or less open throughout the year, but also that these seas abound in animal life; to satisfy enormous numbers of whales, an amount of food is required which cannot be small. And it is well known among the Tchuktchi, on the north-eastern coasts of Siberia, where land to the north is said to exist in contiguity to, and probably connected with, the lands discovered by Captain Kellett, that herds of reindeer migrate between those lands and the continents. Taking all these facts into consideration, the conclusion seems to be a reasonable one, that Franklin, ever since entering Wellington Channel, has found himself in that portion of the arctic regions where animals probably exist in greater plenty than in any other. Under these circumstances alone his party could exist as well as other inhabitants of the Polar regions; but we must not forget that, in addition to the natural resources, they would in their vessels possess more comfortable and substantial houses than any of the native inhabitants. So far as food is concerned, reasonable hope, therefore, may be entertained that the missing Expedition would not altogether suffer by the want of it; their fate, however, depends upon other circumstances as well, among which that dire scourge of mariners, the scurvy, is probably more to be feared than any other.

Commercial Documents relating to the Eastern Horn of Africa, translated and communicated by Dr. Shaw.

Notes on the Possessions of the Imaum of Muscat, and on the Climate of Zanzibar, with Observations on the Prospects of African Discovery. By Lt.-Colonel Sykes, *F.R.S.*

Col. Sykes referred to a graphic account of the condition of Zanzibar by Lieut. Fergusson, Indian Navy, derived from the testimony of a Mohammedan merchant. Nothing, he said, comparatively speaking, was known of these territories, and it was an unfortunate thing that such should be the case, particularly as the Imaum was the friend of England, and willing to do anything he was asked. Two missionaries of the Church Missionary Society had resided on the coast of Africa, opposite Mombas, for six or seven years, and an account of their experiences appeared in the Journal of that Society. From these we learn that several districts in the country referred to were, owing to their great elevation, very healthy, and that the people on the coast were Mohammedans. The travels of Rebmann and Krapf in these districts led to the discovery of *two* snow-capped mountains directly under the equator. This mountainous region was believed to be the source of the true Nile. The territories of the Imaum of Muscat were confined to the coast from the Red Sea to 10° south latitude.

On the most Rapid Communication with India viâ *British North America. By* Capt. Synge.

Having pointed out that a route towards the North by a line almost direct from England, connecting the Atlantic and Pacific Oceans, would be the shortest, the writer compared the relative advantages afforded in British America and the States when another line was proposed, and stated that the former possessed superior facilities. The plan which he suggested was composed of four distinct links of communication, each independent in itself, capable of separate execution, and opening up important sources of profit. Railways throughout Nova Scotia and New Brunswick, connecting the seaboard with the interior, were essential to the success of the plan. The Report then entered into details of the project; which contemplated the connexion of Lake Superior, Winipeg, the Rainy Lake, and the rivers and lakes intervening, to the foot of the Rocky Mountains, and thence, by creating permanent dams or reservoirs, to open the passes through those mountains, and regulate the descent of the waters to the Pacific. The paper entered into the calculations of the altitudes of the lakes, the highest water being estimated at about 1400 feet above tide-water; and having referred to the ascent accomplished in the Welland Canal, and the necessity of a perfect geographical survey to ascertain the levels with precision, the writer urged the practicability of the design, and gave elaborate details of the beauty and fertility of the country to show the important results which might be obtained from opening up the communication.

Late Explorations in Syria and Palestine. By the Chevalier Van de Velde, *of the Dutch Navy.*

On the Upper Nile. By Consul Vandey.

STATISTICS.

On the Present State of the Law of Settlement and the Removal of Paupers in Scotland. By Professor Alison, *M.D., F.R.S.E.*

Having remarked on the difference of this law in Ireland, England, and Scotland, the Doctor denounced that of the two latter kingdoms as repugnant to justice and common sense; and cited various authorities (*e. g.* Adam Smith, Turgot, and Sir Robert Peel) to show that its impolicy, as impeding the free circulation of labour, and the hardships inflicted by it, *e. g.* in times of distress in manufacturing districts, when labourers from thence, knowing nothing of agriculture, were sent back to agricultural districts merely because they had been born there, had been long since clearly pointed out by the most competent judges.

The law of settlement and removal lately introduced into Scotland had frequently frustrated the otherwise beneficial working of the new poor law. Strangers were allowed to obtain a settlement in any part of Scotland by five years' residence without parochial aid; and this provision he thought equitable, but it was coupled with others, often rendering it quite ineffectual for the relief of the poor, and very burthensome, at least to the charitable amongst the higher ranks. The ill-understood boundaries of parishes in towns were one main cause of such evils. Again, a man, however industrious, after living four years and ten months in one place, might fall ill, require casual relief, and thereby lose his settlement; even if an Irishman gave Scotland the benefit of his labour for thirty years, and acquired several settlements in the country during that time, he lost all claim to relief if he had not been residing five years in the parish where he lived when first requiring relief. A married woman, however respectable, could not gain a legal settlement by her own labour, if deserted by her husband; although an unmarried woman, however profligate, might do so. And the forcible removal of persons thus denied relief led to much fraud, expense, concealment of contagious disease, and other evils of which he gave examples.

He agreed with Mr. Pashley, Q.C., in recommending that the legal right to relief should take effect wherever destitution might show itself; the relief being administered, as at present, by local boards, under due supervision from a general fund, two-thirds of which should be raised throughout the whole United Kingdom, and one-third only in the district where the relief was given, in order to ensure caution and œconomy in the administration; and in this way he thought that much expense would be saved (now incurred by disputed questions of settlement), and the various evils above stated be entirely avoided.

On the Neglected and Perishing Classes, and the Means of their Reformation. By Rev. John Edgar, *D.D.*

On the Laws of the Currency in Ireland, as exemplified in the Changes that have taken place in the amount of the Annual Circulation of Bank Notes in Ireland since the passing of the Act of 1845. *By* J. W. Gilbart, *F.R.S.*

In 1845, the average amount of notes that had been in circulation during the year ending the 1st of May 1845—£6,354,494—was made the fixed or authorized issue. For any amount beyond its authorized issue each bank was required to hold an equal sum in gold or silver coin, the silver not to exceed one-fourth of the gold coin. The Act came into operation on the 6th of December 1845; and from that period each bank has made returns, stating the average amount of notes in circulation during the preceding four weeks, distinguishing the notes under £5 from those of £5 and upwards, and stating the amounts of gold and silver coin it held in its vaults. These returns were made by all the banks of circulation in Ireland. The proportion per cent. these averages bear to the certified circulation of £6,354,494 is also stated hereunder:—

	Average Circulation.	Proportion to Certified Circulation.
1846	7,259,949	114·25
1847	6,008,831	94·55
1848	4,828,849	76
1849	4,310,283	67·83
1850	4,512,442	71
1851	4,462,908	70·25

From this it appeared, that, if the authorized issue be represented by the number 100, the actual circulation for the six years, 1846 to 1851 inclusive, will be represented by the numbers 114, 94, 76, 67, 71, 70. The question occurs—What is the cause of this falling off in the annual circulation since the passing of the Act of 1845? The amount of notes in circulation does not correspond with the amount of gold in the Bank of England; for the gold in the Bank of England is at the present time much higher than it was on the 1st of May 1845, although the Irish notes in circulation are much less. There were three negative laws of the currency in Ireland, namely, that the amount of notes in circulation is not regulated by the Act of Parliament, nor by the wishes of the Irish bankers, nor by the stock of gold in the Bank of England. Notes are issued in Ireland chiefly for the purpose of purchasing agricultural produce; it would seem to follow that the amount of notes put into circulation will be regulated mainly by the quantity of that produce, and by the price at which it is purchased. If, then, we found that, in the years since 1845, the quantity of agricultural produce has been less, or the price at which it has been sold has been less, and especially if both these circumstances should have occurred, then have we an adequate cause for a reduction in the amount of bank notes in circulation. The annual productiveness of the harvest would affect the amount of notes in circulation. Again, a bad harvest in one year may, by the distress it produces, cause a less production of commodities in several following years, and hence there may be a less demand for bank notes. A bad harvest produces distress among the farmers, and this distress affects the amount of the circulation in two ways:—First, the farmer consumes his own produce instead of selling it, and thus does not require the use of notes. Secondly, the distress of the farmer diminishes the instruments of reproduction. If he has no potatoes, he can rear no pigs. An abundant crop of potatoes produces in the following year an abundant crop of pigs. After the failure of the potato in 1846 the exportation of swine was reduced from 480,827 in 1846, to 106,407. The potato crop again failed in 1848. The number of swine exported in 1848 was 110,787; in 1849 it was only 68,053. The destruction of the pigs which took place in 1846 would doubtless affect the circulation of notes in subsequent years, especially in 1847, 1848, and 1849, and probably, also, to a certain extent, in the years 1850 and 1851. He next proceeded to lay down as propositions, that a reduction in the quantity of commodities produced may be caused by a reduction in the number of producers, and this would occasion a less demand for bank notes; and that the amount of notes that circulate in a country will also be affected by the quantity of commodities exported, and the quantity imported. After addressing himself to these points, he said that we found that the reduction in the amount of notes in circulation in Ireland had been preceded or accompanied by a reduction in the amount of commodities produced, occasioned by a reduced productiveness in the land actually cultivated, a destruction in the instruments of reproduction by the distress thus occasioned, a reduction in the number of producers by deaths and emigration, and the exportation of an increased portion of its capital in exchange for food. But there was another circumstance that concurred in powerfully producing the same effect, that is, the price at which the commodities brought to market were sold. He went into a variety of calculations to sustain the foregoing positions, and then said that, from the whole, he inferred that the difference between the amount of bank notes circulating in a country at two different periods cannot be regarded as any correct test of the condition of its inhabitants at those periods, unless we take into account all the circumstances by which that difference is attended—that the decline of the circulation of bank notes in Ireland, from the year 1845 to 1851, is no accurate measure of the distress that has existed in the country, or that now exists, as other causes besides distress have concurred in producing that effect—that in comparing the circulation of 1845 and 1851 we are making a comparison unfavourable to the country, as the year 1845 was a year remarkable for the high amount of its circulation—and that we should indulge in no desponding inferences as to the condition of the country, even if the circulation should never recover its former amount. Even the permanent reduction of the circulation to its present amount would be no conclusive evidence of the distressed condition of the country; for, though distress first caused the decline of the circulation, yet, from the new circumstances which that distress introduced, the same amount of bank notes are not now necessary for conducting its operations.

Should our Gold Standard of Value be maintained if Gold becomes depreciated in consequence of its Discovery in Australia and California? By Professor Hancock.

After a long dissertation on the standard of value in different countries and ages, that in England being now 5 dwts. $9\frac{1}{2}$ grains of gold to the pound (which originally meant the pound weight of fine silver, that standard having been altered in consequence of repeated depreciations in value, until silver was only one-third of the value it was when the standard of value was fixed)—after showing how the standard might be depreciated, by altering the quantity of gold or silver representing it—the alteration of the purity of the metal representing the standard, by the substitution of some other commodity for gold and silver as the standard—and from the standard falling in value from excessive supply—and referring to various tamperings with the currency until it was restored by Sir Robert Peel's Act of 1819—the Professor stated that the last cause of depreciation of the value was the one with which they had then to deal, from the recent discoveries of gold in Australia and California. When the large discoveries of gold and silver took place in South America there prices fell considerably in value; but though the Government took the matter into serious consideration, they were unable to find any remedy for the depreciation in the value of the precious metals arising from their excessive supply, though it caused great confusion in the carrying on of all descriptions of trade, and the collection of taxation. He was of opinion, notwithstanding the theoretical opinions of many writers, that from the parallel of what took place when the South American mines were discovered, the gold, if depreciated in value, would cause great confusion in the country; and he would therefore suggest that silver, which did not appear likely to be depreciated, should be taken as the standard of value. Should, however, silver also be depreciated, there ought to be a scientific inquiry to see whether, from some combination of metals, a standard of value might not be found which would have the same effect with regard to the commerce, &c. of the country as the compensating pendulum had with regard to time.

Are there any Impediments to the Competition of Free Labour with Slave Labour in the West Indies? By Professor HANCOCK.

The principal conclusions to which Prof. Hancock came were,—1. That, as a conclusion of moral philosophy, it was shameful to maintain slavery for a single hour. 2. That, as a conclusion of political œconomy, emancipation should be immediate, and not gradual. This position Prof. Hancock proved by the history of the emancipation in the West Indies, where the apprenticeship system turned out a failure; and remarked that, where emancipation cannot be immediate, it is the duty of those who see that the change is inevitable to make such previous arrangements that the development of free labour may arise as soon as possible. 3. That auxiliary measures, such as education, reform in the courts of law, especially respecting the tenure and sale of land, are essential in order that the blessings of emancipation may be exhibited on the community at large. Prof. Hancock showed that these auxiliary precautions had not been taken. Grants had sometimes been made in favour of education, but as soon as any pressure came they were withdrawn. He also dwelt on the importance of permanently fixing the law of property in land. 4. That the loss of property consequent on emancipation should not be thrown on the slaveholders, but on the community at large, inasmuch as the whole British people had been responsible for slavery. Accordingly, the slave-owners were compensated, partly in money, and partly in differential duties which had not yet quite ceased. 5. That free labour requires no protection to enable it to compete with slave labour. In slavery there was not the same division of labour as in freedom. Again, the invention of machines proceeded from free labour, freemen desiring to œconomize labour. The consequence was, that more labour was wasted in slavery than in freedom to produce equal results. If free labour could not compete successfully with slave labour, he feared that the moral question would be in great danger. 6. That the allegations about the negroes in the West Indies demanding too high wages are untrue, and the imputations on their character unfounded. It turned out, when inquiries were made into the facts, that wages were very low; and Prof. Hancock quoted authorities to show, that wages were at such rates as 6*d.*, 4*d.*, and 3*d.* per day, so that if the negroes had not provision grounds, they would often be in great straits. 7. That the state of the West Indies did not show the impracticability of free labour competing with slavery, but shows, on the contrary, the folly of the laws which have been passed by the Colonial Legislatures, the folly of the short-sighted selfishness of the planters, and the folly of those philanthropists who, instead of seeking the removal of those laws, demand a monopoly for the planters. In arguing this head at length, Prof. Hancock touched upon the following points:—the bankrupt state of the West India proprietors before the emancipation—the evils of the Coolie immigration—the unjust taxes on the labouring classes in the West Indies—the unfair restrictions on their progress —the system of oppressive laws by which a labourer is condemned where a proprietor escapes—and the unsatisfactory tenure of land in the matter of summary ejectment and want of leases, and in the impediments to the transfer of landed property.

Statistics of the Revenues of the University and some of the Colleges of Oxford, compiled from the Report of the Oxford University Commission. By JAMES HEYWOOD, *M.P., F.R.S.*

It appeared, as far as could be ascertained, that of nine colleges, the average income of the heads of houses was £1100 a year; and as regarded Fellows, taking in the Canons of Christ Church, the average income was £234 a year. The total income of Oxford University was about £22,000, and of the colleges £152,000; at Cambridge the total income was about £133,000, and that of Trinity College, Dublin, was about £50,000, making in all about £355,000. There were 557 fellowships in Oxford, of which about thirty-five were vacant every year. The revenue arising from the University Press, by the printing of Bibles and Prayer-books at Oxford, was stated to be about £8000 a year—though the amount was not regularly paid over, but only when it had increased to sums of £40,000 or £60,000.

Notice of the Progress of the Sewed Muslin Manufacture in Ireland. Communicated by MR. HOLDEN, *and read by* Professor HANCOCK.

It stated that the trade was introduced into Ireland between 1800 and 1810, but little progress was made with it until the period between 1820 and 1830. The introduction of lithographic printing between 1830 and 1835, instead of the old block system, was one of the most important elements in firmly establishing the trade. The old blocks cost from 3*s*. 6*d*. for simple patterns, to £6 or £7 for more intricate, besides the time (two or three weeks) occupied in the preparation of the patterns, and cutting them upon the blocks, whilst they could now be produced in a few hours at about the same amount of shillings as it formerly cost pounds. So extensively had the business increased during the last fifteen years, that there was now employed in Ulster, and other parts of Ireland, nearly a quarter of a million individuals. The wages of the young persons were, when they first commenced, only from 6*d*. to 1*s*. per week; the more experienced obtained 4*s*. to 6*s*., and a few first class workers 10*s*.; and there was now paid between £500,000 and £600,000 per annum for the manufacture, exclusive of the cost of the materials; and moreover, the employment was afforded in the best manner, being given to young females at their own homes, under the supervision of their parents. A great deal of good had also been effected by the establishment of training-schools for teaching the embroidery, and the landed proprietors had been very forward in establishing those schools. Amongst others, the Earl and Countess of Enniskillen established one of these schools; and the result was, that the females of Enniskillen were now earning, from embroidery, no less than £400 a week. The Irish manufacture was rapidly growing into importance, and, despite of fiscal arrangements, was making great way on the Continent; even in France, where the import of goods of this description was interdicted, a large quantity obtained admission by smuggling.

Statistics of the Island of Portsea. Communicated by the Literary and Philosophical Society of Portsea.

A mass of documents, giving minute particulars of the results of laborious inquiries into nearly every subject connected with that locality,

Excessive Emigration and its Reparative Agencies in Ireland. By JOHN LOCKE.

The following brief abstract of this paper is intended to indicate the subjects discussed in it. The paper has been printed at length in the proceedings of the Statistical Society of London, and subsequently in a pamphlet by Parker and Son, London.

1. The famine of 1846, originating cause of the excessive emigration.

Number and averages of emigrants for last ten years, and enormous amounts of money remitted from North America to Ireland, chiefly to promote emigration.

Increase of emigration during first four months of 1852.

Causes of the gradual deterioration in the physical type of the natives of the extreme West of Ireland.

2. Reparative agencies. Educational and industrial progress—a well-defined law of land tenure—and improvement of the labouring classes.

Advantages of facilitating the sale and transfer of land, proved by a series of tables compiled from the records of the Incumbered Estates Court.

3. Steady improvement only to be expected from industry and educational progress, all classes, however differing in creed or opinion, being bound to each other and to the throne by the links of constitutional loyalty and social order.

On the Connexion of Atmospheric Impurity with Disease. By HENRY M'CORMAC, *M.D.*

On the Statistics of the Province of Nova Scotia. By D. M'CULLOCH.

On the Sanitary State of Belfast, with Suggestions for its improvement. By A. G. MALCOLM, *M.D.*

In this paper, the sanitary state of Belfast, including its drainage, external ventilation, water supply, street cleansing, construction of small houses, state of its great working establishments, public schools, slaughter-houses, burying-grounds, and suburbs, is first detailed; after which statistical proof is given of the propositions,—1st, that the vital statistics of the town corroborate the sanitary laws already established; and, 2nd, that the tendency to epidemic visitations and outbreaks and their mortality are on the *increase*; and the paper is concluded by a reference to the efforts that have been made, the obstacles encountered, and the objects which are requisite to improve and permanently sustain, when acquired, the public health of the town. An Appendix is added, containing several Tables, besides coloured diagrams and maps for illustration.

[This paper has been published under the charge of the Belfast Social Inquiry Society.]

On the Productive Industry of Paris. By the late G. R. PORTER, *F.R.S.*

After a review of the various inquiries which had been from time to time instituted with a view to ascertain the extent of production and employment within the city of Paris, the writer proceeded to the detail of the most important points ascertained by its Chamber of Commerce in an elaborate investigation into the effects of the Revolution of 1848 on the trade of the French capital. The total number of workmen employed in 1847 was 342,530, which fell, in 1848, to 156,125, being a diminution of fifty-four per cent. The chief falling off was in furnishing, where the reduction was seventy-three per cent., and the least was in the preparation of food, which only fell off nineteen per cent. The latest value of the productions of Parisian labour in 1847, was £58,545,134, and in 1848 only £27,100,964. Although the falling off of employment in the preparation of food was not great, that in consumption was very remarkable. The quantity of flesh meat consumed in Paris in 1847 was 150lbs. per head; in 1848 it fell to 87¾lbs. per head. After affairs settled down again, it rose in 1849 to 146lbs. per head, and in 1850 reached 158lbs. per head. The difference between 1847 and 1850 is partially to be attributed to the increase of population. The statistics on the degree of instruction found among the workmen is very interesting. Out of the entire number of workmen, 147,311, or eighty-seven per cent., could read and write. Out of 86,617 women, 68,219, or seventy-nine per cent., were able to read and write. The rate of weekly wages was given on an average as follows:—Tailors, 20*s.* 2*d.*; butchers, 19*s.* 7*d.*; jewellers, 31*s.* 9*d.*; bakers, 19*s.* 7*d.*;

shoe-makers, 16*s.* 6*d.*; carpenters, 27*s.* 4*d.*; cabinet-makers, 20*s.* 3*d.*; masons, 18*s.* 9*d.*; confectioners, 21*s.* 9*d.*; milliners, 20*s.* 3*d.*; laundresses, 12*s.* 3*d.* It was found that 950 women earned less than 6*d.* per diem; 27,452 males and 100,050 females earned 6*d.* to 2*s.* 5*d.*; 157,216 men and 626 women earned 2*s.* 5*d.* to 4*s.*; and 10,393 more than 4*s.*

On the Progress and Extent of Steamboat Building in the Clyde. *By* JOHN STRANG, *LL.D.*

No business during the last fifty years had exhibited so much progress in the West of Scotland as that of steamboat building. It was a manufacture of home production, the materials being within themselves, and requiring skill in every department, the remuneration was higher than in the ordinary manufactures of the country; it, in fact, created the districts in which it was established, and gave constant employment to the industrious. It was just forty years since the Comet made its first trip from Glasgow to Greenock. The Comet was only 30 tons burthen, and its engine was but 3 horse-power. Dr. Strang then proceeded to trace the different forms in which steam-vessels had been built, and paid a just tribute to Henry Bell, the first man who rendered steam available for navigation purposes. In reference to the progress of the trade of steamboat building on the Clyde, he showed that in the year ending June 1852, the number and tonnage of steamers engaged in traffic on the Clyde were 93 vessels, of 11,992 tons; the increase on regularly employed vessels on the river was 26, and in tonnage 5301 tons. But that gave no idea of the magnitude of the steamboat building and marine engine making. During the last seven years, there have been constructed, or are constructing, in Glasgow and neighbourhood, 123 vessels, 122 of which were iron, 80 paddle, and 43 screw, consisting of 200 wooden tonnage, 70,441 iron tonnage; 6610 horse-power engines for wooden hulls; 22,539 horse-power for iron hulls; and 4720 horse-power engines for vessels not built in the Clyde. At Greenock and Port Glasgow, during the last seven years, there have been constructed, or are constructing, 66 steam-vessels, 13 of which are wood and 53 of iron, 25 being paddles and 41 screws; the gross tonnage being 47,202 tons. At Dumbarton 58 of iron, 20 paddles and 38 screws, having a tonnage of 29,761. It would be seen that the wooden hulls are fast giving place to those of iron, and the screw is more patronized than the paddle. The proportion in 1852 was 73 iron against 4 of wood, and of screws to paddles it is as 43 to 30. Dr. Strang then exhibited the amount of money expended in this branch of trade, and the quantity of employment it gives. Both were enormous; taking the last seven years of building on the Clyde at £4,650,652, and the employed at Dumbarton, Greenock, Port Glasgow, and Glasgow, at 10,820 persons at annual wages of £450,112, without reference to the very large body of joiners, painters, carvers, gilders, upholsterers, sail-makers employed by this trade.

On the Census and Condition of the Island of Bombay. *By* Lieut.-Colonel SYKES, *F.R.S.*

The author observed that on the night of the 1st of May 1849, the government obtained a census, as to population and as to the distinctive castes into which the population was divided. The entire population of the island, which is only seven miles in length and not more than twenty miles in circumference, was 569,119. Of this number, 354,090 were males, and 212,029 females. The Hindoos comprise more than one-half of the population. The Mussulmans are more numerous than the Parsees, the descendants of the ancient fire-worshipers; who, even in the present day, observe the old form of worshiping the sun, and the old ceremony of exposing their dead as food to fowls of the air. They construct towers, on the top of which the dead bodies are placed. The Parsees have newspapers, printed in the Guzerat language; and on one occasion they published a life of Mohammed, with an engraving or likeness of him. The Mussulmans, regarding this as a caricature of their prophet, rose against the Parsees, and threatened to exterminate them. The feud was only put a stop to by the intervention of the military. The Europeans, Indo-Europeans, native Christians and Jews are 20,426; and all are subject to the same social and political influences and laws. In the Bombay tables there is nothing to indicate the extent of vagrancy, or the number of houses. One great feature is presented in the tables—the excess of males over females. The contrary is the case in Europe, where the females are much in excess of the males. The disparity between the sexes in India was attributed to the crime of female infanticide; and so great was the evil in Kattywar, that the government encouraged a marriage fund from which portions might be given with the daughters of the chiefs and others, so that the inducement to destroy their infant females might be lessened; and the result has been very satisfactory. In Bombay female infanticide never did exist, and the disparity between the sexes is owing to the Persian Gulf and Red Sea traders and immigrant labourers leaving their females at home. Among the Hindoos the females number 48 per cent.; among the Mussulmans, 48 per cent.; and among the Parsees, 82 per cent. The youth of both sexes in the Parsee population are as 23·4 per cent. of the population; Mussulmans, 17·7 per cent.; and Hindoos only 10·8 per cent. Bombay had anciently been considered the grave of Europeans—the Sierra Leone of India—owing to the high tides which divided the island into six or seven parts; the water formed morasses, giving rise to pestilent miasmata; however, means have been taken to prevent the influx of the tides, and the best results have followed, in a sanitary point of view. In Great Britain the mortality is as one in forty-seven; and it is represented in the tables to be now only 2·1 per cent. in Bombay, though the view is thought to be too favourable.

Statistics of the Deaf and Dumb in Ireland. By W. A. Wilde.

This was an abstract of the Report on the condition of the Deaf and Dumb in Ireland taken in connexion with the Census Commission of 1851. In a series of tables amounting to no less than sixteen in number, Mr. Wilde furnished a variety of data for judging of the conditions under which this form of permanent disease exists and is perpetuated. Among these, were tables showing its proportion to the general population, and relative proportion of the sexes affected—their education, and susceptibility to education, both literary and industrial—the class of the community which the malady chiefly affects—and the localities where it principally prevails—with a view to seeing whether geological position, soil, aspect, elevation, humidity, dryness, salubrity or insalubrity of climate, density or paucity of population, unhealthy crowded cities or open fertile plains, acquired disease, hereditary predisposition, family peculiarity, or the consanguinity of parents, may have conduced to the development and propagation of this disease. Mr. Wilde stated generally, that while in Europe the average of deaf and dumb was one in 1593, 4449 deaf mutes were returned for all Ireland, or one in 1580.

A short Account of the early Bills of Mortality at Dublin. By W. A. Wilde.

MECHANICAL SCIENCE.

On Telegraphic Commmunications by Land and Sea. By F. C. Bakewell.

Mr. Bakewell took a general review of the progress which has been made in this important medium for the transmission of intelligence, and examined the accidents which have still interrupted the perfection of the medium, with a view to suggesting remedies. The principal remedies suggested referred to the formation of submarine telegraphic communication. Instead of employing several thin copper wires enclosed in a protecting wire cable, he recommended the use of a strong self-protecting iron wire covered with gutta percha. He contended that a single wire might be made to answer all present purposes, with suitable arrangements and by employing rapidly transmitting instruments, and when more wires became necessary he recommended that they should be sunk separately at considerable distances apart. Mr. Bakewell exhibited a contrivance for still further facilitating Mr. Morse's plan for transmitting symbols by making dots and strokes on chemically prepared paper; and stated that in his Copying Telegraph—which has the great advantage of transmitting at once counterparts of the actual handwriting of parties, so that secrecy as well as the authenticity of the messages is secured—he has effected improvements which increase the rapidity of transmission to three hundred letters per minute.

Mechanical Proof of the Composition of Rotatory Forces. *By* John Barker, *M.B.*

This was an apparatus constructed for the purpose of exhibition and demonstration of these powers.

On the Permanent Way of Railways. *By* James Barton, *C.E.*

After a brief review of the steps by which from the first wooden rail about the year 1676 at Newcastle, the railroad advanced; next to tram-plates, and lately to the present forms of wrought-iron rail secured to wooden sleepers, which are now in common use, the paper proceeded to consider what the defects were in the present system, being generally describable under two heads, the imperfect joint, and the temporary nature of the wooden substructure.

To remedy these evils, those whose professional duties had brought this subject prominently before them, had devised various improvements, and several patents were taken out; amongst which, four were described; the first, that of Sir John Macneill, which consists of a cast-iron sleeper upon which the bridge form of rail beds evenly, and to which it is riveted, the proper gauge and bevil being secured by cross-bars set on edge, and upon which two opposite sleepers are cast. The second is a cast-iron sleeper applicable to the edge rail, as patented by Mr. Peter Barlow, and in which each sleeper consists of two parts, which when bolted together by a horizontal bolt requires no key or other fastening. The third consists of an improvement for the joint of the edge rail on ordinary timber roads, and is a fishing of the joint by bars laid in the hollow of the edge rail and riveted through its vertical web: this is a patent of Mr. Samuel's. The fourth is a patent of Mr. William Henry Barlow, and consists of a wrought-iron rail forming its own sleeper, being rolled wide enough to be its own base; it is of the bridge form, and eleven, twelve, or thirteen inches wide, according to weight; the connections are formed by a chair of wrought iron, the external form of which exactly coincides with the inside of the rail, to which as a joint cover both are riveted, the cross-ties being angle irons, bent to give the bevil for the carriage wheels to the rail, and secured by the same rivets which hold the chair.

The author has laid some of each of these kinds of permanent way, except Mr. Samuel's, and tried a number of experiments thereon, both as to strength, smoothness, and cost of maintenance; and the experimental lengths of each kind have been under the regular traffic of the Belfast Junction Railway for the last year and a half. Of the first kind, Sir J. Macneill's, the Drogheda Railway Company have taken some, their rails being still quite sound but their wooden sleepers decayed; the second, Mr. Peter Barlow's, has been largely laid in England on the South-Eastern, and Ashford and Hastings; and in Ireland, on the Londonderry and Enniskillen. The last described, that of Mr. W. H. Barlow, is now being extensively adopted by Mr. Brunel in England, and Mr. Hemans in Ireland; and the author has laid seven miles, and ordered materials for twelve more; this being the total at present required on the Belfast Junction Railway. The result of the experiments was the adoption of this rail as the best when the rails are not already purchased; it was found by far the strongest and considerably the cheapest. The cost of the different kinds are given in the annexed table, the estimates being either from the author's own knowledge, or when they refer to maintenance for a term of years, are taken from actual tenders made to him for the work. This rail thus gives a first cost saving of £360 per double mile, and an annual saving of £56; the cast-iron sleepers show an increased cost at first of about £160, but an annual saving of about £50.

Description of Road.	Cost of materials for a double line for one mile, and for laying same.	Cost of ballasting per mile of double line. Average.	Cost of renewal from decay and wear of materials of permanent way for double line, per mile, per annum.
Cross-sleeper, timber road, and bridge rail, eighty pounds to the yard	£ 2900	£ 800	£ 80
Cast-iron sleepers either for bridge or edge rail, Sir J. Macneill's, or Mr. Barlow's........................	3260	600*	30
Broad-flanged rail, W. H. Barlow's	2740	600	24

It is proposed to rivet together these rails at the joint; and the paper proceeded to discuss the question of the feasibility of riveting together a continuous line of rails; directly opposite opinions have been given on this point, and amongst those opposed to it were Professor Barlow in 1835. The matter is, the author would submit, one capable of being considered philosophically, and is dependent on the amount of expansion and the strength of the iron; he showed that the contraction by cooling a rail through the whole of our range temperature, say 75°, would cause a tensile strain on the bar only equal to five tons per sectional inch, which the bar is quite capable of bearing. The practical fault appears to be, that the rail when riveted at a low temperature gives way by flexure and gets out of line, acting as a pillar, and so bearing, not as in tension according to its sectional area, but the cube of its width, and inversely as the square of the length unsupported. It would therefore appear perfectly safe to rivet together a line of rails, but it should be done at a high temperature. The effect of change of temperature of the air is moreover largely reduced by the rail being bedded into the ballast instead of placed upon a non-conductor of heat like the timber sleepers.

When the author recommended the adoption of the broad-flanged rail to the Company for whom he tried the experiments, he did not do so on light grounds, as in doing so he took the responsibility of recommending a large outlay on a system hitherto untried except by the patentee; in now however bringing it before the Section, he has the concurrent opinions of a number of the most eminent of his professional brethren. This road having been objected to for a supposed sensation of hardness in passing over it, diagrams of the motion of a carriage over it and other descriptions of road were exhibited, taken by an instrument called a salograph, and which appeared to show the wrought iron had less motion than any other rail.

Tables of experiments were annexed to this paper.

On the Calculation of Strains in Lattice Girders, with practical deductions therefrom. *By* James Barton, *C.E.*

The author commenced by showing, that notwithstanding the large and valuable investigations of late years into the theory and forms of wrought-iron girders for large bridges, yet the nature, intensity, and directions of the strains in the vertical web or portion of the beam which separates the top and bottom were comparatively neglected, or conclusions drawn without correct theory; and having shown the large amount of material used in this portion of girders, the sides in the Britannia tubes weighing 3454 tons, whilst the top is 2962 tons, and the bottom 2944 tons, and therefore the œconomic importance of this investigation, he proceeded to explain the mode in which he had arrived at accurate results as to these strains in the case of lattice girders. He had investigated the subject, and tried some experiments on a

* The iron roads require five or six inches less of ballast in consequence of the depth of wooden sleepers, and this decreased quantity gives the same depth under the sleeper.

large scale with tubular and lattice beams, in connection with some large bridges which he has lately erected on the Belfast Junction Railway, and especially for the design for the Boyne Viaduct, the calculations for which, and the working out of the details, were entrusted to him by Sir J. Macneill and the directors of the company: the results show the high importance of an accurate consideration of the various strains to which each bar is subjected, and the separate and different effects of a passing and constant load. The paper proceeded to explain how these calculations were to be carried out, by resolving each part of the load into its separate effect of tension and compression on every bar in the same system, and on the top and bottom, and adding to these results the constant effect of the weight of the structure, and the results or maxima strains for every bar were shown in diagrams, as also a geometrical elevation of the strains; the general result is, that in ordinary trussed or lattice-bridges the bars sloping downwards towards the bottom at the centre were subject to a tensile, and the others to a compressive strain, and that these strains increase nearly in an arithmetical proportion towards the points of support; but that they pass each other for some distance at the centre, so that a certain number of bars are subject to a small amount of both tensile and compressive strain. The geometric elevation showed the very small proportion the strains in the sides bear to those in the top and bottom, and therefore the inutility of making the sides solid plates, whilst from the amount of compression a single plate does not give rigidity. The paper went on to compare the relative value of single systems bracing with the lattice, and to consider the true angle of œconomic bracing which appeared to be 45°; also how far the calculations are affected by riveting together the bars at their intersections. The paper further proceeded to the practical application, and to the details of construction, explaining some improvements introduced by the author, both as to the mode of construction of the compression bars, which by him are made to form lattice beams, as also in the connection of plates by means of which he proposes to rivet plates with a very slight loss of their sectional area. An isometrical projection of a lattice beam was also exhibited carrying out the principles laid down.

A series of Observations on the Discharge of Water from actual Experiment. By J. F. Bateman, *C.E.*

Mr. Bateman stated that his experiments proved the accuracy of formulæ established by Chevalier Dubuet, for calculating the mean velocity of water in the separate channels.

On the Evolution of Gas in Wallsend Colliery. By George Clarke. *Communicated by* Professor Phillips.

This paper relates to one of the coal-mines in the district of the Tyne which have been rendered remarkable for the frequent explosion of the inflammable gas which they yield, and the loss of life which has in so many cases been the consequence. The colliery in question has been wrought for many years in safety, by the exclusive use of the Davy lamp, though it evolves every moment abundance of gas. A district of this colliery, covering about fifty acres, was effectually walled up, in consequence of the immense discharge of gas that was continually taking place. A pipe was led from this enclosed portion up through the mine and for forty feet above the surface, and from this pipe there has been a constant discharge of gas for the last eighteen years. This gas has been inflamed, and in the roughest and most stormy weather it has burned without intermission; and were it as rich in naphtha as ordinary carburetted hydrogen, it would illuminate the country for miles round. Two water-pressure gauges were fixed, one to the pipe at the surface of the earth, and the other at the bottom of the mine; and the results were that, whilst the pressure in the mine was only $\frac{8}{10}$ths of an inch on an average, that at the top of the pit was upwards of four inches. From observation in these mines, it appears that discharges of fire-damp, governed by atmospheric pressure, have taken place before depressions of the barometer, and that as an indicator of danger that instrument cannot be implicitly relied on. A fact somewhat similar was first observed by Professor Daniell, in his researches at the Royal Society, where the water barometer indicated the change of pressure an hour earlier than the usual mercurial standard barometers constantly employed for observations.

An Account of the Drainage of the Middle Level of the Bedford Level; with Observations on Arterial Drainage. By JAMES COOPER.

On the Mechanical Properties of Metals, as derived from repeated Meltings, exhibiting the maximum Point of Strength, and the Causes of Deterioration. By WILLIAM FAIRBAIRN, *F.R.S.*

After some preliminary observations, Mr. Fairbairn stated that having been requested by the British Association, at their last meeting, to undertake an inquiry into the mechanical properties of cast iron, as deduced from repeated meltings, and feeling desirous of ascertaining to what extent it was improved or deteriorated, arrangements were made for conducting a series of experiments, calculated satisfactorily to determine this question, and to supply such data and such information as will enable the engineer and iron-founder to ascertain with greater certainty how far those remeltings can be carried with safety; or till such time as the maximum of strength is obtained, and such other properties as appear to affect the uses of this valuable and important material. Mr. Fairbairn further stated, in connection with this subject, that it was his intention to investigate another important process, which, to a considerable extent, affects the stability of some of our most important iron constructions, viz. the rate of cooling as it affects the adhesive properties of the material, and the more complete and effective process of crystallization. On these points it is well known that a rapid rate of cooling is invariably attended with risk; that an imperfect crystalline structure is obtained, and that irregular and unequal contractions are not only present, but they are frequently the forerunners of disruption, as well as exceedingly deceptive as regards appearances, or the dangerous consequences which invariably follow in cases of rapid cooling and unequal contraction.

On the Tensile Strength of Unwrought Iron Plates at various Temperatures. By WILLIAM FAIRBAIRN, *F.R.S.*

Mr. Fairbairn said, the experiments were not sufficiently advanced to enable him to lay before the Section any detailed account of them, in consequence of the apparatus for conducting those experiments having, for the last six months, been preoccupied for the Royal Society to determine the temperature of fusion or the laws of the solidification of bodies under great pressure. Under these circumstances, it was next to impossible to make much progress with the experiments on the effects of temperature, &c. on wrought iron plates. Up to the present time, they must therefore be considered preliminary; but, judging results obtained on a former occasion from experiments on bars of iron subjected to a transverse strain at varied degrees of temperature, it is more than probable that some new and interesting facts may be developed by those now in progress.

New Tubular Boiler. By WILLIAM FAIRBAIRN, *F.R.S.*

This subject was illustrated by tables and diagrams. The new boiler consists of two furnaces, the same as the double-flue boiler, but with this difference, that the cylindrical flues which contain the grate bars are united at a distance of eight feet from the front of the boiler into a circular flue which forms the mixing chamber, and which terminates in a disc plate, which contains a series of three-inch tubes, eight feet long, and similar to the locomotive boiler. These tubes in a boiler seven feet diameter are 104 to 110 in number, and from the thinness of the metal become the absorbents of the surplus heat escaping from the mixing chamber and the furnace. On this principle of rapid conduction, the whole of the heat, excepting only what is necessary to maintain the draught, is transmitted into the boiler, and hence follows the œconomy of entirely dispensing with brickwork and flues—an important desideratum in these constructions.

Remarks on the Minie Rifle. By WILLIAM FAIRBAIRN, *F.R.S.*

Mr. Fairbairn observed that, until of late years, all the gun barrels for the army, and other descriptions, had to be welded upon mandrils, some of them formed by a bar of iron rolled upon the mandril, in a spiral direction, and then welded by repeated beatings from the muzzle to the breech. Others were differently constructed, by welding the bars longitudinally, in the line of the barrel, and not in the spiral direction adopted in the former process. Now the whole is welded at one heat, and that through a series of grooves in the iron rollers, specially adapted for the purpose. This, with other improvements, has rendered the manufacture of rifles and other arms a matter of much greater certainty and security than at any former period. Admitting the advantages peculiar to this manufacture, it does not affect the principle of the rifle itself, in which there is no alteration, but in every respect similar, even to the spiral grooves, which he believes are not altered, but are the same as in the old rifle. This being the case, it has been a question of much interest to know wherein consists the great difference in the practice with the new rifle, as compared with that of the old one. It is not in the gun, and must therefore be in the ball, or that part of the charge which generates the projectile force. But, in fact, the improvement consists entirely in the form of the ball, which is made conical, with a hollow recess at the base, into which a metallic plug is thrust by the discharge. The plug is so constructed, as that when driven into the ball, it compresses the outer edges against the sides of the barrel, and at the same time forces a portion of the lead, from its ductility, to enter the groove, and to give the ball, when discharged, that revolving motion which carries with such unerring certainty to the mark. In the practice with one of those rifles on the marshes at Woolwich, the following results were obtained. Out of twelve rounds, at a distance of 700 yards, as near as Mr. Fairbairn can remember, only one bullet missed the target, and the remaining eleven rounds were scattered within distances of about six inches to four feet from the bull's eye. At 800 yards three shots missed the target, and the remaining nine went through the boards, two inches thick, and lodged themselves in the mounds behind, at a distance of about twenty yards. The same results were obtained from a distance of 900 yards, and at 1000 yards there were very few of the bullets but what entered the target. In these experiments the end of the rifle was supported upon a triangular standard, and the greatest precision was observed in fixing the sight, which is graduated to a scale in the ratio of the distance, varying from 100 to 1000 yards, which latter may be considered the range of this destructive instrument.

On Improvements made in the Harbour of Belfast. *By* Robert Garrett, *C.E.*

This paper described the situation of the town of Belfast on the River Lagan, at its junction with that extensive inlet known as Belfast Lough, and stated that the courses of the tides do not tend to the formation of the shoals and bars so formidable at many harbour entrances. It appears there are fourteen miles square of good anchorage ground, and from two to ten fathoms of water. The particulars of the river and the Lough, and the various engineering additions for accommodation were then detailed—from 1720, when the first quay wall was built, and 1785, which marked the commencement of the progress which has continued to the present time. The designs suggested for the improvement of the harbour by Messrs. Rennie, Telford, Cubitt, &c. were described and compared with that given by Messrs. Walker and Burges, attention being in particular directed to the manner in which the tidal action had been taken advantage of in the latter design, now so successfully carried out into execution by Mr. Smith, the Resident Engineer to the Harbour Commissioners.

On Malleable Iron for Beams or Girders. *By* Thomas Murray Gladstone, *C.E. of Belfast.*

This paper pointed out the difference between cast and wrought iron for beams or girders; it was shown that cast iron from its extreme brittleness was unsafe even far below the test usually applied to it, especially where any sudden impact or force was necessary; that as the nature of the metal was changed from cast to a malleable state, its power of bearing tension in the latter condition was increased more than four-fold, while its resistance to compression was not sensibly diminished; that in consequence of this increased strength, the lower webs of the wrought iron girder could be proportionably reduced, and thereby one-half the lineal weight saved, which compensated for the difference of price. The material point which supervened in favour of wrought iron, was that it gave ample warning by great deflection before the breaking point was reached, which was not the case with cast iron.

By experiment it was found that with double T-iron, 8 inches deep, and the top and bottom flanges each 4 inches wide, the whole $\frac{3}{4}$ inches thick, and having two girders 10 feet apart and 10 feet span, with a load of 21 tons, within a radius of 4 feet from the centre, the deflection was only $\frac{3}{8}$ inches, and immediately on the load being removed the beams returned back to their original position. Other examples were given for the Members to see at the Belfast Iron Works, the result showing that with the given section the depth ought to be about $\frac{1}{15}$th the span, and the thickness of all parts $\frac{7}{12}$th the depth of girder, while the best form was for the flanges to be $\frac{1}{2}$ the depth.

The paper was accompanied by drawings showing the different points bearing upon the advantages of this new feature in the application of malleable iron, so interesting for security of life and property in fire-proof buildings.

On an Improved Cast-Iron Sleeper for Railways. *By* JOHN GODWIN, *C.E., Belfast.*

Mr. Godwin said that his attention had been a good deal directed to the subject of laying and upholding the permanent way of railways, from the necessity which had arisen on the Ulster Railway with which he was connected, of relaying a considerable length on which the timber was decayed, and a large outlay became necessary for its reconstruction.

The Ulster line is laid on longitudinal bearings of timber, and the rail is of the bridge-form, of about eighty pounds to the yard; although this kind of permanent way has answered exceedingly well, yet the certainty of decay in the timber, and the consequent necessity of frequent reconstruction, inflict a serious outlay on the company, and renders a large reserve fund necessary to meet such contingences.

In the hope of obviating this serious and frequent source of expense, he directed his attention to the cast-iron sleeper for the bridge rail introduced by Mr. Barlow, and patented by him; on examining the lines on which this sleeper had been laid, he thought that an improved mode of fastening the rail to the sleeper was required, and that the form of the sleeper itself was capable of some improvement.

In Mr. Barlow's plan the sleeper is flat, and the rail is secured to it by means of small detached pieces of iron and small screw bolts; these bolts are liable to shake loose, and the stability of the line is consequently injured.

The alteration which he (Mr. Godwin) had adopted in the form of the sleeper is in making it curved instead of flat, and thus giving it more strength, a better hold on the ballasting, and effecting a consequent saving in the labour of packing and adjusting.

In Mr. Godwin's plan, the chair on which the rail rests is so constructed as to project over the flange of the rail on both sides, and is secured by a broad wedge driven between it and the under side of the rail, forcing it upwards against the projections of the chair: the joints are fastened in a similar manner by a single wedge at each joint.

Before Mr. Godwin had tested this plan of permanent way, by laying a length of it and subjecting it to a severe test, he was apprehensive that the wedges would shake loose, and that it would not remedy the defect of the screw fastenings; but after a severe trial of six months he found the line as secure as when first laid, although it had not been packed or otherwise meddled with; he found, however, that a few of the joint sleepers had broken, but without in the slightest degree affecting the permanence and steadiness of the line.

In order to prevent a recurrence of this he has determined on laying the joint sleeper transversely, and thus preventing the possibility of their breaking.

The advantages to be expected from this kind of permanent way, are its durability, simplicity of construction, facility of replacing defective rails, and œconomy in upholding.

This kind of chair and sleeper is applicable to iines already laid, and to any pattern of rail, and when it is necessary to relay the line, or renew the sleepers.

In concluding his paper, Mr. Godwin suggested the possibility of constructing a railroad in such a manner that the engine and carriages should never rest on a joint, but roll over a continuous and unbroken line of rails. He thought that this might be effected by rolling the rail in two halves, and riveting them together in such a way that the engine would never bear wholly on a joint; and by adopting the wedge-fastening alluded to above, the strain on the rivets would be relieved and not likely to shake loose; indeed, the section of the rail might be so contrived that the action of the wedge in keeping the rail tight in the chair may also tend to force the half rails together, and probably render rivets altogether unnecessary; of course it would be necessary to provide for expansion and contraction, which could easily be effected.

On a Dynamometric Machine for Measuring the Strength of Textile Fabrics and other Substances. By M. PERREAUX.

On Telegraphic Communication between Great Britain and Ireland, by the Mull of Cantyre. By W. J. MACQUORN RANKINE, *C.E., and* JOHN THOMSON, *C.E.*

The authors recommend the construction of a line of electric telegraph between Great Britain and Ireland, crossing the North Channel from the Mull of Cantyre to Tor Point, chiefly on the following grounds:—

1. It involves the construction of a much less length of submarine telegraph than any other line, the distance across the channel in the line proposed being only thirteen miles, while that from Portpatrick to Donaghadee is twenty-two miles; from five to five and a half additional miles of submarine telegraph would be required to cross small arms of the sea; but this would be in small detached portions, easily laid and repaired, and would make the total length of submarine telegraph only about eighteen miles.

2. It is the most secure of all sites for an electric telegraph between Britain and Ireland, for no vessel ever casts anchor in the proposed line.

3. Besides these national advantages, it has the local advantage of connecting the North-East of Ireland directly with the ports on the Clyde.

As it may be considered necessary for local purposes that the electric telegraph should be carried as far north as Larne in Ireland, and as far westward as Dumbarton and Greenock on either bank of the Clyde, Larne may be looked upon as the Irish terminus of this scheme, and either Dumbarton or Greenock as the Scottish terminus. The line from Dumbarton would require 106 miles of land telegraph, the alternative line from Greenock 93 miles, to complete the communication.

The authors consider the security of this line of telegraph to be an advantage, in a national point of view, sufficiently great to warrant its execution, even were the lines by Portpatrick and Holyhead in full operation.

Remarks on the Mechanical Process for Cooling Air in Tropical Climates proposed by Prof. C. Piazzi Smyth. *By* W. J. M. RANKINE, *C.E., F.R.S.E.*

The most improved form of the apparatus proposed by Prof. Smyth consists,—1. of a compressing pump, by which the air is to be forced into, 2. a refrigerator, consisting of a long tube, or a series of tubes, exposed to a stream of water, in which the air will be deprived of the heat generated by the compression, and from which it will escape into, 3. an expansion cylinder, in which the air will at once become cooled by expansion to an extent nearly, but not quite, equal to that of the original heating by compression, and will propel a piston, to assist in working the compressing pump. The air will be delivered from this expansion cylinder into the building to be ventilated. The principal resistance to be overcome in this improved machine will be the friction. The author gives formulæ and rules for calculating the dimensions of the parts of this machine, and the power required to work it, supposing the friction to be known. It is difficult to estimate the amount of friction beforehand; but supposing it to be a little greater in proportion than that of a Cornish pumping-engine, the author calculated that about 25,000 cubic feet of air per hour may be cooled down from 90° Fahr. to 60° by an engine of 1-horse power *.

A Model of a new Reaping Machine, by Mr. R. Robinson, was exhibited by one of the Secretaries.

Design for Safety Harbours. By Captain J. Saunders.

The advantages sought by the author are, durability, cheapness of execution (when compared with the important object it has in view), and security from damage during the progress of the work. The sea pavement, which has heretofore been the ruin of our best harbours, will be by this design dispensed with, substituting a strong sea-wall instead. The bell-work to seaward will be constructed on a new plan, diminishing one foot in each course till it reaches low-water mark, on which the great sea-wall will commence; this wall will be supported from the interior by horizontal arches and sectional walls; the horizontal arches will be filled with concrete and small stones to high-water mark. The contractor may undertake, with a small capital, a large work without any risk or danger, as each section can be completed before another is commenced, as particularly described on the design and model; the cost of execution will be less, and the permanency greater, than by the usual mode of construction, and the design may be adapted to any situation or scale of magnitude.

On the Natural Peculiarities and Advantages of the Mineral Field and the proposed Harbour of Fair Head. By W. H. Smith.

This was a proposal to erect a harbour at Fair Head, the extreme point on the north-eastern coast of Ireland, and establish a submarine telegraph between it and the Mull of Cantyre, which is only twelve miles distant on the Scottish coast, and is the principal point to Glasgow. Having pointed out the variety of mineral wealth and natural products, consisting of coal, iron, sulphur, copperas, ochre, building-stone and limestone, and other valuable substances which abounded in the district, but could not be turned to full advantage in consequence of the want of a harbour,—while shipwrecks on the coast have occurred annually since the old harbour of Ballycastle adjoining was allowed to fall to decay,—the paper stated, that a harbour at Fair Head would be a permanent protection to shipping, and besides increasing the spirit of commercial enterprise, would in some cases be the means of shortening the passage to America by several days. The harbour was proposed to be constructed on the recoil principle, being formed of a framework fastened to piles, with counterbalancing weights attached, so that it would yield to the waves and yet recover its position continually. A lighthouse on the same principle was proposed to be attached.

On Penrose *and* Bennett's *Sliding Helicograph. Communicated by* Professor C. Piazzi Smyth.

The author, Mr. Penrose, observed, "I was led, during my researches on the subject of the refined curves of the Greek mouldings and ornaments, to consider whether it would be possible to contrive some method of describing the volutes and scroll-work at once more ready and more satisfactory than the tiresome approximations, by means of circular ones, which have generally been used. I invented an instrument for this pur-

* From calculations made since this paper was read, it appears that if the compressing pump and expansion cylinder be made on the principle of the gasometer (by bells dipping into a tank of water, as in M. Struvé's machine for extracting the foul air from mines), the power required to reduce the temperature of a cubic foot of air from 90° Fahr. down to 60°, will be about 16½ foot-pounds for the mere reduction of temperature, and about 13½ foot-pounds additional for friction, or 30 foot-pounds in all; so that by an engine of one real horse-power, 66,000 cubic feet of air per hour may be cooled from 90° to 60° Fahr., being enough for the supply of 264 persons, at 250 cubic feet per hour each.

pose, called the Screw Helicograph. This instrument has been elaborated into the improved form now exhibited. By simply turning round the graduated ring within the square frame, this instrument is enabled to draw in pencil or ink any form of the equiangular spiral from the circle to the straight line; and, by alterations in the position of the pen, or of the centre, with respect to the guide bar, certain variations may be obtained. Also either a parallel line to the first may be drawn by a simple adjustment of the pen, or a duly converging line, by bringing the whole frame nearer to or farther from the centre. Expressing the ratio between two spiral radii at an interval of 360° (viz. $a^{2\pi}$) by the term '*spiral ratio*,' it appears that curves drawn with this instrument with spiral ratios less than 8 or 10 to 1 are fitted for volutes and scroll-work, and those which are drawn with higher ratios form the outlines of vases and other such figures where a *gentle variation of curvature* is desired. This quality is ensured from the property of the curve that the radius of curvature is proportional to the length of the arc. For figures where great energy is required, curves of a different nature are more suitable, but no curves appear to surpass these in sweetness of sequence."

On some Properties of Whirling Fluids, with their application in improving the action of Blowing Fans, Centrifugal Pumps, and certain kinds of Turbines. By JAMES THOMSON, *A.M., Civil Engineer, Belfast.*

The author pointed out several properties possessed by masses of fluids revolving in the circumstances of one of the most ordinary kinds of whirlpools, that, namely, which is formed when water is supplied at the circumference of a widely extended vessel, with a very slight rotatory motion, and is allowed to flow away by a central orifice in the bottom. Of these properties, the following, in which the influence of friction is left out of consideration, may be cited:—

The equation of the curve whose revolution would generate the curved surface of the whirlpool is

$$y=\frac{C^3}{x^2},$$

where y is the depth of any point of the curve below the level of the fluid taken at any part far away from the whirlpool, where there is no perceptible depression, x the distance of the point from the axis of revolution, and C a constant quantity.

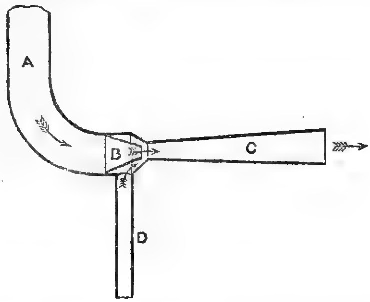
Every point of the surface of the fluid moves with the velocity which a heavy body would attain in falling from the level of the surface far away from the whirlpool to the level of the point. Also every point in the interior of the revolving mass moves with the velocity of the point on the surface vertically above itself; and it follows, that the velocities of points at various distances from the centre are inversely proportional to the distances. It follows also that the velocity of each point in the mass, is the greatest that is possible without an increase of the velocity of every other point revolving further from the centre.

He was led from these and other properties of whirling fluids, to find that the efficiency of centrifugal pumps for water, and of fans for causing blasts of air, may be greatly increased by the provision, outside of the circumference of the wheel, of a space in which the fluid may continue to revolve without any interruption after it has left the wheel. He mentioned also, that an apparatus termed a "diffuser," and involving the same principle, has recently been applied with good results, in turbines of great power constructed in America.

On a Jet Pump, or Apparatus for drawing up Water by the Power of a Jet. By JAMES THOMSON, *C.E.*

The purpose for which the author has designed this new pump, is to clear the water out of the pits of submerged water-wheels, when access to them is required for inspection or repairs. This pump may also be used for raising water in other cases where an abundant fall of water is available; as, for instance, for draining a marsh in the neighbourhood of a waterfall. Its action depends on two principles. One of these is the same as that of the steam blast used in locomotive engines, and in the ventilation of mines. The other is that of the increased flow of water from a pipe, produced by giving a gradually widening form to its discharging extremity.

A sketch of the apparatus is given in the accompanying figure, where A is a pipe



which supplies the water to the nozzle B for the jet, and C is a pipe which receives, at its narrow end, the jet from the nozzle, and on account of its gradually widening form, causes a suction capable of raising water by the pipe D.

The various principles brought into action in this apparatus, have, as was stated by the author, been long known in hydrodynamics; but their combination in this form for use he believed to be new. A rush of water had been used previously in a somewhat similar way in Italy to draw up and carry off the water of a marsh. In respect to the method there employed he had not been able to obtain full information; but the description of it he had received led him to suppose that it was not so efficacious as the method which formed the subject of his communication to the meeting.

On the Production of Cold by Mechanical Means. By W. S. Ward.

To effect the purposes named in a preceding paper, Mr. Ward proposes a different method, and the substitution of the vapours of volatile liquids, such as sulphuric æther in place of air. He believed the theoretical results would be the same, and some sources of loss diminished; but although he doubted whether either form of apparatus would be œconomically efficient, he felt that interesting results would follow well-conducted experiments on the subject.

On Telegraphic Time Signals. By Charles V. Walker.

The object was, to explain the arrangements that have been completed, as far as his part in them extends, for promoting the scheme of transmitting Greenwich mean time throughout the kingdom. On the 5th of August 1852, the first time-signal passed; and on August 19th, the clock at Greenwich, which originates the signals, having been brought to time, and the adjustment elsewhere having been completed, the regular transmission of signals commenced; in the first instance, to Dover, at noon, and at 4 P.M. Mr. Walker then described the apparatus constructed by Mr. Shepherd, and erected at the London Terminus, by which the connexions are made. And, incidental to this, it is to be understood that in the galvanic-room at the Royal Observatory is a set of ordinary sand-acid batteries (to be replaced ultimately by graphite batteries); one battery termination is connected with the earth, by means of the gas-pipes; and the other with a spring contained in Mr. Shepherd's electro-magnetic clock. The Greenwich London wire also terminates in the same clock: and the connexions are such that, at the last second of the last minute of each hour, this line-wire and the battery-wire are placed in contact for an instant; and, consequently, if the circuit is completed at the other end of the wire, whether at London, Dover, Rochester, the Strand, Lothbury, or elsewhere, a signal will pass every hour; and, when the circuit is left open, no signal will pass. To accomplish this, a train of wheels is connected with the rod of Mr. Carter's large turret-clock, now erected over the South-Eastern Terminus. Sets of springs are placed near at hand to some of the wheels; the springs are all tipped with platinum, and are respectively connected with the several wires concerned in the scheme; and, according as the contacts between the several springs are varied, so is the time signal led to its destination. Mr. Walker then explained an ingenious contrivance, by which, at the completion of the circuit at Greenwich, a voltaic current of instantaneous duration passes from Greenwich to Dover, and causes one sharp deflection of the galvanometer needle of the usual electric telegraph. The clerks at the several stations, should they overlook the general order to cease working, and to be on the watch, are reminded that the time is nearly due by finding that the telegraph circuit is broken; which happens during the two minutes that the spring is lifted by the pin off the earth wire at London. The clerks watch the signal, and make note of the error of their local clock. The time-signals will, at set times, be allowed to pass automatically to Hastings, to Deal, and to Ramsgate, by turning them on the main line by the usual telegraph turn-plates now in use at junction stations. The signal will be transmitted to intermediate stations by hand, which can be done correctly to a fraction of a second. The clerk will watch for the signal while he holds in his hand the handle of a group, or a branch instrument; he will move his hand as he sees the signal, and a simultaneous signal will pass along the group.

On Graphite Batteries. By CHARLES V. WALKER.

After referring to the unfitness of copper, and the too great cost of the superior metals for the purpose of batteries for telegraphic purposes, Mr. Walker said he had early sought a substitute, and had found one which seemed to promise all that was required in the deposit of carbon or graphite from iron gas-retorts.

On the New Patent Law. By THOMAS WEBSTER, *F.R.S.*

The author contrasted the facilities which the new law afforded in the application for and obtaining of patents, and in the protection to such property, with the cumbrous, expensive, and duplicated processes which characterized the old system. He further pointed out the necessity of extending further protection to designs according to a system analogous to that of the new patent law, if the industrial education which the schools of design were endeavouring to introduce was to be useful to the pupils as creating a body of educated persons not only dependent on their employers or on capitalists.

On a New Method of Scutching the New Zealand Flax (Phormium tenax). *By* MATTHEW WHYTLAW, *C.E. of Auckland, New Zealand.* (*Communicated by* Sir DAVID BREWSTER.)

After noticing the plan hitherto used in the colony, and pointing out some of its defects, Mr. Whytlaw went on to show that the principle on which New Zealand flax ought to be scutched was by transverse rubbing instead of longitudinal beatings as now in use, and described a very simple machine invented by him, in which this principle was carried into effect, and which was perfectly effectual for the purpose; and he suggested that a machine on the same principle might be used with advantage for European flax.

On the Mould for casting Conical Bullets. By ALFRED J. WOODHOUSE.

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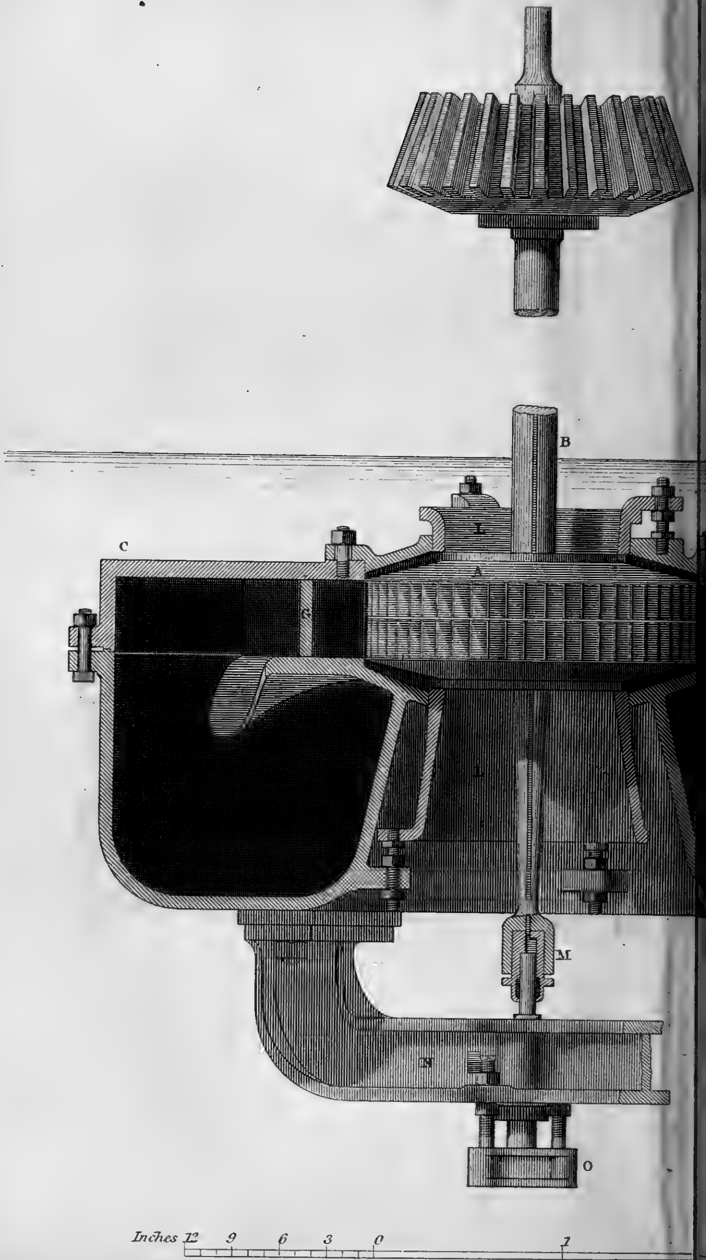

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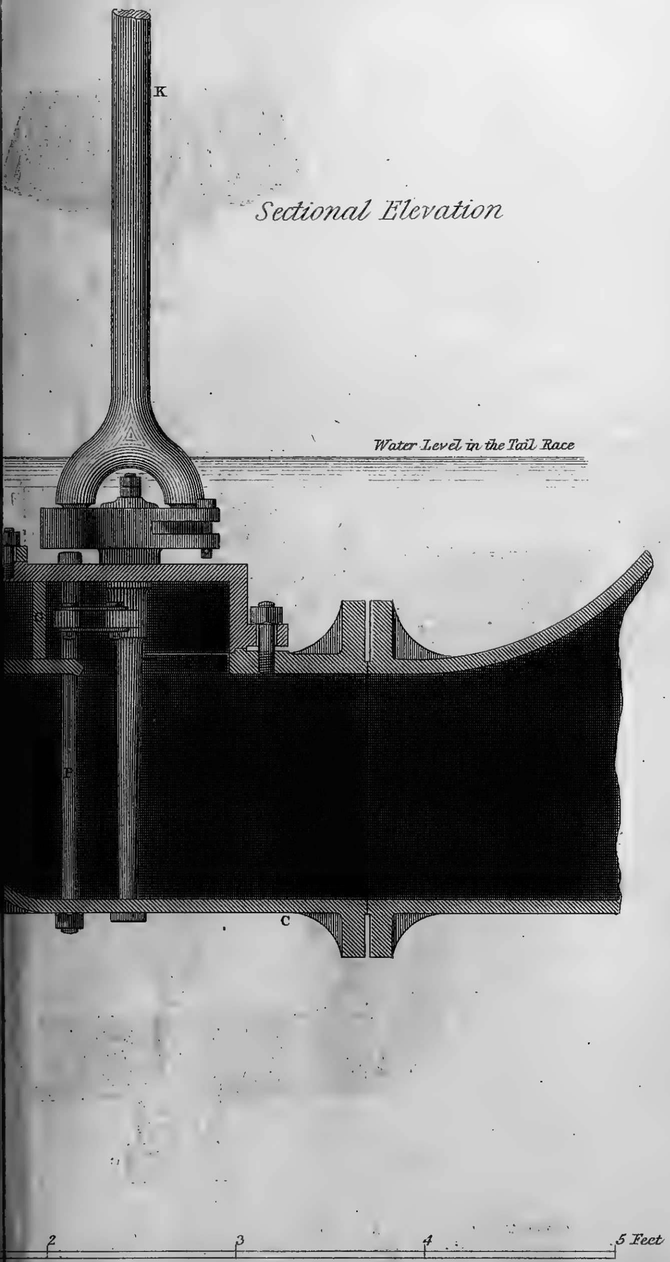

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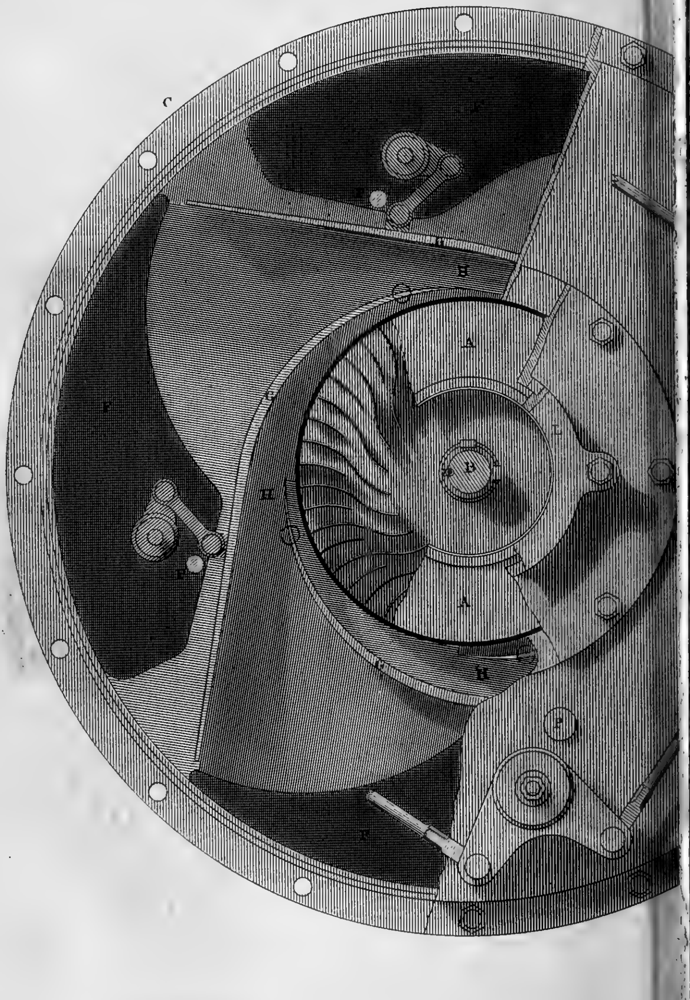

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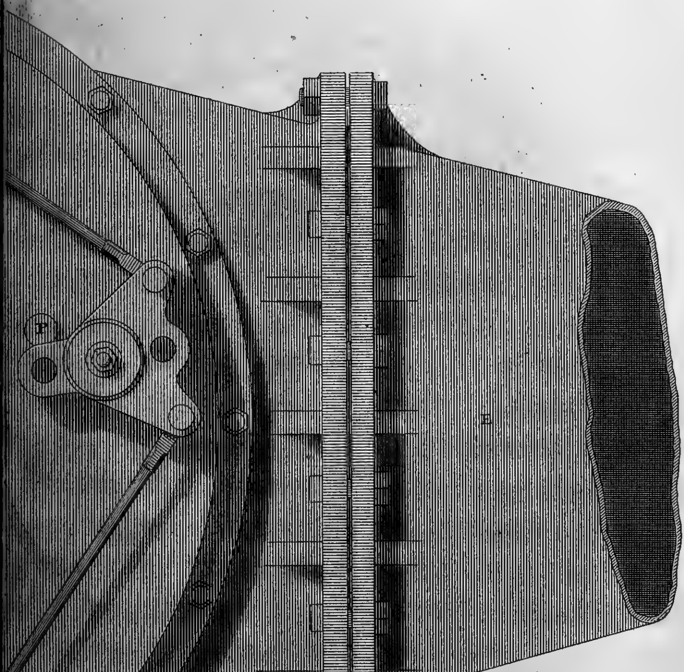

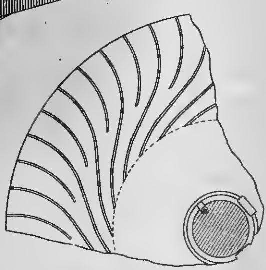

Part of the Wheel on a larger scale, to shew the form of the vanes more accurately

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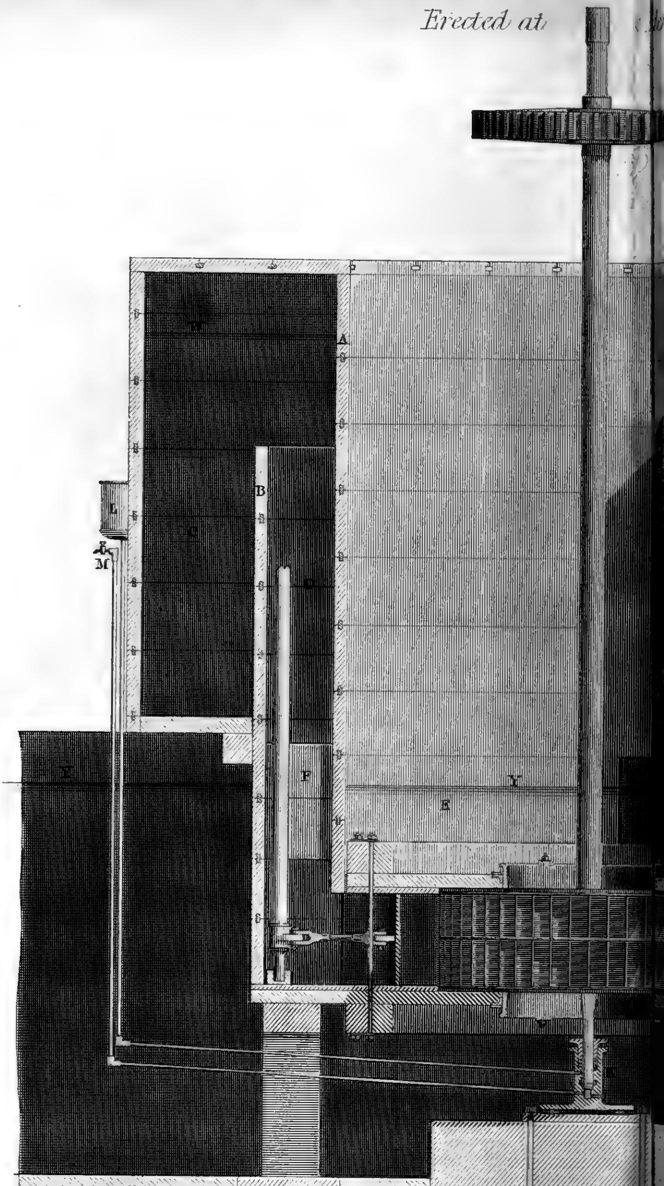

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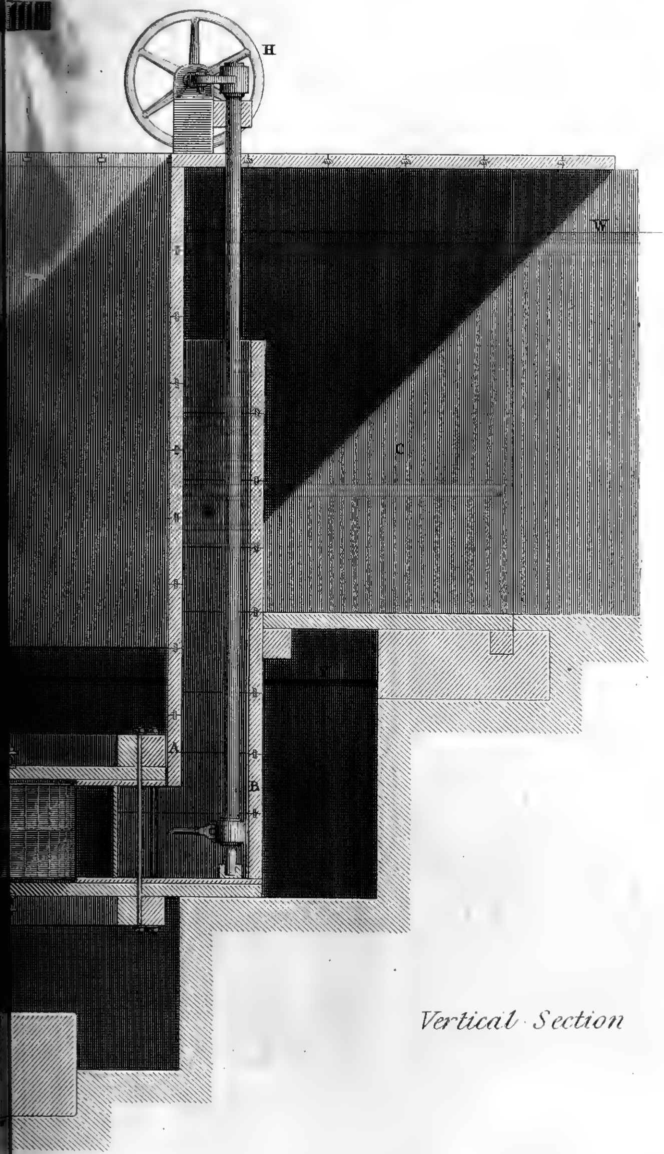

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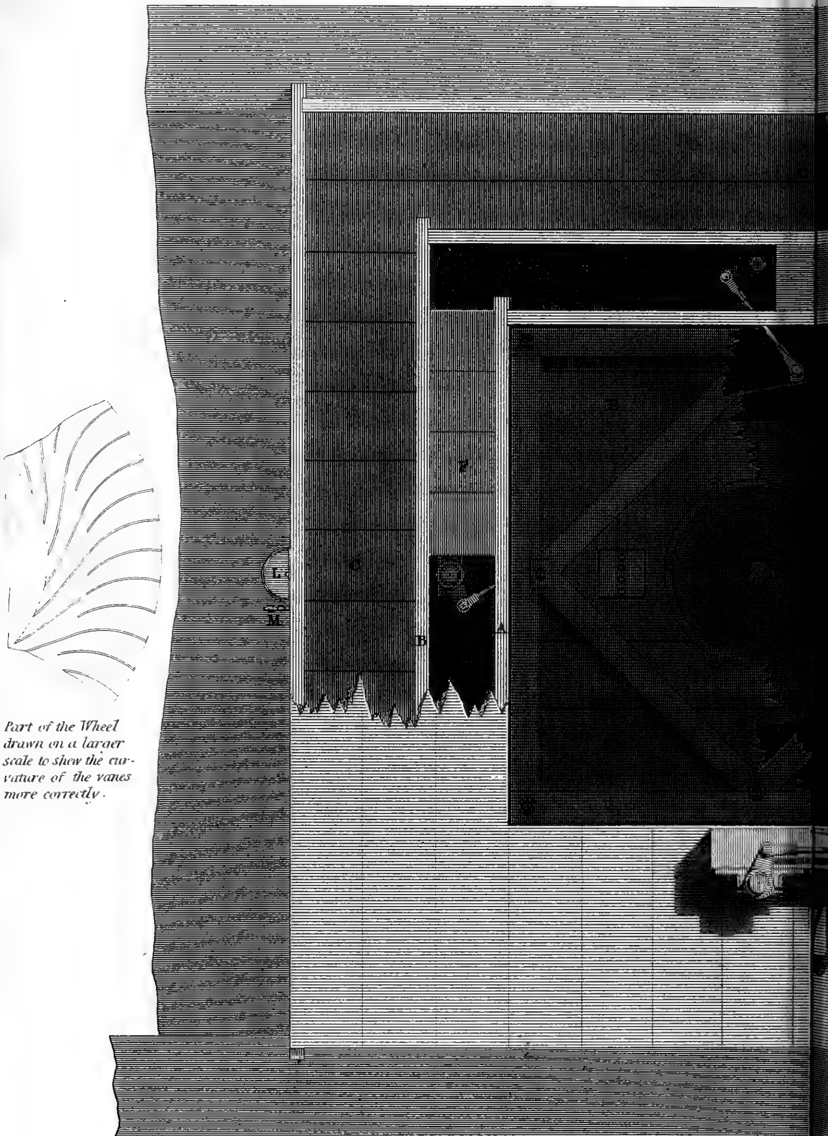

Part of the Wheel drawn on a larger scale to shew the curvature of the vanes more correctly.

Inches 12 9 6 3 0 1 2 3 4

X WITH WOODEN CASE,

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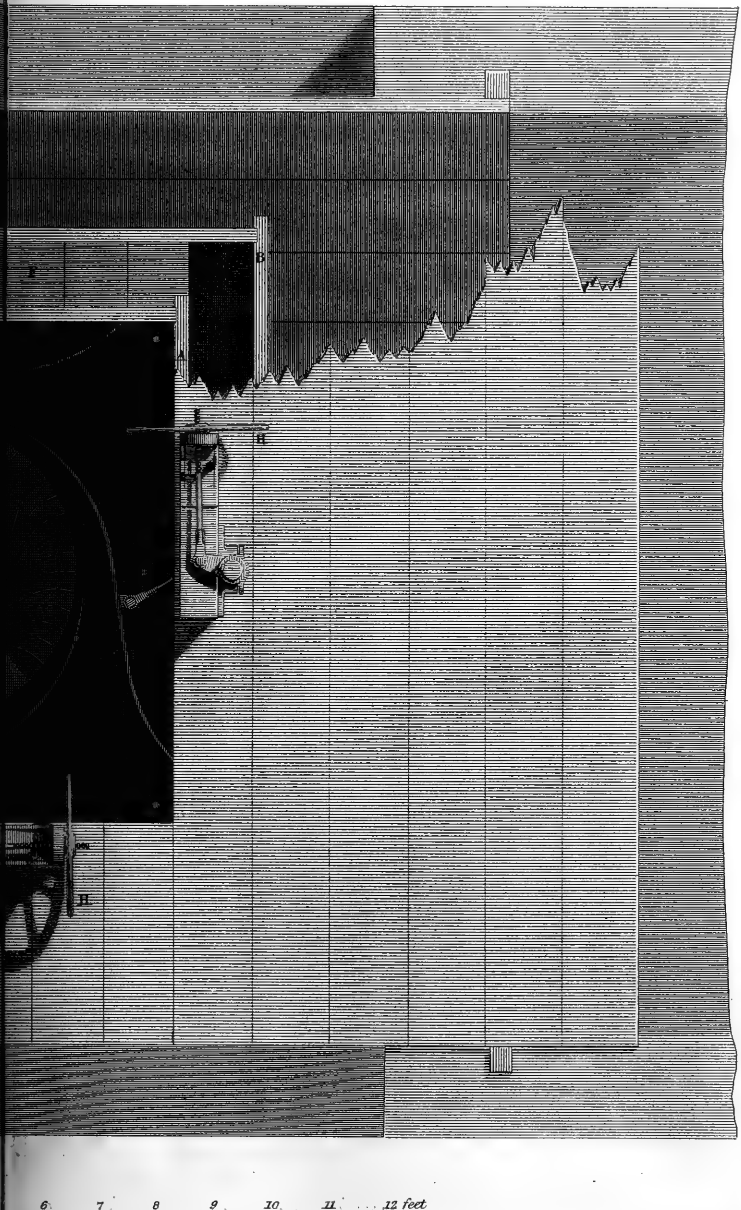
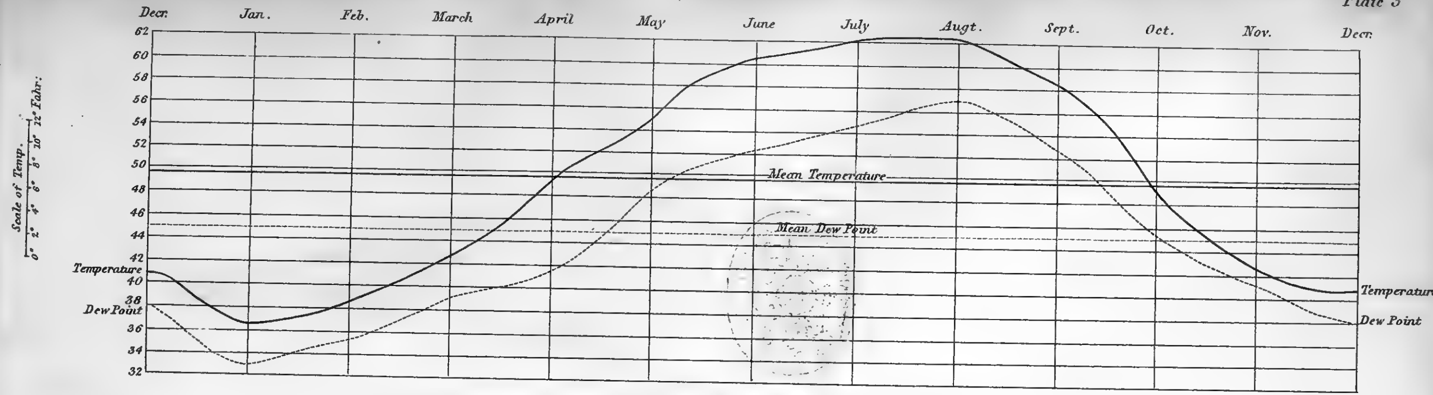
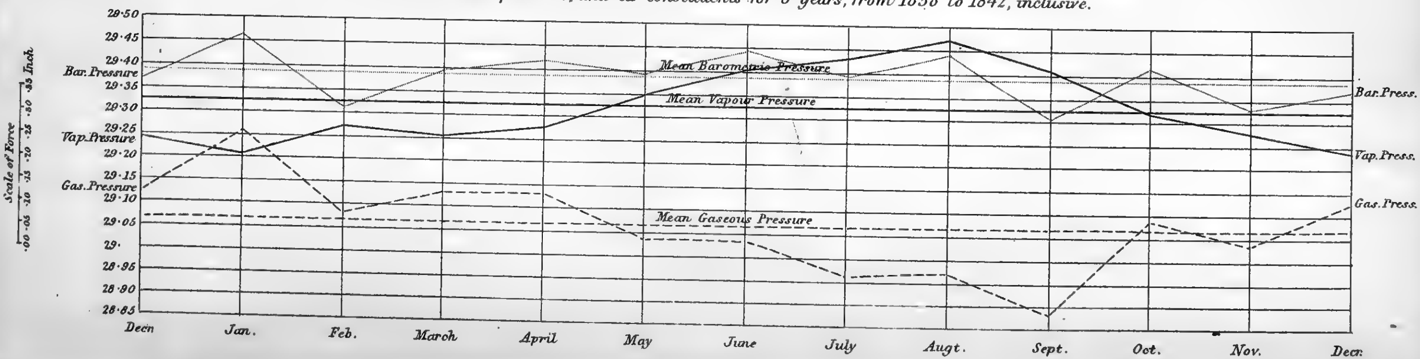
Plan





Curves representing the march of the mean monthly and Annual Temperature, Dew-point, and Barometric pressure, and its constituents for 5 years, from 1838 to 1842, inclusive.



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