REPORT

OF THE

FIFTEENTH MEETING

OF THE

BRITISH ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE;

HELD AT CAMBRIDGE IN JUNE 1845.

LONDON:

JOHN MURRAY, ALBEMARLE STREET.

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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, shall pay 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 or to be 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 Two Pounds as a Book Subscription.
   New Life Members who shall have paid Ten Pounds as a composition.
   Annual Members who have not intermitted their Annual Subscription.
2. *At reduced or Members' Prices.*—Old Life Members who have paid Five Pounds as a composition for Annual Payments, but no Book Subscription.
   Annual Members, who, having paid on admission Two Pounds, have intermitted their Annual Subscription in any subsequent year.
   Associates for the year. [Privilege confined to the volume for that year only.]

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.

OFFICERS AND COUNCIL, 1845-46.

Trustees (permanent).—Sir Roderick Impey Murchison, G.C.S., F.R.S. John Taylor, Esq., F.R.S. The Very Reverend G. Peacock, D.D., Dean of Ely, F.R.S.

President.—Sir John F. W. Herschel, Bart., F.R.S.

Vice-Presidents.—The Right Hon. The Earl of Hardwicke. The Right Reverend the Lord Bishop of Norwich. The Rev. John Graham, D.D., Master of Christ's College. Rev. Gilbert Ainslie, D.D., Master of Pembroke Hall. G.B. Airy, Esq., F.R.S., Astronomer Royal. Rev. Adam Sedgwick, F.R.S., Woodwardian Professor.

President Elect.—Sir Roderick Impey Murchison, G.C.S., F.R.S.

Vice-Presidents Elect.—The Marquis of Winchester. The Earl of Yarborough. Viscount Palmerston, M.P. Lord Ashburton. The Bishop of Oxford, F.R.S., F.G.S. The Right Hon. the Speaker, Charles Shaw Lefevre, M.P., F.G.S. Sir George T. Staunton, Bart., M.P., D.C.L. Professor Owen, M.D., F.R.S. Rev. Professor Powell, F.R.S.

General Secretaries. { Lieut.-Col. Sabine, For. Sec. R.S., Woolwich.

Assistant General Secretary.—John Phillips, Esq., F.R.S., York.

General Treasurer.—John Taylor, Esq., F.R.S., 2 Duke Street, Adelphi, London.

Secretaries for the Southampton Meeting in 1846.—Henry Clark, M.D. T. H. C. Moody, Esq.

Treasurer to the Meeting in 1846.—John Sadleir Moody, Esq.

Council.—Professor Ansted. Sir H. T. De la Beche. Dr. Daubeny. Professor E. Forbes. Professor T. Graham. H. Hallam, Esq. Rev. W. V. Harcourt. James Heywood, Esq. Dr. Hodgkin. Eaton Hodgkinson, Esq. William Hopkins, Esq. Leonard Horner, Esq. Robert Hutton, Esq. Sir Charles Lemon, Bart. The Marquis of Northampton. The Very Rev. G. Peacock, D.D., Dean of Ely. Sir John Richardson, M.D. Dr. Roget. Prof. J. Forbes Royle, M.D. H. E. Strickland, Esq. Lieut.-Col. Sykes. William Thompson, Esq. H. Warburton, Esq. Professor Wheatstone. Professor C. J. B. Williams, M.D. Professor Willis.

Local Treasurers.—William Gray, jun., Esq., York. Dr. Daubeny, Oxford. C. C. Babington, Esq., Cambridge. Charles Forbes, Esq., Edinburgh. John H. Orpen, LL.D., Dublin. William Sanders, Esq., Bristol. Samuel Turner, Esq., Liverpool. William Hutton, Esq., Newcastle-on-Tyne. James Russell, Esq., Birmingham. Professor Ramsay, Glasgow. Henry Woollcombe, Esq., Plymouth. G. W. Ormerod, Esq., Manchester. James Roche, Esq., Cork.

Auditors.—Professor Ansted. Leonard Horner, Esq. Lieut.-Col. Sykes.

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.SS.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. MACDOUGAL BRISBANE, K.C.B., D.C.L., F.R.SS. 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.
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 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 MOST NOBLE THE MARQUIS OF BREADALBANE. 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, F.R.S. Richard Taylor, jun., Esq.
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. Wm. 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. Michael Faraday, Esq., 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., F.R.S. The Rev. Professor Sedgwick, M.A., F.R.S.	William Hopkins, Esq., F.R.S. Professor Ansted, F.R.S.
SIR RODERICK IMPEY MURCHISON, G.C.S., F.R.S. SOUTHAMPTON, September, 10, 1846.	The Marquis of Winchester The Earl of Yarborough. Lord Ashburton. 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 Bishop of Oxford, F.R.S., F.G.S. Prof. Owen, M.D., F.R.S. Prof. Powell, F.R.S.	Henry Clark, M.D. T. H. C. Moody, Esq.

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.
Adamson, J.
Adare, Viscount, M.P., F.R.S.
Airy, G. B., D.C.L., F.R.S., Astronomer Royal.
Ainslie, Rev. Gilbert, D.D., Master of Pembroke Hall, Cambridge.
Ansted, Professor D. T., M.A., F.R.S.
Arnott, Neil, M.D., F.R.S.
Ashburton, Lord.
Babbage, Charles, F.R.S.
Babington, C. C., F.L.S.
Baily, Francis, F.R.S.
Barker, George.
Bengough, George.
Bentham, George, F.L.S.
Bigge, Charles.
Blakiston, Peyton, M.D.
Brewster, Sir David, K.H., LL.D., F.R.S.
Breadalbane, The Marquis of, F.R.S.
Brisbane, Lieut.-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, The Earl of, M.A., F.R.S., Chancellor of the University of London.
Carson, Rev. Joseph.
Cathcart, The Earl, K.C.B., F.R.S.E.
Chalmers, Rev. T., D.D., Professor of Divinity, Edinburgh.
Christie, Professor S. H., M.A., Sec.R.S.
Clare, Peter, F.R.A.S.
Clark, Rev. Professor, M.D. (Cambridge).
Clark, Henry, M.D.
Clark, G. T.
Clift, William, F.R.S.
Colquhoun, J. C., M.P.
Conybeare, Rev. W. D., M.A., F.R.S.
Corrie, John, F.R.S.
Currie, William Wallace.
Dalton, John, D.C.L., F.R.S.
Daniell, Professor J. F., F.R.S.
Dartmouth, The Earl of, D.C.L., F.R.S.
Daubeny, Professor Charles G.B., M.D., F.R.S.
De la Beche, Sir Henry T., F.R.S., Director of the Ordnance Geological Survey of Great Britain.
Drinkwater, J. E.
Durham, The Bishop of, F.R.S.,
Egerton, Lord Francis, F.G.S.
Egerton, Sir Philip de M. Grey, Bart., F.R.S.
Eliot, Lord, M.P.
Faraday, Professor, D.C.L., F.R.S.
Fitzwilliam, The Earl, D.C.L., F.R.S.
Fleming, H., M.D.
Forbes, Charles.
Forbes, Professor Edward, F.R.S.
Forbes, Professor J. D., F.R.S.
Fox, Robert Were.
Gilbert, Davies, D.C.L., F.R.S.
Graham, Rev. John, D.D., Master of Christ's College, Cambridge.
Graham, Professor Thomas, M.A., F.R.S.
Gray, John E., F.R.S.
Gray, Jonathan.
Gray, William, jun., F.G.S.
Green, Professor Joseph Henry, F.R.S.
Greenough, G. B., F.R.S.
Hallam, Henry, M.A., F.R.S.
Hamilton, W. J., M.P., 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, The Earl of.
Harford, J. S., D.C.L., F.R.S.
Harris, W. Snow, F.R.S.
Hatfeild, William, F.G.S.
Henslow, Rev. Professor, M.A., F.L.S.
Henry, W. C., M.D., F.R.S.
Herbert, Hon. and Very Rev. William, 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, F.R.S.
Hodgkin, Thomas, M.D.
Hodgkinson, Eaton, F.R.S.
Hodgson, Joseph, F.R.S.
Hooker, Sir William J., LL.D., F.R.S.
Hope, Rev. F. W., M.A., F.R.S.
Hopkins, William, M.A., F.R.S.
Horner, Leonard, Pres. G.S., V.P.R.S.
Hovenden, V. F., M.A.
Hutton, Robert, F.G.S.
Hutton, William, F.R.S.
Jameson, Professor R., F.R.S.
Jenyns, Rev. Leonard, F.L.S.
Jerrard, H. B.
Johnston, Professor J. F. W., M.A., F.R.S.
Keleher, William.
Lardner, Rev. Dr.
Lee, R., M.D., F.R.S.
Lansdowne, The Marquis of, D.C.L., F.R.S.
Lefevre, Right Hon. Charles Shaw, M.P.
Lemon, Sir Charles, Bart., M.P., F.R.S.
Liddell, Andrew.
Lindley, Professor, Ph.D., F.R.S.
Listowel, The Earl of.
Lloyd, Rev. Bartholomew, D.D., Provost of Trinity College, Dublin.
Lloyd, Rev. Professor, D.D., F.R.S.
Lubbock, Sir John W., Bart., M.A., V.P.R.S.
Luby, Rev. Thomas.
Lyell, Charles, jun., M.A., F.R.S.
MacCullagh, Professor, D.C.L., M.R.I.A.
Macfarlane, The Very Rev. Principal.
MacLeay, William Sharp, F.L.S.
MacNeill, Professor Sir John, F.R.S.
Meynell, Thomas, jun., F.L.S.
Miller, Professor W. H., M.A., F.R.S.
Moilliet, J. L.
Moody, T. F

Morley, The Earl of.
Morpeth, Viscount, F.G.S.
Moseley, Rev. Henry, M.A., F.R.S.
Mount Edgcumbe, The Earl of.
Murchison, Sir Roderick I., G.C.S., F.R.S.
Neill, Patrick, M.D., F.R.S.E.
Nicol, Rev. J. P., LL.D.
Northampton, The Marquis of, President of the Royal Society.
Northumberland, The Duke of, K.G., M.A., F.R.S.
Norwich, The Bishop of, President of the Linnæan Society, F.R.S.
Ormerod, G. W.
Orpen, Thomas Herbert, M.D.
Owen, Professor Richard, M.D., F.R.S.
Oxford, The Bishop of, F.R.S., F.G.S.
Osler, Follett.
Palmerston, Viscount, M.P.
Peacock, Very Rev. George, D.D., Dean of Ely, V.P.R.S.
Pendarves, E., F.R.S.
Phillips, Professor John, F.R.S.
Powell, Rev. Professor, M.A., F.R.S.
Prichard, J. C., M.D., F.R.S.
Ramsay, Professor W., M.A.
Rennie, George, V.P. & Treas.R.S.
Rennie, Sir John, F.R.S., President of the Institute of Civil Engineers.
Richardson, Sir John, M.D., F.R.S.
Ritchie, Rev. Professor, LL.D., F.R.S.
Robinson, Rev. J., D.D.
Robinson, Rev. T. R., D.D.
Robison, Sir John, Sec.R.S.Edin.
Roche, James.
Roget, Peter Mark, M.D., Sec.R.S.
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Rosse, The Earl of, F.R.S.
Royle, Professor John F., M.D., F.R.S.
Russell, James.
Sabine, Lieut.-Colonel Edward, R.A., For. Sec.R.S.
Sanders, William.
Sandon, Lord.
Scoresby, Rev. W., D.D., F.R.S.
Sedgwick, Rev. Professor, M.A., F.R.S.
Selby, Prideaux John, F.R.S.E.
Smith, Lt.-Colonel C. Hamilton, F.R.S.
Staunton, Sir George T., Bart., D.C.L., F.R.S.
Stevelly, Professor John, LL.D.
Strang, John.
Strickland, H. E., F.G.S.
Sykes, Lieut.-Colonel W. H., F.R.S.
Talbot, W. H. Fox, M.A., F.R.S.
Tayler, Rev. J. J.
Taylor, John, F.R.S.
Taylor, Richard, jun., F.G.S.
Thompson, William, F.L.S.
Traill, J. S., M.D.
Turner, Edward, M.D., F.R.S.
Turner, Samuel.
Turner, Rev. W.
Vigors, N. A., D.C.L., F.L.S.
Walker, James, F.R.S.
Walker, J. N.
Warburton, Henry, M.A., M.P., F.R.S.
Washington, Captain, R.N.
West, William, F.R.S.
Wheatstone, Professor, F.R.S.
Whewell, Rev. William, D.D., Master of Trinity College, Cambridge.
Williams, Professor Charles J.B., M.D., F.R.S.
Willis, Rev. Professor Robert, M.A., F.R.S.
Winchester, The Marquis of.
Woollcombe, Henry, F.S.A.
Wortley, The Hon. John Stuart, B.A., M.P., F.R.S.
Yarrell, William, F.L.S.
Yarborough, The Earl of.
Yates, Rev. James, M.A., F.R.S.

TREASURER'S ACCOUNT from

RECEIPTS.

	£	s.	d.	£	s.	d.
To Life Compositions received at the York Meeting and since				781	0	0
To Annual Subscriptions ......Ditto......Ditto......Ditto......				452	2	0
To Ladies' Tickets...............Ditto......Ditto......Ditto......				260	0	0
To Sections' Ticket ....Ditto......Ditto......Ditto......				1	0	0
To Minors' Tickets ....Ditto......Ditto......Ditto......				8	0	0
To received Compositions for Books (future publications) ...				164	0	0
To received Dividends on £5500 in the 3 per cent. Consols, 6 months to January 1845 (less Income Tax)				80	1	11
To received from the Sale of Reports, viz.						
1st vol., 2nd Edition..............................	2	11	3			
2nd vol.	3	0	0			
3rd vol.	4	13	0			
4th vol.	3	15	8			
5th vol.	3	8	0			
6th vol.	6	15	4			
7th vol.	7	1	0			
8th vol.	7	13	0			
9th vol.	12	3	0			
10th vol.	9	11	8			
11th vol.	13	11	3			
12th vol.	47	13	10			
13th vol.	9	6	8			
Lithographs..	1	13	0			
Dublin Communications..........................	0	2	0			
				132	18	8
Balance carried down......................				360	10	5
				£2239	13	0

On Account of the Printing

	£	s.	d.
To Balance of the grant from Her Majesty's Government brought on from last account	934	2	0
	£934	2	0

British Association for the

	£	s.	d.
To Balance in hand of the Account for Printing Lalande and Lacaille's Catalogues	634	2	0
	£634	2	0

ROBERT HUTTON,
LEONARD HORNER,
LIEUT.-COLONEL SYKES, } *Auditors.*

26th of September 1844 to the 19th of June 1845.

PAYMENTS.

	£ s. d.	£ s. d.
By Balance due on the General Account brought on		478 1 5
By Sundry Disbursements by Treasurer and Local Treasurers, including the Expenses of the Meeting at York, Advertising, and Sundry Printing		286 12 10
By Printing, &c. of the 13th Report (12th vol.)		397 13 6
By Engraving, &c. for the 14th Report (13th vol.)............		70 15 6
By Salaries to Assistant General Secretary, Accountant, &c. 6 months to end of December 1844		175 0 0
By Paid to Committees on Account of Grants for Scientific purposes, viz. for—		
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......ditto................	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	
Ditto......ditto...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	
Registration of Earthquake Shocks 1843	15 14 8	
		831 9 9
		£2239 13 0

of Lalande and Lacaille's Catalogues of Stars.

	£ s. d.
By Paid on Account of Printing, &c. since last Meeting........................ ...	300 0 0
Balance	634 2 0
	£934 2 0

Advancement of Science.

By Balance due on the General Account		360 10 5
By Balance in the Bankers' hands	246 19 10	
Ditto......General Treasurer's hands..................	14 3 10	
Ditto......Local Treasurers' hands	12 7 11	
		273 11 7
		£634 2 0

OFFICERS OF SECTIONAL COMMITTEES AT THE CAMBRIDGE MEETING.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

President.—The Very Rev. the Dean of Ely.

Vice-Presidents.—Sir D. Brewster, K.H., F.R.S. L. & E. Sir Thomas M. Brisbane, F.R.S. L. & E. Professor Challis. Professor J. D. Forbes, F.R.S. L. & E. Sir W. R. Hamilton, Astronomer Royal of Ireland.

Secretaries.—Rev. H. Goodwin. Professor Stevelly, LL.D. G. G. Stokes, Esq.

SECTION B.—CHEMICAL SCIENCE, INCLUDING ITS APPLICATION TO AGRICULTURE AND THE ARTS.

President.—Rev. Professor Cumming.

Vice-Presidents.—Dr. Daubeny, F.R.S. Professor Faraday, D.C.L., F.R.S. Professor Thomas Graham, F.R.S. L. & E. Rev. W. V. Harcourt, M.A., F.R.S. Professor Miller, M.A., F.R.S.

Secretaries.—Robert Hunt. J. P. Joule. Professor Miller, M.D., F.R.S. E. Solly, F.R.S.

SECTION C.—GEOLOGY AND PHYSICAL GEOGRAPHY.

President.—Rev. Professor Sedgwick, M.A., F.R.S.

Vice-Presidents.—Captain Sir George Back, R.A., V.P.R. Geog. S. Rev. W. Buckland, D.D., F.R.S. The Earl of Enniskillen, D.C.L., F.R.S. L. Horner, F.R.S. W. J. Hamilton, M.P., F.R.S.

Secretaries.—Rev. J. G. Cumming, M.A. A. C. Ramsay, F.G.S. Rev. W. Thorp, F.G.S.

SECTION D.—ZOOLOGY AND BOTANY.

President.—The Rev. Professor Henslow, F.L.S.

Vice-Presidents.—Bishop of Norwich, F.R.S. Professor E. Forbes, F.R.S. C. C. Babington, F.L.S. Rev. L. Jenyns, F.L.S. W. Ogilby, F.L.S.

Secretaries.—E. Lankester, M.D., F.L.S. J. V. Wollaston, B.A.

SECTION E.—PHYSIOLOGY.

President.—Professor J. Haviland, M.D.

Vice-Presidents.—Professor Clark, M.D. Professor Fisher, M.D. Thomas Hodgkin, M.D. R. G. Latham, M.D.

Secretaries.—R. Sargent, M.D. Dr. Webster.

SECTION F.—STATISTICS.

President.—Earl Fitzwilliam, M.A., F.R.S.

Vice-Presidents.—Lord Sandon, M.P. Colonel Sykes, F.R.S. Sir Charles Lemon, Bart., M.P., F.R.S. Professor Pryme.

Secretaries.—Joseph Fletcher, Esq. W. Cooke Taylor, LL.D.

SECTION G.—MECHANICS.

President.—George Rennie, F.R.S.

Vice-Presidents.—Wm. Fairbairn. Sir John J. Guest, Bart., M.P., F.R.S. J. Scott Russell, F.R.S. Edinb. Professor Willis, F.R.S.

Secretary.—Rev. W. T. Kingsley, M.A.

CORRESPONDING MEMBERS.

Professor Agassiz, Neufchatel. M. Arago, Paris. Dr. A. D. Bache, Philadelphia. Professor Berzelius, Stockholm. Professor Bessel, Königsberg. Professor H. von Boguslawski, Breslau. Professor Braschmann, Moscow. Professor De la Rive, Geneva. Professor Dove, Berlin. Professor Dumas, Paris. Professor Ehrenberg, Berlin. Professor Encke, Berlin. Dr. A. Erman, Berlin. Professor Henry, Princeton, United States. Professor Kreil, Prague. M. Kupffer, St. Petersburg. Dr. Langberg, Christiania. M. Frisiani, Milan. Baron Alexander von Humboldt, Berlin. M. Jacobi, St. Petersburg. Professor Jacobi, Königsberg. Dr. Lamont, Munich. Baron von Liebig, Giessen. Professor Link, Berlin. Professor Œrsted, Copenhagen. M. Otto, Breslau (deceased). Jean Plana, Astronomer Royal, Turin. M. Quetelet, Brussels. Professor C. Ritter, Berlin. Professor Schumacher, Altona. Baron Senftenberg, Bohemia. Professor Wartmann, Lausanne.

Recommendations adopted by the General Committee at the Cambridge Meeting in June 1845.

Involving Applications to Government and Public Institutions.

MAGNETICAL AND METEOROLOGICAL OBSERVATORIES.

Resolutions adopted by the Magnetic Conference.

1. That the Magnetic Observatory at Greenwich be permanently continued, upon the most extensive and efficient scale that the interests of the Sciences of Magnetism and Meteorology may require.

2. That it be earnestly recommended to the Provost and Fellows of Trinity College, Dublin, to continue the Magnetical and Meteorological Observations at the Observatory instituted by that University.

3. That it be recommended to continue the Observatory at Toronto upon its present footing until the 31st of December 1848, unless in the mean time arrangements can be made for its permanent establishment.

4. That it be recommended to continue the Observatory at Van Diemen's Land until the 31st of December 1848, unless in the mean time arrangements can be made for its permanent establishment.

5. That it be recommended that the Observatory at St. Helena should be continued upon its present establishment for a period terminating on the 31st of December 1848, for special Meteorological objects.

6. That it be recommended that the building and materials of the Magnetical and Meteorological Observatory at the Cape of Good Hope should be transferred to the Astronomical Observatory there, to which an Assistant should be added, for the purpose of making absolute Magnetical Determinations.

7. That it be recommended to the Court of Directors of the East India Company, that the Observatories of Simla and Singapore be discontinued at the end of the present year; but that the Magnetic and Meteorological Observations now made at Bombay and Madras be permanently continued in connexion with the Astronomical Observations at these Stations, and that it be further recommended to the Court of Directors, to sanction the proposal made by Mr. Elliot, for a Magnetic Survey of the Indian Seas, to commence at the close of the present year.

8. That it be recommended that the Canadian Survey be continued until the connexion of Toronto with the American Stations be completed.

9. That it be recommended that advantage should be taken of every opportunity of extending Magnetic Surveys in regions not hitherto surveyed, and in the neighbourhood of Magnetic Observatories.

10. That it be strongly recommended that the Staff of Colonel Sabine's establishment at Woolwich be maintained, with such an increased force as may cause the observations which have been made, and those which shall hereafter be made, to be reduced and published with all possible expedition.

11. That this Meeting have recommended the reduction of the Establishments at present attached to some of the Magnetical and Meteorological Observatories, in the full confidence that if, after careful discussion of the Observations made to the end of 1845, there should appear to be reason for restoring some of those Establishments, and for forming new ones, the British Government and the East India Company will give their aid with the same liberality which they have displayed in the maintenance of the existing Observatories.

12. That the cordial cooperation which has hitherto prevailed between the British and Foreign Magnetic and Meteorological Observatories, having produced the most important results, and being considered by us as absolutely essential to the success of the great system of combined observation which has been undertaken, it is earnestly recommended that the same spirit of cooperation should continue to prevail; and that the President of the British Association be requested to make application to the British Government, to convey the expression of this opinion to the Governments of those other countries which have already taken part in the Observations.

13. The British Association, assembled at Cambridge, cannot permit the proceedings of this Meeting to terminate without expressing their sense of great obligation to the eminent Foreign Gentlemen who have taken part in the discussions of the Conference, and whose unwearied attention has been most effectively bestowed on every part of the proceedings.

14. That the Committee which has hitherto conducted the cooperation of the British Association, in the system of combined observations, be reappointed, for the purpose of preparing a report to accompany the presentation to the British Government and to the Directors of the East India Company, of the resolutions passed at this Meeting, and that the

Marquis of Northampton, Professor Christie, and
Sir John Lubbock, Bart., Professor J. D. Forbes,

be added to the Committee.

Resolved, in conformity with the express opinion of the Magnetic Conference, sanctioned by the Committee of Recommendations—

"That it is highly desirable to encourage by specific pecuniary reward the improvement of Self-recording Magnetical and Meteorological Apparatus; and that

The President of the British Association, and
The President of the Royal Society,

be requested to solicit the favourable consideration of Her Majesty's Government to this subject."

GEOLOGY.

That the President of the British Association cooperate with the President of the Royal Society, the President of the Geological Society, the President of the Royal Asiatic Society, Sir H. T. De la Beche, the Rev. Dr. Buckland, and R. I. Murchison, Esq., in making a representation to Her Majesty's Government for a grant in further aid of the publication of the Researches of Dr. Falconer and Captain Cautley of the Bengal Artillery, on the Fossil Fauna of Northern India.

That the President of the British Association, the General Secretary, the President of the Geological Society, the Director of the Geological Survey of the United Kingdom, the Professors of Geology in Oxford and Cambridge, G. B. Greenough, Esq., R. Griffith, Esq., Major S. Clerke, T. Sopwith, Esq., with power to add to their number, be requested to act as a Committee, for the purpose, with special reference to Steam Navigation and Steam Power for manufacturing industry, of laying down, by means of coloured signs upon a Map of the World, every region in which coal, capable of being used as fuel, is known to exist, and to accompany the Map, when completed, with an explanatory Report; showing the geographical and geological position of such coal deposit in the several regions and its superficial extent; the amount in number and thickness of the workable seams, so far as the same can be ascertained, and the facilities of working them; the nearest large towns and sea-ports, and the means of transport from the mines to the sea-ports; the mineral and economical properties of the coal; and whether ores of iron exist in the deposit, accompanied by ready access to limestone.

That the Committee be authorized, on the part of the British Association, to solicit the assistance of Her Majesty's Government in carrying this object into effect.

The President of the Geological Society to be the convener of this Committee.

Recommendations for Reports and Researches not involving Grants of Money.

That M. Dove be requested to carry out his offer to reduce, in the manner stated by him, the Meteorological Observations at the Van Diemen's Land Observatory.

That the Astronomer Royal be requested to reduce, in the same manner, the Observations at the Greenwich Observatory.

That Reports be requested from—

Professor Challis—On the Progress and Present State of Astronomy, from the period embraced in the Report by the Astronomer Royal.

Mr. G. G. Stokes—On recent Researches in Hydrodynamics.

The Dean of Ely—On the recent Progress of that branch of Analysis which relates to the Theory of Equations.

Mr. Phillips—On the instrumental Methods which have been employed in Anemometry.

Mr. Ellis—On the recent Progress of Analysis.

That Mr. T. Stevenson be requested to continue his Experiments on the Force of Waves at different depths.

That Reports be requested from—

Mr. Mallet—On the Corrosion of Iron Rails in and out of use.

Mr. Hunt—On the Influence of Light upon the Growth of Plants.

Mr. Hunt—On the Result of Observations with the Actinograph.

Dr. Percy, Rev. W. V. Harcourt, and Prof. W. H. Miller—On the Result of an Examination of Crystalline Slags.

Dr. Hodgkin and Dr. R. G. Latham—On the Varieties of the Human Race.

Prof. Owen, Prof. E. Forbes, Dr. Lankester, Mr. R. Taylor, Mr. Thompson, Mr. Ball, Prof. Allman, Mr. H. E. Strickland, Mr. Babington, Rev. L. Jenyns, and Rev. Prof. Henslow—On the Registration of Periodical Phænomena in Animals and Vegetables.

Dr. Latham—On Ethnographical Philology.

Dr. Royle—On the Geographical Distribution of Plants in India.

Prof. E. Forbes—On the Results of the Dredging Operations in the British Seas.

Mr. Porter—On the Statistics of the Iron Trade.

Mr. Rennie, Mr. Paxton, Mr. J. Taylor, jun., Mr. Russell, and Mr. Eaton Hodgkinson—On the Hydrodynamical Phænomena of the Reservoir and Fountain at Chatsworth.

That the following Communications, presented to this Meeting, be printed entire in the Transactions of the Association, viz.—

M. Boguslawski—On the Comet of 1843.

M. Paul Erman—On the Effect of Friction on Thermo-Electricity.

Baron Senftenberg—On the Self-Registering Instruments in use at Senftenberg.

Baron Waltershausen—On Etna.

Colonel Sabine—On the Meteorology of Bombay.

Mr. Porter—On Savings' Banks.

That Section E. be in future entitled the 'Section of Physiology.'

That it be referred to the Council to take into consideration previous to the next Meeting the expediency of discontinuing the Kew Observatory.

That a Committee, consisting of Sir J. Herschel, the Astronomer Royal, and Lieut. Stratford, be requested to arrange for the gratuitous distribution of 150 copies of the British Association Catalogue of Stars to Public Institutions, and 25 copies to individuals.

That 10 copies of the British Association Catalogue be placed at the disposal of Lieutenant Stratford.

Recommendations of Special Researches in Science, involving Grants of Money.

KEW OBSERVATORY.

That the sum of £150 be placed at the disposal of the Council for the purpose of maintaining the establishment in Kew Observatory.

MATHEMATICAL AND PHYSICAL SCIENCE.

That Mr. Birt be requested to continue his Researches on Atmospheric Undulations, with £7 at his disposal for the purpose.

That M. A. Erman, Corresponding Member of the British Association, be requested to superintend the computation of the Gaussian Constants for 1839, and of the probable errors of the values so deduced, with £50 at his disposal for the purpose.

That certain expenses incurred by Mr. Osler in completing the arrangements for Anemometry at Plymouth and Edinburgh, amounting to £11 17*s*. 6*d*., be paid.

CHEMICAL SCIENCE.

That Dr. Schunck be requested to continue his investigations on Colouring Matters, with £10 at his disposal for the purpose.

GEOLOGY.

That a Committee, consisting of Mr. Murchison, the Earl of Enniskillen, and Dr. Buckland, be requested to obtain the continuation and completion, by M. Agassiz, of the examination of the Fossil Fishes of the London Clay, as compared with those of the Calcaire grossier of the Paris Basin, with £100 at the disposal of the Committee for the purpose.

ZOOLOGY AND BOTANY.

That Dr. Carpenter be requested to pursue his investigations on the Microscopic Structure of Recent and Fossil Shells, with £10 at his disposal for the purpose.

That a Committee, consisting of Prof. E. Forbes, Mr. Goodsir, Mr. Patterson, Mr. Thompson, Mr. Ball, Mr. J. Smith, Mr. Couch, Dr. Allman, Mr. M'Andrew, Mr. Alder, and the Rev. F. W. Hope, be requested to continue their investigations on the Marine Zoology of Britain by means of the dredge, with £10 at the disposal of the Committee for the purpose.

That a Committee, consisting of Dr. Hodgkin, Dr. R. G. Latham, Dr. Prichard, Prof. Owen, Dr. H. Ware, Mr. J. E. Gray, Dr. Lankester, Dr. A. Smith, Mr. A. Strickland, and Mr. Babington, be requested to continue their investigations into the Varieties of the Human Race, with £15 at the disposal of the Committee for the purpose.

That a Committee, consisting of Prof. Owen, Prof. E. Forbes, Sir C. Lemon, and Mr. Couch, be requested to aid Mr. Peach in his Researches into the Marine Zoology of Cornwall, with £10 at the disposal of the Committee for the purpose.

That a Committee, consisting of Capt. Portlock, Prof. E. Forbes, Mr. Thompson, and Mr. Ball, be requested to pursue their Researches on the Marine Zoology of Corfu by means of the dredge, with £10 at the disposal of the Committee for the purpose.

That a Committee, consisting of Mr. H. E. Strickland, Dr. Daubeny, Prof. Lindley, Prof. Henslow, Mr. Babington, Prof. Balfour, Mr. Mackay, and Mr. D. Moore, be requested to continue their experiments on the Vitality of Seeds, with £10 at the disposal of the Committee for the purpose.

MEDICAL SCIENCE.

That certain expenses incurred by Mr. Erichsen during Researches on Asphyxia, amounting to £6 16*s*. 2*d*., be paid.

STATISTICS.

That a Committee, consisting of Dr. Laycock, Dr. Alison, and Mr. E. Chadwick, be requested to continue their inquiries into the Statistics of Sickness and Mortality in York, with £20 at the disposal of the Committee for the purpose.

MECHANICS.

That Mr. Hodgkinson be requested to continue his Experiments on the Strength of Materials, with £60 at his disposal for the purpose.

Synopsis of Grants of Money appropriated to Scientific Objects by the General Committee at the Cambridge Meeting, June 1845, *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.			
For maintaining the establishment in Kew Observatory under the direction of the Council	150	0	0
Mathematical and Physical Science.			
Birt, W.—For Researches on Atmospheric Undulations	7	0	0
Erman, A.—For Computation of the Gaussian Constants for 1839	50	0	0
Osler, Mr.—Expenses attending Anemometer	11	17	6
Chemical Science.			
Schunck, Dr.—For Investigations on Colouring Matters	10	0	0
Geology.			
Murchison, R. I.—For obtaining the completion of the Examination, by M. Agassiz, of the Fossil Fishes of the London Clay	100	0	0
Zoology and Botany.			
Carpenter, Dr.—For investigations on the Microscopic Structure of Recent and Fossil Shells	10	0	0
Forbes, Prof. E.—For investigations into the Marine Zoology of Britain by means of the Dredge	10	0	0
Hodgkin, Dr.—For investigations into the Varieties of the Human Race	15	0	0
Owen, Professor.—For Researches into the Marine Zoology of Cornwall	10	0	0
Portlock, Captain.—For Researches into the Marine Zoology of Corfu by means of the Dredge	10	0	0
Strickland, H. E.—For continuing Experiments on the Vitality of Seeds	10	0	0
Medical Science.			
Erichsen, I. E.—For Expenses incurred in Researches on Asphyxia	6	16	2
Statistics.			
Laycock, Dr.—For inquiries into the Statistics of Sickness and Mortality in York	20	0	0
Mechanics.			
Hodgkinson, E.—For continuing Experiments on the Strength of Materials	60	0	0
Total of Grants	£480	13	8

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

	£	s.	d.
1834.			
Tide Discussions	20	0	0
1835.			
Tide Discussions	62	0	0
British Fossil Ichthyology	105	0	0
	£167	0	0
1836.			
Tide Discussions	163	0	0
British Fossil Ichthyology	105	0	0
Thermometric Observations, &c.	50	0	0
Experiments on long-continued Heat	17	1	0
Rain Gauges	9	13	0
Refraction Experiments	15	0	0
Lunar Nutation	60	0	0
Thermometers	15	6	0
	£434	14	0
1837.			
Tide Discussions	284	1	0
Chemical Constants ..	24	13	6
Lunar Nutation	70	0	0
Observations on Waves.	100	12	0
Tides at Bristol	150	0	0
Meteorology and Subterranean Temperature .	89	5	0
Vitrification Experiments	150	0	0
Heart Experiments....	8	4	6
Barometric Observations	30	0	0
Barometers	11	18	6
	£918	14	6
1838.			
Tide Discussions	29	0	0
British Fossil Fishes ..	100	0	0
Meteorological Observations and Anemometer (construction)	100	0	0
Cast Iron (strength of) .	60	0	0
Animal and Vegetable Substances (preservation of)	19	1	10
Carried forward	£308	1	10

	£	s.	d.
Brought forward	308	1	10
Railway Constants	41	12	10
Bristol Tides	50	0	0
Growth of Plants	75	0	0
Mud in Rivers	3	6	6
Education Committee ..	50	0	0
Heart Experiments....	5	3	0
Land and Sea Level ..	267	8	7
Subterranean Temperature	8	6	0
Steam-vessels	100	0	0
Meteorological Committee	31	9	5
Thermometers	16	4	0
	£956	12	2
1839.			
Fossil Ichthyology	110	0	0
Meteorological Observations at Plymouth ..	63	10	0
Mechanism of Waves ..	144	2	0
Bristol Tides	35	18	6
Meteorology and Subterranean Temperature .	21	11	0
Vitrification Experiments	9	4	7
Cast Iron Experiments.	100	0	0
Railway Constants	28	7	2
Land and Sea Level ..	274	1	4
Steam-Vessels' Engines.	100	0	0
Stars in Histoire Céleste	331	18	6
Stars in Lacaille	11	0	0
Stars in R.A.S. Catalogue	6	16	6
Animal Secretions	10	10	0
Steam-engines in Cornwall	50	0	0
Atmospheric Air......	16	1	0
Cast and Wrought Iron.	40	0	0
Heat on Organic Bodies	3	0	0
Gases on Solar Spectrum	22	0	0
Hourly Meteorological Observations, Inverness and Kingussie ..	49	7	8
Fossil Reptiles	118	2	9
Mining Statistics......	50	0	0
	£1595	11	0

	£	s.	d.
1840.			
Bristol Tides	100	0	0
Subterranean Temperature	13	13	6
Heart Experiments	18	19	0
Lungs Experiments	8	13	0
Tide Discussions	50	0	0
Land and Sea Level	6	11	1
Stars (Histoire Céleste)	242	10	0
Stars (Lacaille)	4	15	0
Stars (Catalogue)	264	0	0
Atmospheric Air	15	15	0
Water on Iron	10	0	0
Heat on Organic Bodies	7	0	0
Meteorological Observations	52	17	6
Foreign Scientific Memoirs	112	1	6
Working Population	100	0	0
School Statistics	50	0	0
Forms of Vessels	184	7	0
Chemical and Electrical Phænomena	40	0	0
Meteorological Observations at Plymouth	80	0	0
Magnetical Observations	185	13	9
	£1546	16	4
1841.			
Observations on Waves	30	0	0
Meteorology and Subterranean Temperature	8	8	0
Actinometers	10	0	0
Earthquake Shocks	17	7	0
Acrid Poisons	6	0	0
Veins and Absorbents	3	0	0
Mud in Rivers	5	0	0
Marine Zoology	15	12	8
Skeleton Maps	20	0	0
Mountain Barometers	6	18	6
Stars (Histoire Céleste)	185	0	0
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
Carried forward	£539	10	8
Brought forward	539	10	8
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.			
Dynamometric Instruments	113	11	2
Anoplura Britanniæ	52	12	0
Tides at Bristol	59	8	0
Gases on Light	30	14	7
Chronometers	26	17	6
Marine Zoology	1	5	0
British Fossil Mammalia	100	0	0
Statistics of Education	20	0	0
Marine Steam-vessels' Engines	28	0	0
Stars (Histoire Céleste)	59	0	0
Stars (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
Carried forward	£1442	8	8

	£	s.	d.
Brought forward	1442	8	8
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
Coloured Drawings of Railway Sections....	147	18	3
Registration of Earthquake Shocks......	30	0	0
Report on Zoological Nomenclature	10	0	0
Carried forward	£977	6	7

	£	s.	d.
Brought forward	977	6	7
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
Carried forward	£384	2	4

	£	s.	d.
Brought forward	384	2	4
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
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
Registration of Earthquake Shocks .. 1843	15	14	8
	£831	9	9

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., 2 Duke Street, Adelphi, 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.

On Thursday evening, June 19th, at 8 P.M., in the Senate House, Cambridge, the late President, the Very Rev. George Peacock, D.D., F.R.S. (Dean of Ely), resigned his office to Sir John F. W. Herschel, Bart., F.R.S., who took the Chair at the General Meeting, and delivered an Address, for which see p. xxvii.

On Friday evening, June 20th, in the same room, G. B. Airy, Esq., F.R.S., Astronomer Royal, delivered a Discourse on the recent Progress of Terrestrial Magnetism.

On Monday evening, June 23rd, in the same room, R. I. Murchison, Esq., F.R.S., delivered a Discourse on the Geology of Russia.

On Wednesday evening, October 2nd, at 8 P.M., in the same room, the Concluding General Meeting of the Association was held, when the Proceedings of the General Committee, and the grants of money for scientific purposes, were explained to the Members. The Meeting was adjourned to Southampton, in the month of September, 1846.

ADDRESS

BY

SIR JOHN F. W. HERSCHEL, BART., F.R.S.,

&c. &c.

Gentlemen,—The terms of kindness in which I have been introduced to your notice by my predecessor in the office which you have called on me to fill, have been gratifying to me in no common degree—not as contributing to the excitement of personal vanity (a feeling which the circumstances in which I stand, and the presence of so many individuals every way my superiors, must tend powerfully to chastise), but as the emanation of a friendship begun at this University when we were youths together, preparing for our examinations for degrees, and contemplating each other, perhaps, with some degree of rivalry (if that can be called rivalry from which every spark of jealous feeling is absent). That friendship has since continued, warm and unshadowed for a single instant by the slightest cloud of disunion, and among all the stirring and deep-seated remembrances which the sight of these walls within which we are now assembled arouse, I can summon none more every way delightful and cheering than the contemplation of that mutual regard. It is, therefore, with no common feelings that I find myself now placed in this chair, as the representative of such a body as the British Association, and as the successor of such a friend and of such a man as its late President.

Gentlemen, there are many sources of pride and satisfaction, in which *self* has no place, which crowd upon a Cambridge man in revisiting for a second time this University, as the scene of our annual labours. The development of its material splendour which has taken place in that interval of twelve years, vast and noble as it has been, has been more than kept pace with by the triumphs of its intellect, the progress of its system of instruction, and the influence of that progress on the public mind and the state of science in England. When I look at the scene around me—when I see the way in which our Sections are officered in so many instances by Cambridge men, not out of mere compliment to the body which receives us, but for the intrinsic merit of the men, and the pre-eminence which the general voice of society accords them in their several departments—when I think of the large proportion of the muster-roll of science which is filled by Cambridge names, and when, without going into any details, and confining myself to only one branch of public instruction, I look back to the vast and extraordinary development in the state of mathematical cultivation and power in this University, as evidenced both in its examinations and in the published works of its members, now, as compared with what it was in my own time—I am left at no loss to account for those triumphs and that influence to which I have alluded. It has ever been, and I trust it ever will continue to be, the pride and boast of this University to maintain, at a conspicuously high level, that sound and thoughtful and sobering discipline of mind which mathematical studies imply. Independent of the power which such studies confer as instruments of investigation, there never was a period in the history of science in which their moral influence, if I may so term it, was more needed, as a corrective to that propensity which is beginning to prevail widely, and, I fear, balefully, over large departments of our philosophy, the propensity to crude and over-hasty generalization. To all such propensities the steady concentration of thought, and its fixation on the clear and the definite which a long and stern mathematical discipline imparts, is the best, and, indeed, the only proper antagonist. That such habits of thought exist, and characterize, in a pre-eminent degree, the discipline of this University, with a marked influence on the subsequent career of those who have been thoroughly imbued with it, is a matter of too great notoriety to need proof. Yet, in illustration of this disposition, I may be allowed to mention one or two features of its Scientific History, which seem to me especially worthy of notice on this occasion. The first of these is the institution of the Cambridge University Philosophical Society, that body at whose more especial invitation we are now here assembled, which has now subsisted for more than twenty years, and which has been a powerful means of cherishing and continuing those habits among resident members of the University, after the excitement of reading for academical honours is past. From this Society have emanated eight or nine volumes of memoirs, full of variety and interest, and such as no similar collection, originating as this has done in the bosom, and, in great measure, within the walls of an academical institution, can at all compare with; the Memoirs of the École Polytechnique of Paris, perhaps, alone excepted. Without under-valuing any part of this collection, I may be allowed to particularize, as adding largely to our stock of knowledge of their respective subjects, the Hydro-dynamical contributions of Prof. Challis—the Optical and Photological papers of Mr. Airy—those of Mr. Murphy on Definite Integrals—the curious speculations and intricate mathematical investigations of Mr. Hopkins on Geological Dynamics—and, more recently, the papers of Mr. De Morgan on the foundations of Algebra, which, taken in conjunction with the prior researches of the Dean of Ely and Mr. Warren on the geometrical interpretation of imaginary symbols in that science, have effectually dissipated every obscurity which heretofore prevailed on this subject. The elucidation of the metaphysical difficulties in question, by this remarkable train of speculation, has, in fact, been so complete, that henceforward they will never be named as difficulties, but only as illustrations of principle. Nor does its interest end here, since it appears to have given rise to the theory of Quaternions of Sir W. Hamilton, and to the Triple Algebra of Mr. De Morgan himself, as well as to a variety of interesting inquiries of a similar nature on the part of Mr. Graves, Mr. Cayley, and others. Conceptions of a novel and refined kind have thus been introduced into analysis—new forms of imaginary expression rendered familiar—and a vein opened which I cannot but believe will terminate in some first-rate discovery in abstract science.

Neither are inquiries into the logic of symbolic analysis, conducted as these have been, devoid of a bearing on the progress even of physical science. Every inquiry, indeed, has such a bearing which teaches us that terms which we use in a narrow sphere of experience, as if we fully understood them, may, as our knowledge of nature increases, come to have superadded to them a new set of meanings and a wider range of interpretation. It is thus that modes of action and communication, which we hardly yet feel prepared to regard as strictly of a material character, may, ere many years have passed, come to be familiarly included in our notions of Light, Heat, Electricity and other agents of this class; and that the transference of physical causation from point to point in space—nay, even the generation or development of attractive, repulsive or directive forces at their points of arrival may come to be enumerated among their properties. The late marvellous discoveries in actino-chemistry and the phænomena of muscular contraction as dependent on the will, are, perhaps, even now preparing us for the reception of ideas of this kind.

Another instance of the efficacy of the course of study in this University, in producing not merely expert algebraists, but sound and original mathematical *thinkers* (and, perhaps, a more striking one, from the generality of its contributors being men of comparatively junior standing), is to be found in the publication of the Cambridge Mathematical Journal, of which already four volumes, full of very original communications, are before the public. It was set on foot in 1837, by the late Mr. Gregory, Fellow of Trinity College, whose premature death has bereft science of one who, beyond a doubt, had he lived, would have proved one of its chief ornaments, and the worthy representative of a family already so distinguished in the annals of mathematical and optical science. His papers on the 'Calculus of Operations' which appeared in that collection, fully justifies this impression, while they afford an excellent illustration of my general position. Nor ought I to omit mentioning the Chemical Society, of whom he was among the founders, as indicative of the spirit of the place, untrammeled by abstract forms, and eager to spread itself over the whole field of human inquiry.

Another great and distinguishing feature in the scientific history of this place, is the establishment of its Astronomical Observatory, and the regular publication of the observations made in it. The science of Astronomy is so vast, and its objects so noble, that the practical study of it for its own sake is quite sufficient to ensure its pursuit wherever civilization exists. But such institutions have a much wider influence than that which they exercise in forwarding their immediate object. Every astronomical observatory which publishes its observations becomes a nucleus for the formation around it of a school of exact practice— a standing and accessible example of the manner in which theories are brought to their extreme test—a centre, from which emanate a continual demand for and suggestion of refinements, delicacies, and precautions in matters of observation and apparatus which re-act upon the whole body of science, and stimulate, while they tend to render possible an equal refinement and precision in all its processes. It is impossible to speak too highly of the mode in which the business of this institution is carried on under its present eminent director; nor can it be forgotten in our appreciation of what it has done for science, that in it our present Astronomer Royal first proved and familiarized himself with that admirable system of astronomical observation, registry, and computation, which he has since brought to perfection in our great national observatory, and which have rendered it, under his direction, the pride and ornament of British science, and the admiration of Europe.

Gentlemen, I should never have done if I were to enlarge on, or even attempt to enumerate the many proofs which this University has afforded of its determination to render its institutions and endowments efficient for the purposes of public instruction, and available to science. But such encomiums, however merited, must not be allowed to encroach too largely on other objects which I propose to bring before your notice, and which relate to the more immediate business of the present meeting, and to the general interests of science. The first and every way the most important, is the subject of the Magnetic and Meteorological Observatories. Every member of this Association is, of course, aware of the great exertions which have been made during the last five years, on the part of the British, Russian, and several other foreign governments, and of our own East India Company, to furnish data on the most extensive and systematic scale, for elucidating the great problems of Terrestrial Magnetism and Meteorology, by the establishment of a system of observatories all over the world, in which the phænomena are registered at instants strictly simultaneous, and at intervals of two hours throughout both day and night. With the particulars of these national institutions, and of the multitude of local and private ones of a similar nature, both in Europe, Asia, and America, working on the same concerted plan, so far as the means at their disposal enable them, I need not detain you: neither need I enter into any detailed explanation of the system of Magnetic Surveys, both by sea and land, which have been executed or are in progress, in connexion with, and based upon the observations carried on at the fixed stations. These things form the subject of Special Annual Reports, which the Committee appointed for the purpose have laid before us at our several meetings, ever since the commencement of the undertaking; and the most recent of which will be read in the Physical Section of the present meeting, in its regular course. It is sufficient for me to observe, that the result has been the accumulation of an *enormous* mass of most valuable observations, which are now and have been for some time in the course of publication; and when thoroughly digested and discussed, as they are sure to be, by the talent and industry of magnetists and meteorologists, both in this country and abroad, cannot fail to place those sciences very far indeed in advance of their actual state. For such discussion, however, time must be allowed. Even were all the returns from the several observatories before the public (which they are not, and are very far from being), such is the mass of matter to be grappled with, and such the multitude of ways in which the observations will necessarily have to be grouped and combined to elicit mean results and quantitative laws, that several years must elapse before the full scientific value of the work done can possibly be realized.

Meanwhile, a question of the utmost moment arises, and which *must* be resolved, so far as the British Association is concerned, before the breaking-up of this meeting. The second term of three years, for which the British Government and the East India Company have granted their establishments —nine in number—will terminate with the expiration of the current year, at which period, if no provision be made for their continuance, the observations at those establishments will of course cease, and with them, beyond a doubt, those at a great many—probably the great majority—of the foreign establishments, both national and local, which have been called into existence by the example of England, and depend on that example for their continuance or abandonment. Now, under these circumstances, it becomes a very grave subject for the consideration of our Committee of Recommendations, whether, to suffer this term to expire without an effort on the part of this Association to influence the Government for its continuance, or whether, on the other hand, we ought to make such an effort, and endeavour to secure either the continuance of these establishments for a further limited term, or the perpetuity of this or some equivalent system of observation in the same or different localities, according to the present and future exigencies of science. I term this a grave subject of deliberation, and one which will call for the exercise of their soundest judgement; *because*, in the first place, this system of combined observation is by far the greatest and most prolonged effort of scientific co-operation which the world has ever witnessed; *because*, moreover, the spirit in which the demands of science have been met on this occasion by our own Government, by the Company, and by the other governments who have taken part in the matter, has been, in the largest sense of the words, munificent and unstinting; and *because* the existence of such a spirit throws upon us a solemn responsibility to recommend nothing but upon the most entire conviction of very great evils consequent on the interruption, and very great benefits to accrue to science from the continuance of the observations.

Happily we are not left without the means of forming a sound judgement on this momentous question. It is a case in which, connected as the science of Britain is with that of the other co-operating nations, we cannot and ought not to come to any conclusion without taking into our counsels the most eminent magnetists and meteorologists of other countries who have either taken a direct part in the observations, or whose reputation in those sciences is such as to give their opinions, in matters respecting them, a commanding weight. Accordingly it was resolved, at the York meeting last year, to invite the attendance of the eminent individuals I have alluded to at this meeting, with the especial object of conference on the subject. And in the interval since elapsed, knowing the improbability of a complete personal reunion from so many distant quarters, a circular has been forwarded to each of them, proposing certain special questions for reply, and inviting, besides, the fullest and freest communication of their views on the general subject. The replies received to this circular, which are numerous and in the highest degree interesting and instructive, have been printed and forwarded to the parties replying, with a request for their reconsideration and further communication, and have also been largely distributed at home to every member of our own Council, and the Committee of Recommendations, and to each member of the Council and Physical Committee of the Royal Society, which, conjointly with ourselves, memorialized Government for the establishment of the observatories.

In addition to the valuable matter thus communicated, I am happy to add, that several of the distinguished foreigners in question have responded to our invitation, and that in consequence this meeting is honoured by the personal presence of M. Kupffer, the Director-General of the Russian System of Magnetic and Meteorological Observation; of M. Ermann, the celebrated circumnavigator and meteorologist; of Baron von Senftenberg, the founder of the Astronomical, Magnetic, and Meteorological Observatory of Senftenberg; of M. Kreil, the director of the Imperial Observatory at Prague; and of M. Boguslawski, director of the Royal Prussian Observatory of Breslau, all of whom have come over for the express purpose of affording us the benefit of their advice and experience in this discussion. To all the conferences between these eminent foreigners and our own Magnetic and Meteorological Committee, and such of our members present as have taken any direct theoretical or practical interest in the subjects, all the members of our Committee of Recommendations will have free access for the purpose of enabling them fully to acquaint themselves with the whole bearing of the case, and the arguments used respecting all the questions to be discussed, so that when the subject comes to be referred to them, as it must be if the opinion of the conference should be favourable to the continuance of the system, they may be fully prepared to make up their minds on it.

I will not say one word from this chair which can have the appearance of in any way anticipating the conclusion which the conference thus organized may come to, or the course to be adopted in consequence. But I will take this opportunity of stating my ideas generally on the position to be assumed by this Association and by other scientific bodies in making demands on the national purse for scientific purposes. And I will also state, quite irrespective of the immediate question of magnetic co-operation, and therefore of the fate of this particular measure, what I conceive to be the objects which might be accomplished, and ought to be aimed at in the establishment of PHYSICAL OBSERVATORIES, as part of the integrant institutions of each nation calling itself civilized, and as its contribution to Terrestrial Physics.

It is the pride and boast of an Englishman to pay his taxes cheerfully when he feels assured of their application to great and worthy objects. And as civilization advances, we feel constantly more and more strongly, that, after the great objects of national defence, the stability of our institutions, the due administration of justice, and the healthy maintenance of our social state, are provided for, there is no object greater and more noble—none more worthy of national effort—than the furtherance of science. Indeed, there is no surer test of the civilization of an age or nation than the degree in which this conviction is felt. Among Englishmen it has been for a long time steadily increasing, and may now be regarded as universal among educated men of all classes. No government, and least of all a British government, can be insensible to the general prevalence of a sentiment of this kind; and it is our good fortune, and has been so for several years, to have a government, (no matter what its denomination as respects party), impressible with such considerations, and really desirous to aid the forward struggle of intellect by placing at its disposal the material means of its advances.

But to do so with effect, it is necessary to be thoroughly well-informed. The mere knowledge that such a disposition exists, is sufficient to surround those in power with every form of extravagant pretension. And even if this were not so, the number of competing claims, which cannot be all satisfied, can only harass and bewilder, unless there be somewhere seated a discriminating and selecting judgement, which, among many important claims, shall fix upon the most important, and urge them with the weight of well-established character. I know not where such a selecting judgement can be so confidently looked for as in the great scientific bodies of the country, each in its own department, and in this Association, constituted, in great measure, out of, and so representing them all, and numbering besides, among its members, abundance of men of excellent science and enlightened minds who belong to none of them. The constitution of such a body is the guarantee both for the general soundness of its recommendations, and for the due weighing of their comparative importance, should ever the claims of different branches of science come into competition with each other.

In performing this most important office of suggesting channels through which the fertilizing streams of national munificence can be most usefully conveyed over the immense and varied fields of scientific culture, it becomes us, in the first place, to be so fully impressed with a sense of duty to the great cause for which we are assembled, as not to hesitate for an instant in making a recommendation of whose propriety we are satisfied, on them ere ground that the aid required is of great and even of unusual magnitude. And on the other hand, keeping within certain reasonable limits of total amount, which each individual must estimate for himself, and which it would be unwise and indeed impossible to express in terms, it will be at once felt that *economy in asking* is quite as high a "distributive virtue" as economy in *granting*, and that every pound recommended unnecessarily is so mueh character thrown away. I make these observations because the principles they contain cannot be too frequently impressed, and by no means because I consider them to have been overstepped in any part of our conduct hitherto. In the next place, it should be borne in mind that, in recommending to Government, not a mere grant of money, but a scientific enterprise or a national establishment, whether temporary or permanent, not only is it our duty so to place it before them that its grounds of recommendation shall be thoroughly intelligible, but that its whole proposed extent shall be seen; or at least if that cannot be, that it should be clearly stated to be the possible commencement of something more extensive; and besides, that the printing and publication of results should, in every such case, be made an express part of the recommendation. And, again, we must not forget that our interest in the matter does not cease with such publication. It becomes our duty to forward, by every encouragement in our power, the due consideration and scientific discussion of results so procured—to urge it upon the science of our own country and of Europe, and to aid from our own resources those who may be willing to charge themselves with their analysis, and direct or execute the numerical computations or graphical projections it may involve. This is actually the predicament in which we stand, in reference to the immense mass of data already accumulated by the magnetic and meteorological observatories. Let the science of England, and especially the rising and vigorous mind which is pressing onward to distinction, gird itself to the work of grappling with this mass. Let it not be said that we are always to look abroad whenever industry and genius are required to act in union for the discussion of great masses of raw observation. Let us take example from what we see going on in Germany, where a Dove, a Kämtz and a Mahlmann are battling with the meteorology, a Gauss, a Weber and an Ermann with the magnetism of the world. The mind of Britain is equal to the task; its mathematical strength, developed of late years to an unprecedented extent, is competent to any theoretical analysis or technical combination. Nothing is wanting but the resolute and persevering devotion of undistracted thought to a single object, and that will not be long wanting when once the want is declared and dwelt upon, and the high prize of public estimation held forth to those who fairly and freely adventure themselves in this career. Never was there a time when the mind of the country, as well as its resources of every kind, answered so fully and readily to any call reasonable in itself and properly urged upon it. Do we call for *facts*? they are poured upon us in such profusion as for a time to overwhelm us, like the Roman maid who sank under the load of wealth she called down upon herself. Witness the piles of unreduced meteorological observations which load our shelves and archives; witness the immense and admirably arranged catalogues of stars which have been and still are pouring in from all quarters upon our astronomy so soon as the want of extensive catalogues came to be felt and declared. What we now want is *thought*, steadily directed to single objects, with a determination to eschew the besetting evil of our age—the temptation to squander and dilute it upon a thousand different lines of inquiry. The philosopher must be wedded to his subject if he would see the children and the children's children of his intellect flourishing in honour around him.

The establishment of astronomical observatories has been, in all ages and nations, the first public recognition of science as an integrant part of civilization. Astronomy, however, is only one out of many sciences, which can be advanced by a combined system of observation and calculation carried on uninterruptedly; where, in the way of experiment, man has no control, and whose only handle is the continual observation of Nature as it developes itself under our eyes, and a constant collateral endeavour to concentrate the records of that observation into empirical laws in the first instance, and to ascend from those laws to theories. Speaking in a utilitarian point of view, the globe which we inhabit is quite as important a subject of scientific inquiry as the stars. We depend for our bread of life and every comfort on its climates and seasons, on the movements of its winds and waters. We guide ourselves over the ocean, when astronomical observations fail, by our knowledge of the laws of its magnetism; we learn the sublimest lessons from the records of its geological history; and the great facts which its figure, magnitude, and attraction, offer to mathematical inquiry, form the very basis of Astronomy itself. Terrestrial Physics, therefore, form a subject every way worthy to be associated with Astronomy as a matter of universal interest and public support, and one which cannot be adequately studied except in the way in which Astronomy itself has been—by permanent establishments keeping up an unbroken series of observation:—but with this difference, that whereas the chief data of Astronomy might be supplied by the establishment of a very few well-worked observatories properly dispersed in the two hemispheres—the gigantic problems of meteorology, magnetism, and oceanic movements can only be resolved by a far more extensive geographical distribution of observing stations, and by a steady, persevering, systematic attack, to which every civilized nation, as it has a direct interest in the result, ought to feel bound to contribute its contingent.

I trust that the time is not far distant when such will be the case, and when no nation calling itself civilized will deem its institutions complete without the establishment of a permanent physical observatory, with at least so much provision for astronomical and magnetic observation as shall suffice to make it a local centre of reference for geographical determinations and trigonometrical and magnetic surveys—which latter, if we are ever to attain to a theory of the secular changes of the earth's magnetism, will have to be repeated at intervals of twenty or thirty years for a long while to come. Rapidly progressive as our colonies are, and emulous of the civilization of the mother country, it seems not too much to hope from them, that they should take upon themselves, each according to its means, the establishment and maintenance of such institutions both for their own advantage and improvement, and as their contributions to the science of the world. A noble example has been set them in this respect, within a very few months, by our colony of British Guiana, in which a society recently constituted, in the best spirit of British co-operation, has established and endowed an observatory of this very description, furnishing it partly from their own resources and partly by the aid of government, with astronomical, magnetic, and meteorological instruments, and engaging a competent observer at a handsome salary to work the establishment—an example which deserves to be followed wherever British enterprise has struck root and flourished.

The perfectly unbroken and normal registry of all the meteorological and magnetic elements—and of tidal fluctuations where the locality admits—would form the staple business of every such observatory, and, according to its means of observation, periodical phænomena of every description would claim attention, for which the list supplied by M. Quetelet, which extends not merely to the phases of inanimate life, but to their effects on the animal and vegetable creation, will leave us at no loss beyond the difficulty of selection. The division of phænomena which magnetic observation has suggested into periodical, secular, and occasional, will apply *mutatis mutandis* to every department. Under the head of occasional phænomena, storms, magnetic disturbances, auroras, extraordinary tides, earthquake movements, meteors, &c., would supply an ample field of observation; while among the secular changes, indications of the varying level of land and sea would necessitate the establishment of permanent marks, and the reference to them of the actual mean sea level which would emerge from a series of tidal observations, carried round a complete period of the moon's nodes with a certainty capable of detecting the smallest changes.

The abridgement of the merely mechanical work of such observatories by self-registering apparatus, is a subject which cannot be too strongly insisted on. Neither has the invention of instruments for superseding the necessity of much arithmetical calculation by the direct registry of *total* effects received anything like the attention it deserves. Considering the perfection to which mechanism has arrived in all its departments, these contrivances promise to become of immense utility. The more the merely mechanical part of the observer's duty can be alleviated, the more will he be enabled to apply himself to the theory of his subject, and to perform what I conceive ought to be regarded as the most important of all his duties, and which in time will come to be universally so considered—I mean the systematic deduction from the registered observations of the mean values and local co-efficients of diurnal, menstrual, and annual change. These deductions, in the case of permanent institutions, ought not, if possible, to be thrown upon the public, and their effective execution would be the best and most honourable test of the zeal and ability of their directors.

Nothing damps the ardour of an observer like the absence of an object appreciable and attainable by himself. One of my predecessors in this chair has well remarked, that a man may as well keep a register of his dreams as of the weather, or any other set of daily phænomena, if the spirit of grouping, combining, and eliciting results be absent. It can hardly be expected, indeed, that observers of facts of this nature should themselves reason from them up to the highest theories. For that their position unfits them, as they see but locally and partially. But no other class of persons stands in anything like so favourable a position for working out the first elementary laws of phænomena, and referring them to their immediate points of dependence. Those who witness their daily progress, with that interest which a direct object in view inspires, have in this respect an infinite advantage over those who have to go over the same ground in the form of a mass of dry figures. A thousand suggestions arise, a thousand improvements occur—a spirit of interchange of ideas is generated, the surrounding district is laid under contribution for the elucidation of innumerable points, where a chain of corresponding observation is desirable; and what would otherwise be a scene of irksome routine, becomes a school of physical science. It is needless to say how much such a spirit must be excited by the institution of provincial and colonial scientific societies, like that which I have just had occasion to mention. Sea as well as land observations are, however, equally required for the effectual working out of these great physical problems. A ship is an itinerant observatory; and, in spite of its instability, one which enjoys several eminent advantages—in the uniform level and nature of the surface, which eliminate a multitude of causes of disturbance and uncertainty, to which land observations are liable. The exceeding precision with which magnetic observations can be made at sea, has been abundantly proved in the Antarctic Voyage of Sir James Ross, by which an invaluable mass of data has been thus secured to science. That voyage has also conferred another and most important accession to our knowledge in the striking discovery of a permanently low barometric pressure in high south latitudes over the whole Antarctic ocean—a pressure actually inferior by considerably more than an inch of mercury, to what is found between the Tropics. A fact so novel and remarkable will of course give rise to a variety of speculations as to its cause; and I anticipate one of the most interesting discussions which have ever taken place in our Physical Section, should that great circumnavigator favour us, as I hope he will, with a *vivâ voce* account of it. The voyage now happily commenced under the most favourable auspices for the further prosecution of our Arctic discoveries under Sir John Franklin, will bring to the test of direct experiment a mode of accounting for this extraordinary phænomenon thrown out by Colonel Sabine, which, if realized, will necessitate a complete revision of our whole system of barometric observation in high latitudes, and a total reconstruction of all our knowledge of the laws of pressure in regions where excessive cold prevails. This, with the magnetic survey of the Arctic seas, and the not improbable solution of the great geographical problem which forms the chief object of the expedition, will furnish a sufficient answer to those, if any there be, who regard such voyages as useless. Let us hope and pray, that it may please Providence to shield him and his brave companions from the many dangers of their enterprise, and restore them in health and honour to their country.

I cannot quit this subject without reverting to and deploring the great loss which science has recently sustained in the death of the late Prof. Daniell, one of its most eminent and successful cultivators in this country. His work on Meteorology is, if I mistake not, the first in which the distinction between the aqueous and gaseous atmospheres, and their mutual independence, was clearly and strongly insisted on as a highly influential element in meteorological theory. Every succeeding investigation has placed this in a clearer light. In the hands of M. Dove, and more recently of Colonel Sabine, it has proved the means of accounting for some of the most striking features in the diurnal variations of the barometer. The continual generation of the aqueous atmosphere at the Equator, and its destruction in high latitudes, furnishes a *motive power* in meteorology, whose mode of action, and the mechanism through which it acts, have yet to be inquired into. Mr. Daniell's claims to scientific distinction were, however, not confined to this branch. In his hands, the voltaic pile became an infinitely more powerful and manageable instrument than had ever before been thought possible; and his improvements in its construction (the effect not of accident, but of patient and persevering experimental inquiry), have in effect changed the face of Electro-Chemistry. Nor did he confine himself to these improvements. He applied them: and among the last and most interesting inquiries of his life, are a series of electro-chemical researches which may rank with the best things yet produced in that line.

The immediate importance of these subjects to one material part of our business at this meeting, has caused me to dwell more at length than perhaps I otherwise should on them. I would gladly use what time may remain without exciting your impatience, in taking a view of some features in the present state and future prospects of that branch of science to which my own attention has been chiefly directed, as well as to some points in the philosophy of science generally, in which it appears to me that a disposition is becoming prevalent towards lines of speculation, calculated rather to bewilder than enlighten, and, at all events, to deprive the pursuit of science of that which, to a rightly constituted mind, must ever be one of its highest and most attractive sources of interest, by reducing it to a mere assemblage of marrowless and meaningless facts and laws.

The last year must ever be considered an epoch in astronomy, from its having witnessed the successful completion of the Earl of Rosse's six-feet reflector—an achievement of such magnitude, both in itself as a means of discovery, and in respect of the difficulties to be surmounted in its construction (difficulties which perhaps few persons here present are better able from experience to appreciate than myself), that I want words to express my admiration of it. I have not myself been so fortunate as to have witnessed its performance, but from what its noble constructor has himself informed me of its effects on one particular nebula, with whose appearance in powerful telescopes I am familiar, I am prepared for any statement which may be made of its optical capacity. What may be the effect of so enormous a power in adding to our knowledge of our own immediate neighbours in the universe, it is of course impossible to conjecture; but for my own part I cannot help contemplating, as one of the grand fields open for discovery with such an instrument, those marvellous and mysterious bodies or systems of bodies, the Nebulæ. By far the major part, probably at least nine-tenths of the nebulous contents of the heavens, consist of nebulæ of spherical or elliptical forms presenting every variety of elongation and central condensation. Of these a great number have been resolved into distinct stars, and a vast multitude more have been found to present that mottled appearance which renders it almost a matter of certainty that an increase of optical power would show them to be similarly composed. A not unnatural or unfair induction would therefore seem to be, that those which resist such resolution do so only in consequence of the smallness and closeness of the stars of which they consist; that, in short, they are only optically and not physically nebulous. There is, however, one circumstance which deserves especial remark, and which, now that my own observation has extended to the nebulæ of both hemispheres, I feel able to announce with confidence as a general law, viz. that the character of easy resolvability into separate and distinct stars is almost entirely confined to nebulæ deviating but little from the spherical form; while, on the other hand, very elliptic nebulæ, even large and bright ones, offer much greater difficulty in this respect. The cause of this difference must, of course, be conjectural, but, I believe, it is not possible for any one to review *seriatim* the nebulous contents of the heavens without being satisfied of its reality as a physical character. Possibly the limits of the conditions of dynamical stability in a spherical cluster may be compatible with less numerous and comparatively larger individual constituents than in an elliptic one. Be that as it may, though there is no doubt a great number of elliptic nebulæ in which stars have *not* yet been noticed, yet there are so many in which they *have*, and the gradation is so insensible from the most perfectly spherical to the most elongated elliptic form, that the force of the general induction is hardly weakened by this peculiarity; and for my own part I should have little hesitation in admitting all nebulæ of this class to be, in fact, congeries of stars. And this seems to have been my Father's opinion of their constitution, with the exception of certain very peculiar-looking objects, respecting whose nature all opinion must for the present be suspended. Now, among all the wonders which the heavens present to our contemplation, there is none more astonishing than such close compacted families or communities of stars, forming systems either insulated from all others, or in binary connexion, as double clusters whose confines intermix, and consisting of individual stars nearly equal in apparent magnitude, and crowded together in such multitudes as to defy all attempts to count or even to estimate their numbers. What *are* these mysterious families? Under what dynamical conditions do they subsist? Is it conceivable that they can exist at all, and endure under the Newtonian law of gravitation without perpetual collisions? And, if so, what a problem of unimaginable complexity is presented by such a system if we should attempt to dive into its perturbations and its conditions of stability by the feeble aid of our analysis! The existence of a luminous matter, not congregated into massive bodies in the nature of stars, but disseminated through vast regions of space in a vaporous or cloud-like state, undergoing, or awaiting the slow process of aggregation into masses by the power of gravitation, was originally suggested to the late Sir W. Herschel in his reviews of the nebulæ, by those extraordinary objects which his researches disclosed, which exhibit no regularity of outline, no systematic gradation of brightness, but of which the wisps and curls of a cirrhus cloud afford a not inapt description. The wildest imagination can conceive nothing more capricious than their forms, which in many instances seem totally devoid of plan—as much so as real clouds,—in others offer traces of a regularity hardly less uncouth and characteristic, and which in some cases seems to indicate a cellular, in others a sheeted structure, complicated in folds as if agitated by internal winds.

Should the powers of an instrument such as Lord Rosse's succeed in resolving these also into stars, and, moreover, in demonstrating the starry nature of the regular elliptic nebulæ, which have hitherto resisted such decomposition, the idea of a *nebulous matter*, in the nature of a shining fluid, or condensible gas, must, of course, cease to rest on any support derived from actual observation in the sidereal heavens, whatever countenance it may still receive in the minds of cosmogonists from the tails and atmospheres of comets, and the zodiacal light in our own system. But though all idea of its being ever given to mortal eye, to view aught that can be regarded as an outstanding portion of primæval chaos, be dissipated, it will by no means have been even then demonstrated that among those stars so confusedly scattered, no aggregating powers are in action, tending to draw them into groups and insulate them from neighbouring groups; and, speaking from my own impressions, I should say that, in the structure of the Magellanic Clouds, it is really difficult not to believe we see distinct evidences of the exercise of such a power. This part of my Father's general views of the construction of the heavens, therefore, being entirely distinct from what has of late been called "the nebulous hypothesis," will still subsist as a matter of rational and philosophical speculation,—and perhaps all the better for being separated from the other.

Much has been said of late of the Nebulous Hypothesis, as a mode of representing the origin of our own planetary system. An idea of Laplace, of which it is impossible to deny the ingenuity, of the successive abandonment of planetary rings, collecting themselves into planets by a revolving mass gradually shrinking in dimension by the loss of heat, and finally concentrating itself into a sun, has been insisted on with some pertinacity, and supposed to receive almost demonstrative support from considerations to which I shall presently refer. I am by no means disposed to quarrel with the nebulous hypothesis even in this form, as a matter of pure speculation, and without any reference to final causes; but if it is to be regarded as a demonstrated truth, or as receiving the smallest support from any observed numerical relations which actually hold good among the elements of the planetary orbits, I beg leave to demur. Assuredly it receives no support from observation of the effects of sidereal aggregation, as exemplified in the formation of globular and elliptic clusters, supposing *them* to have resulted from such aggregation. For we see this cause, working itself out in thousands of instances, to have resulted, *not* in the formation of a single large central body, surrounded by a few much smaller attendants, disposed in one plane around it,—but in systems of infinitely greater complexity, consisting of multitudes of nearly equal luminaries, grouped together in a solid elliptic or globular form. So far, then, as any conclusion from our observations of nebulæ can go, the result of agglomerative tendencies *may*, indeed, be the formation of families of stars of a general and very striking character; but we see nothing to lead us to presume its further result to be the surrounding of those stars with planetary attendants. If, therefore, we go on to push its application to that extent, we clearly theorize in advance of all inductive observation.

But if we go still farther, as has been done in a philosophical work of much mathematical pretension, which has lately come into a good deal of notice in this country*, and attempt "to give a mathematical consistency" to such a cosmogony by the "*indispensable criterion*" of "a numerical verification,"—and so exhibit, as "necessary consequences of such a mode of formation," a series of numbers which observation has established independent of any such hypothesis, as primordial elements of our system—if, in pursuit of this idea, we find the author first computing the time of rotation the sun must have had about its axis so that a planet situate on its surface and forming a part of it should not press on that surface, and should therefore be in a state of indifference as to its adhesion or detachment—if we find him, in this computation, throwing overboard as troublesome all those essential con-

* M. Comte, Phil. Positive, ii. 376.

siderations of the law of cooling, the change of spheroidical form, the internal distribution of density, the probable non-circulation of the internal and external shells in the same periodic time, on which alone it is possible to execute such a calculation correctly; and avowedly, as a short-cut to a result, using as the basis of his calculation "the elementary Huyghenian theorems for the evaluation of centrifugal forces in combination with the law of gravitation";—a combination which, I need not explain to those who have read the first book of Newton, leads direct to Kepler's law;—and if we find him then gravely turning round upon us, and adducing the coincidence of the resulting periods compared with the distances of the planets with this law of Kepler, as *being* the numerical verification in question,—where, I would ask, is there a student to be found who has graduated as a Senior Optime in this University, who will not at once lay his finger on the fallacy of such an argument*, and declare it a vicious circle? I really should consider some apology needed for even mentioning an argument of the kind to such a meeting, were it not that this very reasoning, so ostentatiously put forward and so utterly baseless, has been eagerly received among us† as the revelation of a profound analysis. When such is the case, it is surely time to throw in a word of warning, and to reiterate our recommendation of an early initiation into mathematics, and the cherishing a mathematical habit of thought, as the safeguard of all philosophy.

A very great obstacle to the improvement of telescopes in this country has been happily removed within the past year by the repeal of the duty on glass. Hitherto, owing to the enormous expense of experiments to private individuals not manufacturers, and to the heavy excise duties imposed on the manufacture, which has operated to repress all attempts on the part of practical men to produce glass adapted to the construction of large achromatics, our opticians have been compelled to resort abroad for their materials—purchasing them at enormous prices, and never being able to procure the largest sizes. The skill, enterprise and capital of the British manufacturer have now free scope, and it is our own fault if we do not speedily rival, and perhaps outdo the far-famed works of Munich and Paris. Indeed, it is hardly

* M. Comte (Philosophie Positive, ii. 376, &c.), the author of the reasoning alluded to, assures us that his calculations lead to results agreeing only approximately with the exact periods, a difference to the amount of one-forty-fifth part more or less existing in all. As he gives neither the steps nor the data of his calculations, it is impossible to trace the origin of this difference,—which, however, *must* arise from error *somewhere*, if his fundamental princ le be really what he states. For the Huyghenian measure of centrifugal force $\left(F \propto \frac{V^2}{R}\right)$ "combined" with "the law of gravitation" $\left(F \propto \frac{M+m}{R^2}\right)$, replacing V by its equivalent, $\frac{R}{P}$ can result in no other relation between P and R than what is expressed in the Keplerian law, and is incompatible with the smallest deviation from it.

Whether the sun threw off the planets or not, Kepler's law *must* be obeyed by them when once fairly detached, and the sun concentrated into a spherical nucleus, such as we now find it.

In the above reasoning, the consideration of the sun's varying oblateness has been omitted as complicating the argument. It is easily taken account of, but with no benefit to the theory contended against. It should moreover be noticed that the actual time of rotation of the sun on its axis stands in utter contradiction with that theory.

How, then, can their actual observance of this law be adduced in proof of their origin, one way or the other? How is it proved that the sun must have thrown off planets *at those distances and at no others*, where we find them,—no matter in what times revolving? *That*, indeed, would be a powerful presumptive argument; but what geometer will venture on such a *tour d'analyse*? And, lastly, how can it be adduced as *a numerical coincidence of an hypothesis with observed fact* to say that, at an unknown epoch, the sun's rotation (*not observed*) *must have been* so and so, *if* the hypothesis were a true one?

† Mill. Logic, ii. 28.—Also, 'Vestiges of the Creation,' p. 17.

possible to over-estimate the effect of this fiscal change on a variety of other sciences to which the costliness of glass apparatus has been hitherto an exceeding drawback, not only from the actual expense of apparatus already in common use, but as repressing the invention and construction of new applications of this useful material.

A great deal of attention has been lately, and I think very wisely, drawn to the philosophy of science and to the principles of logic, as founded, not on arbitrary and pedantic forms, but on a careful inductive inquiry into the grounds of human belief, and the nature and extent of man's intellectual faculties. If we are ever to hope that science will extend its range into the domain of social conduct, and model the course of human actions on that thoughtful and effective adaptation of means to their end, which is its fundamental principle in all its applications (the *means* being here the total devotion of our moral and intellectual powers—the *end*, our own happiness and that of all around us)—if such be the far hopes and long-protracted aspirations of science, its philosophy and its logic assume a paramount importance, in proportion to the practical danger of erroneous conceptions in the one, and fallacious tests of the validity of reasoning in the other.

On both these subjects works of first-rate importance have of late illustrated the scientific literature of this country. On the philosophy of science, we have witnessed the production, by the pen of a most distinguished member of this University, of a work so comprehensive in its views, so vivid in its illustrations, and so right-minded in its leading directions, that it seems to me impossible for any man of science, be his particular department of inquiry what it may, to rise from its perusal without feeling himself strengthened and invigorated for his own especial pursuit, and placed in a more favourable position for discovery in it than before, as well as more competent to estimate the true philosophical value and import of any new views which may open to him in its prosecution. From the peculiar and *à priori* point of view in which the distinguished author of the work in question has thought proper to place himself before his subject, many may dissent; and I own myself to be of the number;—but from this point of view it is perfectly possible to depart without losing sight of the massive reality of that subject itself: on the contrary, that reality will be all the better seen and understood, and its magnitude felt when viewed from opposite sides, and under the influence of every accident of light and shadow which peculiar habits of thought may throw over it.

Accordingly, in the other work to which I have made allusion, and which, under the title of a 'System of Logic,' has for its object to give "*a connected view of the principles of evidence and the methods of scientific investigation*," its acute, and in many respects profound author, taking up an almost diametrically opposite station, and looking to experience as the ultimate foundation of all knowledge—at least, of all scientific knowledge, in its simplest axioms as well as in its most remote results—has presented us with a view of the inductive philosophy, very different indeed in its general aspect, but in which, when carefully examined, most essential features may be recognised as identical, while some are brought out with a salience and effect which could not be attained from the contrary point of sight. It cannot be expected that I should enter into any analysis or comparison of these remarkable works; but it seemed to me impossible to avoid pointedly mentioning them on this occasion, because they certainly, taken together, leave the philosophy of science, and indeed *the principles of all general reasoning*, in a very different state from that in which they found them. Their influence indeed, and that of some other works of prior date, in which the same general subjects have been more lightly touched upon, has already begun to be fe and responded to from a quarter where, perhaps, any sympathy in this respect might hardly have been looked for. The philosophical mind of Germany has begun, at length, effectually to awaken from the dreamy trance in which it had been held for the last half-century, and in which the jargon of the Absolutists and Ontologists had been received as oracular. An "anti-speculative philosophy" has arisen and found supporters—rejected, indeed, by the Ontologists, but yearly gaining ground in the general mind. It is something so new for an English and a German philosopher to agree in their estimate either of the proper objects of speculation or of the proper mode of pursuing them, that we greet, not without some degree of astonishment, the appearance of works like the Logic and the New Psychology of Beneke, in which this false and delusive philosophy is entirely thrown aside, and appeal at once made to the nature of things as we find them, and to the laws of our intellectual and moral nature, as our own consciousness and the history of mankind reveal them to us*.

Meanwhile, the fact is every year becoming more broadly manifest, by the successful application of scientific principles to subjects which had hitherto been only empirically treated (of which agriculture may be taken as perhaps the most conspicuous instance), that the great work of Bacon was not the completion, but, as he himself foresaw and foretold, only the commencement of his own philosophy; and that we are even yet only at the threshold of that palace of Truth which succeeding generations will range over as their own —a world of scientific inquiry, in which not matter only and its properties, but the far more rich and complex relations of life and thought, of passion and motive, interest and actions, will come to be regarded as its legitimate objects. Nor let us fear that in so regarding them we run the smallest danger of collision with any of those great principles which we regard, and rightly regard, as sacred from question. A faithful and undoubting spirit carried into the inquiry will secure us from such dangers, and guide us, like an instinct, in our paths through that vast and entangled region which intervenes between those ultimate principles and their extreme practical applications. It is only by working our way *upwards towards* those principles as well as *downwards from them*, that we can ever hope to penetrate such intricacies and thread their maze; and it would be worse than folly—it would be treason against all our highest feelings—to doubt that to those who spread themselves over these opposite lines, each moving in his own direction, a thousand points of meeting and mutual and joyful recognition will occur.

But if Science be really destined to expand its scope, and embrace objects beyond the range of merely material relation, it must not altogether and obstinately refuse, even within the limits of such relations, to admit conceptions which at first sight may seem to trench upon the immaterial, such as we have been accustomed to regard it. The time seems to be approaching when a merely mechanical view of nature will become impossible—when the notion of accounting for *all* the phænomena of nature, and even of mere physics, by simple attractions and repulsions fixedly and unchangeably inherent in material centres (granting any conceivable system of Boscovichian alternations), will be deemed untenable. Already we have introduced the idea of *heat-atmospheres* about particles to vary their repulsive forces according to definite laws. But surely this can only be regarded as one of those provisional and temporary conceptions, which, though it may be useful as helping us to laws and as suggesting experiments, we must be prepared to resign if ever such ideas, for instance, as radiant stimulus or conducted influence

* *Vide* Beneke, Neue Psychologie, s. 300 *et seq.* for an admirable view of the state of metaphysical and logical philosophy in England.

should lose their present vagueness, and come to receive some distinct scientific interpretation. It is one thing, however, to suggest that our present language and conceptions should be held as provisional—another to recommend a general unsettling of all received ideas. Whatever innovations of this kind may arise, they can only be introduced slowly, and on a full sense of their necessity; for the limited faculties of our nature will bear but little of this sort at a time without a kind of intoxication, which precludes all rectilinear progress—or, rather, all progress whatever, except in a direction which terminates in the wildest vagaries of mysticism and clairvoyance.

But, without going into any subtleties, I may be allowed to suggest that it is at least high time that philosophers, both physical and others, should come to some nearer agreement than appears to prevail as to the meaning they intend to convey in speaking of causes and causation. On the one hand we are told that the grand object of physical inquiry is to explain the phænomena of nature by referring them to their causes; on the other, that the inquiry into causes is altogether vain and futile, and that Science has no concern but with the discovery of *laws*. Which of these is the truth? Or are both views of the matter true on a different interpretation of the terms? Whichever view we may take, or whichever interpretation adopt, there is one thing certain,—the extreme inconvenience of such a state of language. This can only be reformed by a careful analysis of this widest of all human generalizations, disentangling from one another the innumerable shades of meaning which have got confounded together in its progress, and establishing among them a rational classification and nomenclature. Until this is done we cannot be sure, that by the relation of cause and effect one and the same kind of relation is understood. Indeed, using the words as we do, we are quite sure that the contrary is often the case; and so long as uncertainty in this respect is suffered to prevail, so long will this unseemly contradiction subsist, and not only prejudice the cause of science in the eyes of mankind, but create disunion of feeling, and even give rise to accusations and recriminations on the score of principle among its cultivators.

The evil I complain of becomes yet more grievous when the idea of *law* is brought so prominently forward as not merely to throw into the background that of *cause*, but almost to thrust it out of view altogether; and if not to assume something approaching to the character of direct agency, at least to place itself in the position of a substitute for what mankind in general understand by *explanation*: as when we are told, for example, that the successive appearance of races of organized beings on earth, and their disappearance, to give place to others, which Geology teaches us, is a result of some certain law of development, in virtue of which an unbroken chain of gradually exalted organization from the crystal to the globule, and thence, through the successive stages of the polypus, the mollusk, the insect, the fish, the reptile, the bird, and the beast, up to the monkey and the man (nay, for aught we know, even to the angel), has been (or remains to be) evolved. Surely, when we hear such a theory, the natural human craving after *causes*, capable in some conceivable way of giving rise to such changes and transformations of organ and intellect,—*causes why* the development at different parts of its progress should divaricate into different lines,—*causes*, at all events, intermediate between the steps of the development—becomes importunate. And when nothing is offered to satisfy this craving, but loose and vague reference to *favourable circumstances* of climate, food, and general situation, which no experience has ever shown to convert one species into another; who is there who does not at once perceive that such a theory is in no respect more *explanatory*, than that would be which simply asserted a miraculous intervention at every successive step of that unknown series of events by which the earth has been alternately peopled and dispeopled of its denizens?

A *law* may be a *rule* of action, but it is not *action*. The Great First Agent may lay down a rule of action for himself, and that rule may become known to man by observation of its uniformity: but constituted as our minds are, and having that conscious knowledge of causation which is forced upon us by the reality of the distinction between *intending* a thing and *doing* it, we can never substitute the *Rule* for the *Act*. Either directly or through delegated agency, whatever takes place is not merely *willed*, but *done*, and what is done we then only declare to be explained, when we can trace a process, and show that it consists of steps analogous to those we observe in occurrences which have passed often enough before our own eyes to have become familiar, and to be termed *natural*. So long as no such process can be traced and analysed out in this manner, so long the phænomenon is unexplained, and remains equally so whatever be the number of unexplained steps inserted between its beginning and its end. The transition from an inanimate crystal to a globule capable of such endless organic and intellectual development, is *as* great a step—*as* unexplained a one—*as* unintelligible to us—and in any human sense of the word, as *miraculous* as the immediate creation and introduction upon earth of every species and every individual would be. Take these amazing facts of geology which way we will, we must resort elsewhere than to a mere speculative law of development for their explanation.

Visiting as we do once more this scene of one of our earliest and most agreeable receptions—as travellers on the journey of life brought back by the course of events to scenes associated with exciting recollections and the memory of past kindness—we naturally pause and look back on the interval with that interest which always arises on such occasions: "How has it fared with you meanwhile?" we fancy ourselves asked. "How have you prospered?" "Has this long interval been well or ill spent?" "How is it with the cause in which you have embarked?" "Has it flourished or receded, and to what extent have you been able to advance it?" To all these questions we may, I believe, conscientiously, and with some self-gratulation, answer—Well! The young and then but partially fledged institution has become established and matured. Its principles have been brought to the test of a long and various experience, and been found to work according to the expectations of its founders. Its practice has been brought to uniformity and consistency, on rules which, on the whole, have been found productive of no inconvenience to any of the parties concerned. Our calls for reports on the actual state and deficiencies of important branches of science, and on the most promising lines of research in them, have been answered by most valuable and important essays from men of the first eminence in their respective departments, not only condensing what is known, but adding largely to it, and in a multitude of cases entering very extensively indeed into original inquiries and investigations; of which Mr. Scott Russell's Report on Waves, and Dr. Carpenter's on the Structure of Shells, and several others in the most recently published volume of our Reports, that for the York meeting last summer, may be specified as conspicuous instances.

Independent of these reports, the original communications read or verbally made to our several Sections have been in the highest degree interesting and copious; not only as illustrating and extending almost every branch of science, but as having given rise to discussions and interchanges of idea and information between the members present, of which it is perfectly impossible to appreciate sufficiently the influence and value. Ideas thus communicated fructify in a wonderful manner on subsequent reflection, and become, I am persuaded, in innumerable cases, the germs of theories, and the connecting links between distant regions of thought, which might have otherwise continued indefinitely dissociated.

How far this Association has hitherto been instrumental in fulfilling the ends for which it was called into existence, can, however, be only imperfectly estimated from these considerations. Science, as it stands at present, is not merely advanced by speculation and thought; it stands in need of material appliances and means; its pursuit is costly, and to those who pursue it for its own sake, utterly unremunerative, however largely the community may benefit by its applications, and however successfully practical men may turn their own or others' discoveries to account. Hence arises a wide field for scientific utility in the application of pecuniary resources in aid of private research, and one in which assuredly this Association has not held back its hand. I have had the curiosity to cast up the sums which have been actually paid, or are now in immediate course of payment, on account of grants for scientific purposes by this Association since its last meeting at this place, and I find them to amount to not less than 11,167*l*. And when it is recollected that in no case is any portion of these grants applied to cover any personal expense, it will easily be seen how very large an amount of scientific activity has been brought into play by its exertions in this respect, to say nothing of the now very numerous occasions in which the attention and aid of Government have been effectually drawn to specific objects at our instance.

As regards the general progress of Science within the interval I have alluded to, it is far too wide a field for me now to enter upon, and it would be needless to do so in this assembly, scarcely a man of which has not been actively employed in urging on the triumphant march of its chariot-wheels, and felt in his own person the high excitement of success joined with that noble glow which is the result of companionship in honourable effort. May such ever be the prevalent feeling among us! True Science, like true Religion, is wide-embracing in its extent and aim. Let interests divide the worldly and jealousies torment the envious! We breathe, or long to breathe, a purer empyrean. The common pursuit of Truth is of itself a brotherhood. In these our annual meetings, to which every corner of Britain—almost every nation in Europe sends forth as its representative some distinguished cultivator of some separate branch of knowledge; where, I would ask, in so vast a variety of pursuits which seem to have hardly anything in common, are we to look for that acknowledged source of delight which draws us together and inspires us with a sense of unity? That astronomers should congregate to talk of stars and planets—chemists of atoms—geologists of strata—is natural enough; but what is there of *equal* mutual interest, *equally* connected with and *equally* pervading all they are engaged upon, which causes their hearts to burn within them for mutual communication and unbosoming? Surely, were each of us to give utterance to all he feels, we should hear the chemist, the astronomer, the physiologist, the electrician, the botanist, the geologist, all with one accord, and each in the language of his own science, declaring not only the wonderful works of God disclosed by it, but the delight which their disclosure affords him, and the privilege he feels it to be to have aided in it. This is indeed a magnificent induction—a consilience there is no refusing. It leads us to look onward, through the long vista of time, with chastened but confident assurance that Science has still other and nobler work to do than any she has yet attempted; work, which before she is prepared to attempt, the minds of men must be prepared to *receive* the attempt, —prepared, I mean, by an entire conviction of the wisdom of her views, the purity of her objects and the faithfulness of her disciples.

REPORTS

ON

THE STATE OF SCIENCE.

Proceedings connected with the Magnetical and Meteorological Conference, held at Cambridge in June 1845.

CONTENTS.

Seventh Report of the Committee, consisting of Sir J. Herschel, *Bart.; the* Master of Trinity College, *Cambridge; the* Dean of Ely, *the* Astronomer Royal, Dr. Lloyd *and Colonel* Sabine, *appointed to conduct the cooperation of the British Association in the System of Simultaneous Magnetical and Meteorological Observations.*

Arctic Expedition.

It having been resolved upon by government to equip a new Arctic Expedition, under the command of Sir John Franklin, with a view to the completion of the discovery of a north-west passage, two ships, the Erebus and Terror, the former commanded by Sir J. Franklin, the latter by Captain Crozier, have been commissioned for the purpose, and provided not only with every former means of security and comfort, but with a means of applying the power of steam for availing themselves of occasional favourable opportunities for its application. So far as relates to the prosecution of magnetic and meteorological observation, they go provided with all the necessary instruments and instructions. The officers, five in number, who will be charged with their use, have availed themselves with all diligence and assiduity of the instructions afforded them by Colonel Sabine, and should the Expedition pass the winter in the Arctic Sea, to the north of America, the opportunities afforded of observing magnetic disturbances, in near proximity to the Magnetic Pole and in the region of the Aurora, will be in the highest degree interesting, and will call for every practicable exertion in watching for and observing simultaneous disturbances in Europe and America, wherever magnetic observation is at the time in progress. Among the instruments with which this Expedition is provided, is one of a novel description, contrived by Professor Lloyd, for determining the absolute total force by direct observation in dips from 80° to 90°. The interesting discovery of Sir James Ross, of a barometric pressure in the Antarctic Seas lower by more than an inch than at the equator, will render the barometric observations of this Expedition especially important, in consequence of attention being drawn to circumstances in the usual mode of executing barometric observations in severe colds, which have been supposed capable of partially masking this peculiarity, and upon which we shall now be enabled to pronounce definitively.

As the Magnetic Pole will be again probably *approached* in this Expedition, an opportunity will be afforded of ascertaining (at least by subsequent calculation) whether any and what change has taken place in the situation of that important point since the date of Sir James Ross's observations, and should the Expedition be successful in making their passage home by Behring's Straits, an invaluable series of data along the northern coast of America to the Straits in question will be secured.

New Stations for Meteorological and Magnetic Observations.

The Astronomical and Meteorological Society of British Guiana have recently established an observatory in that colony for the purpose of making astronomical, meteorological and magnetic observations, and have (partly by the grant of magnetic and other instruments used by Sir R. Schomburgk in his survey of the colony, partly at their own cost) furnished it with instruments. Not content with this, however, they have engaged a competent and well-recommended observer, at a liberal salary, so that we have here an example which it may be hoped our other colonies will eagerly imitate, of scientific cooperation, voluntarily undertaken, in a highly interesting region, from which the best results may be hoped.

The prospect of a colonial observatory at Colombo in Ceylon, though not yet realized, appears by a letter received by Colonel Sabine from Capt. Pickering, dated January 18, 1845, to be still entertained, since that gentleman has received the Governor's directions to prepare estimates for the building and establishment.

It is assuredly much to be desired that such of our colonies as are capable of bearing the expense of such institutions, should be encouraged by such examples to take part in the great and important work which remains to be done, in order to place terrestrial magnetism and meteorology in the rank of permanently progressive sciences. The government observatories, by improving the instruments and methods of observation and chalking out the course of observation most desirable to be pursued, have laid the foundations of a system which must, sooner or later, be carried out in all climates and in every part of the globe. But the system is yet susceptible of further perfection, which it has been and is receiving. Several important defects have been remedied, and as far as the magnetic observations go, a definite and well-directed course is taken. The meteorological system is also beginning to assume a more distinct and regularly improving form ; distinct notions of important objects to be attained, and improvements introduced into the instrumental departments, which by degrees will fit them for objects they are not yet competent to. Should the government observatories at Toronto and Van Diemen's Land ultimately come to be handed over to their respective colonies as part of their domestic institutions, not only would a permanent contribution of data be secured to science, but incalculable benefit would arise to the colonies themselves, in the possession of establishments in which the art of observing has been wrought up to elaborate perfection, and in which practice going hand in hand with theory, would act as a powerful engine of public instruction.

Magnetic Surveys.

The completion of Lieut. Lefroy's North American Survey has furnished data in the highest degree satisfactory. Above 100 stations have been observed by him, at which the three elements have been determined within the isodynamic oval of 1·7 in North America. The examination which has been instituted of these shows the observations to be satisfactory. His magnetometric observations, made hourly during the winter, show some extraordinary disturbances; one on the 17th April 1844, gave changes of 8° 10′ in declination and 0·16 of horizontal force.

Lieuts. Moor and Clerk sailed on the 9th of January from the Cape, on the magnetic survey of that portion of the Antarctic Ocean left unexplored by Sir James Ross, to which allusion was made as contemplated in our last report. This survey will complete our knowledge of iso-magnetic lines in the South Seas.

In the United States Prof. Renwick has occupied himself with the observation of the three magnetic elements at the stations of the Trigonometrical Survey from Rhode Island southward to Annapolis in Maryland, while Prof. Bache carries on the same process from Annapolis southward, and in the course of the current year will probably have extended his operations to the Gulf of Mexico. The former of these zealous cooperators in our cause has proposed to establish, at Columbia College, a barometrical record simultaneous with that at Toronto, in which instruments carefully compared with our standards, by means of a portable barometer making the circuit of London, New York, Toronto, New York, and London, will be employed.

Publication of Magnetic and Meteorological Observations.

The Toronto observations of 1840, 1841 and 1842, are printed, and in the hands of most of our correspondents. So are also the first volume of 'Extraordinary Magnetic Disturbances at the Government Stations,' and two volumes of the 'Greenwich Observations,' containing those of 1840, 1841 and 1842. An immense arrear remains, and must remain, in spite of every exertion, unless an increase in the superintendent's establishment afford the means of greater despatch. Representations have been made with the view of procuring such increase, the result of which is not yet known. Should it prove, as it is hoped, successful, the work of reduction and publication will proceed with all desirable alacrity, and the world be speedily put in possession of the whole results.

The Honourable the Court of Directors of the East India Company has been applied to on the part of the Royal Society, to authorize the printing of the observations communicated from the four Indian establishments. The proposition has been entertained, and estimates are in course of preparation. No final decision has been yet however come to, though there seems no reason to fear that it will be unfavourable. The observations which have been received from these observatories have been partially examined by Dr. Lloyd, and awaiting the appearance of the observations themselves in a public form, the following remarks on them, so far as that examination has gone, will probably be considered interesting to the Association :—

Extracts of a Letter from Dr. Lloyd to Sir J. Herschel.

"Trinity College, Dublin, Feb. 12, 1845.

"The observations made during the first year and a half at the East India Company's Observatories were transmitted to me from the Royal Society, and their examination has, I hope, enabled me to be of some use to the observers, in the correction and improvement of their methods of observing. Much valuable time however was lost at the commencement, owing to some difficulty respecting the transmission of the observations, of the nature of which I am not aware; and, as the last of the records sent were those of June or July 1842, I am unable to say how far the instructions suggested by the perusal of the earlier observations may have turned to account. These circumstances, over which I had no control, prevented me from sending (as I otherwise should) any report on these observations to the Royal Society, as I felt that any report, founded upon the data which had come before me, would necessarily be unsatisfactory, and in some degree unjust, to the very zealous directors of the observatories.

"I shall best perhaps fulfil the wish expressed in your letter, by sending a few notes extracted from the memoranda which I made at the time of the perusal of the observations, which you can use as you think fit.

"The observatory at Simla, under the direction of Major Boileau, is in all respects admirably organized, and has furnished a larger amount of work than perhaps any of the whole cooperation.

"In order to save time, Major Boileau erected a temporary wooden building at Simla on his arrival, and commenced his series of observations there the 1st of January 1841. Meanwhile, the site of the permanent observatory was selected, the stone available for the building carefully examined for magnetism, &c.; the building erected on a judicious plan, and the observations begun there the 1st of July 1841.

"At this station the mean height of the barometer is only 23·2 inches; I need not observe upon the value of an extended and complete series of meteorological observations made at this altitude (8000 feet about). The many questions, the solution of which has been but partly obtained by the observations of meteorologists upon the Faulhorn and the St. Bernard, may be expected to receive a complete answer in the Simla observations.

"Major Boileau has added much to the usual routine of observatory work. In September 1841, he commenced observing every fifteen minutes! and has, I believe, continued that immense labour to the present time. He also made, daily, two series of corresponding observations taken every five minutes, and each lasting one hour. One of these was made in correspondence with the Van Diemen's Land Observatory, and the other with Singapore and Trevandrum. He has made a very complete comparison of the wet-bulb and of Daniell's hygrometer, and has constructed an elaborate table for reducing the results obtained with the former instrument.

"Among the remarkable results which appear on the face of the observations, I may mention that, generally, during magnetic storms, the changes of intensity preponderate over those of direction in the results; while it seems to be otherwise in the regular hourly variations.

"Smart shocks of earthquake were felt at Simla on the 19th of February and 5th of March 1842, which disturbed all the magnets violently. Their mean positions were however unaltered, so that the effect was merely mechanical.

"Of the true magnetic disturbances, Major Boileau says, that that of the 2nd and 4th of July 1842, was 'the greatest which occurred since the establishment of the observatory.' It was also the greatest observed in Dublin; considerably greater than that of September 1841.

"The absolute observations of declination and inclination at Simla are excellent. Those of intensity are less so, owing to defects in the method of observation, which have been since remedied.

"*Madras.*

"Lieut. Ludlow waited for the completion of the building of his observatory, and accordingly his regular series of observations commenced only in March 1841. He took the precaution of observing the time of vibration of all his magnets in Dublin before starting, and on his arrival at Madras, and was thus enabled to select for use those whose magnetism was most steady.

"You are aware that a perfect determination of the changes of the third element has been a serious desideratum in most of the observatories, the instrument devised by me for the determination of the variations of the *vertical component of the force* having in most cases failed. The value of the results in this case depends entirely on the individual instrument, and I do not know any that have given good results, with the exception of those belonging to the observatories of Toronto, Madras and Singapore. This circumstance adds much value to the results of these observatories, inasmuch as the observations made with this apparatus cover a space of nearly three years, and of course it furnishes an argument for the publication of the Madras and Singapore observations.

"Lieut. Ludlow cautiously avoided all the difficult work of absolute determinations, until he found himself master of the methods; and accordingly his results of this kind are free from the errors which are to be found in the earlier observations made elsewhere. The absolute determinations commenced at Madras with the year 1842.

"*Singapore.*

"The observations made at Singapore, under the direction of Lieut. Elliott, commenced earlier than either of the other Indian stations, namely, in December 1840, and (as regards term observations) in the month preceding.

"The vertical force instrument has worked at this station perhaps better than at any other, and accordingly the results have a peculiar value.

"The diurnal changes at Singapore are remarkable for their regularity, so much so, that the diurnal curve may be obtained satisfactorily from a very limited number of observations.

"After the example of Major Boileau, Lieut. Elliott has had observations taken every fifteen minutes, commencing in April 1842. I am not aware whether he still continues this labour.

"Lieut. Elliott has made, from time to time, a considerable series of observations (simultaneous with those of the observatory) at Java, Borneo, and other places.

"The atmosphere at Singapore is loaded with moisture. Lieut. Elliott has taken numerous observations of the actinometer; but the place is unfavourable and the observations unsatisfactory.

"Believe me to be,

"Dear Sir, very truly yours,

"H. LLOYD."

A letter from Professor Bache to Colonel Sabine announces the gratifying fact, that the Senate of the United States has ordered the publication, in full, at the expense of that government, of the magnetic and meteorological observations at Girard College, Philadelphia, and at Washington; both which publications are now proceeding.

M. Plantamour has commenced the publication of the observations at Geneva. M. Kreil has published the fifth volume of the Prague observations. As regards the circulation of the printed observations, arrangements have been made by the Royal Society for the regular communication of the Greenwich observations in this department to all the institutions and persons named in the annexed list, and as the demand for them will in all probability be hereafter greater than at present, an additional number will henceforward be printed.

List of Observatories, Institutions and Individuals, entitled to receive a Copy of the Magnetical and Meteorological Observations made at the Royal Observatory, Greenwich.

OBSERVATORIES.

Algiers	M. Aimé.
Altona	M. Schumacher.
Armagh	Dr. Robinson.
Berlin	M. Encke.
Bogoslowsk	
Bombay	G. Buist.
Barnaoul	M. Prang, 1st.
Breda	
Breslau	
Brussels	M. Quetelet.
Cadiz	M. Cerquero.
Cairo	M. Lambert.
Cambridge	J. Challis.
Cambridge	United States.
Cape of Good Hope	T. Maclear.
Catherineburgh	M. Rochkoff.
Christiana	M. Hansteen.
Cincinnati	Mr. Locke.
Copenhagen	M. Oersted.
Coimbra	
Dorpat	M. Mädler.
Dublin	Sir W. R. Hamilton.
Gotha	
Hammerfest	
Hanover	
Heidelberg	M. Tiedemann.
Helsingfors	M. Nervander.
Hobarton	Van Diemen's Land.
Hudson College	United States.
Kasan	M. Simonoff.
Kew	Observatory.
Königsberg	M. Bessel.
Kremsmunster	
Leipsic	M. Weber.
Lougan	
Madras	J. Ludlow.
Manheim	
Marburg	
Marseilles	
Milan	M. Carlini.
Munich	M. Lamont.
Nertchinsk	M. Prang, 2nd.
Nikolaieff	
Oxford	M. J. Johnson, Esq.
Palermo	
Paramatta	
Paris	M. Arago.

Pekin	M. Gachkévitche.
Philadelphia	— Bache, Esq.
Prague	M. Kreil.
Pulkowa	M. Struve.
St. Helena	
St. Petersburgh	M. Kupffer.
Seeberg	M. Hansen.
Simla	J. H. Boileau.
Singapore	C. M. Elliot.
Sitka	Messrs. Homann and Ivanoff.
Stockholm	
Teflis	M. Philadelphine.
Toronto	Lieut. Lefroy.
Trevandrum	J. Caldecott.
Tubingen	
Upsal	
Vienna	M. Littrow.
Wilna	
Zlatoouste	

INSTITUTIONS.

Aberdeen	University.
Berlin	Academy of Sciences.
Board of Ordnance	London.
Bologna	Academy.
Boston	Academy of Sciences.
Bowden College	United States.
Dublin	University.
Edinburgh	Astronomical Institution.
Edinburgh	Royal Society.
Edinburgh	University.
Glasgow	University.
Göttingen	University.
Harvard College	United States.
Leyden	University.
Paris	Academy of Sciences.
Paris	Board of Longitude.
Paris	Dépôt de la Marine.
Philadelphia	Philosophical Society.
Queen's Library	London.
Royal Institution	London.
Royal Society	" "
St. Andrews	University.
St. Petersburgh	Academy of Sciences.
Savilian Library	Oxford.
Stockholm	Academy of Sciences.
Trinity College, Library . .	Cambridge.
Upsal	Society of Sciences.
Waterville College	United States.

INDIVIDUALS.

Bessel, Prof.	Königsberg.
Brisbane, Sir Thomas	Makerstown, Kelso.

Brittingham, Lieutenant, R.A.	Newfoundland.
Lowndes Professor of Astronomy	Cambridge.
Plumian Professor of Astronomy	Cambridge.
Colebrook, Sir W.	New Brunswick.
Dove, M.	Berlin.
Erman, M.	Berlin.
Fox, R. W.	Falmouth.
Harris, W. Snow, Esq.	Plymouth.
Howard, Luke, Esq.	Tottenham.
Humboldt, Baron	Berlin.
Kaemtz, M.	Dorpat.
Lloyd, Rev. H.	University, Dublin.
Loomis, —, Esq.	New York.
Lubbock, Sir John W., Bart	London.
MacCullagh, James, Esq.	University, Dublin.
Phillips, John, Esq.	York.
Pickering, Captain, R.A.	Ceylon.
Redfield, W. C., Esq.	New York.
Reid, Lieutenant-Colonel	Bermuda.
Smyth, W. H., Captain R.N.	London.
South, Sir James	London.

List of Meteorological and Magnetical Observations in the possession of the Royal Society.

Meteorological Observations.

Observatories.	Periods of Observation.	Observers.
Bombay.	1842, 1843.	G. Buist.
Cape of Good Hope.	February 7 to November 1841.	Lieut. Wilmot.
Cochin.	July 1842 to January 1844.	J. B. Taylor.
Erebus and Terror.	October 1839 to November 1842.	Ross and Crozier.
Lucknow.	June 1842 to October 1843.	R. Wilcox.
Madras.	January to December 1843, to June 1844.	J. Ludlow.
Niger Expedition.	May to July 1841.	
Penang.	April 1843 to January 1844.	J. B. Taylor.
Port Arthur.	1840.	J. Lemprière.
Ross Bank.	October 1840 to December 1842.	Capt. Ross.
St. Helena.	February to October 1840.	Lieut. Lefroy.
Singapore.	1841, 1842, 1843 to October 1844.	C. M. Elliot.
Simla.	1841, 1842, June to Dec. 1843, Jan. to Nov. 1844.	J. H. Boileau.
Toronto.	Jan. 1840 to August 1842.	Lieut. Riddell.

Magnetical Observations.

Observatories.	Periods of Observation.	Observers.
Bombay.	November 1841 to April 1842, September 1842 to May 1844.	G. Buist.
Borneo.	October 1842.	C. M. Elliot.
Lucknow.	June 1842 to December 1843.	R. Wilcox.
Madras.	1841, March 1842 to December 1843.	J. Ludlow.
Singapore.	1840 to June 1842, August 1842 to December 1844.	C. M. Elliot.
Simla.	September 1841 to April 1843, June 1843 to October 1844.	J. H. Boileau.
Trevandrum.	May 1841 to March 1842.	John Caldecott, Esq.

The Board of Ordnance has given orders that copies of all the observations at the Ordnance observatories shall henceforward be sent to the governors of all our colonies, to be by them deposited in the most accessible public libraries for colonial reference. They have been hitherto, and will in future continue to be presented to the directors of all foreign magnetic and meteorological observatories officially instituted, and to eminent persons in those sciences.

Approaching conclusion of the present system of magnetic and meteorological establishments, and considerations thereby rendered necessary.

The second term of three years for which the British Government and the East India Company have granted the existing establishments will conclude with the expiration of the current year; and as the termination of the British system of observation will in all probability carry along with it the cessation of many or most of the other European series of observations, it has been an anxious subject of deliberation with your Committee what course to recommend to the Association under such circumstances. On the one hand there is the serious responsibility of advising the continuance of very heavy expense, both to the Government and the East India Company, and of a vast devotion of time and labour of eminent individuals in science, and of energetic and devoted observers. On the other, the high importance of the objects in view, the interest which they yearly continue to excite more and more in the public mind, and the perception that the great problems they propose to resolve are of a nature to yield only to continued and persevering inquiry. Under these considerations it was resolved at the last meeting of the Association to request a conference of the most eminent foreign magnetists and meteorologists on the subject, viz. Messrs. Gauss, Weber, Humboldt, Dove, Erman, Hansteen, Plana, Plantamour, Kämtz, Gillis, Bache, Loomis, Kupffer, Arago, Quetelet, Kreil, Lamont, Boguslawski and Baron Senftenberg, to be held at this meeting, and invitations were issued accordingly, the gratifying effect of which has been to procure a prospect of the personal attendance at their deliberations, of Messrs. Kupffer, Kreil, Dove, Erman, and Baron Senftenberg.

In addition to this, an extensive correspondence has been entered into on the part of your Committee for the purpose of learning the sentiments both of them, and of such other high authorities in the practical and theoretical departments of these subjects, on the important matter under deliberation. This correspondence will be found attached as an appendix to the present report, and it has afforded your Committee the means of presenting to the conference for discussion the principal features of the subject in a more methodical order than would probably have been the case without some preliminary communication of the kind. A careful and minute analysis of the several letters received has enabled them to classify the various and valuable suggestions contained in them, and to arrange under distinct heads the questions which will have to be decided on in case the general opinion should prove favourable to the longer continuance of the system.

It has therefore appeared to your Committee advisable to propose for consideration at the approaching conference, the following heads of inquiry, without prejudice to such other points relative to the general question as the experience and judgement of any of their distinguished coadjutors may suggest for discussion.

I. Under all the circumstances, is it the opinion of the conference that the combined system of magnetic and meteorological observation ought to be continued longer?

Should their opinion be in the negative, there is of course no room for further deliberation, except in so far as may relate to any changes of apparatus, methods, &c. which it may be worth while to make, or any experiments to perform in the short interval to the end of the year. In order therefore to give room for any further inquiry, it is necessary to suppose, at least provisionally, that some considerable amount of opinion in favour of continuance is manifested, which, should it prove to be the case (as the general tenor of the correspondence would appear to indicate), it may perhaps be advisable still to wave coming to any *final* conclusion on this principal head, until the subordinate subjects shall have undergone discussion; and this, if for no other reason, because, agreeing in the general principle, it may be found impossible to reconcile all opinion respecting the details. Assuming then provisionally an affirmative opinion on the general principle, the following are the general heads under which it would appear most convenient to arrange the subjects of consideration:—

A. *The general system of magnetic observation at fixed stations.*
- *a.* The daily observations.
- *b.* The absolute determinations.
- *c.* Term observations.
- *d.* Disturbances.
- *e.* Instruments.
- *f.* Additional observations.

B. *The general system of meteorological observation at fixed stations.*
- *a.* The daily observations.
- *b.* Term observations.
- *c.* Instruments.
- *d.* Additional observations.

C. *Stations, and duration of the system.*
- *a.* The Ordnance stations.
- *b.* The Admiralty stations.
- *c.* The East India stations.
- *d.* Permanence or temporary duration of the stations.
- *e.* Observers and assistants.

D. *Surveys and auxiliary stations.*
- *a.* Magnetic surveys by land and sea.
- *b.* Auxiliary barometric stations.

E. *Problems solved and to be solved.*

F. *Particular suggestions which deserve consideration.*

Under each of these general heads and their subdivisions, particular suggestions have been made and alterations proposed or objected to, giving rise to questions a great deal too numerous and extensive to admit of their being each discussed in full detail at a conference so limited in time as this must be. Nevertheless it will be proper to specify under each, in the manner of a *resumé*, what *are* the particular questions which have arisen in the minds of our correspondents or have been subsequently suggested, with a view to selecting those of most importance; and these are as follows:—

A *a. Daily observations.*—Should they be made hourly, two-hourly, four-, six- or eight-hourly? by night as well as by day? at Gottingen time or that of the place? at constant or variable hours with the season of the year? Should they be made two-hourly for a certain time and subsequently changed to four- or six-hourly?

A *b. Absolute determinations.*—Should they be made monthly, or how often? For what elements? What methods should be pursued in their determination?

A *c.* *Term observations.*—Should they be discarded (as seems the general impression) or increased in number and made weekly, as Dr. Lloyd recommends? Should Gottingen time be used in them? Should a term be broken off if no disturbance be apparent at the usual time of greatest disturbance?

A *d.* *Disturbances.*—Should the inquiry into disturbances rely on term-observations only, or should extra observations be made whenever they are supposed to be in progress? Should a few continuous observations be made at the usual hours of maximum disturbance, to detect them? Ought the readings of the instruments during them to be registered at definite instants of Gottingen mean time, or at the instants of great jumps or turning points? Ought any special provision to be made for their observation during Sir John Franklin's stay near the pole?

A *e.* *Instruments.*—Ought the present instruments to continue in use, or any, and what changed? Ought magnets to be interchanged? Should self-registering magnetic apparatus to register disturbances attaining a certain magnitude? New instruments—induction magnetometer—theodolite ditto—M. Lamont's new inventions?

A *f.* *Additional observations.*—Should any, and what, be in future made?

B *a.* *Daily Meteorological Observations.*—Should any immediate change be made in the hours? in the instruments? Should night observations be discontinued?

B *b.* *Meteorological Terms.*—Should these be discontinued? Should they be modified as to the extent of the observations?

B *c.* *Meteorological Instruments.*—Should self-registering instruments be used? and what? Should encouragements be held out for their improval? and of what sort? who to be the judges, and what the conditions of their introduction into use? At what times and on what understandings are new instruments generally to be introduced? Should a system of itinerant instruments of comparison be adopted? at what intervals? and in what order?

B *d.* *Additional Observations.*—Of thermometers, wet and dry, at several elevations in the air? Of temperatures of soil at several depths? Of atmospheric electricity? with what instrument? Peltier's? Gourjon's? Mr. Wheatstone's new principle and apparatus? of barometer continuously during storms? Should the wind be registered at each observation? Should any other class of phænomena be observed?

C *a*, c *b.* *Of the Ordnance and Admiralty Stations.*—Should *all* be continued in activity or not, and which? If the same *number* be retained, is it desirable to continue or change the *stations*? Should any endeavour be made to procure *additional* colonial stations?

C *c.* *The East India Observatories.*—Should any and which of them be continued? The expense of Simla being particularly heavy, is it desirable to recommend *its* continuance?

C *d.* *Permanence or Temporary continuance.*—For *how long* a period would it be desirable to continue *each station seriatim*? Should any one or more be permanent?

C *e.* *Observers and Assistants.*—Should the force of *each* observatory *seriatim* be diminished or increased?

D *a.* *Survey and Auxiliary Stations.*—Should any and what local surveys be *recommended*? Should the observatories be given up, would any local surveys deserve recommendation? Should the observations of travellers be encouraged, and how?—by publication of their results? At whose expense? Are there any extensive tracts of sea in which nautical surveys (Magnetic and Meteorological) would be desirable?

D *b*. *Auxiliary Stations.*—By what means can chains or triangles of stations of meteorological observation be best encouraged or effected? Should any attempt be made to carry out such a chain of posts northward from Toronto?

E. *Problems Solved and to be Solved.*

Is it the opinion of the conference that the *law* of diurnal change of the magnetic elements may be considered as satisfactorily ascertained for any and what station?

Is the law of *daily range* (disturbances excepted) of the magnetic elements or any of them made out?

Is the law of annual (periodical) fluctuation made out? Is its dependence on temperature?—on evaporation?—on precipitation?—distinctly ascertained?

Is the *direction* and *amount* of secular change for any and what station made out?

Is Toronto favourably or unfavourably situated for,—1st, the determination of the maximum or minimum *quantity* of dip, and has it been determined? 2ndly, for the *epoch* of the turning point of dip, and has *that* been ascertained, or in how many years *could* it be ascertained, or is it *now* possible to ascertain it at all?

Has any correspondence in the magnitude and direction of great disturbances been perceived in *very* distant stations?

Are *days* of great disturbance general though the particular phases differ in different localities?

Shall we, at the end of 1845, be in possession of data for computing the Gaussian constants for 1842–43, in virtue of the totality of observations made or to be made up to that time?

If not, is there a reasonable prospect that in a given time, say three or four years more, by proceeding as at present with observatories and surveys, we *shall* be so?

Have the disturbance observations as yet manifested any intelligible connexion with aurora further than that certain auroras do and certain do not affect the needle?

Have the observations hitherto made held out any appearance of connexion with any other cause?

In Meteorology.—Has any striking discovery been elicited by the observations made, either at fixed stations or in the progress of the Antarctic expedition besides that of the lower barometric pressure already noticed?

Has M. Dove's resolution of barometric fluctuation into two elements received any confirmation?

F. *Particular Suggestions deserving Consideration.*

Is it desirable that meteorological registers made at sea in toto—or reduced—should be published?

Would it be desirable if practicable to publish monthly or quarterly returns?

Would it be advisable to procure from the Royal Society, or other quarters where meteorological observations are published, extra copies of *these alone* for circulation among meteorologists? and *how* are they to be circulated? and who to bear the expense?

Would it be advisable to recommend to the General Committee to appoint M. Erman to act as a committee to superintend the calculation of the Gaussian constants for 1829, with a grant of £50 per annum for two years according to his proposal?

Would it be advisable to accept M. Dove's offer to reduce one station's meteorological observations in the mode proposed by him, and to call on other members or others who may be disposed to follow his example, and to request them to act as a committee with or without money at disposal to do so on the system to be proposed by M. Dove?

Is there any one ready to undertake a climatology of England according to M. Dove's suggestion?

Professor Bache proposes general hourly observations for a year all over America, to commence a year hence [? exact day . . .], would it be right to call upon private observers or public bodies to do the same in Europe, and in that case to guarantee their publication?

Is there any decided improvement capable of being suggested in the mode of publication of the colonial observations?

Your Committee further report, that they have expended out of the grant of £50 placed at their disposal the amount of £16 16*s.* 8*d.*, and request a continuance of the grant.

Signed on the part of the Committee,

J. F. W. HERSCHEL.

Appendix.

I. *Circular addressed by Sir John Herschel, on the part of the Committee appointed to conduct the co-operation of the* British Association *in the system of Magnetical and Meteorological Observations.*

December 5, 1844.

Sir,—It being understood that the term for which the British Government and East India Company have pledged their support of the British magnetic and meteorological establishments expires with the year 1845, so that, unless renewed, the British co-operation in those observations, on its present extensive footing, will cease with the expiration of that year;—and the Committee of the British Association for the advancement of Science, appointed to conduct the co-operation of the Association in that system of observations, having to make, at the next meeting of the Association in June 1845, a general report on the progress made and the objects accomplished by the several establishments in Europe and elsewhere (so far as they shall be in possession of the necessary information), in which report this circumstance will necessarily be adverted to, they request the favour of your consideration of and reply to the following inquiries.

1st. Whether in your judgement there are *any*, and if so, *what* important objects to be accomplished by a continuance of the existing establishments for a longer period,—executing as at present both systematic and simultaneous observations, or either class to the exclusion of the other?

2nd. Do you consider that private research has to any useful and valuable degree been stimulated by the example of the government establishments in Europe and elsewhere, and that science has thereby received material contributions which would probably not otherwise have arisen? and can you state instances?

3rd. In case of the continuance of the observatories beyond 1845, would you be disposed to recommend any, and what modifications, extensions or alterations in the system of observing, or in the apparatus to be employed?

The full and free communication of your views in reply to these inquiries and on every part of the general subject, is very particularly requested; and the Committee will also gladly be informed whether you will object to your reply to this letter being printed entire, or in part (by extracts) for mutual circulation, in continuance of this correspondence, should it appear to the Committee to be necessary.

They further request that you will so time your reply that it may reach London before the 10th of March 1845, and that you will address it by post to

Lieut.-Colonel Sabine, R.A.,
Woolwich,
Magnetic Committee. England.

Before the end of the current year, the first volume of the Observations at the British government stations, and the second of those at Greenwich, will be forwarded to you. A volume of extraordinary magnetic disturbances at the former stations, and the first volume of the Greenwich Observations, have already been so forwarded, and it is hoped duly received.

I have the honour to be, with the highest consideration,
Sir, your very obedient servant,
J. F. W. Herschel,
On the part of the Committee.

THE LETTERS WHICH FOLLOW ARE REPLIES TO THE ABOVE CIRCULAR.

II. *Professor Wilhelm Weber to Colonel Sabine.*

Leipzic, 1845, February 20.

Hochgeehrter Herr,—Ich weiss, dass ich Ihnen auf die vom Magnetic Committee vorgelegten Fragen keine Antwort geben kann, welche irgend wichtige und neue Notizen für Sie enthielte; dennoch verfehle ich nicht, der mir gewordenen Aufforderung zu entsprechen, indem ich Ihnen ganz anheim stelle ob und welchen Gebrauch Sie davon machen wollen.

I. Wir setzen wohl Alle das Vertrauen in diejenigen Regierungen, welche zur Begründung *systematischer* magnetischer Beobachtungen auf der Erdoberfläche beigetragen haben, dass sie auch den *regelmässigen Fortgang* dieser systematischen Beobachtungen für die Zukunft sichern werden. In diesem Vertrauen habe auch ich die Errichtung eines magnetischen Observatoriums kürzlich noch hier in Leipzig betrieben. Das in den ersten 6 Jahren ausgeführte System von Beobachtungen ist ein sehr umfassendes gewesen, welches darauf berechnet war *allen* Forderungen zu genügen, sowohl denen welche aus der *bleibenden Aufgabe* entspringen, zu deren Lösung jedes Jahr und jedes Zeitalter seinen Beitrag liefern soll, als auch denen, welche in einer Menge *vorübergehender* oder ein für allemal zu lösender Aufgaben begründet waren. Welche Aufgaben der letzteren Art nach Ablauf der ersten 6 Jahre nun schon als vollkommen gelöst und erledigt betrachtet werden dürfen, darüber steht uns hier noch kein Urtheil zu; aber die Magnetic Committee wird vielleicht jetzt schon ein Urtheil darüber aus den ihr allein vorliegenden Materialien fällen können. Es muss daher der Magnetic Committee die Entscheidung überlassen bleiben, welche Forderungen in Betreff jener Art *vorübergehender Aufgaben* an die Zukunft noch übrig bleiben, und ich beschränke mich auf eine Antwort darauf, ob die *bleibende Aufgabe* für sich allein die fernere Beibehaltung des *ganzen Beobachtungs-Systems* erfordere, welches für die ersten 6 Jahre angenommen worden war. Wenn es sich künftig einmal nur noch um die stets *bleibende Aufgabe* handelt, nämlich

von Jahr zu Jahr die Veränderungen genau zu bestimmen, welche in den vier und zwanzig (künftig vielleicht 35) Elementen der Erdmagnetismus-Theorie Platz nehmen

so werden wie ich glaube dann beträchtliche Reductionen in dem obigen sehr umfassenden Systeme vorgenommen werden dürfen.

Nothwendig für diese *bleibende Aufgabe* scheint mir

1. Die Erhaltung aller Observatorien auf entfernten Stationen ausser Europa;
2. Die regelmässige (monatliche) Wiederholung *aller absoluten Messungen* in allen diesen Observatorien.

Nicht nothwendig für diese *bleibende Aufgabe* betrachte ich dagegen.

1. Die bisherigen Termins-Beobachtungen—die vielleicht künftig auf die europäischen Stationen beschränkt werden dürften;
2. Die zweistündigen täglichen Beobachtungen—die sich dann vielleicht auf achtstündige reduciren liessen.

Kurz es scheint mir möglich, wenn man wirklich so weit gelangt ist, dass bloss die *bleibende Aufgabe* noch in Rücksicht kommt, das System der Beobachtungen in der Art zu vereinfachen, dass Ein wohl unterrichtetes und geübter Beobachter auf jedem Observatorium genügt und keines Assistenten bedarf. Ein solches beschränkteres System von Beobachtungen muss stets ununterbrochen fortgesetzt werden, wenn die *Geschichte des Erdmagnetismus* kein blosses Stückwerk bleiben soll und wenn die darauf beruhenden *magnetischen Karten* diejenige Präcision und Planmässigkeit erlangen sollen, welche sie für die Praxis so nützlich machen würden.

II. Was den *mittelbaren* Erfolg betrifft, welcher die *systematische* Betreibung der magnetischen Beobachtungen durch Anregung und Förderung anderer wissenchaftlicher Bestrebungen gehabt habe, so lassen sich zwar diese Wirkungen schon jetzt nicht verkennen, doch bedürfen dieselben Zeit zu weiterer Entfaltung, bevor man ihren ganzen Umfang und ihre volle Wichtigkeit übersehen kann.

In Deutschland z. B. existirten bisher blosse Sammlungen physikalischer Instrumente ohne feste Einrichtungen zu ihrer Benutzung, es gab keine physikalischen *Laboratorien* und *Observatorien*. Solche Laboratorien und Observatorien, welche für die Fortschritte der Wissenschaft unentbehrlich geworden sind, fangen jetzt an zu entstehen, und die den magnetischen Beobachtungen gemachten Bewilligungen geben dabei einen festen und sicheren *Stützpunct*, wie ich aus eigener Erfahrung bezeugen kann. Seitdem ferner die magnetischen Beobachtungen ihre neuere Ausbildung und Vollendung gewonnen haben, haben wir in Deutschland mehrfach begonnen, die *galvanischen* Beobachtungen analogen Principien zu unterwerfen und wir haben auch dafür *absolute Maase* eingeführt. Für alle diese Untersuchungen bilden aber die magnetischen Beobachtungen *nothwendige Elemente*, die dabei als gegeben betrachtet werden müssen. Die magnetischen Beobachtungen sind daher nicht bloss zur Erforschung des Erdmagnetismus nothwendig, sondern sie sind jetzt auch ein wichtiges Element für *viele andere physikalische Untersuchungen* geworden. An unseren Universitäten wird endlich die Wichtigkeit immer mehr erkannt, welche die Bildung *exacter Natur-Beobachter* für die Wissenschaft und für das practische Leben hat. Bisher bot nur die Astronomie eine sehr einseitige Gelegenheit zur Bildung feiner Beobachter dar, welche nur von Wenigen benutzt werden konnte. Die Erfahrung hat bewiesen, dass magnetische Observatorien zu vortrefflichen *Bildungs-Anstalten* für Beobachter dienen können.

III. Was die Instrumente betrifft, so scheint mir, wenn die bisherigen Resultate den Erwartungen der Magnetic Committee entsprechen sollten, kein Grund zu einer Aenderung vorzuliegen; selbst aber wenn hie und da die Erwartungen der Magnetic Committee in den Resultaten sich getäuscht fänden, würde ich doch die Uberzeugung hegen, dass die Schuld davon (die verticalen Variationen ausgenommen) nicht in den Instrumenten, sondern in Mangel kunstgerechter Behandlung einzelner Beobachter zu suchen sei; und dass daher durch Vertäuschung der Instrumente die Sache eher verschlimmert als verbessert werden möchte, weil jeder neue Instrument eine neue kunstgerechte Behandlung fordern würde. Mir scheint es in jeder Beziehung rathsam, die bisherigen Instrumente im Wesentlichen beizubehalten. Doch würde ich es für sehr nützlich halten, wenn häufiger die Gelegenheit benutzt würde, dass Magnetstäbe, deren Schwingungsdauer (und Temperatur) in dem einen magnetischen Observatorium genau gemessen worden wäre, nach einem anderen Observatorium versandt würden, um ihre Schwingungsdauer auch dort messen zu lassen, und umgekehrt. Es würde dadurch eine Controle für die absoluten Intensitätsmessungen gewonnen werden, welche von Wichtigkeit wäre so lange man noch nicht uberall auf eine ganz zuverlässige Ausführung der absoluten Messungen sollte trauen können.

Ich benutze diese Gelegenheit, Ihnen, Hochgeehrter Herr, meinen Dank für den Empfang des 1sten Bandes Observations on days of unusual Magnetic Disturbance, für mich sowohl als für das hiesige Observatorium auszusprechen; dagegen bemerke ich, dass die anderen im Schreiben des Magnetic Committee genannten Bücher mir bisher nicht zugekommen sind, nämlich the 1st and the 2nd volume of the Greenwich Observations, and the 1st volume of the Observations at the Government Stations.

Mit wahrer Hochachtung
Ihr stets ergebenster,
WILHELM WEBER.

(*Translation.*)

Leipsic, February 20, 1845.

DEAR SIR,—I know that I cannot return any answers to the questions proposed by the Magnetic Committee which shall contain any important matter new to you; I will not however omit to send a reply, leaving it to yourself to make use of it or not in any way you may see fit.

I. We have all confidence in those governments who have aided in establishing *systematic* magnetic observations over the surface of the earth, that they will assure the *regular continuance* of these systematic observations for the future. In this confidence I have recently promoted the establishment of a magnetic observatory here in Leipsic. The system of observation executed during the first six years has been a very comprehensive one, calculated to satisfy *all* demands, both those which arise out of the *permanent problem* to the solution of which every year and every epoch ought to furnish its share, and also those which had respect to a number of *temporary problems*, or such as may be solved once for all. In regard to this latter class of problems, we have here no means of judging which of them may be already considered as completely satisfied and solved by means of the work of the first six years; but the Magnetic Committee may perhaps already possess the materials on which to found such a judgement. It must therefore remain for them to decide what demands may still remain to be satisfied in respect to the temporary problems referred to; I confine myself to the consideration whether the continuation of the whole observation system adopted for the first six years is required for the permanent problem only, this problem being,

To determine accurately, year by year, the changes taking place in the twenty-four (perhaps in future thirty-five) elements of the 'Erdmagnetismus-Theorie.'

I believe that as far as this object is concerned considerable reductions may be made in the above very comprehensive system.

It appears to me *necessary* for the permanent problem,—

1st. To preserve all the observatories at remote stations out of Europe;

2nd. To repeat regularly (every month) *all absolute measurements* at all these observatories.

I consider it *unnecessary* for this object to continue,—

1st. The term observations, which may perhaps in future be confined to European stations;

2nd. The two-hourly daily observations, which may perhaps be reduced to eight-hourly.

In short, it seems to me that, supposing we have really been so successful that nothing but the permanent problem remains, we may so far simplify our system that one well-instructed and practised observer at each observatory will suffice and will need no assistants. Such a limited system of observation must be constantly continued without interruption, if the *history of terrestrial magnetism* is to be no mere fragmentary work; and if the magnetic maps based upon it are to possess that precision and conformity to system which would make them so useful in praxis.

II. In regard to the *indirect* results which the *systematic* prosecution of magnetic observations may have had in exciting and furthering other scientific efforts, such effects are already unmistakeably recognizable, but they require time for their further development before their whole extent and full importance can be seen. In Germany, for example, there existed hitherto mere collections of physical instruments without arrangements for their use; there were no physical laboratories and observatories: these, which are become indispensable to the progress of science, are now beginning to arise, and for this the arrangements made for magnetic observations afford a solid and secure *point d'appui*, as I can testify from my own experience. Further, since magnetic observations have received their recent improvement and completeness, we have begun in several places in Germany to subject *galvanic* observations to analogous principles, and have introduced for them also *absolute measure*; but for all these researches magnetic observations afford necessary elements which must be regarded as data. Magnetic observations are therefore not only necessary for terrestrial magnetism, but are besides now become an important element *for many other physical investigations*. There is at our universities a growing recognition of the importance, both for science and for practical life, of forming exact *observers of nature*. Hitherto astronomy alone has afforded a very partial opportunity for the formation of fine observers, of which few could avail themselves. Experience has shown that magnetic observatories may serve as excellent training-schools in this respect.

III. In regard to instruments, it appears to me that if the results obtained shall be found to correspond to the expectations of the Magnetic Committee, there will be no ground for alteration; and even if these expectations shall have been occasionally disappointed, I should yet be persuaded that (except in regard to *vertical* variations) the cause would be found to be not in the instruments, but in the unskilful handling of particular observers, and that a change of instruments would be likely to do more harm than good, as every new instrument requires a new skilful mode of handling. In every point of view it seems to me advisable to retain the present instruments without material alteration. But I should think it very desirable to take more frequent opportunities of sending magnetic bars, whose time of vibration (and correction for temperature) had been exactly determined at one observatory, to other observatories where the time of vibration should be also determined and the bars sent back; thus affording a check on the absolute measurements of intensity, which is of importance until we can confide entirely in the thoroughly good execution of the absolute measurements at all the stations.

I take this opportunity of expressing my thanks, both for myself and for the observatory at this place, for the first volume of 'Observations on Days of unusual Magnetic Disturbance:' the other works mentioned in the letter of the Magnetic Committee, viz. the first and second volumes of the 'Greenwich Observations,' and the first volume of the 'Observations at the Government Stations,' have not yet reached me.

With sincere esteem, always yours,
WILHELM WEBER.

III. *From M. Kupffer, Director-General of the Magnetic Observatories in Russia, to Sir John Herschel.*

MONSIEUR LE PRÉSIDENT,—En réponse à votre lettre du 5 Décembre 1844, j'ai l'honneur de vous adresser les remarques suivantes sur les trois points y contenus:

1°. Selon moi, nous ne sommes, rélativement à nos connaissances magnétiques, qu'à l'entrée d'une nouvelle carrière, d'un nouveau champ d'exploitation, qui s'étend indéfinement devant nous. Voici effectivement, en peu de mots, ce que nous savons déjà par nos observations, et ce que nous ne pouvons apprendre que par des observations ultérieures.

Nous possédons une excellente méthode pour déterminer la déclinaison absolue et ses variations, et nous avons étudié avec un soin extrême cet élément important du magnétisme terrestre; nous avons constaté et déterminé plus exactement les rapports intimes qui existent entre les variations offertes par la position de l'aiguille sur des points très distans de la surface terrestre; nous trouverons peut-être même déjà, par une discussion plus approfondie de nos observations, les lois qui régissent ces phénomènes, et les causes aux quelles on peut les attribuer. Mais nous sommes bien éloignés de posséder des méthodes aussi exactes pour l'observation des deux autres élémens du magnétisme terrestre. Nous savons bien déterminer la valeur absolue de l'intensité et ses variations, dans leur composante horizontale, mais l'observation de la valeur absolue de l'intensité totale et de l'inclinaison, et de leurs variations ont encore offert des obstacles insurmontables aux efforts les plus persévérans. D'un autre côté, il n'y a pas lieu de renoncer à l'espoir de réussir prochainement; la théorie des inductions éléctriques nous ouvre une nouvelle route et une perspective de succès.

Outre cela, nos observations mêmes nous ont fait voir, d'une manière non douteuse, que la marche de l'aiguille présente, à coté des phénomènes généraux, dont la simultanéité sur une grande portion de la surface terrestre a été démontrée par des observations antérieures, des irrégularités locales, dont la cause nous est encore entièrement inconnue et dont les rapports probables avec les phénomènes météorologiques sont encore à découvrir.

Il y a donc encore beaucoup à faire et la matière est bien loin d'être épuisée; il me semble au contraire, que la solution du problème, que nous nous sommes proposé, n'a été qu'ébauchée.

Mais qu'y a-t-il encore à faire? La rapidité de notre marche nous a empêché de regarder en arrière, nous ne savons pas encore bien nous mêmes, à quels résultats nous sommes arrivés; une réunion des observateurs les plus actifs et les plus influens, qui ont pris part à notre entreprise, est devenu indispensable, pour discuter la marche à suivre.

2°. Pour répondre à cette question, il sera nécessaire d'établir avant tout le point de vue, dont la science en général est envisagée par notre gouvernement. En Angleterre, la science a éclairé d'abord, et réglé ensuite la marche d'une civilisation indigène, elle en est le résultat et la fleur pour ainsi dire, et réclame le sécours du gouvernement dans quelques cas seulement, où il y a de très fortes dépenses à faire. La Russie, étant venue plus tard, a pu profiter du travail intellectuel de toute l'Europe, elle a reçu chez elle la science toute faite, comme une chose, dont l'utilité est généralement réconnue, et comme un des plus beaux ornemens de sa grandeur. Voilà pourquoi le gouvernement russe cherche les hommes de science et est pour ainsi dire jaloux que rien de vraiment utile et bon ne se fasse en dehors de son influence. Il est facile de comprendre l'avantage de ce principe; il y a unité partout et il n'y a jamais double emploi; la science n'est pas la seule à y gagner, l'état y gagne aussi, parceque les mêmes choses se font plus rapidement, plus sûrement et avec moins de dépenses.

Il n'est donc pas étonnant qu'il n'y a que fort peu d'hommes privés, qui se soient occupés d'observations météorologiques, et pas un, qui ait consacré une partie de ses moyens et de son temps aux observations magnétiques. Mr. Anatole Démidoff a établi un observatoire météorologique à Nigeney-tagnilsk dans l'Oural; Mr. Ougritchitch-Trebinsky, directeur de la douane à Taganrog, fait des observations météorologiques à 23 pieds au dessus du niveau de la mer noire; nous avons plusieurs années d'observations thermométriques faites à Yakoutzk par le Sieur Névéroff négociant; un autre, simple agriculteur, le Sieur Séménoff fait des observations météorologiques très complètes à Koursk (midi de la Russie); Mr. Kalk en fait à Baltischport; plusieurs médécins en font dans les lieux respectifs de leurs résidences. Il est en général facile de voir, que le goût des observations météorologiques a fait de grands progrès en Russie, depuis l'établissement de nos observatoires magnétiques et météorologiques, qui, d'ailleurs, date déjà chez nous de 1835; l'archive météorologique de l'Académie des Sciences, dans lequel se concentrent toutes les observations météorologiques faites hors de notre entreprise magnétique, contient déjà des séries plus ou moins complètes de 75 points, situés dans toute l'étendue de l'Empire. Il faut encore dire que le gouvernement a bien fourni des instrumens à presque toutes ces stations, mais toujours sur la demande des personnes qui ont voulu se charger de ces observations, et qu'il n'a donné aucune rétribution personnelle.

3°. Quant aux modifications, qu'il y aurait à faire au plan des observations je crois qu'une convocation de tous les directeurs généraux (un représentant au moins pour chaque pays): et d'autant de directeurs spéciaux, qu'il sera possible de réunir, est indispensable, pour discuter à fond cette importante question. Je pense que la réunion de l'Association Britannique à Cambridge, qui aura lieu cette année, offre une excellente occasion, qu'il ne faut pas laisser passer.

En vous priant, Monsieur de bien vouloir communiquer ces remarques au Comité, dont vous êtes le président, et en vous autorisant de les faire imprimer, si vous le jugez convenable, j'ai l'honneur d'être avec la considération la plus distinguée et les hommages les plus affectueux.

Votre tout devoué,

A. T. Kupffer,

Directeur-général des Observatoires Magnétiques de l'Empire de Russie.

St. Petersbourg, ce $\frac{13}{25}$ Février, 1845.

IV. *From Professor Loomis of New York University to Lieut.-Col. Sabine.*

New York University, Feb. 28, 1845.

Dear Sir,—Having been invited to express my opinion respecting the importance of continuing the establishments so liberally set on foot by the British government for magnetic and meteorological observations, while I admire the liberal policy of the government in what has already been done, I do not hesitate to express it as my conviction, that the immediate abandonment of these establishments would prove highly prejudicial to the cause of science. The present combined movement for magnetic observations had for its object the discovery of the *cause* of all terrestrial magnetic phænomena. This was to be accomplished by simultaneous observations of each of the magnetic elements at numerous stations scattered over the globe. The observations however must not only be made, they must all be brought together, compared, discussed, interrogated, before we can know what language they speak; they must be published and placed in the hands of all who are interested in the subject. The observations themselves constitute but the raw material; they are of little value until they are reduced, and it is discovered what general truths can be derived from them.

But it may be asked, whether, having made our observations, we may not now safely pause until we have ascertained what results they are to furnish? To this there are numerous objections; one of which is, that to suspend temporarily the present system of observations, would in many cases lead to their entire abandonment. But have not observations already been made sufficient to secure the object originally proposed? I presume no one is ready to answer this question in the affirmative. It commonly happens in experimental research, that after a series of fortunate experiments which have shed light on what was before shrouded in mystery, a careful comparison of all the experiments suggests some new combination, which, like an *experimentum crucis*, would enable us finally to decide between conflicting theories. It is not reasonable to anticipate any better success in our magnetic researches. A discussion of the past observations will suggest plausible explanations which are consistent perhaps with all the observed phænomena; but to preclude all objections, it may be necessary to observe the phænomena under varied circumstances; perhaps at new stations peculiarly situated, perhaps with peculiar instruments. To abandon the present system, therefore, before a thorough discussion has been undertaken of the observations already made, may be to stop short in the race when the prize is just within our reach. Let the observations be published as rapidly as possible, let them be freely circulated. When the object for which the observatories were founded has been shown to be attained, then let them be dismantled. But suppose they are abandoned forthwith, and after a comparison of all the observations, we arrive at the probable clue to all the phænomena of terrestrial magnetism; but still some doubt remains, which however might probably be cleared up by a further continuance of the observations, with perhaps some slight modifications suggested by experience. Should we not condemn that ill-judged œconomy, which, after forming a liberal plan for the accomplishment of a glorious end, stopped short in its execution before ascertaining whether or not the object in view had been attained? Surely it is the dictate of wisdom to hold on to the present positions until we have ascertained whether the enemy has really surrendered; and if he still holds out, let us inquire whether a different system of tactics would not promise better success. Let us not then abandon our present posts until we ascertain that our objects are accomplished, or until it is clear that success is not to be expected.

In the progress of my own researches, I have been particularly impressed with the importance of the observatory at Toronto. In an article published in the 'American Journal of Science,' vol. xliii. p. 93, I attempted to determine the annual change of dip in the United States; I found the materials for this investigation exceedingly meagre. It is of the utmost importance that there should be a few central stations where the mean annual motions of all the magnetic elements are accurately measured, as only in this way can observations made at scattered stations be reduced to a common epoch.

The meteorological observations made at Toronto are perhaps no less important than the magnetic. Having lately undertaken to investigate two storms which occurred in February 1842, my attention has been particularly called to this subject. I collected observations as far as practicable from every part of the United States and the adjoining British possessions. The observations at Toronto were pre-eminent for their accuracy and completeness; they were made every two hours of the twenty-four, whereas at few other stations were there more than three or four daily observations. I attempted to analyse the phænomena on a somewhat novel plan, which rendered the utmost accuracy desirable in all the observations of the barometer, thermometer, wind, &c. It is believed that a continuance of these observations promises important results to the science of meteorology. Observers are now organized all over the United States, so that any storm which is embraced within our limits can be pretty fully investigated. But our great winter storms, whose features are the most strongly marked, and which are therefore best suited to inquiries of this kind, are of vast dimensions. On the morning of Feb. 3, 1842, rain was falling throughout nearly every portion of the United States, from an unknown distance in the Atlantic to far beyond the Mississippi, and from the Gulf of Mexico northward to an unknown distance beyond Lake Superior. The area upon which rain is ascertained to have been simultaneously falling was more than 1400 miles in a north and south direction. Now in order to exhibit a complete analysis of a storm, we need observations embracing its *whole extent*, otherwise we are obliged to supply deficiencies by conjecture. But almost all our great winter storms project over the British possessions on the north of us to an unknown extent; that is, it is seldom we have an opportunity to investigate the phænomena of a great storm on its northern limit. The storms extend northward beyond our present posts of observation. We have one station at Sault St. Mary, latitude 46° 29′ N., but this is not sufficiently remote. We want a chain of meteorological posts extending indefinitely northward from the great lakes across the British possessions. There is nothing which would hold out a prospect of so rich a harvest to American meteorology as the establishment of such a chain of posts; this can only be effected through the agency of the British government. It would be desirable to have stations at intervals of 100 miles extending northward to the furthest outpost of civilization. Ten pounds will provide a station with instruments, and with a little pains-taking, competent men might probably be found to make the observations gratuitously. The United States are admirably situated for a grand meteorological crusade. We have here a vast territory, covered by a population all speaking the same language. We have more than a hundred observers who are now keeping registers, besides the observations at sixty military posts, mostly situated on the frontier. With a generous cooperation on the part of the British government in procuring registers from their extensive possessions north of the United States, our own observers would be inspired with new enthusiasm, and we might speedily hope for richer conquests than have been hitherto known in the domain of meteorology. Moreover, the progress made in American meteorology is not exclusively of local value; a law of nature in America must be a law in Europe; so that every new principle here developed is the common property of the scientific world.

With much respect I remain, yours truly,

Elias Loomis.

V. *Dr. Lamont, Director of the Magnetical and Meteorological Observatory at Munich, to Lieut.-Col. Sabine.*

Munich, March 1, 1845.

My dear Sir,—In reply to the letter addressed to me by the Committee of the British Association appointed to conduct the cooperation of the Association with regard to magnetic observatories, I have in the first place to regret, that, with the exception of one volume of the 'Greenwich Observations,' and the first part of the 'Observations on Days of unusual Magnetic Disturbance,' no observations made at the British or colonial observatories have come to my knowledge; and though from the dispositions that have been made I have no doubt that the results will be found to answer the different purposes of theoretical investigation, yet I cannot consider myself entitled to express as yet any positive opinion on the subject*.

The same question however that is now to be decided by the Committee of the British Association, viz. whether and in what manner the magnetic observations ought to be continued after 1845, I have been for some time considering myself with regard to our own observatory, and after a careful review of our results, and others that have come to my knowledge, I have resolved on the following plan:—

1. At the end of this year I will give up the present system of two-hourly observations, and will make only three or four observations a-day; the times of observation to be disposed in such a manner as will seem most advantageous for obtaining the *daily range* and the *monthly means*. As for the term days, they were observed at Munich only to the end of 1842, and then discontinued, from the reasons I mentioned in my report to the Academy (published in the 'Gelehrte Anzeigen'); the same reasons are also mentioned in the 'Bulletins de l'Académie Royale de Bruxelles' (vol. x. p. i. 178).

2. I will determine the absolute values of the different magnetic elements from time to time as has been done hitherto, both in the observatory and its immediate vicinity, and will endeavour to extend my observations to other parts of the country as far as circumstances will permit.

3. Investigations respecting the construction of instruments and the methods of observation will be continued. It would, in my opinion, be a great advantage to science, and is also I believe possible, to render the results less liable to error and the methods more simple than they now are.

4. I will endeavour to have the magnetic observatory kept exactly in its present state with regard to the instruments and their arrangement, in order that, if any circumstance be afterwards found to have influence on the observations, the amount may be determined and the results corrected. Causes of error might yet be discovered, the effects of which it would be impossible to determine, except with the same instrument and in the same place.

I have given this account of the system I myself intend to pursue, in order that the Committee may judge how far it might seem expedient to arrange the British and colonial observatories for two or three years to come on a similar plan, reducing at the same time the personal establishment to one or two assistants besides the director. On computing my own observations and those

* Dr. Lamont's opinion on this subject is contained in a subsequent letter, No. XVII.

of different other places, I have lately remarked a circumstance that seems to me in the present discussion not unworthy of attention, viz. that the *form* of the daily curves, as given by the monthly means, is nearly the same every year, while the *magnitude* of the curves or the mean daily range differs considerably from one year to another; thus, for instance, the curve representing the daily changes of declination for the month of August 1841 resembles very nearly the curve of the same month in 1842, but the ordinates in the former year are much greater; in other words, the *law* according to which the sun produced the daily changes was the same in both years, but the *force* (represented by the ordinates, the greatest of which is equal to the daily range) was not the same. On this account the daily range may be considered as the most important magnetic element; and what is most likely to lead us to a discovery of the causes of magnetic phænomena is a careful investigation of the circumstances (probably meteorological) on which the daily range depends. Similar considerations apply to the secular changes, which present remarkable irregularities from one month to another; these irregularities (not the secular change itself) are probably connected with the same or similar causes as the differences of the daily range. I intend, as I mentioned before, that the observations of our establishment shall be for some years to come particularly directed to these points; and I am inclined to suppose that a similar system, if followed in the British and colonial observatories, would prove not only in this, but also in other respects, beneficial to the magnetic inquiry. The daily work of magnetic observatories has been hitherto so considerable, that little time was afforded for different minute investigations, that nevertheless are of great importance for the final results. By diminishing the daily work as I have mentioned, ample time will be afforded for various investigations respecting instruments, methods and probable errors; the different methods of determining the absolute horizontal force and inclination may be tried and the results compared; the constants of the instruments may be determined by repeated experiments and the probable errors ascertained; experiments may be made to determine the effects of the temperature and moisture of the air on the suspension, the difference between the temperature indicated by the thermometer of the bifilar and the true temperature of the bar, together with the corrections depending on this difference, &c. Besides, if the observations (which I would think it important to publish with as little delay as possible) should at any place show anomalies or peculiarities, new observations may be made to any extent that may seem necessary for obtaining a decisive result. These I believe are the considerations that may be urged for continuing all the magnetic establishments as they now are, but on a reduced scale. As to the question whether the present system of observations should be continued without alteration, I will simply express my opinion that I do not think it advisable, and will not attempt to give reasons for this opinion, because I believe I agree on this point with all those who have taken active part in the magnetic inquiry.

There is one point alluded to in the letter of the Committee on which I will add a few words; I mean the powerful influence which the example of the British government has had in promoting in other countries the important branch of science now under consideration. A general interest in the progress of science, and, above all, a willingness evinced in almost every country to take part in scientific enterprises that seem to require *general cooperation*, may be considered as characteristic of the present time, at least the effects have not at any former period been so conspicuously manifested. A plan of great utility for science, if judiciously arranged and once realized to a certain extent, can scarcely fail to obtain not only the support of scientific men in every quarter, but also the countenance of the governments, which in most countries is indispensable for every great undertaking. In establishing a chain of regular magnetic observatories to be extended over the different parts of the globe, the first and most powerful impulse was given in England; and I think it may be justly asserted, that all that has been done in magnetism during the last six years is in some degree to be attributed to the example of the British government, and the zeal and energy with which the vast enterprise, once resolved upon, was carried into effect.

Believe me, my dear Sir, yours most sincerely,

LAMONT.

P.S. I do not think that I have been able to answer satisfactorily any of the questions proposed by the Committee; if however it were thought expedient to publish any part of this letter, I have no objection.

VI. *From Professor Dove of Berlin to Lieut.-Col. Sabine.*

Berlin, März 1, 1845.

DEAR SIR,—Die Antwort auf die von Sir John Herschel mir vorgelegten Fragen habe ich deutsch beantwortet, da jeder sich in seiner Muttersprache wohl am praecisesten ausdrückt. Ich hoffe, dass sie noch zu rechter Zeit in London ankommen werden, obgleich seit einigen Tagen alle unsre Eisenbahnen in Schnee vergraben sind und selbst vermittelst des Militärs noch nicht haben frei gemacht werden können. Ich sage Ihnen meinen herzlichen Dank für die mir aüsserst interessante Schrift 'Meteorology of Toronto,' in der Sie so freundlich meiner Arbeiten gedacht haben. Auch danke ich Hr. Riddell freundichst für die übersendeten Magnetical Instructions. Leider habe ich nichts entgegenzusenden, da der vierte Theil meines "Non-periodic Variations in the Distribution of Temperature on the surface of the Earth between 1729 and 1843," erst im Laufe des Sommers erscheinen wird.

In dem Briefe von Sir John Herschel erfahre ich, dass an mich a volume of Extraordinary Magnetic Disturbances at the British Government Stations, and the 1st volume of the 'Greenwich Observations' abgesendet worden sind, und dass ich the 1st volume of the 'Observations at the British Government Stations,' and the 2nd of those at Greenwich, erhalten werde. Leider habe ich nur die Magnetic Disturbances erhalten, wofür ich meinen herzlichen Dank abstatte.

Sollte es gewünscht werden, dass ich an den Berechnungen der meteorologischen Observationen Antheil nehme, so stelle ich meine Thätigkeit gern zur Disposition des Committee.

Bei den non-periodic variations habe ich oft Gelegenheit gehabt, zu bedauern, dass mir in England erschienene Beobachtungs-journale nicht zugänglich waren. Sollte es nicht möglich seyn, dass jemand im Auftrage des British Association eine Climatologie von England schreibe, in welche die monatliche Mittel der einzelnen Jahre der verschiedenen Beobachtungs-stationen abgedruckt würden, wozu meine Arbeit doch bereits eine Vorarbeit ist. Sollte es ferner nicht zweckmässig seyn, wenn meteorologische Journale, welche den Transactions der Learned Societies und den philosophical Journals beigedruckt werden, in mehr Exemplaren abgezogen würden um nachher als selbstständige Jahrgänge in Druck zu kommen. Wie unendlich viel Zeit würde gewonnen werden, wenn man nicht mehr gezwungen wäre sich jeden einzelnen Monat in einem besondern Bande aufzusuchen, der, wenn er in einer öffentlichen Bibliothek gerade verliehen ist eine Arbeit oft Monate lang unterbricht. Ein von der British Association ausgehender Vorschlag würde dann wohl auch in andern Ländern Nachahmung findern, und man würde in der Folge schneller die Wissenschaft durch Arbeiten fördern können.

I have the honour to be, with the highest consideration,

Your very obedient servant, H. W. Dove.

Die Aufgabe, welche meteorologische Observatorien zu lösen haben, ist eine dreifache, sie sollen die mittlern Werthe liefern, die empirischen Gesetze ihrer periodischen Veränderungen, endlich Data an die Hand geben, um die gleichzeitige Verbreitung einer meteorologischen Erscheinung und ihr Fortschreiten über die Oberfläche der Erde auffinden zu können.

Da die Mittel nur nach Elimination der periodischen Veränderungen erhalten werden können, so kommt es zunächst auf die Feststellung dieser an. Dazu sind stündliche Beobachtungen unerlässlich, für Temperatur, Druck und Feuchtigkeit. Da aber der Spielraum der täglichen Oscillationen bei trübem Wetter viel geringer als bei heiterm, der Gang der täglichen barometrischen Veränderungen in beiden Fällen sogar ein verschiedener, so scheinen zur Feststellung der Gesetze derselben mehrere Jahre unerlässlich. Auch können nur mehrere Jahre die nöthigen Correctionselemente geben, um aus der Beobachtung einzelner Stunden die monatlichen Mittel der drei oben erwähnten Grössen (Temperatur, Druck, Feuchtigkeit) zu berechnen. Ich glaube dass bei dem jetzigen Standpunkt der Wissenschaft zweijährige stündliche Beobachtungen schon ein sehr werthvolles Material liefern, und dass fünfjährige den Anforderungen wohl vollständig genügen.

Was die Veränderungen in der jährlichen Periode betrifft, so haben die dreimonatlichen Abschnitte, welche man in der Regel meteorologische Jahreszeiten nennt, nur für gewisse geographische Breiten diese Bedeutung, während sie für andre Breiten heterogenes verbinden und zusammengehöriges auseinander reissen. Ich halte es daher für nothwendig überall bis auf monatliche Mittel zurückzugehen. Da aber mit der Verkürzung des Zeitraumes seine Veränderlichkeit wächst, so wird eine länger fortgesetzte Beobachtungsreihe hier erst sichre Elemente geben. Da aber ein System stündlicher Beobachtungen nicht so lange fortgesetzt werden kann, so werden an die Stelle derselben Beobachtungen einzelner Stunden treten müssen. Welche sind zu wählen?

Will man die Gesetze der täglichen Veränderungen hierbei noch im Auge behalten, so wird die Wahl gleichweit von einander abstehender Stunden wünschenswerth seyn, weil empirische Formeln, die ihren Gang darstellen sollen, am bequemsten aus diesen berechnet werden können. Wie aber auch diese gewählt werden mögen, immer werden einige in die Nacht also unbequem fallen. So wie aber die Nachtbeobachtungen wegfallen verliert man den Vortheil der Theilung der täglichen Periode in gleiche Abschnitte.

Die Stunden 6, 9, 12, 3, 6, 9, oder 9, 12, 3, 9, sind mit Rücksicht auf die barometrischen Oscillationen gewählt, sie sind für die Berechnung der mittleren Temperatur $\frac{9+9}{2}$ ebenfalls bequem. Was aber die Rücksicht auf das Barometer betrifft, so halte ich es für erwiesen, dass man es hier mit der Differenz zweier Veränderungen zu thun hat, und dass es daher grösseres Interesse hat, die täglichen Extreme der Veränderungen des Druckes der trocknen Luft und der Elasticität der ihr beigemengten Wasserdämpfe gesondert zu kennen. Da aber die Stunden 3, 9, 3, 9, in dem Report of the Committee of Physics, including meteorology, empfohlen sind, so halte ich es für gut sie beizubehalten. Nach meiner Ansicht nämlich ist es vorzuziehen, einen einmal gefassten Beobachtungsplan consequent fortzufuhren, als ihn zu verändern, selbst wenn sich später herausstellen sollte, dass für gewisse Zwecke andre Stunden vorzuziehen gewesen wären. Denn die Hauptsache bei der Beantwortung einer meteorologischen Frage bleibt immer, über eine möglichst lange Reihe gleichartiger Beobachtungen disponiren zu können.

Meine Antwort auf die Frage 3, "would you be disposed to recommend any modification, extension or alteration in the system of observing or in the apparatus to be employed," würde also verneinend seyn.

Ad I. "What important objects are to be accomplished by the continuance of the existing establishments for a longer period," erlaube ich mir folgende Bemerkungen:

Wir besitzen von keinem Punkte der südlichen Halbkugel, von keinem Punkte in Nordamerika eine barometrische, thermische oder atmische Windrose, keine Berechnung der vom Drehungsgesetze des Windes abhängigen Veränderungen des Barometers, Thermometers und Hygrometers, die sich auf eine hinlängliche Anzahl von Beobachtungen gründet. Ich würde es für einen wesentlichen Dienst der Wissenschaft halten, wenn auch nur von einem extratropischen Station der südlichen Halbkugel und einer aus Nordamerika eine 5- oder 10-jährige Reihe dreimal täglich angestellter Beobachtungen des Barometers, Thermometers, Hygrometers der Windesrichtung und des Regens vorhanden wäre, um den Einfluss des auf der südlichen Erdhälfte entgegengesetzten Drehungsgesetzes und der Lage des Continentes gegen das Meer scharf bestimmen zu können. Der Gang des Barometers in der jährlichen Periode, die Vertheilung der Regenmenge innerhalb derselben sind ebenfalls wichtige Fragen, welche dadurch ihre Beantwortung erhalten würden. Freilich müssten dazu mehrere Stationen mit einander verglichen werden.

Ich erlaube mir hier noch einige Fragen anzudeuten, welche wenn sie auch nicht durch die bisherigen Stationen erledigt werden, dennoch ihrer Beantwortung näher rücken würden.

1. Die an der aüssern Grenze des N.E. Passats herabfallenden Winterregen verwandeln sich in Südeuropa in ein Frühlings- und Herbstmaximum, welche während des Winters durch schwächere Niederschläge verbunden sind. An den Alpen fallen diese beiden Maxima zusammen in ein Sommermaximum; von da nach Norden hin findet eine regenlose Zeit im Jahre nicht mehr statt, indem überall im Innern des Continents bis nach Holland hin das Maximum auf dem Sommer fällt. Finden ähnliche Verhältnisse auf der Südhälfte der Erde statt?

2. Die Vertheilung des atmosphärischen Druckes in der jährlichen Periode giebt wohl das sicherste Mittel darüber zu entscheiden, ob ein in der Region der Passate oder Monsoons liegender Ort meteorologisch zur Südhälfte oder Nordhälfte der Erde gehört. Wo liegt diese Grenze und wie breit ist unter verschiedenen Längen die indifferente Zone, welche als diese Grenze anzusehen ist?

3. Die sogenannten unregelmässigen Veränderungen des Barometers werden von einigen nur als Wirkungen verschieden temperirter und ungleich feuchter Luftströme angesehn, andere unterscheiden hingegen die Wirkung der Ströme von der Wirkung nach Art der Tonwellen fortschreitender Undulationen, welche sich über sehr grosse Theile der Erdfläche mit erheblicher Geschwindigkeit fortpflanzen. Aus der letzen Annahme scheint mir zufolgen:

a. dass sie sich nicht einseitig nach einer Richtung fortpflanzen werden, sondern peripherisch.

b. dass sie aus der gemässigten Zone auch in die heisse dringen müssen.

c. dass sie zu Interferenzerscheinungen Veranlassung geben werden.

Die Beobachtungen an einzelnen Tagen (stündlich) können daruber entscheiden welche Ansicht die richtige.

4. Nachdem durch Untersuchungen über die nichtperiodischen Veränderungen der Temperaturvertheilung auf der Oberfläche der Erde, sich herausgestellt hat, dass keine ungewöhnliche Kälte irgendwo hervortritt ohne ein entgegengesetztes Extrem einer ungewöhnlichen Wärme als Compensation neben sich zu haben fragt sich

a. ob diese Gegensätze stets auf einer Erdhälfte sich finden

b. oder ob auch solche Gegensätze zwischen beiden Erdhälften stattfinden?

5. Findet in der Gegend des Monsoons nach den aüssern Grenzen hin eine Zunahme des mittleren jährlichen atmosphärischen Druckes statt, wie in der Passatzone?

6. Ist man berechtigt, bei der Vertheilung des mittleren atmosphärischen Druckes auf der Oberfläche der Erde den Druck der troknen Luft zu sondern von dem der Dampfatmosphäre, wie es sich bei der Betrachtung der periodischen Veränderungen als erfolgreich ergeben hat?

Die Frage II. Do you consider that private research has to any successful and valuable degree been estimated by the example of the government establishment in Europe and elsewhere, and that science has thereby received material contributions, which would probably not otherwise have arisen, and can you state instances? glaube ich mit Ja beantworten zu können.

Die Wirkung grossartiger wissenschaftlicher Unternehmungen ist eine nachhaltige, nicht auf die Gegenwart beschränkte. Was wäre die Meteorologie ohne die Mannheimer Societät, welche es zuerst möglich machte, atmosphärische Erscheinungen mit verglichenen Instrumenten durch gleichzeitige Beobachtungen einer schärfern Prufung zu unterwerfen. Welche wichtigen wissenschaftlichen Arbeiten sind auf diese Collectanen gegründet worden. Aber diese Arbeiten datiren alle aus einer viel spätern Zeit als die ihrer Wirksamkeit. Daher würde es nicht auffallend seyn, wenn die jetzt wahrnehmbare Folgen des jetzigen Unternehmens noch unerheblich wären. Doch ist diess nicht. Die Feststellung dass die aus der Gegend des Monsoons früher bekannte periodische Veränderung des atmosphärischen Druckes im Verlauf des Jahres sich auf ganz Centralasien erstrecke (wie ich ausführlich in Pogg. Annal. 58, p. 176, gezeigt habe) und die vollständige Sonderung des continentalen Klima vom Seeklima ist eine Entdeckung, welche wir den russischen Observatorien verdanken ebenso wie die Möglichkeit in der heissen Zone die täglichen Aenderungen des Barometers in die constituirenden Elemente (Dampf und trockne Luft) zu zerlegen, nur den englischen Observatorien zu verdanken ist. Das wichtige Resultat der allgemeinen Verbreitung eines geringen atmosphärischen Druckes vom Cap Horn bis in die südarktischen Gegenden ist endlich das dritte erhebliche meteorologische Resultat, welches ohne die Südpolarexpedition noch lange unbekannt geblieben wäre. Rechnet man dazu, wie vielversprechend das System gleichzeitiger Beobachtungen ist, welches Hr. Lamont gegründet hat, wie in den von Hrn. Herschel und Quetelet gesammelten und veranlassten stündlichen Beobachtungen Data vorhanden sind, einzelne auffallende Phænomene in erwünschten Detail zu controlliren, so glaube ich wohl kaum noch hinzufügen zu dürfen, dass jeder, welcher seine Thätigkeit vorzugsweise der Meteorologie zugewendet hat, nun im Stande sich fühlt, Probleme von Neuem aufzunehmen, deren Lösung er einer viel spätern Zeit vorbehalten glaubte.

Meine schliessliche Ueberzeugung ist daher, dass vorzugsweise durch längere Fortsetzung der systematischen Beobachtungen der Wissenschaft die erheblichste Dienst geleistet werden wird.

H. W. Dove.

Vorstehende Bemerkungen, so unbedeutend sie sind, stelle ich ganz zur

Disposition des Committee indem ich zugleich mich zu entschuldigen bitte, dass ich sie deutsch geschrieben habe, um meine Ansicht mit der Bestimmtheit auszudrücken, wie sie jedem in seiner Muttersprache gegeben ist.

(*Translation.*)

Berlin, 1st March 1845.

Dear Sir,—I have answered the questions proposed to me by Sir John Herschel in German, because every one can express himself with greater precision in his native language than in any other. I hope my letter will arrive in sufficient time, although all our railways have been for some days buried in snow, and are not yet opened even by the exertions of the military. I return you my hearty thanks for the to me exceedingly interesting paper, 'Meteorology of Toronto,' in which you have so kindly referred to my works. Pray also give Mr. Riddell my very friendly thanks for 'Magnetical Instructions.' I am sorry I have nothing to send in return, as the fourth part of my 'Non-periodic Variations in the Distribution of Temperature on the Surface of the Earth between 1729 and 1843,' will only appear in the course of the summer.

From Sir John Herschel's letter, I perceive that a volume of 'Extraordinary Magnetic Disturbances at the British Government Stations,' and the first volume of the 'Greenwich Observations,' have been sent to me, and that I am to receive the first volume of the 'Observations at the British Government Stations,' and the second volume of the 'Greenwich Observations.' Unfortunately I have received only the 'Magnetic Disturbances,' for which I return my cordial thanks. Should it be wished that I should take part in the calculations of the meteorological observations, I place my activity entirely at the disposal of the Committee.

In the study of the non-periodic variations, I have often had occasion to regret that the journals of observations published in England were not accessible to me. Would it not be possible that some one should undertake, at the request of the British Association, a Climatology of England, in which the monthly means of the several years at the different observation stations should be printed, for which my work is even already a preparatory work? Would it not further be very advantageous if the meteorological journals which are printed to accompany the Transactions of Learned Societies and Philosophical Journals had more copies taken off, that they might afterwards be bound up in complete and independent years? What an infinity of time would be saved if one was no longer forced to look for every single month in a different volume, which, if it happens to be lent away from a public library, often interrupts a work for months! A proposition emanating from the British Association would soon be imitated in other countries as well, and we should then be enabled to advance science more quickly.

I have the honour to be, with the highest consideration,

Your very obedient servant,

(Signed) H. W. Dove.

The problem to be solved by meteorological observations is a threefold one: they are to give mean values, empirical laws for the periodic variations of these values, and finally, to furnish data for tracing the simultaneous extension and the progressive march of a meteorological phænomenon over the surface of the earth.

As the mean quantities can only be obtained after the elimination of periodical variations, the determination of the latter is directly demanded for both these objects, and hourly observations of temperature, pressure, and humidity are indispensable for this purpose. As the range of the diurnal variations is much less in clouded than in clear weather, and the diurnal march of the barometer is even different in the two cases, more years than one appear to be indispensable for the establishment of their laws; more years than one are also required to give the necessary elements of correction for calculating the monthly means of temperature, pressure, and humidity, from the observations at the several hours. I believe that in the present state of science, even two years of hourly observation will give us very valuable materials, and that five years will completely satisfy what is required in this respect. In regard to variations within the annual period, the three monthly sections ordinarily employed as meteorological seasons, are only truly such for certain latitudes; in other latitudes they combine heterogeneous data and dissever corresponding ones; I therefore hold it better to return everywhere to monthly means; but as the shortening of the intervals increases their variability, a longer continued series becomes necessary to give assured elements. As however the system of hourly observations cannot be continued so long, certain hours must be selected; which are they to be?

If it is desired to keep the laws of the diurnal variations still in view, hours at equal intervals will be desirable for the convenience of empirical formulæ; but this would necessitate the inconvenience of night observation; and if this is avoided, the advantage of equal intervals must be given up.

The hours of 6, 9, 12, 3, 6, 9, or 9, 12, 3, 9, have been chosen with a view to the barometric oscillations; they are also convenient for the calculation of the mean temperature. But as respects the barometer, I regard it as proved that we have here to do with the difference of two variations, and that it is therefore of greater interest to learn separately the daily extremes of the variations of the pressure of the dry air and of the elasticity of the aqueous vapour mingled therein. As however the hours 3, 9, 3, 9 have been recommended in the 'Report of the Committee of Physics,' I hold it good to keep to them, thinking it better to continue consistently a system of observation once begun than to alter it, even though it be afterwards shown that other hours are preferable for certain objects: the command of as long a series as possible of precisely similar observations is always that which is chiefly to be desired for the solution of a meteorological question.

To question 3, "Would you be disposed to recommend any modification," &c. &c., my answer would therefore be negative.

To question 1, "What important objects are to be accomplished by the continuance of the existing establishments for a longer period," I permit myself the following remarks:—

We possess from no point of the southern hemisphere, and from no point in North America, a barometric, thermic, or atmic windrose, no calculation of the variations of the barometer, thermometer, and hygrometer, dependent on the law of rotation of the wind, founded on a sufficient number of observations. I should regard it as an essential service to science, if from only one extra-tropical station in the southern hemisphere, and from one in North America, we had a five or ten years series of observations three times a day of the barometer, thermometer, and hygrometer, direction of the wind, and quantity of rain; to enable us to determine the question of the opposite law of rotation in the southern hemisphere, and the influence of the relative position of continent and sea. The annual march of the barometer and annual distribution of the quantity of rain are also important questions which would thus be answered. It would however require the intercomparison of different stations.

I will now permit myself to allude to some questions, which if not solved by the stations hitherto established, will be at least brought nearer to a solution.

1. The winter rain which falls at the external limit of the N.E. trade, is changed in southern Europe to a spring and autumn maximum, connected by a less precipitation in winter; these two maxima, when we come to the Alps, join themselves to form a summer maximum, and from thence northwards we find no season free from rain; everywhere on the interior of the continent and as far as Holland the maximum is in summer. Does the southern hemisphere show similar relations?

2. The annual distribution of the atmospheric pressure gives the most certain means of deciding whether a station within the region of trades or of monsoons belongs meteorologically to the northern or to the southern half of the globe. Where lies this limit, and how broad under different meridians is the indifferent zone, which is to be regarded as this limit?

3. The so-called irregular variations of the barometer are regarded by some persons as only the effects of currents of air of unequal temperature and moisture; other persons distinguish the effect of currents from the effect of undulations progressing in the manner of waves of sound, and propagating themselves with great velocity over large portions of the earth's surface.

From the latter hypothesis the consequences appear to me to be,—

a. That they will not propagate themselves towards one side, but peripherically.

b. That they must penetrate from the temperate into the torrid zone also.

c. That they will give rise to phænomena of interference.

Hourly observations on single days are capable of showing which view is correct.

4. Investigations on the non-periodic variations of the distribution of temperature on the surface of the earth having shown that no unusual cold takes place anywhere without an unusual warmth by its side as a compensation, we ask,—

a. Whether these oppositions are always in the same hemisphere?

b. Or whether similar oppositions exist also between the two hemispheres?

5. Is there towards the outer limits of the monsoons an increase of the mean annual atmospheric pressure as in the trade zones?

6. Are we justified, in regard to the distribution of the mean atmospheric pressure on the surface of the earth, in distinguishing the pressure of the dry air from that of the atmosphere of vapour in the manner which in the consideration of the periodical variations has shown itself fruitful in consequences?

To question 2, "Do you consider that private research has," &c., I think I may answer,—The effect of great scientific undertakings is an enduring one, not limited to the present. What would meteorology have been without the Manheim Society, which first made it possible to subject to a closer examination simultaneous observations made with compared instruments? What important scientific works are founded on these collections! yet these works all belong to a period much later than that of the activity of the system of the Manheim Society. It would not therefore be surprising if we could not yet see any important consequences from the present undertaking. It is not so however: the fact that the previously-known periodic annual variation of the atmospheric pressure in the region of the monsoons extends from thence to the whole of central Asia (as I have shown in detail in Pogg. Annal, 58, p. 176), and the complete distinction of the continental from the sea climate, are a discovery for which we have to thank the Russian observatories. The possibility within the torrid zone of resolving the diurnal variations of the barometer into their coexistent elements (vapour and dry air) is due to the

English observatories. A third important meteorological result, which would have remained long unknown to us without the Antarctic Expedition, is the general extension of a low atmospheric pressure from Cape Horn to the Antarctic regions. If we include also the much-promising system of simultaneous observation founded by Lamont, and the data which, in the hourly observations called for and collected by Herschel and Quetelet, exist for controlling with the desired detail single striking phænomena, I believe that I need hardly add, that every one who has devoted his activity to meteorology now feels himself in the case to take up afresh problems of which he formerly believed the solution to be reserved for a much later period.

In conclusion, my conviction is that by longer continuance, especially of the systematic observations, the greatest service will be rendered to science.

(Signed) H. W. Dove.

I place entirely at the disposal of the Committee the foregoing remarks, inconsiderable as they are, and I ask them to excuse my having written them in German, in order to express my views with that definiteness which it is given to every one to do in his mother tongue.

VII. *M. Quetelet of Brussels to Lieut.-Col. Sabine.*

Bruxelles, le 5 Mars, 1845.

Mon cher Monsieur,—Je me hate d'accuser réception de votre lettre du 6 Décembre dernier, qui ne m'est parvenue que depuis trois jours, avec le premier volume des 'Observations de Toronto.' Je regrette vivement que le retard qu'a éprouvé votre lettre, et le peu de jours qui nous séparent du 10 Mars, ne me permettront que de repondre partiellement aux questions que vous m'avez fait l'honneur de m'adresser.

1°. En ce qui concerne la première demande, il me serait bien difficile de juger dès à présent de tous les avantages que la science pourrait retirer de la continuation du système des observations magnétiques actuellement existant, je n'ai pas encore été à même d'établir des comparaisons entre les observations de l'Europe et celles des autres parties du globe, et de juger si les resultats qu'on était en droit d'attendre de l'Association si heureusement constituée, sont suffisamment réalisés, pour qu'on puisse renoncer désormais à en recueillir encore.

Il est un point cependant dont je me suis occupé, et sur lequel je me permettrai d'attirer l'attention du comité; je veux parler du système des observations météorologiques. Malgré les efforts persévérants de quelques savants, parmi lesquels il faut surtout ranger votre digne Président, nos connaissances sur le mouvement des ondes atmosphériques sont encore bien bornées. Nous ne savons à-peu-près rien sur les lieux où ces ondes se forment, sur la manière dont elles se propagent, sur les directions qu'elles suivent plus particulièrement, sur leur vitesse de translation, sur les modifications que leur font subir la forme et la nature des aspérités du globe ainsi que les vents; en un mot, nous sommes dans l'impossibilité de construire une carte qui lie entr'eux les mouvements propagés à travers l'atmosphère; nous ne savons pas même si une pareille carte est possible. Pour expliquer ma pensée, je suppose qu'on réprésente au moyen de lignes, les oscillations atmosphériques, accusées par le baromètre, en faisant usage des observations qui s'exécutent de deux en deux heures, à Greenwich, Dublin, Edimbourg, Bruxelles, Munich, Prague, St. Pétersbourg, et les autres villes qui ont adopté le système d'observation proposé par la Société Royale, on se trouvera dans l'impossibilité de lier entre elles les diverses oscillations par la loi de continuité. Entre

Prague et St. Pétersbourg par exemple, la distance est trop grande pour qu'on puisse reconnaître les ondulations qui sont dues aux mêmes causes. Les mouvements se trouvent presqu'entièrement modifiés en passant de l'une a l'autre ville; et rien sur le passage ne constate ces modifications. On pourrait y suppléer, en prenant des stations intermédiares, où l'on observerait ne fut ce qu'une fois par jour pour établir la continuité, car les sommets consécutifs de deux ondes atmosphériques sont séparés en général par plusieurs jours d'intervalle; or, ce système secondaire qui rattacherait ensemble les points du réseau principal, n'existe pas même pour l'Europe; et par suite il est à craindre que nous ne puissions tirer des observations actuelles, que des bien faibles secours pour résoudre la question qui nous occupe.

Des observations isolées sur les variations de pressions atmosphériques de température, etc. pourront toujours se faire à une époque quelconque; mais il n'existera peut-être plus jamais une occasion aussi favorable pour embrasser dans leur géneralité plusieurs importantes questions de la physique du globe, et particulièrement l'intéressant problême de la formation et de la transmission des ondes atmosphériques.

Je pense donc que, dans le cas où l'existence de l'association serait prolongée, le comité rendrait le service le plus important, si autour des grands points du réseau météorologique qu'on est parvenu à former, elle établissait, dans les localités qui le permettraient et notamment dans toute l'Europe, un réseau secondaire de points séparés par des intervalles de 60 à 80 lieues seulement, et où l'on se bornerait à observer ne fut ce qu'une seule fois par jour à une heure déterminée. Ces observations suffiraient pour établir la continuité entre les observations des stations principales, et pour leur donner une connection d'utilité que malheureusement elles n'ont pas à present. Assez d'observateurs zélés repondraient sans doute à l'appel qui leur serait fait.

2°. Vous avez bien voulu me demander encore si je pense que l'exemple du gouvernement Britannique a pu faire naître des recherches particulières, et provoquer des travaux qui n'auraient pas été faits autrement? Votre question m'autorise à citer ce qui s'est passé en Belgique; ce n'est qu'en m'appuyant sur l'invitation que la Société Royale m'avait fait l'honneur de m'adresser, que j'ai obtenu du gouvernement, les aides et les moyens nécessaires pour entreprendre une série d'observations qui manquaient complètement pour notre royaume. Nous ne connaissions absolument rien sur les variations diurnes et annuelles qui subissent, chez nous, les élémens magnétiques du globe. Pour la météorologie, nous avons pu recueillir également un ensemble d'observations qui ne sont pas sans importance pour la connaissance de notre climat. L'appel qui nous a été fait, a donc eu d'heureux resultats pour la science, en dehors même de son objet spécial; car j'ignore encore si ces pénibles travaux répondront au but que le comité s'était proposé en les demandant; il ne m'appartient pas de décider cette question.

3°. J'ai répondu en partie à la troisième demande du comité, en lui proposant de rattacher au grand réseau météorologique actuellement existant, un réseau secondaire, formé de triangles n'ayant que 60 à 80 lieues de côté.

Quant aux instruments qu'on pourrait employer avec succès, je crois devoir specialement recommender l'électromètre de M. Peltier, dont je me sers depuis quelque temps avec le plus grand avantage. Cet instrument extrêmement sensible accuse l'electricité de l'air avec plus de sureté que tous les autres instruments que j'ai employés; il fonctionne rapidement et a l'avantage de donner des résultats comparables. Conjointement avec cette électromètre, nous observons un galvanomètre de Gourjon; mais cet instrument, malgré son extrème sensibilité, ne parle guères qu'à l'approche des orages, et pendant les grandes commotions atmosphériques. Vous jugerez sans doute que l'electricité joue un trop grande rôle dans les phénomènes météorologiques pour qu'on ne lui accorda pas la plus sérieuse attention.

Depuis 1839, aux observations météorologiques, je joins des observations sur la floraison des plantes, et en général sur les phénomènes périodiques naturels. À la reunion de l'association Britannique à Plymouth, j'ai appelé l'attention des observateurs sur ce genre d'études ; je me permettrai de le faire encore auprès du comité, bien persuadé que si l'on se bornait à enregistrer les phénomènes les plus frappants, et les plus faciles à observer, on en retirerait des avantages réels pour la science, et l'on completerait le système des observations relatives aux phénomènes qui modifient périodiquement l'état de notre planète.

Permettez-moi d'ajouter encore quelques mots à cette lettre, pour vous faire connaître où en sont les travaux exécutés à l'observatoire de Bruxelles pour repondre aux demandes de la Société Royale. Les observations à termes fixes, pour les trois instruments magnétiques, ont été commencées en Janvier 1840, et continuées régulièrement, de mois en mois, jusqu'à ce jour. Les différents resultats ont été successivement publiés pour 1840, 1841, 1842, et 1843 ; on achève en ce moment l'impression pour 1844.

Les observations magnétiques et météorologiques regulières ont été faites, nuit et jour, de deux en deux heures ; et, de plus, à quelques heures de rang impair, depuis le mois de Juin 1841. Tous les resultats ont été publiés également jusqu'à la fin de 1842 ; et l'on achève d'imprimer ceux de 1843.

Si le comité de l'association se proposait de continuer le système actuel d'observations au delà de 1845, et s'il jugeait encore utile la coopération de l'observatoire de Bruxelles, je serais charmé de pouvoir en être informé à temps, âfin de prendre les mesures nécessaires pour que les travaux n'éprouvent pas d'interruption.

Agréez, je vous prie, mon cher Monsieur, l'expression de mes sentiments les plus distingués et les plus dévoués.

Tout à vous,

QUETELET.

Si vous croyez que la lettre précédente puisse intéresser, je vous prierais de la communiquer au comité qui pourra en faire tel usage qui lui conviendra.

VIII. *Sir T. M. Brisbane to Lieut.-Col. Sabine.*

Makerstoun, Kelso, 7th March, 1845.

SIR,—I beg to acknowledge the receipt of the Toronto Magnetic Observations, accompanied by the inquiries for the information of the Committee appointed in that system of observation. I herewith transmit the replies to these inquiries by Mr. Broun my first assistant, who has evinced the utmost zeal and attention throughout, and he has been steadily supported by the others. Should the government decide on continuing the magnetic and meteorological observations, I shall feel equally disposed to extend those made here, but on this point I shall decide hereafter. I hope shortly to furnish a copy of an abstract made by Professor Forbes, of the paper read to the Royal Society of Edinburgh on these observations; the abstract is short, but shows what has been done. It is now in types, and as soon as I receive it, a copy shall be sent.

I have the honour to be, Sir, your obedient servant,

THOMAS MAKDOUGAL BRISBANE.

From J. A. Broun, Esq., First Assistant in the Magnetical and Meteorological Observatory at Makerstoun.

(*Extract.*)

Query 1. "Whether in your judgement there are *any*, and if so, *what* important objects to be accomplished by a continuance of the existing establishments for a longer period, executing as at present both systematic and simultaneous observations, or either class to the exclusion of the others."

The declination, the easiest ascertained of all the magnetic elements, because unconnected with the varying magnetic moment of the needle, is still mixed up with many errors which we are only discovering. This remark holds much more strongly for the components of intensity. The imperfections of our instruments and methods are only beginning to be ascertained. What shall we say of magnetic disturbances? Have we found out the laws which connect these wonderful irregularities? Have we ascertained their connexion with other terrestrial phænomena, aurora for example?

I am afraid that to these and many other questions of a like nature, the answer would be unsatisfactory. A sifting investigation of the observations already made *may* do much. Dr. Lamont's deductions of the law which seems to connect the excursions of the declination needle at different places during disturbances, while they show what may be done, likewise show how much there is to do.

But are accurate and complete results to be obtained by the allotment of any short period for their determination? No. It is only gradually that we discover error, gradually remove it; time alone can show us what we ought and we need not observe.

I am inclined to believe that it is from a thorough and careful investigation of magnetic disturbances and their collateral phænomena, that we shall first arrive at a solution of the great questions of terrestrial magnetism. To observe disturbances well requires a continuous watch upon the magnetical instruments, and no watch is better than that which hourly or two-hourly observations impose, besides their utility in determining the regular variations.

It has long been my opinion that regular term observations are, at least at present, unnecessary. There is little doubt that magnetic disturbances occur for the most part simultaneously over the whole world; what use then of prearranged periods of observations, when the earth itself telegraphs the time, and the magnets point to the zealous observer, when he should and when he need not observe?

I have spoken chiefly of magnetism, but my remarks will apply equally to meteorology; with it also much has to be done. The work of a few well-placed observatories in a few years will do more for science than all the scattered observations made loosely and irregularly for the last century.

One great use of these observatories should be to co-ordinate the scattered observations made by travellers or others around them; for this purpose there should be some provision for publishing these along with the observations of the observatory, especially when the instruments have been compared and are trustworthy.

To the second query I cannot give any general answer. It may not be amiss, however, to mention this, the Makerstoun Observatory, as a consequence of the foundation of the government observatories, nor to state that hourly magnetical and meteorological observations have been made here throughout 1844, and are being continued in 1845, while a large mass of extra observations have been obtained.

Query 3. "In case of the continuance of the observatories beyond 1845, would you be disposed to recommend any, and what modifications, extensions or alterations in the system of observing, or in the apparatus employed?"

Under *Query* 1, I have pointed out the preference which I would give to extra observations of disturbances, and have recommended the discontinuance at present of term observations.

I am inclined to prefer hourly observations to two-hourly, as the first compared with the second does not add so greatly to the labour of the observer or the computer as might at first appear, at least when the whole work of the observatory is taken into account.

IX. *Dr. Lloyd to Sir John Herschel.*

Trinity College, Dublin, March 8, 1845.

Dear Sir,—I beg to acknowledge the receipt of your letter, on the part of the Magnetic Committee of the British Association, and to reply to its several queries as far as I am able.

The *first* question, viz. "Whether there are *any*, and if so, *what* important objects to be accomplished by a continuance of the existing establishments for a longer period," necessarily suggests the inquiry,—how far the *objects originally proposed* have been attained, or are likely to be attained, by the course of observation now in progress, and terminating with the present year? We may afterwards inquire, whether there are any *new* objects suggested by the results themselves, or otherwise.

In reference to the first inquiry, it will be convenient to keep in mind the distinctions of magnetic determinations into those of the *absolute values* of the direction and intensity of the magnetic force at particular epochs, and those of the *changes* which they are continually undergoing; and again, the subdivision of the latter into *periodic* variations, *secular* changes, and *disturbances.* Of these, the diurnal variations are those whose determination demands the greatest amount of labour, and they are fortunately also those which seem now to be best determined. I am of opinion that five years of uninterrupted hourly or two-hourly observation is fully adequate to the establishment of their empirical laws, with all the requisite precision; and this opinion is confirmed by the examination of the results of two years at the Toronto observatory, recently published.

The knowledge of the *annual* variations of the magnetic elements, and that of their *secular* changes, can be obtained with precision only by means of *absolute* determinations, often repeated at particular epochs, and reduced to their *mean* values by the help of the *differential* instruments. The instrumental means which we at present possess are probably sufficient to furnish the data required in both parts of this delicate deduction with all the necessary exactness; but the difficulty seems to lie in the irregular fluctuations of the elements themselves, or in other words, in the want of regularity in the annual period, and in the progression of the secular change. To eliminate completely the effects of these irregularities, a longer course of observation is probably necessary; but in carrying it on it is by no means requisite that the daily observations should be as numerous as heretofore.

Enough has probably been done to ascertain the more obvious phænomena of *disturbances*, and perhaps also to furnish the principal data for theory. But it is not improbable that the application of theory may suggest or demand additional data respecting them, and other methods of combined observation.

With respect to the *meteorological* results, it is probable that the diurnal and annual periods of the pressure, temperature and moisture, will have been sufficiently determined by the course of observation now in progress; and in any case, should further data be required, they may be furnished by *self-registering apparatus*. It would, however, be desirable to ascertain, at more than one latitude, the *influence of height* upon the temperature and moisture, by the means devised by Prof. Wheatstone, and about to be employed at Woolwich. To this we may add, as a *desideratum*, the determination of the laws of the *electrical changes*, taken in connexion with other meteorological phænomena. The observatory of the Association at Kew, and that of Greenwich, are the only stations which have furnished such results.

On the whole, I cannot but consider the continuance of the observatories for a *longer period*, if not *permanently*, to be important to the branches of science which they were intended to elucidate, although I believe that their number may be somewhat diminished, and that the amount of systematic work (and therefore also the observing staff) may, without detriment, be reduced at all.

In reply to the *second* query, I am not able to state any instance in which the establishment of the combined system of observation has elicited *privae* research, with the exception of the signal one of the Brisbane observatory. The very magnitude of the plan itself is a sufficient reason for this. It is however no inconsiderable boon to science that it has enlisted in her cause many zealous young men, willing and able to promote it, and whose talents probably might not otherwise have received this direction. It may be added, that private research may naturally be expected in the theoretical discussion of the experimental data.

The answer to the *third* query is connected with that already given to the first. Assuming that the general features of the diurnal changes are sufficiently determined, I would recommend the discontinuance of the *daily* observations, except at those hours in which the magnetic elements are in their *most stable* state, whether as respects the influence of the periodic changes, or of disturbances. Both these conditions are satisfied for Europe and America at the hour of the maximum of westerly declination, and that of the principal minimum of the horizontal force.

I would recommend that more time be allotted to *absolute* and *occasional* observations, and in particular, that the absolute determination of the *declination* should be made from time to time, like those of the other two elements, with a *separate* instrument.

I would suggest that simultaneous observations at short intervals should be made on *one day in each week* during the year 1846. The objects which may be expected to be attained by such an extension of this class of observations, are—

1. To furnish a record of a sufficient number of *disturbances* without the help of occasional observations.
2. To supply a number of *undisturbed* series, sufficient to determine the diurnal curves for *summer* and *winter* from observations at *short* intervals.
3. To afford the means of separating from one another the two classes of changes.
4. To supply the simultaneous observations which are required in absolute and occasional determinations.

It would probably in most cases be possible to obtain the occasional assistance necessary for such observations, without keeping up the whole of the present observing staff.

With respect to *magnetic instruments*, I am not disposed to recommend any considerable alteration in the *Declinometer* and *Bifilar Magnetometer* already in use. Most of the improvements suggested by experience have been added from time to time; and the advantage of strict comparability in method seems to outweigh any which might be derived from more perfect instrumental forms. Neither should I recommend the discontinuance of the *Balance Magnetometer* where (as at Toronto) it has given good results. I would however propose to add the *Induction Inclinometer* as an additional means of determining the variations of the third element, if in any case it has not been already furnished; and for the observation of the absolute declination and absolute intensity, I have suggested a form of instrument (the *Theodolite Magnetometer*) which appears to combine exactness with facility of manipulation. Of the two latter instruments I send printed descriptions. To these I would propose to add a *self-registering* apparatus for *recording* the *disturbances* of the declination, which should reach a certain limit, constructed on Professor Wheatstone's fertile principle of employing the force of a closed electrical circuit; and it would be easy to contrive it so as to distinguish positive and negative deflections on the record.

In *Meteorology*, *self-registering* instruments (on Prof. Wheatstone's principle, or some other) will probably soon supersede all other means of observing. It will of course be desirable that each observatory which is to remain in operation should be furnished with such instruments as soon as their most convenient form shall have been determined. If to these be added an apparatus for the observation of *atmospheric electricity*, on the principle of that at Kew, the equipment would probably be adequate to the present demands of meteorological science.

I fear I have been somewhat prolix, and have only to add, that you are of course at liberty to make use of the foregoing suggestions in any manner you may think expedient.

Believe me to be, dear Sir, yours very faithfully,

H. Lloyd.

X. *John Phillips, Esq., to Lieut.-Col. Sabine.*

1 Islington Terrace, Kingstown, March 8, 1845.

Dear Sir,—1. The objects to be sought for in observations of magnetical and meteorological phænomena appear to be the following:—

α. Observations coincident with the *local occurrences* of unusual or unexplained phænomena, such as meteors, rotatory storms, remarkable hailstorms, &c.

β. Observations to detect the laws of *extensive disturbances* in magnetical and meteorological elements, for in all such cases laws must be presumed to exist, and may probably be detected and determined.

γ. Observations to determine precisely the laws of *general periodical oscillation* and *progression*, whose ordinary aspect is known or supposed, such as *daily oscillation*, *annual oscillation*, and *secular variation.*

In reference to *all these points*, it appears to me that the observatories already established should be continued. There can be no question that these objects are worthy of continued effort; that they are not yet fully attained, but are in progress of being attained by the steady employment of the present observation-power; and that to cease this effort when the laws of phænomena are only just beginning to appear, would be quite unworthy of the scientific spirit which dictated this great combination.

2. I am not aware that the establishment of the magnetical and meteorological observatories has yet had any great effect in stimulating private experimental research. This may be in part attributed to the very slight degree in which the peculiar character of these establishments has become known to the public by their published fruits. It appears to me, however, that it is

rather as *consequent* on the published results of the observatories, than as *coincident* with their labours, that we may expect to see private exertion stimulated and directed, and science advanced by these means. Individual efforts may be useful at the beginning to indicate, and finally to complete the application of great natural laws, but in such branches of knowledge as magnetism, the great body of facts must embrace areas of surface, duration of time, and frequency of observation, which remove all but special problems from the domain of private exertion. Nor can these special problems be properly defined or prosecuted by good methods until the more general results to which they are supplementary are further advanced.

If indeed self-registering instruments can be found for magnetism, it may become popular, as meteorology undoubtedly is popular, however little advanced by the circumstance.

3. In respect of magnetical phænomena, the systematic, simultaneous and extraordinary observations appear to include all that is essential. To the meteorological registration something may be added.

To complete the data for studying the relations of heat and moisture, it is desirable to have observations of the thermometer and wet-bulb hygrometer at more than one height above the ground. If at three or four levels, say 3, 6, 12, 24 feet above the surface, these instruments were frequently observed, information would be gained concerning the distribution of heat and moisture, in the part of the atmosphere where these conditions are the most variable, which could not fail to be important.

There would probably be little difficulty in adding to the observations a register of *long thermometers*, sunk 3, 6, 12, and 24 feet below the surface, so as to extend the basis of the laws of distribution of daily and annual heats at small depths, which have been developed by Quetelet and Forbes.

The rate of evaporation of water appears worthy of record, in connection with so complete a system of two-hourly (better hourly) temperature and hygrometry, especially as this observation may be found hereafter a valuable check upon the mechanical indications of the anemometers, which taken alone are liable to some objection.

Very truly yours,
To Col. Sabine, R.A., Woolwich. JOHN PHILLIPS.

XI. *Dr. Adolphe Erman, of Berlin, to Sir John Herschel and the Committee of the British Association for the Advancement of Science.*

Berlin, March 11, 1845.

GENTLEMEN,—I had the pleasure, a few days since, of receiving the volume entitled 'Observations at the Toronto Observatory, 1840 to 1842,' and take the earliest opportunity of expressing my thanks to the British Government, through your kind intervention, for this most important present. Magnetical and meteorological observations made so uninterruptedly, and with such perfect regard of all important circumstances as those contained in this volume, are of immeasurable value for the physical knowledge of our globe. The true object of meteorology appears more and more to be twofold, viz.—

1. The representation of the periodical changes of every phænomenon by function of sines; and

2. The representation of the mean values of the various phænomena by the V functions of Laplace, which must be applied to the values of atmospheric pressure, temperature, &c. observed in different points of the globe, as they have been by Gauss to the phænomena of terrestrial magnetism.

Which part soever of these two we may employ ourselves with, it is always most welcome, and indeed indispensable, to be possessed of such a stock of exact facts relating to several parts of the earth as have been furnished by the English magnetical and meteorological observatories. In the first place, as regards the laws of periodical changes, the *probable error* of each particular observation has been exceedingly reduced by the exemplary and successful care your observers bestowed on the examination of the instruments employed. If therefore the phænomena under investigation were *strictly periodical*, I am inclined to think that a set of five years' observations would suffice for determining exactly the constants of the series that must represent them. But in reality this is not the case. In almost every one of the phænomena examined, the particular values for a given day varied so much from the average periodical range, and the discovery of the law of these variations relative to many of these phænomena is of so much importance, that the prolongation of the activity of the English observatories beyond the period of five years is rendered particularly desirable by this same circumstance. Let me quote only one example of this fact, out of the great number that actually exist. The English observations have first demonstrated that the instantaneous changes of terrestrial magnetism do not take place at so strictly contemporaneous moments in America and in Europe as we were led to surmise by the European observations only. The proofs of this important fact however have not been obtained for every day of the period of observations, but only during the so-called *term days*, in which the English operations corresponded with those of the German Magnetic Association (*Verein*). How desirable would it be, notwithstanding, to discover on which of the stations a given perturbation has first occurred, and in what degree and rate of proceeding it has extended to the other points of observation! It is only by this course that we may hope to fathom the true law of these momentary variations of magnetic power; or, in other words, the real position of their active cause and the propagation of its effects. It will certainly be of material service to a future inquirer on this subject to be provided with simultaneous observations of all the principal meteorological phænomena; but nevertheless it may be confidently predicted that he will be highly gratified to be furnished with the results of a longer series of observations than those given by a period of five years. Any one who has been engaged in similar investigations will recollect the pleasure he has often felt if, after having had a limited number of observations as the basis of his work, he has been able to strengthen it by the addition of some new ones. It seems to me, therefore, that the English Government will give a new proof of the zeal so worthy of a free and happy nation which they have displayed in the patronage and promotion of science, by granting a prolongation of their magnetical and meteorological observations, *in exactly the same manner as they have been proceeding hitherto*, even after the expiration of the year 1845. A sufficient encouragement for the continuation of this institution is afforded indeed by the brilliant results already obtained, which would immortalize it, even if its visible existence should be prematurely discontinued. I allude particularly to the exactitude of the *mean annual values* obtained at the different stations for every particular phænomenon. Toronto, for instance, affords in meteorological respects a highly interesting comparison with the opposite (western) coast of America. In an article on the climate of Ross in California, which I take the liberty of inclosing, I fixed the isothermal line of $9^{\circ}\cdot267$ *R.* = *the mean temperature at the level of the sea*, in 38° 34′ lat., 233° 41′ long. east of Paris. A further investigation proved that there is scarcely a point on our globe where in an equal latitude the mean temperature is as low as under this meridian, although in higher latitudes it is distinguished by relatively high temperatures. I found on this occasion the isothermal points to be as follows:—

Longitude east of Paris.	Mean temperature 9°·267.	Mean temperature 5°·700.	Distance of both isothermal lines.
5°·0	47°·82 lat.	60°·32 lat.	12°·5
25·0	45·25 ...	— ...	—
30·0	— ...	53·30 ...	8·9
35·0	43·51 ...	— ...	—
127·0	40·41 ...	45·51 ...	5·1
228·0	— ...	57·40 ...	18·9
233·7	38·56 ...	— ...	—
263·0	41·16 ...	— ...	—
285·0	40·45 ...	43·95 ...	3·5

This remarkable want of parallelism of the isothermal lines of 9°·267 and of 5°·70, is confirmed in a surprising manner by the results obtained at *Toronto*.

In 43°·659 lat.
In 280°·642 east of Paris,
At 320·74 Paris feet elevation,
the mean temperature is = + 5°·489 *R.*
or reduced to the level of the sea = + 5°·934 *R.*

The above statements relative to the meridian of 285° east of Paris are founded on the following equation derived from former observations (p being the latitude, l the longitude east of Paris, both in degrees):—

Mean temperature at the oceanic level = 9°·267 − (p − 40°·45) 1°·16
− (l − 285°·00) 0°·10,

which gives for the point of the sea's level, lying vertically under Toronto, . . . + 5°·969 R mean temperature; *i. e.* a result differing only by 0°·035 R from the one observed. From this it appears evident that it is well worth while to take the laws of these phænomena into serious consideration.

Again, from the values observed at Toronto, viz.—

Pressure of the whole atmosphere = 333‴·223 Parisian,
Pressure of aqueous vapour = 2‴·914 ...
Results for the sea's level in the same latitude:
Pressure of the whole atmosphere = 337‴·474 ...
Press. of aqueous vapour (about) = 3‴·0 ...
Without correction for differences in the intensity of gravity.

From my three years' observations at sea, I concluded* the following *mean annual values*:—

Latitude.	Pacific Ocean.		Atlantic Ocean.		
	Pressure of the whole atmosphere.	Pressure of aqueous vapour.	Pressure of the whole atmosphere.	Pressure of aqueous vapour.	
40° ′	337‴·10	4‴·25	339‴·59	5‴·53	Parisian.
45	336·46	3·62	338·10	4·26	
43 39	336·62	3·78	338·50	4·61	

* For calculating, as at Toronto, by the heights of mercury in the barometer, corrected only for temperature (viz. reduced to 0° *R.*) but *not* for differences in the intensity of gravity.

The pressure of the whole atmosphere at Toronto is therefore, as was to be expected, superior to that of the Pacific and inferior to that of the Atlantic in the same latitude. The pressure of vapour at this point, however, is considerably less than under the same latitude in either of the two oceans. This circumstance is explained, partly, by the hygrometrical observations giving the humidity of the air at Toronto = 0·78, and on the ocean at 40° lat. = 0·84, and on the ocean at 45° = 0·85; partly by the mean temperature of the continent at Toronto having been found to be considerably lower than under the same parallel at sea.

You will pardon these superficial reflections, considering how difficult it is to avoid the temptation of making a *preliminary* use of a treasure like the Toronto observations, even when hoping to devote one's leisure to its further study and development.

In conclusion, I avail myself of your kind permission to submit two proposals relative to future magnetical and meteorological labours.

1. The determinations of mean magnetic values for the year 1829 have not yet been completely applied to the deduction of the *Gaussian constants of terrestrial magnetism* for the same year. A comparison of the magnetical maps, representing the empirical results on the one hand and those calculated by the Gaussian constants on the other, is still far from presenting a perfect agreement. For the above year there is still wanting, therefore,—

1. Those values of the constants which *best* correspond to the existing observations; and
2. The *probable errors* of each of those first bases of the theory.

This deficiency appears to me a material one as regards science. The English and Russian observations combined will afford the most probable values of these constants for the year 1845, and it is consequently most desirable to learn, by a comparison with equally probable values of the same for the year 1829, their *annual variation*. Even should these values for 1829 be somewhat less exact than the later ones, this circumstance is not of material importance, if the amount of their *probable error* is ascertained. Now both these requisites, the *best possible* determination of the constants for 1829 and the calculation of their *probable error*, can be effected in the following manner:—

1. By forming from each magnetic element observed in 1829 an equation containing on the one hand a known *numeric value* (*i. e.* the difference between the observed value of this element and the same calculated theoretically with the assumed preliminary amounts of the constants), and on the other certain given multiples of the corrections to be applied singly to each of the 24 Gaussian constants; and
2. By resolving, according to the method of least squares, the linear equations with 24 unknown elements, obtained in this manner (amounting in all to about 1000).

By this means we shall obtain not only the *most probable corrected values of the above constants*, but likewise the *probable error* of each of them.

In Schumacher's Astronomical Notices (Astron. Nachrichten, Nos. 450, 452 and 454), the commencement of this undertaking has been published as executed at my request with exemplary zeal by a scientific young friend of mine. At my own suggestion, however, the prosecution and conclusion of this work has been deferred to a period when it might be performed without a ruinous sacrifice of time and trouble on the part of the individual engaged in it. It became evident indeed that a calculation of this extent would necessitate an entire devotion to the task of one or two years, for which the pecuniary assistance of some government would be indispensable. If you should be of the same opinion as I am concerning the importance of this undertaking, you would confer an essential obligation on me by expressing your approval in a manner that would give it a sufficient weight to induce some government to grant the requisite means; 40*l.* or 50*l.* a year, for the term of two years, would suffice for a person residing in this country, and I could guarantee the complete and satisfactory performance of the whole, if completed in the same manner as it was begun. I leave it to the decision of the Committee of the British Association for the Advancement of Science to recommend this work to the attention of one of the two governments (the English and Russian) that have already displayed their zeal for the advancement of the magnetic science, or to some other, the Prussian for instance, that may wish to follow so laudable an example. At all events, I am convinced that the recommendation of a committee enjoying so deserved a reputation as yours would be attended with the most complete success, a success so desirable for the advancement of science.

The second desideratum that occurs to me, refers to the form of publication of *meteorological observations at sea.* Such observations having been regularly made during the many scientific expeditions of later years, the journals of these voyages would easily furnish us with the *diurnal* value of the observed phænomena, accompanied by a section of the latitude, longitude and date on each day of observation.

The acquisition of similar tables, as afforded by the different voyages, is in my opinion of the greatest possible value as regards all questions of scientific meteorology. What imparts particular importance to the meteorological observations as made at sea is,

1. The equal elevation of the instruments;
2. The equal constitution of the surface on which the observations take place.

As such tables would greatly facilitate the due combination of the observations, I consider them in fact as indispensable.

I am, Gentlemen,

Your most obedient servant,

A. Erman.

XII. *M. Gauss to Sir John Herschel.*

Göttingen, March 14, 1845.

Dear Sir,—In answer to your letter of December 5th, 1844, I shall begin by replying to your *last* question, that I have no objection against your making what use you please of this letter, were it not my consciousness of its utter insignificancy. At all events, as I do not pretend to correctness in writing in your idiom, I beg your leave to put down what little I may have to say in German, the more so as yourself are perfectly master of the language of your forefathers.

So sehr ich mich geehrt fühle, dass Sie auf mein Urtheil in Beziehung auf das langere Fortbestehen der mit grossartiger Munificenz von der Britischen Regierung in fremden Welttheilen errichteten magnetischen Anstalten einen Werth zu legen scheinen, so leid thut es mir dass ich ausser Stande bin, auf die mir vorgelegten bestimmten Fragen eben so bestimmte Antworten zu geben, und zwar hauptsächlich aus dem Grunde, weil mir die Resultate der bisher in jenen Anstalten ausgeführten Arbeiten noch fast gänzlich unbekannt sind. In der That sind mir zwar der erster Band der zu Greenwich gemachten magnetischen Beobachtungen und ein Band ausserordentliche magnetische Störungen zu seiner Zeit richtig zugekommen, wofür ich meinen ergebensten

Dank abstatte, allein der erste Band der Beobachtungen auf den aussereuropäischen britischen Stationen, dessen Empfang Ihr gütiges Schreiben mich vor Schluss des vorigen Jahres hoffen liess, und der nach einem spätern Schreiben des Herrn Obristlieutenants Sabine spätestens bis zum 25 Februar hier eintreffen sollte, ist bis diese Stunde noch nicht angelangt. So lange aber noch nicht die Beobachtungen aus einer Anzahl von Jahren wirklich vorliegen, und, wie ich hinzusetzen muss, bevor solche nicht einer in gewissem Grade schon ins Einzelne gehenden Verarbeitung unterworfen sind, lässt sich unmöglich ein Urtheil darüber fällen, ob und in welchem Maasse die vorgesetsten Zwecke bereits erreicht seien.

Von meinem Standpunkte aus muss ich demnach, gerade dieser Ungewissheit wegen, dringend wünschen, dass diese Arbeiten wenigstens noch einige Jahre in der bisherigen Art und Ausdehnung fortgesetzt werden.

Ich muss aber noch weiter gehen, und meine unversichtliche Hoffnung aussprechen, dass das Britisches Gouvernement vorzugsweise *diesem* Zweige wissenschaftlicher Bestrebungen eine *fortdauernde* Pflege zuwenden, und jenen Anstalten auf unbestimmte Zeit ihren Bestand sichern werde, möchte es auch nur mit gewissen Einschränkungen sein. Sollte es, der Kosten wegen, für nothige erachtet werden, gewisse Beschränkungen eintreten zu lassen, so würden solche meines Erachtens sich auf die Terminsbeobachtungen und auf die stündlichen Aufzeichnungen beziehen können, und zwar so, dass man die erstern demnächst ganz aufhören liesse, die letztern aber, anstatt wie bisher von 2 zu 2 Stunden, künftig nur von 6 zu 6, oder allenfalls auch nur von 8 zu 8 Stunden ausführte, in Folge welcher Abänderungen das Personal und die Unterhaltungskosten wesentlich wurden verringert werden können. Ob aber diese Einschränkungen schon sofort, oder erst nach einigen Jahren eintreten sollen, darüber kann ich, aus oben angeführten Gründen, für jetzt noch kein bestimmtes Urtheil aussprechen.

Neben jenen täglich drei oder viermahl, in gleichen Zwischenzeiten zu machenden Aufzeichnungen der magnetischen Elemente, würde die jährlich mehreremahl mit äusserster Sorgfalt auszufährende absolute Bestimmung derselben das Hauptgeschäft bilden, unbeschadet derjenigen andern Arbeiten, welche die Vorsteher der Anstalten nach gemeinschaftlich unter sich zu treffenden Verabredungen ausführen möchten, und wobei häufiger wechselseitiger Austausch von Magnetstaben und Apparaten manche lehrreiche Resultate geben, auch die Thätigkeit und die Geschicklichkeit der Vorsteher vielfach bewahren und controlliren könnten. Dass überhaupt denjenigen Vorstehern, die auf angemessene Art ihre Talente und ihrer Eifer schon bewährt haben, ein etwas freierer Spielraum für ihre Thätigkeit gelassen wurde, mochte ich für sehr rathsam halten.

Die Gründe für das nachhaltige Fortbestehen dieser Anstalten liegen übrigens so nahe, dass es unnöthig scheint, sie weitläuftig zu entwickeln. Unsere kenntniss des Erdmagnetismus ist nur erst ein dürftiges Stückwerk, so lange wir uns nur auf eine bestimmte Zeitepoche beschränken, und nicht die schon nach wenigen Jahren sich merkliche machenden Säcularänderungen mit gleicher Sorgfall und Liebe verfolgen. Allerdings ist dazu das Zusammenwirken sehr vieler Wissenschaftsfreunde an sehr vielen Punkten der Erdoberfläche nothwendig, und ein halbes oder ganzes Dutzend magnetischer Observatorien über die ganze Erde zerstreuet kann *für sich allein betrachtet* nur einen kleinen Beitrag liefern. Aber diese Muster Observatorien werden zugleich die Pflanzschulen von vielen tüchtigen Beobachtern werden, die ihre Thätigkeit überall hin verbreiten. Sie werden ferner reisenden Beobachtern zu Wasser und Lande Gelegenheit geben, ihre Instrumente zu prüfen und zu berichtigen, und ihre Beobachtungsgeschicklichkeit zu bewähren und zu vervollkommnen. Sie werden endlich dazu beitragen den Sinn für Erreichung möglich grösster Schärfe, der sonst nur in der Astronomie und höhern Geodäsie zu treffen war, auch für die andern Theile der Naturwissenschaften zu beleben, zu nähren und zu verbreiten.

Die Privatthätigkeit im Felde der magnetischen Beobachtungen liegt ubrigens was Deutschland und die benachbarten Länder betrifft seit einer Reihe von Jahren offenkundig vor. Obgleich man nicht sagen kann, dass die Britischen Anstalten dieselbe erst erweckt haben, da sie bekanntlich schon vor denselben vorhanden war, so haben doch diese Anstalten an mehrern Orten Erweiterung jener Thätigkeit veranlasst. Daran aber ist jedenfalls nicht zu zweifeln, dass wenn die Britische Regierung ihre aussereuropäischen Anstalten eingehen liesse, dies auch einen entmuthigenden Einfluss auf die in Deutschland und anderwerts bestehenden Anstalten haben würde, um so mehr, da das Erscheinen des Organs dieser Thätigkeit, der Resultate des Magnetischen Vereins, seit der Entfernung des Professors Weber von Göttingen auf unbestimmte Zeit suspendirt ist.

This indeed is all I have to say under present circumstances. I had delayed my reply, which you expected to receive before 10th March, till today, in hopes to get the promised volume for inspection. But I can tarry no longer now (though Mr. Sabine's letter seems to prorogate the ultimate term to 31st March), because, even if that volume should arrive tomorrow or in the next days, I am for the next weeks so overcharged with other affairs, that it would be impossible to give it a close examination. I conclude therefore with the assurance that I ever remain

Faithfully yours,
CH. FR. GAUSS.

(*Translation.*)

Much as I feel honoured by your appearing to attach a value to my judgement in regard to the longer continuance of the magnetic establishments which the munificence of the British government has founded in different parts of the world, my regret is equally great that I cannot give to your questions answers as definite, and this chiefly because the results of the work executed in those establishments are still almost wholly unknown to me. I have as yet only received the 1st volume of the Greenwich magnetic observations, and one volume of extraordinary magnetic disturbances, both which arrived duly, and I return my best thanks for them; but the 1st volume of the observations of the extra European British stations, which your letter made me hope for before the close of the year, and which, by a later letter from Colonel Sabine, should have arrived at latest on the 25th of February, has not yet reached me. But until the observations of some years are actually seen, and I must add, until they have undergone a certain degree of discussion and examination in detail, it is impossible to pronounce a judgement as to whether, and how far, the proposed objects are already obtained.

In my present position, therefore, and on account of this very uncertainty, I can only urgently desire that these labours may be continued at least for some years longer, in the same manner and to the same extent as hitherto.

But I must go still further, and must express my confident hope that the British government will apply to *this* branch of science especially its *persevering* care, and that it will secure these establishments for an indefinite period, even should it be with certain limitations, should such be thought necessary on account of expense; if so, the reductions might, I conceive, apply to terms and to hourly observations, discontinuing the former altogether, and reducing the latter to six-hourly or even eight-hourly records, which would materially lessen the personal staff and therefore the expense. But whether such reduction may take place yet, or whether only at the end of some years longer, is a question concerning which for the reasons already given I can pronounce no decided opinion at present.

The principal employment at each observatory, in addition to the daily observations at equal intervals of six or eight hours, will be to make, several times a year, absolute determinations with the most extreme care, and this without prejudice to other work which the directors of the different establishments may concert together; among which, frequently-repeated interchange of magnetic bars and apparatuses will give many instructive results, and will also keep up and check the activity and the skill of the directors in many ways. I should also think it very advisable that those directors who have shown in a suitable manner their talents and their zeal, should be allowed somewhat freer scope for their activity.

The reasons for continuing such establishments are so direct, that it seems unnecessary to develope them at much length. Our knowledge of terrestrial magnetism is but a fragment, so long as we confine it to one period of time only, and do not follow with equal care and interest those secular changes which make themselves felt even in the course of a few years. There is indeed required the concurrence of very many friends of science at very many points on the earth's surface; and half a dozen, or even a dozen observatories scattered over the whole earth can, if *taken alone*, give only a small contribution. But these normal observatories may at the same time be schools for many good observers, who will extend their activity over a wider range. They will also afford to travelling observers the opportunity of testing and correcting their instruments, and keeping up and perfecting their skill in observation, and they will contribute to arouse, to nourish, and to extend to other parts of natural knowledge that desire for the greatest possible accuracy in observation which was formerly met with only in astronomy and the higher geodesy.

Private activity in the field of magnetic observation has, it is well known, existed for several years in Germany and the adjacent countries; but though it cannot be said to have been first awakened here by the British undertakings, since it existed before them, yet they have caused its further extension. It cannot be doubted that if the British government were now to discontinue its extra-European-establishments, this would have a discouraging influence on the existing establishments in Germany and elsewhere; the more so, as the publication of the organ of their activity (the 'Resultate des Magnetischen Vereins') has been indefinitely suspended since the removal of Professor Weber from Göttingen.

XIII. *M. Kreil, Director of the Magnetical and Meteorological Observatory at Prague, to Lieut.-Colonel Sabine.*

Prag, 23 Marz, 1845.

Verehrter Herr,

Ich erhielt vor wenigen Tagen die werth vollenmagnetischen und meteorologischen Beobachtungen von Toronto 1840–41–42, und beeile mich nun das Schreiben zu beantworten, womit mich unterm 5 Dec. 1844, das magnetische Comité beehrte, und in welchem meine Ansicht über einige dort vorgelegte Fragen gewünscht wird.

Mit grossem Vergnügen durchblätterte ich den Band, so wie auch den schon früher erhaltenen der 'Observations on days of unusual disturbances;'

denn ich ersah daraus, dass den hochgespannten Erwartungen, die ich von den Leistungen dieser Anstalten hegte, nicht nur entsprochen, sondern dass sie in vieler Beziehung noch übertroffen worden waren. Die Geschichte der Wissenschaften biethet kaum ein zweites Beispiel dar, wo so viele und mit so reichen Mitteln versehene Kräfte gleichzeitig und für denselben Zweck wären in Bewegung gesetzt worden; und da ein mächtiger Impuls in der physischen wie in der moralischen Welt seine Wirkungen stets nach allen Seiten hin äussert, so haben auch die grossartigen Anordnungen, wit welchen England auf die von aussen her ergangenen Aufforderungen antwortete, auf dem europäischen Continente wieder manche Bestrebungen hervorgerufen, welche nicht ohne wesentlichen Nutzen für die Wissenschaft vorüber gehen werden. Um nur die nächsten dieser Bestrebungen zu nennen, so besitzen wir in der östreichischen Monarchie zwei Anstalten für magnetische und meteorologische Untersuchungen, Kremsmünster und Senftenberg, von denen die erste wohl schon seit einem Jahrhunderte für Astronomie wirksam in den letzten Jahren ihre Thätigkeit auch dem Magnetismus zugewendet, und ihre Leistungen in den 'Annalen für Meteorologie und Erdmagnetismus' bekannt gemacht; die zweite aber, wenn gleich erst ein Jahr alt, doch ihre Erstlingsfrüchte bereits der Oeffentlichkeit übergeben hat. Bei beiden ist es mehr als zweifelhaft, ob sie ohne dem vorzüglich durch Englands Beitritt hervorgebrachten Ausschwunge, sich dem magnetischen Vereine angeschlossen hätten. Auch die nun in Aussicht stehende Bereisung der östreichischen Monarchie zu magnetischen Zwecken, welche ich in diesem oder dem nächsten Jahre zu beginnen hoffe, würde kaum zur Wirklichkeit gebracht worden seyn, hätte man nicht auf England's Beispiel hinweisen können.

Ich beschränke mich hier diese unserem Staate angehörigen Beispiele als Beweise aufzuführen, dass die von der grossbritanischen Regierung errichteten Anstalten manche andere Bemühungen ins Leben gerufen haben, von denen die wissenschaftwerthvolle Resultate theils schon erhalten hat, theils noch erwarten kann, und überlasse es anderen Gelehrten diese Thatsache durch die in ihrem Gebiethe vorfindigen Beweise noch mehr zu bekräftigen.

Wenn aber gleich durch das Zusammenwirken so vieler ausgezeichneter Gelehrter fast aller gebildeten Nationen, berühmter Gesellschaften und erleuchteter Regierungen im Fache des Magnetismus und der Meteorologie in den letzten Jahren mehr geleistet worden ist, als in irgend einem andern wissensschaftlichen Zweige in so kurzer Zeit je erreicht wurde, so darf man sich doch nicht schmeicheln, viel weiter als, wenigstens in den meisten Fällen, zur Erkenntniss der ersten, in die Augen fallendsten Thatsachen gelangt zu seyn. Der vorliegende Band der Toronto Beobachtungen liefert hiezu selbst den Beweis, da in vielen Fällen die bisher ausgeführte dreijährige Beobachtungsreihe noch nicht ausreichend erscheint zur Erziehung sicherer Ergebnisse; so musste die Erkenntniss der jährlichen Periode der Declinationsänderung (pag. 11), manche Einzelnheiten bei den Störungserscheinungen (pag. 21, 49), die Aenderungen der Vertical-Kraft (pag. 62.) und der Inclination (pag. 65.) einer längeren Beobachtungsreihe vorbehalten bleiben. Es ist zu vermuthen dass die Jahre 1843–45 die über manche dieser Punkte schwebenden Perioden eingeschlossenen, sogenannten Säcular-Aenderungen so vollständige Aufklärung zu geben, dass sie für alle in Zukunft darüber anzustellenden Untersuchungen eine vollkommen feste Grundlage bilden könnten. Um nur ein Beispiel anzuführen, so wurde in diesen drei Jahren die Säcular-Aenderung der Inclination in Toronto so klein gefunden, dass aus den Beobachtungen nicht erkannt werden konnte in welcher Richtung sie vor sich gienge. Da man doch nicht annehmen kann, dass eine solche Aenderung gar nicht bestehe, oder immer zu klein sey, um sich in einem dreijährigen Zeitraum selbst durch so scharfe Beobachtungen zu offenbaren, so muss man voraussetzen, dass sie an diesem Orte eben jetzt im Stillstande begriffen sey. Diess ist aber für alle zukünftigen Untersuchungen über die Natur der magnetischen Kraft ein eben so wichtiger Moment als z. B. die Erforschung der Sonnennähe eines Planeten zur Bestimmung seiner Bahn, und ein Abbrechen der Beobachtungen ehe dieser, und so viele andere nicht minder wichtige Punkte gehörig festgestellt sind, würde von den Gelehrten unseres und der künftigen Jahrhunderte, welche ihre Thätigkeit diesem Zweige widmen, höchlich bedauert werden.

Wenn aber auch manche Punkte ihrer Natur nach nicht durch eine sechsjährige Beobachtungsreihe festgestellt werden konnten, so sind doch gewiss andere dadurch zur völligen Evidenz gebracht worden, und was daran noch fehlt, ist nur der Mangelhaftigkeit der Instrumente zuzuschreiben, welche noch nicht jenen Grad von Vollendung erlangt haben, den wir an den für andere Beobachtungen bestimmten Apparaten zu sehen gewohnt sind. Dahin gehören die täglichen Aenderungen und die davon abhängigen Grössen. Selbst von vielen der in längere Perioden eingeschlossenen Aenderungen wie z. B. den monatlichen und jährlichen wurden die meisten Umstände wo nicht mit Gewisheit doch mit einem hohen Grad von Wahrscheinlichkeit erkannt.

Wenn also, wie gewiss alle Theilnehmer an ähnlichen Untersuchungen hoffen und wünschen, das Bestehen der von der grossbritanischen Regierung errichteten magnetischen und meteorologischen Observatorien noch um einige Jahre verlängert wird, so sollten die *säculären Aenderungen* und die *Gesetze der Störungen* als Hauptzweck im Auge behalten werden, und es wäre die künftige Thätigkeit der Anstalten diesem Zwecke gemäss einzurichten. Demnach scheint es mir hinreichend zu sein, statt stündlichen oder zweistündigen Beobachtungen, vierstündige, also an jedem Tage sechs Beobachtungen auszuführen, um Mittag, 4^h, 8^h, Mitternacht, 16^h, 20^h, und zwar nicht nach Göttinger- sondern nach Ortszeit, weil es sich vorzugsweise um eine gründliche Kenntniss der Erscheinungen handelt, wie sie am Beobachtungsorte vor sich gehen, und weil fast alle rücksichtlich ihrer Periode von dem Stande der Sonne gegen den eigenen Meridian, nicht gegen einen fremden abhängen, ein Grundsatz, den man schon von jeher bei Ausführung der meteorologischen Beobachtungen befolgt hat. Bei den magnetischen Terminsbeobachtungen war eine strenge Gleichzeitigkeit der Ablesungen allerdings wünschenswerth, bei den täglich zu fixen Stunden anzustellenden Beobachtungen aber, glaube ich, sollte man sich eben so an die Ortszeit halten, als man es bisher bei den meteorologischen Terminen gethan hat. Hiebei wäre es gut, wenn die sechs zu fixen Stunden anzustellenden magnet. Beobachtungen doppelt ausgeführt würden, nämlich jedes Element sollte nach 5 Minuten zum zweitenmale beobachtet werden, weil die in der Zwischenzeit eingetretene Aenderung sehr oft das Vorhandenseyn einer Störung anzeigt, welche bei einer einfachen Beobachtung unbemerkt bleibt, und weil bei gut aufgestellten und gegen Luftströmungen gehörig geschützten Apparaten diese Aenderungen auch über den täglichen Gang näheren Aufschluss geben können.

Die magnetischen Terminsbeobachtungen, welche hauptsächlich zur genaueren Erforschung der Gesetze der Störungen eingeführt wurden, haben diesem Zwecke nicht vollkommen entsprochen, weil wenige Störungen grösserer Art an den für diese Beobachtungen vorausbestimmten Tagen eingetroffen sind, daher viele Mühe vergebens angewendet wurde. Da man voraussetzen darf, dass die Beobachter sich für den Erfolg ihrer Arbeiten selbst interessiren, und alles aufbiethen werden, was sie für die Wissenschaft nützlich machen kann, so dürfte man, wie ich glaube, die ausser den festgesetzten sechs Beobachtungsstunden anzustellenden Störungsbeobachtungen ihrem eigenen Er-messen überlassen, und ihnen höchstens über die Zeit-Intervalle, in welchen die Ablesungen zu geschehen haben, und welche bei gut aufgestellten Apparaten die möglichst kürzesten seyn sollen, einige Instruction ertheilen. Ihr Hauptaugenmerk soll hiebei auf die Wendungspunkt, d. h. jene Zeit-Momente gerichtet seyn, wann ein Wachsen in ein Abnehmen und umgekehrt übergeht. Will man aber noch ferner Beobachtungen an vorherbestimmten Tagen anstellen lassen, so könnte diess versuchsweise, d. h. so geschehen, dass man an diesen Tagen zu jenen Stunden, an welchen die Störungen am öftesten einzutreten pflegen, nämlich von 4^h bis 10^h Abends so beobachtet, wie es bisher bei Terminen zu geschehen pflegte, und die Beobachtungen nur in dem Falle über 24 Stunden ausdehnt, wenn sich Spuren einer Störung zeigen.

Da barometrische Störungen dieselbe Wichtigkeit haben, wie magnetische, wenn gleich ihr Umfang nicht so ausgedehnt ist, so wäre es wünschenswerth, dass auch an Tagen, wo solche eintreten, die Ablesungen des Barometers in kürzeren Intervallen als gewöhnlich ausgeführt würden, etwa von Stunde zu Stunde, und in der Nähe de Wendepunkte, welche auch hier ganz besonders berücksichtigt werden sollen, noch öfters, weil aus der Vergleichung näher gelegener Beobachtungsorte die Richtung und Schnelligkeit der Luftwellen erkannt werden kann.

In Hinsicht auf Instrumente scheint es mir zweckmässiger zu seyn, die einmal eingeführten so lange zu behalten, als nicht eine neue Erfindung sie wesentlich verbessert hat, weil bei Differenzbeobachtungen, um welche es sich hier vorzüglich handelt, der Nachtheil, den eine Unterbrechung und die Anwendung eines verschiedenen Apparates herbeiführt, nicht immer durch die grössere Genauigkeit des letzteren aufgehoben wird. Ueberall sollte man, so gut es angeht, die Arbeit durch Autographen zu erleichtern und zu vervollständigen trachten. Wenn die von hier nach England gesandten Exemplare der Baro- Thermo- und Hygrometrographen sich als zweckmässig bewähren, so ist für die Meteorologie viel gewonnen, und sie sollten verbreitet werden. Ich habe manche Versuche angestellt, nach demselben Principe auch magnetische Autographen zu verfertigen; allein diese Versuche führten zu grösseren Auslagen, als ich bestreiten konnte. Ich musste sie aufgeben, ohne von der Unmöglichkeit des Gelingens überzeugt zu seyn. In England, wo die practische Mechanik auf einer so hohen Stufe steht, würde man leichter damit zu Stande kommen.

Die Mittheilungen der Beobachtungen und ihrer Resultate haben stets um so grösseres Interesse, je frischer sie sind, und oft kann eine Vergleichung der Wahrnehmungen, so lange der erste Eindruck noch nicht erloschen ist, auch zu nicht unwichtigen Folgerungen führen, welche uns entgehen, wenn man die Vergleichung bloss nach den Ziffern austellen muss. Deshalb könnte vielleicht die Herausgabe der Beobachtungen in kleineren Parthien und in kürzeren Fristen, nach Art einer Zeitschrift, etwa von Monat zu Monat geschehen.

Da durch die Vereinfachung des Beobachtungssystems wahrscheinlich mehrere Beobachter disponibil werden, so könnte man diese vielleicht dazu verwenden, die Umgebungen des Beobachtungsortes zu bereisen, und einen magnetischen Survey auszuführen. Meines Erachtens ist die Vervielfältigung dieser Reisen, und die damit verbundene Untersuchung über die Vertheilung des Erdmagnetismus, derjenige Schritt, welcher in diesem Fache zunächst zu thun ist. Die Beobachtungen sollten sich hiebei nicht nur über alle magnetischen Elemente, sondern wo möglich auch über die geognostische Beschaffenheit des Bodens ausdehnen, weil der Zusammenhang zwischen dieser und dem Erdmagnetismus ein Punkt von der grössten Wichtigkeit ist.

Diess sind die Ansichten welche ich über diese grosse wissenschaftliche

Unternehmung hege, und die ich hiemit frei und unumwunden ausgesprochen habe. Findet die Association es für zweckmässig sie ganz oder theilweise zu veröffentlichen, so steht von meiner Seite nichts im Wege.

Mit ausgezeichneter Hochachtung,

Ergebenster,

KREIL.

(*Translation.*)

Prague, 23rd March, 1845.

DEAR SIR,—I received a few days ago the valuable 'Magnetical and Meteorological Observations at Toronto, 1840–42,' and I now hasten to reply to the communication with which the Magnetic Committee have honoured me under date of the 5th of December 1844, in which my views respecting some questions therein proposed were requested.

I have looked over this volume and that which I had previously received, entitled 'Observations on Days of unusual Magnetic Disturbance' with great pleasure, for I have seen by these volumes that the highly-wrought expectations of the results of these establishments which I cherished, are not only met but have in many respects been even exceeded. The history of science hardly offers a second example where so many and such richly-provided forces have been put into action simultaneously and for the same object; and as a powerful impulse, whether in the physical or in the moral world, always extends its effects on every side, so the great system of action by which England has responded to the call which proceeded from hence has reacted on the continent of Europe, and has called forth several efforts which will not pass away without having done essential service to science. Among these I will name only the two which fall most immediately under my notice. We have in Austria two establishments for magnetical and meteorological researches, Kremsmünster and Senftenberg; at the first of which places astronomy has been actively followed for a century, magnetism only since the last few years, and its results are published in the 'Annalen für Meteorologie und Erdmagnetismus.' The Senftenberg establishment, though only a year old, has already published its first fruits. It is more than doubtful whether either would have joined the magnetic cooperative system, had it not been for that great development which is due to England especially. The magnetic survey of Austria, which I hope to begin either this year or the next, would hardly have been brought to pass if we had not been enabled to point to the example of England. I confine myself to adducing instances belonging to our own state, to show that establishments and other endeavours which have produced, or which promise to produce, valuable results, have been stimulated by the example of England; and I leave to other cultivators of science to confirm this fact by instances more particularly belonging to their own spheres of observation.

But although the concurrence of so many distinguished men of science, and of almost all the civilized nations, illustrious societies, and enlightened governments, has done more for magnetism and meteorology than was ever accomplished for any other branch of science in so short a time, yet we ought not to flatter ourselves that we have done more, at least in the majority of cases, than arrive at the knowledge of the first and most obvious facts. The volume of the 'Toronto Observations' now before me itself affords proof of this, for in many cases it appears that the series of three years' observations is not sufficient to afford assured results; the knowledge of the annual period of declination changes (p. xi.), of some peculiarities in the phænomena of disturbances (pp. xxi. and xlix.), the variations of the vertical force (p. lxii.), and of the inclination (p. lxv.), require a longer series of observations. We may hope that the years 1843–45 will have done much to clear away the doubts remaining on these particular points, but they certainly cannot afford such a complete elucidation of the variations comprehended within longer periods, otherwise called secular variations, as may be capable of forming a perfectly solid foundation for all future researches. To allude only to one instance; the secular change of the inclination at Toronto during the last three years has been found to be so small, that it cannot even be discovered in which direction it takes place. As we cannot assume that there is no such change, or that it is always so small as to escape detection even by such exact observations during an interval of three years, we must suppose that at Toronto the inclination was stationary at that time. But such a moment is, for all future investigations concerning the nature of the magnetic forces, of an importance similar for instance to that of the perihelion of a planet for the determination of its path, and to break off the observations before this and so many other no less important points are properly established, would be greatly lamented by those men of science who may devote their activity to this branch of science either in the present or in the ensuing century.

If however there are many points which from their very nature cannot be settled by a six years' series of observations, there are others certainly for which the evidence will be complete; or if anything be still wanting, it will be owing solely to the incompleteness of the instrumental means which have not yet attained to that high degree of perfection to which we are accustomed in the apparatus belonging to other kinds of observation. The diurnal variation and all the quantities depending thereon are of this class; and even for the variations comprised by longer periods, the monthly and annual variations for example, most of the circumstances belonging to them will be known, if not with certainty, yet with a high degree of probability.

If, then, as is assuredly wished and hoped by all who take part in investigations of this nature, the magnetical and meteorological observatories established by the British government be continued for some years longer, the *secular variations* and the *laws of disturbances* should be regarded as the principal objects to be kept in view, and the activity of the different establishments should be directed accordingly. In this view it might suffice if four-hourly observations were substituted for hourly or two-hourly, taking for instance, 0, 4^h, 8^h, 12^h, 16^h and 20^h, and employing not Göttingen time but the time of the station, as the special object in view is to obtain a thorough knowledge of the phænomena as they present themselves at the place of observation, inasmuch as their march depends in almost all cases on the position of the sun relatively to their own meridian, not to that of another and distant station, a principle always followed in meteorological observations. In magnetic terms, no doubt strict simultaneity of reading is always desirable, but the daily observations at fixed hours should I think be taken by the time of the station, as has hitherto been done in meteorological terms. The magnetic observations, if made at fixed hours each day, might be taken doubly by repeating the reading of each element at the end of five minutes. By this means, the presence of disturbance, which might escape detection by a single observation, would often be discovered, and with well-established instruments properly protected against currents of air, the alterations taking place in those short intervals would also furnish inferences concerning the diurnal march.

The magnetic term days, which were principally designed for the more accurate investigation of the laws of disturbances, have not perfectly answered to this view, because few of the greater disturbances occurred on the prescribed days of observation, so that much labour has been bestowed in vain. As we may assume that the observers are themselves interested in the results of their labours, and will willingly supply all the useful service to science in their power, we may, I think, leave to themselves what they may do at times of disturbance, in addition to the six daily observations, directing them at the utmost in some degree as to the intervals at which the readings should be taken, and which, with well-established instruments, ought to be as short as possible. The chief attention of the observers should be directed to the turning points, *i.e.* to the moment of time when an increase is changed into a decrease, and *vice versâ*. If however it be still desired to institute observations on prescribed days, it might be done tentatively, *i.e.* by observing on such days, in the manner hitherto followed on term days, at those hours when disturbances most frequently begin, *i.e.* from 4 to 10 P.M., completing the twenty-four hours of observation only when indications of disturbance are perceived.

As barometric disturbances have the same interest as magnetic ones, although their range is more limited, it would be desirable on days when they occur to take more frequent readings than usual, it may be every hour, and oftener near the points of turning, which ought to receive especial attention, as the comparison of neighbouring stations of observation may make known the direction and velocity of the atmospheric wave.

In respect to instruments, it appears to me better to retain those already in use, unless newly-devised ones offer very important improvement; because in differential observations, which are chiefly in question, the disadvantages attendant on breaks and on the introduction of a different apparatus, are not always compensated by the greater exactness of the new instrument. As far as can be done, it will be desirable to lighten the work, and to render it more complete by the use of self-registering apparatus. If the barometro- thermometro- and hygrometro-graphs sent to England are found to answer, their advantage to meteorology will be great, and their use ought to be extended. I have made many trials at constructing magnetic autographs on the same principle, but have found the experiment too expensive, and have therefore relinquished it, though without being convinced of the impossibility of success. In England, where there are such good artists, it might be less difficult.

The earlier the observations and their results are communicated the greater will be their interest, and it may often happen that a comparison made while the first impression is still fresh on the mind may lead to not unimportant deductions, which escape when the comparison has to be made with the figures merely. Possibly it might be advantageous to publish the observations in smaller parts after the manner of a periodical journal,—it might be monthly.

As the simplification of the system of observation would probably leave several observers at liberty, they might perhaps devote the time thus gained to the execution of magnetic surveys in adjoining districts. The multiplication of such journeys and their results concerning the distribution of terrestrial magnetism appears to me to be the step most immediately needed. These observations ought to include, besides all the magnetic elements, a notice of the geognostic character of the ground, as its connexion with terrestrial magnetism is a point of great importance.

I have now given freely my views respecting this great scientific undertaking, and if the Association would think it useful to publish them, either in whole or in part, they are entirely at their disposal.

With highest esteem, yours, KREIL.

XIV.—*G. B. Airy, Esq., Astronomer Royal, to Sir John Herschel.*

Royal Observatory, Greenwich, April 7, 1845.

My dear Sir,—I have to acknowledge the receipt of the circular letter issued by you on the part of a Committee of the British Association, dated 5th December 1844, and proposing certain queries regarding the propriety of continuing the existing magnetic and meteorological observatories beyond the termination of the present year, to which answers are invited.

In the answers which I subjoin, I beg leave to refer to the numbers attached to the questions in your letter.

In reply to question 1.

Several important points have already been made out from the observations; and undoubtedly, by continuing the observations, these same points would be established with an accuracy somewhat (but not much) greater than at present. I do not expect to obtain anything new; but it is scarcely possible yet to tell, for want of reduction and digestion of the observations as far as they are made. It seems not improbable that a great part of what future theory may suggest can be made out by simultaneous observations conducted at a comparatively trifling expense: at the same time it is certain that great light has been cast upon the interpretation of the simultaneous observations by using them in conjunction with the hourly and two-hourly observations. All things considered, I do not see sufficient ground for continuing the systematic two-hourly observations.

In reply to question 2.

If by "private research" is meant "research by persons not officially connected with the various Magnetical, &c. Observatories," I do not believe that private research has been stimulated in the smallest degree. The research of persons connected with the observatories, in subjects nearly related to but not exactly included in the routine of the observatories, has naturally been much stimulated.

In reply to question 3.

I am totally unable, from want of discussion of the observations already made, to suggest anything. I perceive that strict simultaneity of observations and precisely similar construction of instruments are desirable; and I urge the latter point the more strongly, because there has been a sensible change in the construction of the instruments adopted for many observatories, and because it is far more difficult to carry out any general regulation regarding the instruments than anything which depends on mere personal arrangements.

I now advert generally to the general question, as requested in the last paragraph of the circular letter.

First, it must be remarked that the object of these observatories is totally different from that of astronomical observatories. It is not intended to attach very great importance to the accurate determination of the present state of certain elements, or of their secular changes (as in astronomical determinations), not because they are unimportant, but because they can be determined in a very much less expensive way. It is scarcely an object to ascertain the co-efficients or argument-epochs of inequalities following known laws (as in astronomy), because the present state of the science does not admit of it. The object is, to make out such laws as we can, to use our discoveries for the suggestion of other observations, and from these to make out other laws, &c. Now it is to be remarked that we shall have at most of the observatories full five years of continuous and simultaneous observations. I certainly do think that these are sufficient to give us, with reasonable accuracy, the first laws to which I have alluded above (if they are not, I can hardly conceive that any number of years would be found sufficient). And if they are sufficient, then I see that very great mischief is done by continuing them. At present, by the greatest efforts which it is possible to make, the Prague observations are published in a roughly reduced form, only as far as 1843; those of Toronto and Greenwich as far as 1842, and no other so far. While the observations continue, with the existing establishment of computers, there is no possibility of hastening this reduction and publication. Now we want leisure to complete the publication (to the same extent to which it has already gone). We want leisure further to discuss with reference to more scientific principles the observations at each station. We want leisure calmly to compare the results obtained at different stations. And above all, we want leisure to unite all by some such comprehensive theory as that by which Gauss united the then accessible observations of declination, dip, and intensity, all over the earth. As long as the observations shall be continued, so long *at least* will those discussions be delayed, and so long *at least* will the real intellectual progress of the science be put off.

I am therefore clearly of opinion that it is desirable to terminate the present system of observations at the end of the present year.

In thus terminating the existing system of observations, I do not consider that the attention to the subject is at all suspended. I consider that the attention is diverted to a more favourable direction; and I look to the resumption of the observations at some future time as a probable consequence of it. Such observations would probably be undertaken under very different circumstances from those of the present series. New points of theory would have been suggested, new stations selected, new instruments adopted; and the object of the new series of observations would be, to make out the new laws to which I have alluded above.

In all that I have said thus far, I have alluded only to the interests of science as involved in the decision as to the time of terminating the observations. But I think that I should be wrong if I omitted to call attention to the expense of the observations. The annual expense of the Greenwich Magnetical and Meteorological Observatory, including printing, is almost £1200. This expense, while the observations and reductions are printed in the same detail, can scarcely be diminished.

I request that you will use your discretion as to printing the whole or any part of this letter.

I am, my dear Sir,
Very truly yours,
G. B. Airy.

XV.—*Lieut.-Colonel Sabine to Sir John Herschel, Bart.*

Woolwich, April 21, 1845.

My dear Sir,—It has been intimated to me that the consideration of the questions now before the Committee may be materially aided by such a brief notice as I may be able to take in the compass of a letter, of what the colonial observatories will have accomplished at the close of 1845, towards the fulfilment of the objects originally proposed; and of what further they may be expected to accomplish if their continuance is prolonged for another period. I propose to comply with this suggestion, and at the same time to state the opinions to which my own judgement at present inclines.

I. *Magnetical Observations.*—We shall have determined the *absolute values* of the different magnetic elements at the several stations with as much, or almost as much precision, as such determinations can be made with the most recent instruments, and in a manner which will probably leave little to be desired on that head.

We shall also have determined satisfactorily the mean values of the *diurnal variations*; including under that expression the effects both of the so-called *irregular* disturbances, now ascertained* to have a sensible *mean* influence on the diurnal variation of the magnetic direction and force, and of the more regular diurnal fluctuation connected with the sun's hour angle. In the first two years of the Toronto Observations these effects have been in a great degree separated from each other, and the mean values of each ascertained.

In respect to *secular changes*, we have learnt that neither the instrumental means which were originally furnished, nor the methods of observation originally directed, were fully competent for this part of the inquiry; and we have substituted a system of absolute determinations made monthly with instruments subsequently contrived, combined with the observations of the differential instruments used with various precautions stated in the published volume of the Toronto Observations†. This process has already been some months in operation, and we are able to say with confidence that it will accomplish the purpose, if a sufficient time be given. I fully concur with those who consider, that the endeavours which we are making, to place on record and transmit to posterity the present magnetic state of the globe, would be deficient in a most essential particular, if they failed to determine the secular changes which are at present taking place at our stations of observation.

There is also a very important class of determinations which are in progress of accomplishment by the same improved means that have been resorted to for the secular changes, which yet require some further time for their satisfactory completion. I allude to the *annual variations* of the magnetic elements. The evidence brought forward in the volume of the Toronto Observations appears to leave little doubt of the general fact, that the terrestrial magnetic force is at that station *considerably greater* in summer than in winter, and that the annual variation forms a regular progression intimately connected with the march of the temperature‡. The complete establishment of this important fact in terrestrial physics, and a satisfactory measure of its mean value at each of the stations, together with similar determinations in respect to the annual variation of the magnetic *direction* (which is also indicated at Toronto, though in a less decided manner), may be confidently expected by perseverance in the means which have been adopted in the last few months.

For the sake therefore of the secular and annual changes, I concur in opinion with those who desire a somewhat longer continuance of the magnetic observations at the stations which are now occupied; though I am at the same time of opinion that an observatory starting with our present instruments, and our present methods of observation, might be expected to satisfy in a reasonable manner *all* the desiderata which have been mentioned, in a period of five years.

With respect to the *simultaneous* observations made at the periods now familiarly known by the name of magnetic term-days, the objects sought were of a less definite character, and it is therefore not so easy to say to what extent the purposes which called them forth have been fulfilled by what has already been done. Much has undoubtedly been learned respecting the phæ-

* Toronto Observations, pp. xxvii and xlix.

† Pp. xi. xxxiii. l. vii. (note).

‡ Pp. xxxvii. *et seq.*

nomena of disturbances. They have been shown by the Toronto observations to follow a certain order, in frequency, in force, and in direction, connected with the hours of the day. The comparison of the observations at Toronto and Van Diemen Island, in the volume of 'Unusual Magnetic Disturbances,'—the intercomparison of the observations at the several European stations in the 'Resultate' of MM. Gauss and Weber,—the comparison of the American stations with each other and with a European station in the Toronto volume,—have all shown that highly interesting and important conclusions are derivable from this class of observations. It cannot be doubted that a more general and elaborate examination of what has been already done, will both add to the number of these conclusions, and will point out special problems to be solved by a continuance, and possibly by some modification, of the system of simultaneous observation. Meanwhile it may perhaps be desirable to discontinue, for the present at least, pre-arranged term observations, and to substitute for them the most comprehensive and assiduous observation of the phænomena at times of great disturbance that the strength of each observatory will permit; holding all things ready, however, to cooperate in any proposition of conjoint observation, that may grow out of the further examination to which the great body of observations already collected will doubtless be subjected. Whilst the Arctic Expedition is in the northern seas, the phænomena during periods of great disturbance ought to be particularly attended to at stations in high magnetic latitudes in Europe and America, and specially at Toronto; as, should the Expedition be detained during a winter, their instruments will be established in a locality which may render simultaneous observations of extraordinary interest and value. I think also that it may be more advantageous on some occasions to observe the precise instants of the occurrence of remarkable phænomena, than to record the indications of the instruments at fixed intervals of regular recurrence.

II. *Meteorological Observations.*—The periods during which *hourly observations* have been maintained at our observatories is probably sufficient in the greater part of instances to meet the problems now presenting themselves; if so, the attention bestowed on them might now be advantageously directed to observations having more special objects in view. I feel by no means confident, however, that more than three and a half years of hourly observation may not be desirable at Toronto, to meet questions which, if not already beginning to be considered, are not unlikely to be so in the rapid march which this science is now making; and I am inclined to think that it may be expedient that there should be a full series of at least five years of hourly observation, obtained at some one station in Europe and another in America; and that for the latter, Toronto is remarkably well situated.

There are a variety of special problems requiring systematic observation, of which the solution is extremely important in theoretical respects, and indispensable if anything like completeness is desired in the record to be left by our observatories. 1°. The separation of the pressures of the air and vapour, which united constitute the barometric pressure, has only been feasible since the invention of instruments to measure the tension of the vapour. The facts which this most important addition to our instrumental means has disclosed in the different observatories, some portion of which is already before the public*, are sufficient to show that a new æra has opened in scientific meteorology; that observations conducted as they have been at the observatories reveal as their immediate fruits the laws of the periodical and systematic variations of the aqueous and gaseous pressures, and their connection with the variations of the temperature and those of the direction and force of the wind.

* Brit. Assoc. Reports, 1844, pp. 42–62.

There are however many points yet to be ascertained, which have grown out of the observations already made, and which are essential to our perfect acquaintance with the mutual relations and dependencies of the periodical variations; such, for example, as a more precise knowledge of the several turning periods of the different variations. These are now occupying attention, and will require some further time. 2°. A meteorological record can scarcely be considered as otherwise than imperfect that does not show, with some satisfactory degree of approximation, the volume of air which, on the average of the year, passes the station of observation, and the direction in which it moves. For this purpose our instrumental means need, and are receiving, further improvements. 3°. The investigations into the *laws of storms* have shown the importance of *continuous* records being made of the several meteorological phænomena at periods of great atmospherical disturbance: at Toronto in particular these are likely to be very valuable, on account of the excellent field afforded by the North American continent for the prosecution of this inquiry.

I have named a few of the meteorological objects which are likely to be obtained by a prolongation of the term for which the observatories have been sanctioned. Other objects have been pointed out in the letters of several of the correspondents who have addressed the Committee. Those which I have mentioned are all more or less involved in the original instructions, though the instrumental means, or the methods of observation, required to carry them out, may not have been so clearly perceived then as they are now. Amongst these may also be classed, observations on the important subject of atmospherical electricity.

I am of opinion, therefore,—with reference to the observatories originally recommended by the British Association,—that it is now desirable to recommend,—

1st. That the time for which the observatory at Toronto is sanctioned should be prolonged.

2nd. That the time for which the observatory at Van Diemen Island is sanctioned should also be prolonged; but that the establishment of that observatory should be reduced to a director and one assistant, reducing the routine of daily observation proportionally. The personal establishment of this observatory is on a different footing from that of the Ordnance observatories, and the reduction will *there* be attended with a considerable saving of expense.

3rd. That one, *at least*, of the observatories at the Cape of Good Hope and St. Helena should be continued. If the astronomical observatory at the Cape will undertake the monthly absolute magnetical determinations, and their connexion by means of the differential instruments, the Ordnance observatory at the Cape may be discontinued, and that at St. Helena maintained.

Before I close this letter, I wish to advert to the expediency of extending the system of observation now in operation at Toronto, St. Helena, and the Cape of Good Hope, to other of the British colonies, where the same objects can be accomplished in an equally effective and economical manner.

In cases where the institution of similar establishments is strongly urged by the governor of a colony,—where competent persons are present and disposed to superintend the observations,—and where soldiers of the artillery are stationed whose services may be available, and whose employment has now been shown to be economical and effective in a high degree in the execution of a laborious and exact routine of observation,—there is wanting only a supply of instruments,—the temporary allotment of a building to contain them,—extra pay such as the individuals at the above-named observatories receive,—

and an authoritative connexion with the head-quarter establishment, whence they may derive instruction and guidance.

The cost of one of the Ordnance observatories (including 100*l.* a-year for incidentals of all kinds) is 392*l.* a-year, exclusive of publication. It may be assumed that five years of hourly observation is a sufficient time of continuance for obtaining in any particular colony the mean values of the magnetical and meteorological elements, and their diurnal, annual, and secular variations, as well as the peculiarities of climate bearing on the health and industrial occupations of man. If the observations were printed *in full detail* for the five years, they would occupy two quarto volumes; but if it were thought sufficient that duplicate or triplicate manuscript copies should be deposited in different public libraries, and that publication should be confined to abstracts and an analysis, the cost of the publication would form but a small addition.

The colonies of Ceylon, New Brunswick, Bermuda, and Newfoundland are in the described case; their respective governors are recommending the establishment of magnetical and meteorological observatories in them; competent directors are on the spot; and they are all artillery stations.

The volume of the Observations at Toronto in 1840–1842 is now before the public, and affords a fair example of what these institutions accomplish at the above-named cost*. It furnishes also the means of estimating the advantages to the sciences of magnetism and meteorology, of accomplishing the same objects in other and different parts of the globe, at an expense which is small in comparison with that of civil establishments, and which may in some instances at least (as at Ceylon) be offered from the colony itself.

Believe me, my dear Sir, sincerely yours,

EDWARD SABINE.

XVI.—*Professor Dove to Lieut.-Colonel Sabine.*

Berlin, April 21.

AUF Ihren Wunsch füge ich diesen Zeilen noch einige Bemerkungen über die Toronto Beobachtungen bei, welche ich so wie die beiden Theile des Greenwich Magnetical and Meteorological Observations erhalten habe, für welche Geschenke ich mich auf das Dankbarste verpflichtet fühle. Ich ersuche Sie, diese Bemerkungen nur als meine individuelle Ansicht anzusehen, und überzeugt zu sein, dass ich mein Urtheil bereitwillig dem der Männer unterordne, von welchen dieses grossartige Unternehmen veranlasst worden ist und geleitet wird. Die meteorologischen Beobachtungen in Toronto sind nach meinem Urtheil vollkommen geeignet, um weiter in demselben Weise fortgesetzt, jede Frage zu beantworten, welche in Beziehung auf die barometrischen, thermischen und hygrometrischen Verhältnisse der Atmosphäre in Rücksicht auf die periodischen Veränderungen derselben auf dem jetzigen Standpunkte der Wissenschaft aufgeworfen werden können. Auch lässt die Redaction derselben in dieser Beziehung, so viel ich sehe, nichts zu wünschen

* £392 is the annual amount of the sum paid by the public for one of these establishments, which would not be paid if the establishment did not exist. It does not include the *regimental* pay (nearly an equal sum) of the officer and men employed in the observatory, because they continue to form a part of the peace establishment of the regiment of artillery, and of the available strength of the corps in the particular colony. A discretionary power has been given by the Master-General of the Ordnance to the commanding officer of artillery in each colony, to stop the work of an observatory on the occurrence of an emergency requiring the military services of all; but at all other times, whilst thus temporarily occupied in rendering scientific services, their military duties are performed *gratuitously* by their brother officers and soldiers, and form to that extent a contribution to science on the part of the whole regiment.

übrig, denn sie ist vollkommen übersichtlich und gewährt die bedeutende Erleichterung einer bereits bereckneten Elasticität der Dämpfe.

Detaillirte Beobachtungsjournale dienen aber ausserdem dazu, die mit den periodischen Veränderungen sich verwebenden Veränderungen kennen zu lernen, welche vorzugsweise von einer Änderung in der Windesrichtung abhängen. Ziehe ich zum Beispiel an allen den Tagen, an welchen Mittags N.W. beobachtet wurde, die vorhergehende Ablesung des Barometers um 10^h von der Mittagsbeobachtung, oder diese von der um 2^h erhaltenen ab, so werde ich unmittelbar erfahren, ob auch in Nordamerika mit N.W. das Barometer steigt d. h. ob der N.W. der Uebergang eines wärmeren leichteren Windes in einen schwereren kälteren ist. Bei den grossen Bogen, durch welche die Windfahne sich dreht, sind nahe abstehende Beobachtung wünschenswerth, und bei der Seltenheit mancher Richtungen wird man bei solchen Rechnungen so viel Aufzeichnungen der Windesrichtung wünschen, als überhaupt Ablesungen andrer Instrumente erfolgt sind. In Beziehung auf die Auffindung der Gesetze der von der Windesrichtung abhängigen Veränderungen, scheint es mir daher höchst wünschenswerth, auch sämtliche Aufzeichnungen der Windesrichtungen zu erhalten. Um den Raum zu ersparen, könnte zugleich the pressure etwa so angegeben werden, SW_2 SW_1 wo die danebenstehende Zahl den Druck bezeichnete.

Was bei dem grossartigen Englischen und Russischen Unternehmen, denen sich die Stationen Brüssel, München und Prag so verdienstlich angeschlossen haben, mir vorzugsweise wünschenswerth scheint, ist dass das erhaltene Beobachtungsmaterial nicht blos publicirt werde, um wie die Mannheimer Ephemeriden fast ein halbes Jahrhundert unbenutzt zu liegen, sondern dass sobald als möglich Resultate daraus gezogen werden, um zu zeigen, was auf diesem Wege geleistet werden kann. Die grossen damit verknüpften Recknungen verlangen aber eine Theilung der Arbeit. Ich würde daher vorschlagen, dass die British Association diese Vertheilung übernehme, wie sie in ähnlicher Weise in Beziehung auf die Sterncharten von der Berliner Akademie ausgegangen ist. Um zum Beispiel also die von der Windesrichtung abhängigen Veränderungen des Druckes der Luft und der Dämpfe, ebenso die der Temperatur kennen zu lernen, müsste z. B. für jede Windesrichtung die Veränderung jener drei Grössen in 4 Stunden berechnet werden. Um aber die periodische Veränderung zu eliminiren, müssten die Beobachtungen um 12, 2, 4 .... noch nicht zu einem gemeinsamen Mittel vereinigt werden. Ich würde mich z. B. gern anheischig machen, für eine der Stationen in jedem Jahre diese Rechnung zu übernehmen. Nach einem Zeitraum von 5 Jahren könnten die so gesammelten Data dann vereinigt werden und man würde durch die Stationen Greenwich, Newfoundland, Toronto, Van Diemen's Land, Petersburg, Barnaul, Nertchinsk, Peking, Brüssel, München, Prag eine sehr genügende Beantwortung der Frage erhalten, welchen modificirenden Einfluss die Lage an der Ost- oder Westseite eine Meeres, im Innern der Continente oder an der Küste, auf der nördlichen oder südlichen Erdhälfte habe.

Da man annehmen darf, dass, so wie zwischen den Tropen die Luftmenge, welche unten nach dem Æquator hinfliest, compensirt wird durch einen entgegengesetzten Strom in der Höhe, auch die neben einander liegenden Ströme in der gemässigten Zone einander in der Weise das Gleichgewicht halten, dass, was innerhalb eines Jahres über gewisse Stellen eines Parallels dem Pole zufliesst, über andre Stellen desselben Parallels zum Æquator zurückkehrt, so sollte man zunächst mit Berücksichtigung der Intensität entweder an keinem Orte eine vorherschende Windesrichtung erwarten, oder an einigen eine der andern entgegengesetzte. Aber die Luft, welche vom Æquator her den Parallel überschreitet, kommt bei diesem mit einer hohen Temperatur an, welche sie bei ihrem weitern Fortschreiten nach dem Pole immer mehr an den Boden, über welchen sie strömt, abgiebt, welche sie daher bei ihrer Rückkehr zum Parallel nach dem Æquator hin nicht wieder mitbringt. Kältere Luft nimmt einen geringeren Raum ein als wärmere. Der Luftstrom ist daher, wenn er vom Pole zum Æquator fliesst, schmaler als wenn er dem Pole zuströmt. Findet diess Hin- und Herströmen in veränderlichen Betten statt, so wird derselbe Beobachtungsort nothwendig öfter in einem Südstrome sich befinden, als in einem Nordströme, die Anzahl der südlichen Winde also im ganzen Jahre die der nördlichen übertreffen. Da aber ausserdem die südlichen feuchten Winde in immer erneuerten Niederschlägen ihren Wasserdampf in Form von Regen, &c. absetzen, so kehrt zwar in dem trocknem nördlichen Winde dieselbe Luftmasse nach dem Æquator zurück, welche als Südstrom dem Pole zufloss, aber das, was als luftförmiger Begleiter auf dem Hinwege mit die Quecksilbersaüle hob, fliesst theilweise unter dem Gefässe des Barometers als tropfbar Flüssiges zurück, ohne zur Hebung des Quecksilbers mitzuwirken. Bei Erwägung der eben besprochenen Veränderungen, welche die Luft zwischen Hingang nach den Polen und Rückkehr von ihnen erfährt, sieht man ein, dass in der ganzen gemässigten Zone die mittlere Windesrichtung eine æquatoriale sein kann, welche wegen der Drehung der Erde in der nördlicher Erdhälfte eine südwestliche, in der südlicher eine nordwestliche wird. Es ist aber klar, dass innerhalb einzelner Theile der jährlichen Periode an einem Ort die Luft nach dem Pole, an andern nach dem Æquator strömen wird, ja es scheint diess im Allgemeinen in der Weise stattzufinden, dass während in Nordamerika im Sommer die Windesrichtung verhältnissmässig südlicher ist als im Winter, das Umgekehrte in Europa stattfindet. Bei der Veränderlichkeit der mittlern Windesrichtung überhaupt lässt sich diese Frage nur durch gleichzeitige Beobachtungen entscheiden, ein neuer Grund die beobachteten Windesrichtungen in aller Vollständigkeit zu erhalten.

Bezeichnet $b_1\, b_2\, b_3\, b_4 \ldots\ldots b_8$ den mittleren Barometerstand respective bei den Winden S.S.W. W..... S.E, $n_1\, n_2 \ldots\ldots n_8$ die Anzahl der beobachteten Richtungen, so wird der mittlere Barometerstand

$$b = \frac{n_1\, b_1 + n_2\, b_2 + n_3\, b_3 \ldots\ldots + n_8\, b_8}{n_1 + n_2 + \ldots\ldots n_8}$$

werden. Hätten also Winde gleich oft geweht, so würde die Windesrichtung keinen Einfluss auf den Barometerstand gehabt haben. Es wäre dann da $n_1 = n_2 = n_3 \ldots = n_8$ der Barometerstand $b_8 = \frac{b_1 + b_2 + b_3 \ldots\ldots + b_8}{8}$. Der Unterschied $b - b_0$ giebt also den Einfluss der mittleren Windesrichtung auf den mittleren Barometerstand. Besitzt man also eine barometrische Windrose, so kann man entscheiden, ob der mittlere Druck ein auf diese Art normaler oder anomaler ist. Dasselbe gielt für Temperatur, Feuchtigkeit. Aber an solche Berechnungen ist nur zu denken, wenn die Windesrichtungen mit den entsprechenden Ablesungen vollständig publicirt sind. Ob der so ungenugsam Einfluss erheblich oder nicht ist, ist ganz gleichgültig, denn es ist ein eben solcher Fortschritt, wenn man eine mögliche Erklärung als ungenugsam beseitigt, als wenn man eine vermuthete rechtfertigt. Die Aufnahme der Intensitätsbestimmungen verändert die Aufgabe. Bis jetzt nennt man die mitlere Temperatur eines Ortes das arithmetische Mittel einander nahe liegender gleichweit abstehender Beobachtungen innerhalb der zu betrachtenden Periode. Da aber während der Wind stürmischer weht mehr Luft über den Beobachtungsort strömt als bei langsamen Luftstrome, so ist die Zahl, welche die mittlere Temperatur der über den Beobachtungsort strömenden Luft angiebt eine andre als das was man als mittlere Temperatur des Zeitraumes bis jetzt allein betrachtet hat. Es ist nicht unwahrscheinlich, dass bei gewisse meteorologischen Fragen es sich um diese Zahlen handelt, und es wird daher ein wenn auch annäherndes Intensitätsmaass ein wichtiger Beitrag wo aber ebenfalls jede Intensitätsmessung mit der gleichzeitige barometrischen, thermischen und hygrometrischen combinirt werden muss.

Die wichtige Frage, ob bei horizontaler Bewegung der atmosphärischen Luft eine Sonderung der trocknen Luft und der ihnen beigemengten Wasserdämpfe zu machen sei, wie es bei den periodischen Änderungen wohl nun erwiesen ist, wird durch die angestellten Beobachtungen ebenfalls erledigt werden.

Diess sind die Gründe welche es mir wünschenswerth erscheinen lassen, den speciellen Angaben des Standes der Instrumente auch noch die der Windesrichtungen hinzuzufügen. Es ist diess aber auch der einzige Wunsch, der mir bei einer aufmerksamen Prufung erheblich schien. Vortrefflich ist, dass ausser die quantitative Bestimmungen auch eine Art Commentar dem Journale beigefügt ist. Die Physionomie des Wetters lässt sich nur so beschreiben und es ist dabei wieder höchlich anzuerkennen, dass die vortreffliche Terminologie von Howard beibehalten ist.

Die Beobachtungen von Van Diemen's-land erwarte ich mit der grössten Spannung. Ein meteorologisches Journal von der südlichen Erdhälfte in solcher Vollständigkeit füllt eine Lücke aus, welche seit lange so sehr fühlbar war. Auch die Station St. Helena ist sehr glücklich gewählt, in der Passatzone ohne Monsoons und dabei das Cap als Controlle an der aussern Grenze des Passat.

Entschuldigen Sie alle diese flüchtigen Bemerkungen, die ich deutsch schreibe, um den Brief nicht aufzuhalten. Ich freue mich im Voraus an den Besprechungen Theil nehmen zu können, welche über ein so grossartiges Unternehmen unter Männern stattfinden werden, die im Stande sind unter so verschiedenen Himmelstrichen der Natur Fragen vorzulegen. Das einzige was ein deutscher Naturforscher zu bringen im Stande ist, ist das Versprechen sich bei den Arbeiten, welche nun erfodert werden, zu betheiligen, so weit diess der Sache förderlich sein kann. Meteorologische Untersuchungen können im günstigsten Falle von einem Einzelnen wohl angeregt werden, sie bedürfen aber zu ihrer weitern Förderung des Zusammenwirkens einer Gesammtheit. Dass die Meteorologie diess finden würde, war immer bei mir eine stille Hoffnung, dass sie es aber so bald und in so grossem Maasstabe gefunden hat, ist selbst über meine kühnsten Erwartungen.

Believe me, sincerely yours,

H. W. Dove.

(*Translation.*)

Berlin, April 21.

At your wish I add some remarks on the Toronto Observations, which I have received, as well as the two volumes of the 'Greenwich Magnetical and Meteorological Observations,' for all of which I return my grateful thanks. I desire that the following remarks may be regarded as only my own individual views, which I submit to those of the persons by whom this great undertaking has been promoted and guided.

The meteorological observations at Toronto, continued in the same manner, appear to me to be perfectly fitted to answer every question which, in the present state of science, can be proposed concerning the barometric, thermic and hygrometric relations of the atmosphere, in respect to their periodical changes. The redaction also leaves nothing to be desired in this respect, for it is perfectly lucid, and has the great advantage of the tension of the vapour being already computed.

But detailed observation-journals offer the further advantage of enabling us to trace the changes, depending chiefly on variations in the direction of the wind, which are mixed up with the periodical changes. If, for example, on every day when the direction of the wind at noon was north-west I deduct the preceding or 10^h reading of the barometer from the noon-observation, or the noon-observation from that at 2 hours, I shall infer directly whether in North America, as in Europe, the barometer rises with the north-west wind, *i. e.* whether north-west is the passage from a warmer lighter wind to a heavier colder one. Considering the large arcs through which the wind-vane moves, it is desirable to have observations near together, and the rare occurrence of several directions is an additional reason why we should have as many records of the direction of the wind as of the readings of the other meteorological instruments. With the directions the pressures also may be given, and to save space they might perhaps be thus recorded: SW_1 SW_2, where the number expresses the pressure.

That which appears to me most desirable in the great English and Russian undertaking, to which Brussels, Munich and Prague have so meritoriously joined themselves, is, that the materials gathered should not only be published as was done with the Mannheim Ephemerides, which remained unemployed for more than half a century afterwards, but that results should be deduced from them as soon as possible. The extensive calculations connected herewith will require a division of labour: I would propose that the British Association should undertake the distribution of the parts, as the Berlin Academy did in regard to the maps of the stars. For example; in order to learn the variations in the pressures of the air and vapour, and in the temperature, dependent on the direction of the wind, we must not combine in a common mean the values at the several observation-hours when any particular wind has blown, but we must first eliminate from these values the periodical variations by which they have been affected. I would willingly offer to undertake this calculation for each year for one station. If at the end of five years the data from the stations of Greenwich, Newfoundland, Toronto, Van Diemen Island, Petersburg, Nertchinsk, Pekin, Brussels, Munich and Prague were combined, we should obtain from them a satisfactory reply in respect to the modifying influence of situation, whether on the east or on the west side of the sea,—whether in the interior of a continent, or on the coast,—whether in the northern or in the southern hemisphere.

As within the tropics the lower current of air flowing towards the equator is compensated by an opposite current above, so we may assume that in the temperate zone the equipoise is maintained by currents on the same level flowing in opposite directions, and thus that the air, which in the course of the year passes over certain stations on a given parallel towards the pole, returns towards the equator, passing over other stations on the same parallel. We should expect, that if we find (taking the intensity into account) a prevailing direction of the wind at some stations, we should find an opposite direction at other stations. But the air which passes over the parallel coming from the equator brings with it a higher temperature, which it gradually parts with as it flows over the surface of the earth, and which it cannot therefore bring back with it when it passes the same parallel on its return towards the equator. Now colder air occupies less space than warmer air, and therefore the current of air flowing from the pole to the equator is narrower than when it flows from the equator to the pole. If the beds in which these opposite currents flow are shifting ones, the same station will necessarily be oftener in a southerly than in a northerly current (in the northern hemisphere), and the proportion of southerly wind will in the course of the year exceed that of northerly. Moreover the southerly winds bring with them a quantity of vapour, with which they are continually parting in the form of rain and other precipitations: the returning northern dry winds do indeed bring back the same mass of *air*, but without its aëriform companion, which having now assumed the form of liquid, no longer contributes to raise the column of mercury in the barometer. On considering the above-described alterations to which the atmosphere is subjected on its passage from and return to the equator, we see that throughout the temperate zones the *mean direction* of the wind may be from the equator, converted by the rotation of the earth into a south-westerly direction in the northern, and a north-westerly in the southern hemisphere. It is plain, however, that taking the year in detached parts, the air may be flowing towards the pole in one place and towards the equator in another: and we do find that in summer the direction of the wind in North America is relatively more southerly than in winter; whilst the contrary is the case at the same season in Europe. To arrive at decided conclusions, however, on this point, we require *simultaneous* observations, and on account of the great variability, the *full record* of the direction and pressure of the wind.

If $b_1\ b_2\ b_3\ b_4 \ldots . b_8$ denote the mean height of the barometer respectively for the winds S., S.W., W., ... S.E., $n_1\ n_2 \ldots . n_8$ the number of the observed directions, then the mean height of the barometer b will be

$$= \frac{n_1 b_1 + n_2 b_2 + n_3 b_3 \ldots . + n_8 b_8}{n_1 + n_2 + n_3 \ldots . + n_8}.$$

If all the winds had blown with equal frequency, the direction of the wind would have had no influence on the mean height of the barometer. If, then,

$n_1 = n_2 = n_3 \ldots . = n_8$, the barometric height $b' = \dfrac{b_1 + b_2 + b_3 \ldots . + b_8}{8}$.

Thus the difference $b - b'$ gives the influence of the mean direction of the wind on the mean height of the barometer. If we thus possess a barometric wind-rose, we are enabled to decide whether the mean pressure is in this way normal or anomalous. The same holds good for temperature and moisture. But such calculations require the directions of the wind to be given as fully as the corresponding readings of the other instruments. No matter whether the result be to find a material influence or not, for progress is equally made by a proposed possible explanation being set aside as insufficient, or by its being justified and confirmed. The taking in determinations of intensity alters the problem. Hitherto we have regarded as the mean temperature of a place, the arithmetical mean of observations at equal and short intervals during the period under consideration. But inasmuch as when the wind blows strongly more air passes over the place of observation than when the current is slower, the number which should give the mean temperature of the air flowing over the station may differ from that which is given by the arithmetical mean of the observations. It is not improbable that in certain meteorological questions these hitherto unconsidered values may be those treated of, and hence even an approximate measure of intensity may be an important contribution; in this case also every measurement of intensity must be combined with the corresponding barometric, thermic and hygrometric record.

These observations will also determine the important question, whether, in the horizontal movement of the atmosphere, we are to separate the dry air and the aqueous vapour mingled therein, as has been proved to be just with respect to the periodical changes.

These are the reasons for which it appears to me desirable that the directions of the wind should be given in every instance in addition to the other observations. But this is the only wish which I can form after attentive examination. It is excellent, that besides the quantitative determinations, a kind of commentary has been added to the journal. It is only thus that the physiognomy of the weather can be described, and it is deserving of acknowledgement, that in this commentary the approved nomenclature of Howard has been employed.

I await the observations of the Van Diemen Island observations with the greatest earnestness. A meteorological journal of such completeness from the southern hemisphere supplies a want which has long been greatly felt. St. Helena also is very happily chosen, being in the trade zone without monsoons; and the Cape being at the outer limit of the south-east trade will be valuable as a check.

Excuse these passing remarks being written in German, not to delay the letter. I rejoice in the anticipation of being enabled to take part in the conversations and discussions which will take place at Cambridge on the subject of this great undertaking, between men who are in the position to interrogate nature in such various regions of the earth. All that a German cultivator of science can bring is the promise to take part in the work which may be now required, so far as may aid the furtherance of the cause. Meteorological investigations may indeed in the most favourable cases be excited by one individual, but for their more extended prosecution they need the cooperation of many. That meteorology should receive this advantage was always with me a hope, which I scarcely ventured to express; but that she should find it so soon, and on such a scale, has indeed surpassed my boldest expectations.

Believe me, sincerely yours,

H. W. Dove.

XVII.—*Extract from a Letter from Dr. Lamont to Lieut.-Colonel Sabine.*

Munich, April 26, 1845.

My dear Sir,—I have received a short time ago the volume which you had the kindness to send me, containing the observations of Toronto, 1840–1842, and can assure you that the results have greatly surpassed my expectations. Indeed, I believe that very few European establishments have been conducted with so much skill and care and scrupulous attention to the various circumstances on which the accuracy of the observations depend. This is deserving of particular acknowledgement, because those entrusted with the care of the observatory might have contented themselves with simply executing the instructions of the Royal Society: in this way also a series of observations would have been made, but the value of the results would have been very different. The historical details prefixed to the Toronto observations agree perfectly with what has been experienced at other observatories, and particularly at ours: the same difficulties were met with and the same reforms gradually introduced. At present the Toronto observatory, by the accounts given in the Introduction to the Observations, must be considered as being in the most efficient state; all the arrangements seem to me to be very judiciously made. It must be considered as an immense advantage, that the same observations can be made with different instruments: the agreement of the results obtained in different ways affords the best means of judging how far confidence can be placed in the observations. I have been comparing the daily changes at Toronto with those observed at Munich and other places in Europe, but do not think that any law can be found out till a greater number of places in both hemispheres can be compared.

* * * * * *

The beginning of this letter might, if you think proper, be added to the one I wrote you in answer to the questions of the Committee.

Believe me, my dear Sir,

Yours most sincerely,

LAMONT.

XVIII.—*From Professor Ch. F. Gauss to Lieut.-Colonel Sabine.*

Gottingen, May 5, 1845.

MY DEAR SIR,—It has been long a nourished favourite wish of mine to pay once at least a visit to your happy island, the seat of so much grandeur in all pursuits that ennoble and embellish life, and certainly there could not be a more favourable opportunity than the congregation of the British Association, where almost all, eminent in science, may be expected to be met with.

The invitation of the President, and your kind offers to clear perplexities a stranger might be exposed to, have therefore been very strong temptations to me, and I have long balanced before submitting to the weighty reasons my state of health opposes at present to undertaking such a journey. Be pleased therefore to express to the President my excuses, and my deep regret for my not being able to profit by the honourable invitation, and accept yourself my warmest thanks for your kind intentions.

Also I feel highly obliged to you for the volume of 'Toronto Observations,' and the VIth part of your Contributions, which I received a few weeks ago. Beset as I have been by a train of urgent business, I could till now only look over hastily these precious materials. My anxious wishes for the permanent continuance of the Foreign British Magnetic Establishments have indeed been strengthened by the inspection of the 'Toronto Observations;' but a work of this description deserves and requires a much closer scrutiny than at this moment is in my power to afford. For this same reason, and in consideration of the extremely short term prescribed by Sir John Herschel (which would have left only two or three days for gathering materials and writing down the note he desired), I felt disqualified to send any important addition to what I had already written on that head.

Probably Dr. Weber will be under less impediment than myself to be present at the approaching meeting of the British Association, in which case I hope he will take his road by Gottingen, and favour me with some sojourn here. We may then confer between ourselves on the matter in hand, and exchange and rectify our views on that head, so that he may take to the debates the result of our joint opinions.

Believe me to remain always, dear Sir,

Your obliged, faithful servant,

C. F. GAUSS.

XIX.—*Baron A. Von Humboldt to the Committee of the British Association.*

Par, le 15 Mai, 1845.

INFINIMENT sensible aux marques de confiance bienveillante dont j'ai été honoré de la part du Committee of the British Association for the Advancement of Science, je ne puis plus explicitement répondre à la question qui m'a été addressée par cette illustre societé qu'en exprimant le plus vif désir de voir continuer les observations des stations magnétiques au delà du terme de l'année 1845. Tout ce qui a été publié jusqu'ici aux frais et par la noble munificence du Gouvernement Britannique est d'une si haute importance pour l'étude des perturbations simultanées dans les regions les plus éloignées du globe que cette importance meme suffit pour motiver le désir que j'exprime. Il ne me parait pas douteux que le gouvernement Russe s'associera à cette continuation des observations magnétiques et météorologiques de sorte que pendant le séjour du Capitaine Franklin dans les régions arctiques; les stations restées en activité dans les deux hémisphères offriront des points de comparaison dont il serait bien regrettable de se priver lorsqu'il s'agit d'un interêt si généralement reconnu.

Je supplie le Committee et individuellement mon excellent ami Sir John Herschel d'agréer l'hommage de mon respectueux dévouement.

LE BARON DE HUMBOLDT.

XX.—*From W. C. Redfield, Esq. of New York to Lieut.-Colonel Sabine.*

New York, March 13th, 1845.
Received at Woolwich, June 5th.

SIR,—I had the honour to receive by the last steamer a letter from the President of the British Association relating to the combined system of magnetical and meteorological observations, which will close on the first of January next, and inviting my attendance at the consultations which are proposed to be held on this subject by the principal cultivators of the sciences of magnetism and meteorology at the next meeting of the Association in the University of Cambridge, on the 19th of June.

I regret to say that pressing engagements will prevent me from being present on that interesting occasion, and compel me to forego the pleasure of attending the proceedings and deliberations of that distinguished body. But I ardently desire that some means may be devised for procuring the further continuance of this invaluable system of combined observations in magnetism and meteorology. These observations, if continued, appear likely to have an important influence upon the progress of these sciences, and their suspension at this early period, when the difficulties of concerted action have been so far overcome and the importance of the observations has begun to be realized, would be greatly lamented by the friends of science throughout the world.

I have long desired that these combined observations might be made available for determining the course of the main current of the lower atmosphere, in different regions, as shown by the observed courses of the clouds, apart from the particular and varying directions of the winds at the earth's surface, and also as apart from the low scuds or cumuli which are borne by the surface winds, for I deem this knowledge as being perhaps essential to a just estimate of the laws or forces which control the circulation of our atmosphere.

With my best wishes for the continued prosperity and usefulness of the Association, and with sentiments of high consideration and regard,

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

W. C. REDFIELD.

Lieut.-Col. Sabine, Woolwich.

XXI.—In compliance with a resolution passed at a meeting of the General Committee of the British Association at York in October 1844, the following letter has been addressed to those foreign gentlemen who have taken a leading part in the combined system of magnetical and meteorological observations now in progress.

"Cambridge, February 22nd, 1845.

"Sir,—As the second triennial period of the combined system of Magnetical and Meteorological Observations will close on the 1st of January 1846, it becomes extremely desirable to ascertain, as far as may be practicable, the opinions of the various distinguished philosophers who have taken a prominent part in suggesting or making them, with respect to the expediency of continuing them for a longer term.

"It was with this view that a letter was addressed to you, Sir, by Sir John Herschel, the President Elect of the British Association, respectfully requesting your opinion, as far as the results of the observations had come to your knowledge, of the extent to which you considered the objects for which they were instituted as already accomplished, and also of the advantages which the sciences of Magnetism and Meteorology might derive from their longer continuance.

"Considering, however, the great difficulty of communicating by writing the latest results of observations made at such distant stations, and of concentrating into one view the united experience of so many observers, the British Association at their last Meeting at York unanimously adopted a suggestion made by M. Kupffer of St. Petersburg, to invite the attendance at their next Meeting in the University of Cambridge on the 19th of June, of the principal cultivators of the sciences of terrestrial magnetism and meteorology, for the purpose of conferring together upon the course which they might judge to be most expedient hereafter to pursue, and of recommending to their respective Governments such measures as they might consider best calculated to give full effect to this great scientific operation.

"I have been, consequently, requested by the Council of the British Association to solicit the honour of your attendance at their next meeting at Cambridge, which begins on the 19th and closes on the 25th of June; and I beg further to inform you that arrangements will be made by Lieut.-Colonel Sabine and the Staff of Computers placed under his orders by the British Government, to bring under your notice the results of the observations brought down to the latest possible period, and to furnish every information which an extensive correspondence with the observers and others interested in this important inquiry may place at his disposal.

"I have reason to believe that the railway between London and Cambridge, and between Yarmouth and Cambridge, will be opened before the 19th of June; and I am further authorized to state that the leading Members of the University of Cambridge will feel highly favoured by your appearance amongst them, and will endeavour to make every arrangement in their power which may contribute to your comfort and convenience during your visit.

"If it should be your intention to attend the proposed conference, I should feel obliged to you if you would communicate your intention to Lieut.-Colonel Sabine at Woolwich, who will gladly furnish you with any further information which you may require.

"I have the honour to be, Sir,
"With the greatest consideration and regard,
"Your most obedient servant,
(Signed) "George Peacock,
"*President of the British Association.*"

From the Marquis of Northampton, President of the Royal Society, to the Right Honourable Sir Robert Peel, Bart.

London, July 3, 1845.

Dear Sir,—The Council of the Royal Society having had before them the resolutions of the Magnetic Conference at Cambridge, to which, as a member of that Conference, I drew their attention, entirely concur in the recommendations that they contain, and request the favourable consideration of Her Majesty's Government to the subject, to which they attach the highest importance.

The Council of the Royal Society having named the same gentlemen to draw up an accompanying explanatory report as the British Association, it is of course the report of the Royal Society.

I am, dear Sir,
Yours truly,
(Signed) Northampton.

From Sir J. Herschel, Bart., President of the British Association, to the Right Honourable Sir Robert Peel, Bart.

London, July 3, 1845.

Sir,—I have the honour to forward for your perusal the accompanying resolutions of the British Association for the Advancement of Science, assembled at Cambridge on the 25th ult., and respectfully to request your favourable consideration of them on the part of Her Majesty's Government, and more particularly of the 1st, 3rd, 4th, 5th, 6th, 8th, 9th, 10th, 11th, 12th, and 14th, in which the aid and countenance of Government are solicited in favour of the continuance of the magnetic and meteorological operations now in progress, and which terminates on the 31st of December 1845.

Accompanying this letter, I have moreover the honour to enclose the report alluded to in resolution 14th, explanatory of the proceedings which have led to this application, and which I trust will place their whole bearing in a distinct and satisfactory light.

I have the honour to be, Sir,
Very respectfully, your obedient and humble Servant,
(Signed) J. F. W. Herschel,
President of the British Association.

Resolutions of the Magnetic Conference, adopted by the General Committee of the British Association, June 25th, 1845.

1. That it be recommended that the Magnetic Observatory at Greenwich be permanently continued upon the most extensive and efficient scale that the interests of the sciences of Magnetism and Meteorology may require.

2. That it be earnestly recommended to the Provost and Fellows of Trinity College, Dublin, to continue the magnetical and meteorological observations at the Observatory instituted by that University.

3. That it be recommended to continue the Observatory at Toronto upon its present footing until the 31st of December 1848, unless in the mean time arrangements can be made for its permanent establishment.

4. That it be recommended to continue the Observatory at Van Diemen's

Land until the 31st of December 1848, unless in the meantime arrangements can be made for its permanent establishment.

5. That it be recommended that the Observatory at St. Helena should be continued upon its present establishment for a period terminating on the 31st of December 1848, for special meteorological objects.

6. That it be recommended that the building and instruments of the Magnetical and Meteorological Observatory at the Cape of Good Hope be transferred to the Astronomical Observatory, to which an assistant should be added, for the purpose of making absolute magnetic determinations.

7. That it be recommended to the Court of Directors of the Honourable East India Company, that the Observatories of Simla and Singapore be discontinued at the end of the present year; but that the Magnetic and Meteorological Observatories now made at Bombay and Madras be permanently continued in connexion with the Astronomical Observatories at those stations; and that it be further recommended to the Court of Directors to sanction the proposal made by Lieutenant Elliot for a magnetic survey of the Indian Seas, to commence with the close of the present year.

8. That it be recommended that the Canadian survey be continued until the connexion of Toronto with the American stations be completed.

9. That it be recommended that advantage should be taken of every opportunity of extending magnetic surveys in regions not hitherto surveyed, and in the neighbourhood of magnetic observatories.

10. That it be strongly recommended that the staff of Colonel Sabine's establishment at Woolwich be maintained, with such an increased force as may cause the observations which have been made, and those which shall hereafter be made, to be reduced and published with all possible expedition.

11. That this Meeting have recommended the reduction of the establishments at present attached to some of the magnetic and meteorological observatories, in the full confidence, that if, after careful discussion of the observations made to the end of 1845, there should appear to be reason for restoring some of those establishments and for forming new ones, the British Government and the East India Company will give their aid with the same liberality which they have displayed in the maintenance of the existing observatories.

12. That the cordial co-operation which has hitherto prevailed between the British and Foreign Magnetic and Meteorological Observatories having produced the most important results, and being considered by us as absolutely essential to the success of the great system of combined observation which has been undertaken, it is earnestly hoped that the same spirit of co-operation will continue to prevail; and that the President of the British Association be requested to make application to the British Government to convey the expression of this opinion to the governments of those other countries which have already taken part in the observations.

13. The British Association assembled at Cambridge cannot permit the proceedings of this Meeting to terminate without expressing their sense of great obligation to the eminent foreign gentlemen who have taken part in the discussions of the Conference, and whose unwearied attention has been most effectively bestowed on every part of the proceedings.

14. That the Committee which has hitherto conducted the co-operation of the British Association in the system of combined observations, be reappointed, for the purpose of preparing a report to accompany the presentation to the British Government and to the Directors of the Honourable East India Company, of the resolutions passed at this meeting; and that the Marquis of Northampton, Sir John Lubbock, Bart., Professor Christie, and Professor J. D. Forbes, be added to the Committee. J. F. W. Herschel.

Report, explanatory of the proceedings which have led to an application on the part of the British Association and of the Royal Society to Her Majesty's Government and to the Honourable Court of Directors of the East India Company, for a continuance of the Magnetic and Meteorological Observations now carrying on under their respective sanctions: drawn up by a Committee appointed by those bodies, consisting of Sir J. Herschel, the Marquis of Northampton, the Dean of Ely, the Master of Trinity College, Cambridge, Col. Sabine, Dr. Lloyd, the Astronomer Royal, Sir J. Lubbock, Professor Christie, and Professor J. D. Forbes.

It being understood that the second term of three years for which the Magnetic and Meteorological Observatories established under Her Majesty's Board of Admiralty at Greenwich and in Van Diemen's Island, those supported by Her Majesty's Board of Ordnance at Toronto, St. Helena, and the Cape of Good Hope, and those of the Honourable East India Company at Simla, Madras, Bombay and Singapore, was granted, will terminate at the expiration of the current year, unless provision be made for their continuance, and that with their cessation the combined system of British and Foreign cooperation for the investigation of magnetic and meteorological phænomena, which has now been five years in progress, must be broken up,—it became a subject of deep consideration to the British Association, in which the conception of this operation was matured, and at whose instance, conjointly with that of the Royal Society, it was set on foot and supported by the munificence of the Government and the Honourable East India Company, whether it were consistent with the interests of science that they should suffer this term to expire without an effort on their part to procure its continuance, or the contrary.

Connected as the science of Britain is with that of the other nations whose Governments have taken an interest in these operations, it appeared alike unjust to those nations and unsatisfactory in itself to come to any conclusion without calling for the opinion and judgement, not only on those of our own countrymen who have most distinguished themselves in these departments of science and have taken active part in the observations, but also of the most eminent magnetists and meteorologists of other countries, especially such as have superintended observatories established for these objects.

Accordingly it was resolved, at a meeting of the British Association held at York in the year 1844, to invite to a conference on the subject all the most eminent persons in those sciences in Russia, Germany, Prussia, Belgium, France, Italy and America, who had taken any part in the observations, and some others particularly distinguished in the sciences of Magnetism and Meteorology whose opinions appeared entitled to great weight; and in the meantime also to solicit the written communication of their sentiments on the subject in question, as a further guide to the formation of a well-considered opinion.

In reply to the request for written communications, which was also made to such of our own countrymen as were known best to understand the subjects and to have advanced them by their researches, a number of very valuable letters were received, which were forthwith printed (with translations of those written in the German language) and placed in the hands of every person likely to take any part in the discussion or effective consideration of the subject, including the President and Council of the Royal Society, and also the members of the Committee of Physics of the Royal Society, and the Council and Committee of Recommendations of the British Association itself.

Pursuant to the invitation of the Association above alluded to, the following gentlemen attended the proposed Conference, which was held at Cambridge in the week terminating on the 25th of June, viz.—

M. Kupffer, Director-General of the Magnetic Observatories of the Empire of Russia.

M. Kreil, Director of the Meteorological and Magnetic Observatory at Prague.

Baron von Senftenberg, Founder of the Astronomical, Magnetic and Meteorological Observatory at Senftenberg in Bohemia.

Dr. Adolphe Erman, Professor of Physics in the University of Berlin, and author of a work entitled 'Reise um die Erde in den Jahren 1828 bis 1830. Physikalische Beobachtungen.'

Herr Dove, Professor of Physics in the University of Berlin, author of a work entitled 'Ueber die nicht periodischen Veränder ungen der Temperatur Vertheilung auf die Oberfläche der Erde."

Dr. von Boguslawski, Conservator of the Royal Observatory at Breslau, and Professor of Astronomy of that University.

The Conference was also attended by the Baron von Waltershausen, a gentleman who has taken part in the magnetic observations of Messrs. Gauss and Weber at Göttingen, and executed a magnetic survey of portions of Italy and Sicily.

In addition to these gentlemen and to a Committee consisting of Sir John Herschel, Bart., the Very Rev. the Dean of Ely, Dr. Lloyd, Dr. Whewell, Lieutenant-Colonel Sabine, and the Astronomer Royal, the following gentlemen, eminent as magnetists or meteorologists, were also requested especially to attend the meetings of the Conference, viz.—

J. Phillips, Esq., author of several works on magnetism and meteorology.

Sir Thomas Macdougall Brisbane, Bart., P.R.S. Edin.

J. A. Broun, Esq., Director of Sir T. Brisbane's Magnetic and Meteorological Observatory at Makerstown.

J. D. Forbes, Esq., Professor of Natural Philosophy at Edinburgh.

Capt. Sir James C. Ross, R.N.

The Rev. Dr. Scoresby, author of several well-known publications on magnetism.

A. Lawson, Esq., Founder of a Meteorological Observatory at Bath.

Lieut. Riddell, R.A., Assistant-Superintendent of Ordnance Magnetic Observatories.

W. Snow Harris, Esq., author of several well-known publications on meteorology.

The Conference was also attended by the Marquis of Northampton, President of the Royal Society, and by Colonel Sykes, one of the Directors of the Hon. East India Company.

And to secure at once the due publicity for its discussions by the attendance of persons whose opinions are entitled to weight, but who might be accidentally omitted in the above list, and an impartial judgement by that body on whose recorded judgement the British Association is accustomed to rely in matters of scientific importance, every member of the Committee of Recommendations of that Association was requested to attend the meetings of the Conference, which were held at Cambridge on the 20th, 21st, 23rd, 24th, and 25th of June, and in which every part of the subject underwent discussion upon a plan previously arranged and placed in the hands of all present, in the report drawn up for that purpose by the Magnetic Committee.

In these meetings the following opinions of the Conference were recorded, on an understanding that the general question of continuance should be deferred till it should appear whether or not the members of the Conference were sufficiently agreed on the details of the observations desirable to be pursued to enable them to come to any affirmative conclusion thereupon:—

In reference to the *daily magnetic observations*, after discussing a variety of suggestions as to the hours at which observations might most advantageously be made, in case the curtailment of the two-hourly system were deemed necessary, it was agreed that the Conference was unable to suggest a scheme less comprehensive than the one- or two-hourly system, which would provide with sufficient security for the accomplishment of all the objects of the daily observations; and that therefore, in observatories whose strength will permit, it is expedient that the system be carried on henceforth as heretofore, and at the Göttingen hours.

In reference to the *absolute magnetic determinations*, it appeared to be the general opinion that such determinations of the declination and horizontal force should be made at least monthly, in connexion with the differential magnetometers, and that observations of inclination should be made weekly, and that care should be taken that all absolute determinations should be made beyond the influence of the other magnets and with separate instruments.

In reference to the subjects of term-observations and disturbances, it appeared to be the opinion of the greater part of the members of the Conference, that it is expedient to continue the same yearly number of term-days as at present, and with the intervals which are in use, and that it is very desirable to continue to give the same attention as hitherto to observations of unusual disturbances, leaving however the intervals and mode of observation during disturbances to the discretion of the directors of observatories.

In reference to the magnetic instruments most desirable to be used in the observatories, it appeared to be the general opinion that the differential instruments had better continue as at present; that the absolute determinations of declination and horizontal force should be made with distinct instruments, and that the lengths of the bars of the latter should be left to the discretion of the directors.

The employment of bars of small dimensions, having short times of vibration, was strongly recommended for observations during disturbances.

It appeared to the members desirable that an instrument should be contrived to serve the purposes of an alarm on the occurrence of disturbances exceeding a certain limit. Such an instrument would be particularly useful in observations where the observing staff was smaller, and where therefore the daily observatories were not made hourly or two-hourly.

The importance of obtaining observations of the third element (viz. of the vertical force) and the occasional imperfection of the balance magnetometer, appear to render it the opinion of the members that Dr. Lloyd's induction inclinometer might be advantageously employed in the observatories in addition to the balance magnetometer.

In reference to the question, whether any and what additional magnetic observations should be made in future, it did not appear that any were deemed desirable.

As regards the system of meteorological observation and instruments, the recorded opinions of the Conference were as follows:—

That the instruments and times of observation at present in use should be continued.

That it is very highly important that self-recording meteorological instruments should be improved to such a degree as to enable a considerable portion of the observing staff of an observatory to be dispensed with; and that it might be desirable to hold out some specific pecuniary encouragement for the invention or improvement of such instruments, under such regulations as might seem most likely to be effective for the purpose.

That it is desirable to add to the meteorological observations now made, observations of the thermometer and wet bulb hygrometer, at more than one height above the ground, and to register the temperature below the surface by means of long thermometers, sunk in the ground at depths of three, six, twelve, and at extra-tropical stations twenty-four *French* feet below the surface.

That the meteorological instruments should be observed at short intervals in disturbed states of the atmosphere, during extreme depressions or elevations of the barometer, and during rapid changes; and that the simultaneous directions of the wind should be carefully noted.

That instruments for the observation of atmospheric electricity on the principle of the apparatus at Kew should be employed in the observatories, and that an instrument should be devised and employed for the purpose of indicating the variations in the electricity induced from the earth.

That it is desirable to have rain-gauges established at different heights, the heights to be dependent on local circumstances.

As regards the general question of the continuance of the system, the stations and their duration, surveys and auxiliary stations, and other points connected with the prolongation of the observations, fourteen distinct resolutions were entered into by the Conference, which are contained in the paper marked (A) accompanying this report; all which were subsequently adopted by the Committee of Recommendations, and being thus brought before the General Committee of the British Association, were further adopted as part of the proceedings of the Association, and as such are hereby most respectfully submitted to the favourable consideration of those authorities by which alone they can be carried into effect.

Among particular suggestions deserving consideration, it was agreed that Professor Erman's offer to act as a committee to superintend certain calculations connected with the Gaussian constants for 1829 with a grant of £50 per annum, to be placed at his disposal, out of the funds of the British Association for two years, ought to be accepted and recommended for adoption. And it was accordingly subsequently adopted by the Committee of Recommendations and by the General Committee.

M. Dove's offer to reduce the meteorological observations at one station, viz. Van Diemen's Island, was also recommended to be accepted, as well as a similar offer from the Astronomer Royal to do the same on the same plan for those at Greenwich; and both were accordingly accepted and placed on the list of recommendations not involving grants of money for the year.

During the continuation of the Conference, in an interval of its meetings, an inspection took place by its members of several magnetic instruments of recent construction. Among these were a dipping-needle by Repsold, Dr. Lamont's apparatus for magnetic surveys, and several of the smaller instruments in use in the British Colonial observatories.

The Committee appointed to prepare this report cannot conclude it without recording their opinion of the very great and important advantages secured to science by the zeal and disciplined regularity of the officers, non-commissioned officers, and men of the Royal Regiment of Artillery and of the Naval and East India Service, who have been employed on the duties of the observatories; advantages which could hardly have been secured in so eminent a degree at all the stations by other means. Nor ought they to omit attributing their due share of merit to those officers and non-commissioned officers, who by voluntarily performing the duties of their absent comrades, have enabled them to undertake and perform the duties of the observatories without detriment or inconvenience to the service in general.

Signed, on the part of the Committee,

J. F. W. HERSCHEL.

On some Points in the Meteorology of Bombay. *By* Lieut.-Colonel SABINE, *R.A., F.R.S.*

[A communication read to the Mathematical and Physical Section, and ordered to be printed entire amongst the Reports.]

IN a communication which I had the honour to make to the Section at the York meeting of the British Association, on the subject of the meteorological observations made at Toronto in Canada in the years 1840 to 1842, I noticed some of the advantages which were likely to result to the science of meteorology, from the resolution of the barometric pressure into its two constituents of aqueous and of gaseous pressure. It was shown that when the constituents of the barometric pressure at Toronto were thus disengaged from each other and presented separately, their annual and diurnal variations exhibited a very striking and instructive accordance with the annual and diurnal variations of the temperature. The characteristic features of the several variations when projected in curves were seen to be the same, consisting in all cases of a single progression, having one ascending and one descending branch; the epochs of maxima and minima of the pressures being the same, or very nearly the same, with those of the maxima and minima of temperature; and the correspondence in other respects being such as to manifest the existence of a very intimate connexion between the periodical variations of the temperature, and those of the elastic forces of the air and vapour. The curve of gaseous pressure was inverse in respect to the other two; that is to say, as the temperature increased the elastic force of the vapour increased also, but that of the air diminished, and *vice versâ*; and this was the case both in the annual and the diurnal variations.

Such being the facts, I endeavoured to show, in the case of the diurnal variations, that the correspondence of the phænomena of the temperature and gaseous pressure might be explained, in accordance with principles which had been long and universally admitted in the interpretation of other meteorological phænomena, by the suppositions,—of an extension in height and consequent overflow in the higher regions of the atmosphere of the column of air over the place of observation, during the hours of the day when the surface of the earth was gaining heat by radiation,—and of a contraction of the column during the hours of diminishing temperature, and consequent reception of the overflow from other portions of the atmosphere, which in their turn had become heated and elongated.

According to this explanation there should exist, during the hours of the day when the temperature is increasing,—1st, an *ascending current* of air at the place of observation, of which the strength should be measured by the amount of the increments of temperature corresponding to given intervals of time; and 2nd, a *lateral influx of air at the lower parts of the column*, of proportionate velocity, constituting a *diurnal variation in the force of the wind* at the place of observation, which should also correspond with the variations of the temperature in the epochs of its maximum and minimum, and intermediate gradation of strength. The anemometrical observations at Toronto were shown to be in agreement with the view which had been then taken, confirming the existence of a diurnal variation in the force of the wind, corresponding in all respects with the variation of the temperature.

Admitting the explanation thus offered to be satisfactory in regard to the diurnal variations, it was obvious that the correspondence of the annual variations of the temperature and pressures might receive an analogous explanation.

A comparison of the results of the observations at Toronto with those of the observations of M. Kreil at Prague in Bohemia, (published in the Mag. und Met. Beob. zu Prag, and in the Jahrbuch für Prag. 1843,) showed that the characteristic features of the periodical variations at Toronto were not peculiar to that locality, but might rather be considered as belonging to stations situated in the temperate zone and in the interior of a continent. The annual and diurnal variations at Prague were also single progressions, and the same correspondence was observable between the variations of the temperature and of the gaseous pressure.

The publication of the volume of magnetical and meteorological observations made at Greenwich in 1842, which took place shortly after the meeting of the Association at York, enabled me to add a postscript to the printed statement of my communication in the annual volume of the Association Reports, showing the correspondence of the results at Greenwich with the relations which had been found to exist in the periodical march of the phænomena at Toronto and at Prague.

From the concurrence of these three stations, it was obvious that a considerable insight had been obtained into the laws which regulate the periodical variations in the temperate zone, and into the sequence of natural causes and effects, in accordance with which the annual and diurnal fluctuations of the elastic forces of air and vapour at the surface of the earth depend on the variations of temperature: and from these premises it was inferred, that the normal state of the diurnal variations of the pressures of the air and vapour and of the force of the wind, in the temperate zone, might be regarded as that of a single progression with one maximum and one minimum, the epochs of which should nearly coincide with those of the maximum and minimum of temperature*.

* Since this communication was read at Cambridge I have received from M. Dove a copy of a paper read to the Academy of Berlin, entitled 'Ueber die periodischen aenderungen der druckes der Atmosphäre im Innern der Continente,' in which the remarkable facts are stated, that at Catherinenbourg and Nertchinsk (on the mean of several years), and at Barnaoul (in the years 1838 and 1840), the mean diurnal *barometric* curve itself exhibits but one maximum and one minimum in the twenty-four hours; the maximum coinciding nearly with the coldest, and the minimum with the hottest hours of the day. At these stations therefore, and in the years referred to, the forenoon maximum disappeared, and the barometric curve assimilated in character to the curve of the dry air in other places in the temperate zone. These stations are situated far in the interior of the greatest extent of dry land on the surface of our globe, and at a very great distance from an expanse of water, from whence vapour can be supplied. The diminished pressure of the dry air produced by the ascending current and overflow as the temperature of the day increases, is not therefore compensated by an increased elasticity of vapour, and the curve of the diurnal variation of the barometer approximates to the form assumed when the elasticities of the vapour at the several hours of observation are abstracted. This assimilation in character of the barometric and (inferred) gaseous curves, which is thus found to take place in cases where, from natural causes, the influence of the vapour is greatly lessened, appears a confirmation of the propriety of separating the effects of the elastic forces of the dry air and vapour in their action on the barometer.

M. Dove considers that the single progression of the diurnal barometric curve, which takes place at the three Asiatic stations referred to in this note, is characteristic of a true continental climate. It is, without doubt, characteristic of an extreme climate, and as such is highly instructive. There appears reason to doubt whether an extreme climate of corresponding character exist at all in the temperate latitudes of the continent of America.

If, however, we examine the record of the observations made hourly in the year 1842 at

That exceptions should be found to this state of things in particular localities in the temperate zone was far from being improbable; it could not be expected that the influences of temperature should always be so simple and direct as they appeared to be at Toronto; and a more complex aspect of the phænomena might particularly be looked for, where a juxtaposition should exist of columns of air resting on surfaces differently affected by heat (as those of land and sea), and possessing different retaining and radiating properties. In such localities *within the tropics*, the well-known regular occurrence of land and sea breezes for many months of the year made it obvious that a double progression in the diurnal variation of the force of the wind must exist, and rendered it highly probable that a double progression of the gaseous pressure would also be found. It was therefore with great pleasure that I received, through the kindness of Dr. Buist, a copy of the monthly abstracts of the two-hourly meteorological observations, made under that gentleman's superintendence at the observatory at Bombay in the year 1843; accompanied by a copy of his meteorological report for that year, possessing a particular value, in the full account which it gives of the periodical variations of the wind, and in the means which it thereby affords of explaining the diurnal variation of the gaseous pressure. This pressure presents at Bombay an aspect at first sight more complex than at the three above-named stations in the temperate zone, but I believe it to be equally traceable to variations of the temperature, and to furnish a probable type of the variations at intertropical stations similarly circumstanced in regard to the vicinity of the sea.

The observatory at Bombay is situated on the island of Colabah, in N. lat. 18° 54′ and E. long. 72° 50′ at an elevation of thirty-five feet above the level of the sea. In the copy of the observations received from Dr. Buist, the monthly abstracts are given separately for each month, of the standard thermometer,—of the wet thermometer, and of its depression below the dry,—and of the barometer. In Table I. I have brought in one view the thermometrical and barometrical means at every second hour, and the mean tension of the vapour and mean gaseous pressure at the same hours. The tension of the vapour at the several observation hours has been computed from the *monthly means*, at the same hours, of the wet thermometer and of its depression below the dry thermometer. The values are consequently somewhat less than they would have been, had the tension been computed from each individual observation of the wet and dry thermometers, and had the mean of the tensions thus obtained been taken as the value corresponding to the hour. The difference is however so small, that for the present purpose it may be regarded as quite insignificant. It would not amount in a single instance to the hundredth part of an inch; and as in every instance the difference would be in the same direction, the *relative* values, which are those with which we

Catherinenbourg, Barnaoul and Nertchinsk, in the 'Annuaire Magnétique et Météorologique de Russie,' we find that at Catherinenbourg in that year the barometer exhibits a double progression, but that the morning maximum, which occurs at the observation hour of $8^h\ 22^m$ A.M., exceeds the antecedent minimum only by a quantity less than 0·003 in. At Barnaoul there is also a double progression in the barometric mean in that year, the morning maximum being still small, and taking place between the observation hours of $9^h\ 54^m$ and $10^h\ 54^m$ A.M. At Nertchinsk also there is a morning maximum occurring at the observation hour of $9^h\ 17^m$ A.M. In all the three cases the double progression shown by the barometer disappears wholly in the curve of the dry air, which curve exhibits at these three stations, as well as at Toronto, Prague and Greenwich, but one maximum and one minimum in the twenty-four hours. At the three stations of extreme dryness cited by M. Dove, therefore the vapour was still sufficient to impart, in the year 1842 at least, a double progression to the diurnal variation of the barometer; but the hour of the morning maximum was earlier than where the increase of vapour, as the day advances, is greater.

are at present concerned, would be scarcely sensibly affected. The pressures of the dry air (or the gaseous pressures) are obtained by deducting the tension of the vapour from the whole barometric pressure.

Table I.

Bombay, 1843.—Mean Temperature, Mean Barometric Pressure, Mean Tension of Vapour, and Mean Gaseous Pressure at every second hour.

Hours of Mean Bombay Time. Astronomical Reckoning.	Temperature.	Barometer.	Tension of Vapour.	Gaseous Pressure.
	°	in.	in.	in.
18	78·4	29·805	0·750	29·055
20	79·6	29·840	0·766	29·074
22	81·8	29·852	0·771	29·081
0	83·2	29·817	0·768	29·049
2	84·1	29·776	0·795	28·981
4	83·9	29·755	0·800	28·955
6	82·3	29·774	0·802	28·972
8	81·2	29·806	0·801	29·005
10	80·3	29·825	0·780	29·045
12	79·8	29·809	0·775	29·034
14	79·4	29·786	0·766	29·020
16	78·9	29·778	0·761	29·017
Mean of the year ...	81·1	29·802	0·780	29·022

The sun is vertical at Bombay twice in the year, viz. in the middle of May and towards the end of July. The rainy season sets in about the commencement of June (in 1843 on the 2nd of June), and terminates in August, but with heavy showers of no long duration continuing into September. During the rainy season, and in the month of May which immediately precedes it, the sky is most commonly covered with clouds, by which the heating of the earth by day, and its cooling at night by radiation, are impeded, and the range of the diurnal variation of the temperature is greatly lessened in comparison with what takes place at other times in the year. The strength of the land and the sea breezes in those months is also comparatively feeble, and on many days the alternation of land and sea breeze is wholly wanting. During the months of November, December, January and February, the diurnal range of the temperature is more than twice as great as in the rainy season, and the land and sea breezes prevail with the greatest regularity and force.

In addition to the monthly tables, we may therefore advantageously collect in one view, for purposes of contrast, the means of the months of May, June, July and August, as the season when the sky is generally clouded,—and of the months of November, December, January and February, as the season of opposite character, when the range of the diurnal temperature is greatest, and the land and sea breezes alternate regularly, and blow with considerable strength. These seasons are contrasted in Table II.

If we direct our attention to the diurnal variations, commencing with those of the temperature, we find them exhibiting a single progression, having a minimum at 18^h and a maximum at 2^h; the average difference between the temperature at 18^h and 2^h being $7^\circ{\cdot}77$ in the clear season, $3^\circ{\cdot}71$ in the clouded season, and $5^\circ{\cdot}7$ on the mean of the whole year.

When however we direct our attention to the gaseous pressure, we perceive, very distinctly marked, the characters of a double progression, having one maximum at 10^h and another at 22^h; one minimum at 4^h and another at 16^h.

The double progression is exhibited both in the clouded and in the clear seasons, with a slight difference only in the hours of maxima; the principal maximum in the cloudy season being at 20^h instead of 22^h, and the inferior maximum in the clear season being at 12^h instead of 10^h. The range of the diurnal variation, like that of the temperature, is more than twice as great in the clear as in the clouded season, marking distinctly the connexion subsisting between the phænomena of the temperature and of the gaseous pressure.

TABLE II.

Bombay, 1843.—Comparison of the Temperature and of the Gaseous Pressure in the months of May, June, July and August, when the sky is usually covered with clouds; and in November, December, January and February, when the sky is usually clear.

Hours of Mean Time at Bombay. Astronomical Reckoning.	Temperature.		Gaseous Pressure.	
	November, December, January and February.	May, June, July and August.	November, December, January and February.	May, June, July and August.
	°	°	in.	in.
18	74·1	81·9	29·344	28·782
20	75·3	83·1	29·368	28·806
22	78·1	84·3	29·391	28·798
0	80·8	85·1	29·353	28·782
2	81·9	85·6	29·230	28·746
4	81·7	85·4	29·195	28·724
6	79·6	84·3	29·199	28·740
8	78·4	83·4	29·248	28·754
10	76·9	83·0	29·308	28·800
12	76·2	82·7	29·316	28·775
14	75·7	82·6	29·295	28·754
16	74·9	82·2	29·285	28·753
Means	77·8	83·7	29·298	28·763

If we now turn our attention to the phænomena of the direction and force of the wind, we find by Dr. Buist's report, that for 200 days in the year there is a regular alternation of land and sea breezes. The land breeze springs up usually about 10^h, or between 10^h and 14^h, blows strongest and freshest towards daybreak, and gradually declines until about 22^h, at which time the direction of the aërial currents changes, and there is generally a lull of an hour or an hour and a half's duration. The sea breeze then sets in, the ripple on the surface of the water indicating its commencement being first observed close in shore, and extending itself gradually out to sea. The sea breeze is freshest from 2^h to 4^h, and progressively declines in the evening hours.

The diurnal variation in the force of the wind during these 200 days is therefore obviously a double progression, having two maxima and two minima; one maximum at or near the hottest, and the other at or near the coldest hour of the day,—being the hours when the difference of temperature is greatest between the columns of air which rest respectively on the surfaces of land and sea; and two minima coinciding with the hours, when the surface temperature over the land and over the sea approaches nearly to an equality.

In the remaining portion of the year the diurnal range of the temperature is most frequently insufficient to produce that alternation in the direction of the wind, which prevails uninterruptedly during the larger portion. There appears however to have been only one month, viz. July, in the year 1843, in which there were not some days in which the alternation of land and sea breezes was perceptible. The causes which produce the alternation are not therefore wholly inoperative, though the effects are comparatively feeble during the clouded weather which accompanies the south-west monsoon*.

If we now view together the diurnal variations of the wind and gaseous pressure, as shown in the Plate, we find a minimum of pressure coinciding with the greatest strength of the sea breeze; a second minimum of pressure coinciding with the greatest strength of the land breeze; and a maximum of pressure at each of the periods when a change takes place in the direction of the aërial currents; or, otherwise stated, we find a decrease of pressure coincident with the increase of strength both of the land and sea breezes, and an increase of pressure coincident with their decline in strength.

The facts thus stated appear to me to admit of the following explanation:—the diminution of pressure which precedes the minimum at 4^h is occasioned by the rarefaction and ascent of the column during the heat of the day, and its consequent overflow in the higher regions of the atmosphere, which is but partially counterbalanced in the forenoon by the influx of the sea breeze at the lower part of the column. Shortly after the hottest hour is passed, the overflow above and the supply below become equal in amount, and the diminution of pressure ceases. As the temperature falls towards evening, the column progressively contracts, when the influx from the sea breeze more than counterbalances the overflow, and the pressure again increases until a temporary equilibrium is restored, when the sea breeze ceases and the pressure is stationary.

As the night advances, the air over the land becomes colder than over the sea; the length of the column over the land contracts, and the air in its lower part becomes denser than in that over the sea: an interchange then commences of an opposite character to that which prevailed during the day. The outward flow is now from the *lower* part of the column, or from the land towards the sea, causing the pressure to diminish over the land; it continues to do so until towards daybreak, when the strength of the land breeze is greatest, because the air over the land is then coldest in comparison with that over the sea. As the sun gains in altitude and the temperature of the day advances, the land heats rapidly; the density of the air over the land and sea returns towards an equality; the land breeze declines in strength, and the drain from the lower part of the column ceases to counterbalance the overflow which the land column is at the same time receiving in the higher regions; the pressure consequently having attained a second minimum at or near the hour of the greatest disproportion of temperature, again increases until the temperature and height of the column over the sea and land are the same, and the pressure again becomes stationary. But now the rarefaction of the column over the land continuing, its increase in height above the less heated column with which it is in juxtaposition, and its consequent overflow, occasion the pressure to decrease until the minimum at 4 o'clock is reached.

We have thus therefore at Bombay a *double progression of the diurnal variation of the gaseous pressure*; the principal minimum occurring at 4 o'clock in the afternoon, occasioned by an overflow from the column in the higher regions of the atmosphere; and the second minimum occurring at 18^h, occasioned by an efflux from the lower part of the column. The first minimum is similar to that which has been shown to take place at Toronto, Prague and

* There are no data in Dr. Buist's report from which the diurnal variation in the force of the wind may be judged of in the days during the south-west monsoon, when no alternation takes place in its direction. It would seem probable that on such days the variation should be a single progression, weakest towards daybreak, and strongest about the hottest hour of the day.

Greenwich, and is similarly explained: the second minimum, which does not take place at the three above-named stations, is owing to the juxtaposition of the columns of air over the sea and land, which differ in temperature, and therefore in density and height, in consequence of their resting respectively on surfaces which are differently affected by heat.

The Plate shows the curve of the gaseous pressure, and the curve of the elastic force of the vapour; and between them is placed a diagram illustrating the hours of prevalence and of the greatest strength of the land and sea breezes. At Toronto and at Greenwich the diurnal curve of the vapour is a single progression, having its maximum at or near the hottest hour of the day, and its minimum at or near the coldest hour. We perceive in the Plate which represents the phænomena at Bombay, the modification which takes place in consequence of the supply of vapour brought in by the sea breeze continuing until a late hour in the evening, and prolonging the period during which the tension is at or near its maximum. The minimum occurs as usual at or near the hour of the coldest temperature.

If, then, the explanation which I have offered to the Section, of the physical causes which produce the diurnal variation of the gaseous pressure at Bombay, be correct, the diurnal variation of the barometric pressure occurring there is also explained, since it is simply the combination of the two elastic forces of the air and of the vapour.

The solution of the problem of the diurnal variation of the barometer is therefore obtained by the resolution of the barometric pressure into its constituent pressures of vapour and air; since the physical causes of the diurnal variation of the component pressures have been respectively traced to the variations of temperature produced in the twenty-four hours by the earth's revolution on its axis, and to the different properties possessed by the material bodies at the surface of the globe in respect to the reception, conveyance, and radiation of heat.

Annual variation.—We now proceed to the annual variations, which are shown in the subjoined table.

TABLE III.

1843.	Temperature.	Vapour Pressure.	Gaseous Pressure.	Barometer.	Humidity.	Monthly Means greater (+) or less (—) than the Annual Means.		
						Temperature.	Vapour Pressure.	Gaseous Pressure.
January ...	76·4	0·578	29·352	29·930	67	−4·7	−0·202	+0·329
February ...	77·7	0·648	29·246	29·894	71	−3·4	−0·132	+0·223
March	79·7	0·710	29·128	29·838	74	−1·4	−0·070	+0·105
April	84·2	0·853	28·961	29·814	76	+3·1	+0·073	−0·062
May	85·9	0·921	28·743	29·664	78	+4·8	+0·141	−0·280
June.........	85·4	0·935	28·718	29·653	80	+4·3	+0·155	−0·305
July	82·1	0·896	28·737	29·633	85	+1·0	+0·116	−0·286
August	81·2	0·859	28·869	29·728	84	+0·1	+0·079	−0·154
September..	81·1	0·859	28·920	29·779	84	0·0	+0·079	−0·103
October ...	82·2	0·819	29·026	29·845	78	+1·1	+0·039	+0·003
November ..	80·5	0·675	29·213	29·888	67	−0·6	−0·105	+0·190
December ..	76·6	0·592	29·368	29·960	67	−4·5	−0·188	+0·345
	81·1	0·780	29·023	29·803	76			

We here perceive that the leading features of the phænomena are clearly analogous to those which have been seen to present themselves at Toronto, Prague and Greenwich; viz. a correspondence of the maximum of vapour pressure and minimum of gaseous pressure with the maximum of temperature,—and of the minimum of vapour pressure and maximum of gaseous pressure with the minimum of temperature; and a progressive march of the three variations from the minimum to the maximum, and back to the minimum again. The epochs, or turning-points of the respective phænomena, are not in every case strictly identical; but their connexion, which is the subject immediately before us, is most obvious.

We have thus a further illustration of the universality of the principle of the dependence of the regular periodical variations, annual as well as diurnal, of the pressures of the dry air and of the vapour, on those of the temperature*.

* In the tropics and in the temperate zone the heat of summer produces and accompanies a low gaseous pressure, and the cold of winter a high gaseous pressure. When we consider how large a portion of the northern hemisphere is occupied by land, which becoming greatly heated in summer rarefies the superincumbent atmosphere, causing it to overtop the adjacent less heated masses, and to overflow them, we should be led to expect that in parts of the Arctic Circle situated to the north of the great continents, the gaseous pressure should be *increased* in summer, and that the curve of annual variation should become the converse of what it is in the lower latitudes. It appears from the meteorological observations made in 1843 by Messrs. Grewe and Cole, and presented to the British Association at the York meeting by Dr. Lee, that such is the case at Alten, near the north cape of Europe. The barometer and thermometer were observed three times a day, from October 1842 to December 1843 inclusive. The hours of observation were 9 A.M., 3 P.M. and 9 P.M. No hygrometric observations were made, but we are able to infer the approximate tension of the vapour from the record of the thermometer. The quarterly means of the barometer and thermometer in 1843 are as follows; the barometer being reduced to the level of the sea, and corrected for gravity:—

	Barometer.	Thermometer.
	in.	°
December, January, February......	29·375	24 F.
March, April, May	29·948	27·7
June, July, August	29·905	52·4
September, October, November ...	29·716	34·2
Mean of the year	29·736	34·6

Assuming the humidity in each quarter of the year to be 75, or the vapour to be in each case three-fourths of that required for saturation at the respective temperatures, we should have the following gaseous pressures:—

	in.
December, January, February	29·257
March, April, May	29·804
June, July, August	29·616
September, October, November, December ...	29·566
	29·561

It appears therefore that in the six summer months the mean barometric pressure exceeded that of the winter months by 0·381 inch; and the mean gaseous pressure of summer exceeded that of winter by about 0·3 inch. As in this case the curve of the gaseous pressure, as well as that of the aqueous vapour, accords in character with the curve of temperature, i. e. ascends with ascending temperature, and descends with descending temperature,—the barometric annual range is greater than the gaseous annual range, which is contrary to what takes place in the temperate and equatorial zones. It is not improbable that in the Antarctic Circle the phænomenon which we have just noticed as taking place in the Arctic Circle, viz. the summer increase of the gaseous pressure,—may not be found in the same degree, if at all; for the two hemispheres present a remarkable contrast in their respective proportions of sea and land, and the rarefaction of the atmosphere over the middle latitudes of the southern hemisphere during its summer must be greatly less than in the same latitudes of the northern hemisphere in the corresponding season. The barometrical observations made by Sir James Ross in summer in the Antarctic Circle accord with this inference; since after correcting them for the shortening of the column of mercury by the increased force of gravity in the high latitudes, and abstracting the small tension of vapour corresponding to the temperature, the mean gaseous pressure deduced from them, though nearly equal to the mean gaseous pressure of the year at Bombay, does not exceed it; whereas at Alten it is only in

The humidity exhibits also a single progression; but may perhaps be rather characterized as evidencing a very dry season from November to February, and a very humid one from June to September, the latter season being that of the rains. The average degree of humidity in the year is very slightly lower than either at Toronto or at Greenwich, but is still closely approaching to a value expressing the presence of three-fourths of the quantity of vapour required for saturation.

The mean gaseous pressure in 1843, derived from the two-hourly observations, appears to have been (29·023 + 0·025, an index correction which Dr. Buist gives as that of the barometer with which the observations were made =) 29·048 English inches; or, measured by the height of a mercurial column in the latitude of 45°, 28·988. The height above the sea is thirty-five feet, and the latitude 19° N.

The mean height of the barometer in the year 1843, derived from observations at every second hour, appears to have been (29·803 + 0·025=) 29·828, or, with the correction applied for gravity, 29·768, the elevation being thirty-five feet above the sea. This is less than what is generally received as the average height of the barometer in the same latitude. From the careful comparison described in Dr. Buist's report of the standard barometer with several other barometers, there seems great reason to believe that the mean height shown by it must be a very near approximation at least to the true mean atmospheric pressure in the year 1843 at Bombay.

The mean height of the barometer in the four clouded months of May, June, July and August, is 29·667; and in the four clear months of November, December, January and February, 29·921. The mean vapour pressure in the same seasons is respectively 0·904 and 0·623, and the gaseous pressure consequently 28·763 and 29·298. There is therefore between the two seasons a difference of 0·535 in. of gaseous pressure, and of 5°·84 of temperature; the lowest pressure corresponding to the highest temperature, and *vice versâ*. If we may allow ourselves to make a rough proportion drawn from a single case, we may estimate a decrement of 0·1 in. of pressure to an increment of 1° F. The highest temperature and lowest pressure are accompanied for nearly the whole of the period by the southern monsoon; the lowest temperature and the highest pressure are accompanied by the northern monsoon.

The curves of the annual variation of the gaseous, barometric, and vapour pressures, which are represented in the Plate, show how much of the influence produced on the gaseous pressure, by the alternation of the overflow in the high regions of the atmosphere as either side of the equator becomes heated in its turn, is masked in the barometric curve by the combination in the latter of the vapour pressure, the variations of which take place throughout the year in the opposite direction to those of the gaseous pressure. From this cause the range of the barometric curve during the year is only 0·327 inch, whilst that of the gaseous pressure is 0·650 inch.

The analogy of the annual and diurnal variations, considered in respect to the explanation which has been attempted of the latter, is too obvious to be dwelt upon. The decreased gaseous pressure in the hot season is occasioned

the winter months that the gaseous pressure descends so low as to approximate to the usual mean gaseous pressure of the tropical regions.

It is much to be desired that the zealous observers at Alten should observe the wet thermometer at the same time as the barometer; the register would also be rendered much more complete by the addition of another observation-hour, about 6 A.M., which might not perhaps be inconvenient. The atmospheric pressure and the tension of vapour at or near the coldest hour of the twenty-four, are important data in meteorological discussions.

by the rarefaction of the air over the land whilst the sun is in the northern signs, and its consequent overflow in the higher regions, producing a return current in the lower strata; and the increased pressure in the cold season is occasioned by the cooling and condensation of the air, whilst the sun is on the south side of the equinoctial, and its consequent reception of the overflow in the upper strata from the regions which are then more powerfully warmed, and which is but partially counteracted by the opposite current in the lower strata.

In concluding this communication, I beg respectfully to submit to the consideration of the eminent meteorologists here present, that it is very important towards the progress of this science, that the propriety (in such discussions as the present) of separating the effect of the two elastic forces which are considered to unite in forming the barometric pressure, should be speedily admitted or disproved. The very remarkable fact recently brought to our notice by Sir James Ross, as one of the results of his memorable voyage, that the mean height of the barometer is full an inch less in the latitude of 75° S. than in the tropics, and that it diminishes progressively from the tropics to the high latitudes, presses the consideration of this point upon our notice; for it is either explained wholly or in greater part by the diminution of the vapour constituent in the higher latitudes, which diminution appears nearly to correspond throughout to the decrease of barometric pressure observed by Sir James Ross; or it is a fact unexplained, and I believe hitherto unattempted to be explained, on any other hypothesis, and of so startling a character as to call for immediate attention.

If, by deducting the tension of the vapour from the barometric pressure, we do indeed obtain a true measure of the pressure of the gaseous portion of the atmosphere, the variations of the mean annual gaseous pressure, which will thus be obtained in different parts of the globe,—and the differences of pressure in different seasons at individual stations,—may be expected to throw a much clearer light than we have hitherto possessed on those great aërial currents, which owe their origin to variations of temperature proceeding partly from the different angles of inclination at which the sun's rays are received, and partly from the nature and configuration of the material bodies at the surface of the earth: and a field of research appears to be thus opened by which our knowledge of both the persistent and the periodical disturbances of the equilibrium of the atmosphere may be greatly extended.

Report on the Physiological Action of Medicines. By J. Blake, *M.B., F.R.C.S. &c. &c.*

The present report is but a continuation of that which was read at the last Meeting of the Association, and which has since been published in the Transactions. The investigation of the action of medicines has been confined to the observation of the effects that follow their direct introduction into the blood, by means of injections into the arteries or veins, and in most instances the hæmadynamometer has been used, in order to ascertain more accurately the effects produced on the heart and vascular system. Although this view of the subject may appear to be of no practical utility, yet I trust that the results arrived at will justify the course that has been pursued. In my former memoirs on this subject I have endeavoured to prove that isomorphous substances, when introduced directly into the blood, exert an analogous influence on the animal economy. The experiments I am about to bring forward afford additional confirmation of the views I have already advanced, and, with the facts that have been published, will, I trust, constitute a sufficient amount of evidence to firmly establish the truth of the law in question. The experiments I have now to bring forward have been performed with the tartrate of antimony, the salts of palladium and platinum, and with the chloric, hydrochloric, bromic and iodic acids.

Tartrate of Antimony.—This substance when injected into the veins gives rise to exactly the same phænomena as would the arsenic or phosphoric acids, and which have been detailed in the last report. The quantity required to cause death was about a drachm of the salt.

Chloride of Palladium—This salt is very poisonous, for when introduced into the veins it possesses the power of arresting the action of the heart, in smaller doses than any other substance I have experimented with. On injecting half a grain, dissolved in half an ounce of water, into the jugular of a dog, the action of the heart became rather fluttering after a few seconds, and then slower; there was no expression of pain. On injecting a grain of the salt, the action of the heart was arrested in about 12″. The respiration is often suspended for a minute or two, and then recommences, continues regularly for about a minute, and is again suspended. I have observed this to recur five times after the injection of two doses of a quarter of a grain each; the animal lay on its side without the slightest expression of pain, although perfectly sensible; there were no convulsions: after death the heart was found quite still, the blood in the left cavities of a dirty scarlet, showing that the heart had not been arrested from asphyxia; it coagulated slowly; the lungs were almost white and anæmic. On injecting a solution containing half a grain into the arterial system, violent spasm was immediately produced: the pressure rapidly increased from 5 to 12 inches, as indicated by the hæmadynamometer*; respiration continued at intervals, and the pressure in the arterial system gradually fell, but was still at six inches four minutes and a half after all regular respiratory movements had ceased. The salts of platinum give rise to precisely similar phænomena when injected into the arteries and veins; they do not appear to be so poisonous as those of palladium, as it requires three or four grains to be injected into the vein before the action of the heart is arrested. Osmium and iridium, the other members of this isomorphous group, have not been experimented with on account of their great rarity.

I have only now to notice the phænomena that are produced by the well-known isomorphous group—iodine, chlorine and bromine. The forms under which these substances have been used are as iodic, bromic, chloric and hydrochloric acids. I shall only allude to the effects that have been observed after the introduction of the iodic acid into the veins and arteries, as the acids of chlorine and bromine give rise to effects perfectly analogous. Iodic acid and the substances that are related to it present an analogy with the salts of silver and soda in their action on the animal economy; they are however perfectly distinct in one or two particulars, in which also they closely agree amongst themselves.

When injected into the veins, iodic acid evidently exerts an influence on the passage of the blood through the lungs: immediately after the injection of a solution containing 10 grains of the acid into the veins, the pressure in the arteries becomes lowered. In a short time we have most unequivocal proofs of its action on the lungs, by the escape of a quantity of frothy fluid from the air-passages, which soon causes the death of the animal by asphyxia.

* The pressure in the arterial system is given in inches of mercury, as ascertained by the hæmadynamometer.

If the dose be larger (25 grains of iodic acid for instance), the passage of the blood through the lungs becomes at once arrested, and the animal rapidly dies from congestion of the venous system. After death the lungs are found congested and red, serous effusion having taken place in their tissue as well as in the air-passages. The heart generally contains a medium quantity of dark blood, which coagulates firmly. If the thorax is opened immediately after death, the ventricles are found beating rhythmically, although the auricles have lost all trace of irritability,—a fact which forms a curious exception to the general rule, and which has only been observed in connection with this class of substances. When injected into the arteries, the phænomena produced by iodic acid are very extraordinary. The first effect that followed the introduction of six grains of the acid into the artery was an immediate diminution of the pressure in the arterial system: in the instance alluded to, it fell in the course of a few seconds from six to eight inches down to two, the heart's action being very slow; the animal cried, respiration became suspended, and in about a minute it lay to all appearance quite dead; after another minute however the pressure in the arterial system suddenly increased to nine inches, the heart beating quite regularly, although the animal still lay as if dead; the pressure gradually diminished, and at four minutes after the injection, and three minutes after every external sign of life had ceased, it had again sunk to five inches. A most curious phænomenon now presented itself, viz. a sudden rise of full three inches, in the pressure of the blood in the arterial system. This increase in the pressure was followed by two respiratory movements, and by slight motion in the legs and tail. After this the pressure gradually sunk, and the heart stopped seven minutes after the injection. The chloric and bromic acids give rise when injected into the arteries to phænomena exactly analogous to those just described: with hydrochloric acid the action of the heart does not continue so long after respiration has ceased, nor has the augmentation in the pressure after the cessation of respiratory movements been observed with this substance; this might possibly be owing to its not containing oxygen.

Having now brought forward the facts which have been ascertained since my last report, in support of the analogous action of isomorphous substances on animals, I propose to take a general review of the whole of the evidence we are now in possession of relating to this law, and also of those facts which appear to militate against it; merely premising, that, in the present imperfect state of our knowledge as regards the isomorphous relations of bodies, it is not to be expected that a first attempt to arrive at any generalization founded on these properties should not present many anomalies and apparent contradictions, which it will require further investigations to clear up, or which may lead to important modifications in the expression of the law itself. The evidence in favour of the law is derived from the following facts:—first, the similarity of action of the following isomorphous substances belonging to the magnesian class; viz. magnesia, lime, manganese, iron, cobalt, nickel, zinc, cadmium, copper and bismuth,—substances which present striking differences in their ordinary chemical affinities, but which agree in being isomorphous, and also in producing analogous phænomena on animals when introduced directly into the blood. The salts also of another well-marked isomorphous group, viz. lead, strontia and baryta, closely agree in their actions on the animal system. Palladium and platinum, in the effects they produce when introduced directly into the blood, lend their support to this law. Phosphorus, antimony and arsenic, a strictly isomorphous group, give rise to analogous reactions on the animal economy. The chlorine group also fully bears out the law, at least as regards iodine, bromine and chlorine, for fluorine has not been experimented with. The salts of soda and silver also agree in the effects they produce, although presenting a more striking contrast in many of their chemical properties than is to be found in any other class. On the other hand, potash and ammonia, two substances between which well-marked isomorphous relations exist, differ to a certain extent in the phænomena they give rise to when introduced into the blood. It is possible that the compound nature of the radical of ammonia, differing so completely as it does from the other inorganic radicals, may introduce certain modifications in its relation to organized compounds. The only other fact that my investigations have made me acquainted with, which appears to oppose itself to this law, is, the analogy that exists to a certain extent between the salts of lead and the chlorine group and silver. As regards the more marked phænomena produced by the salts of lead, they are such as its connection with strontian and baryta would lead us to suppose; but in one respect, viz. in their action on the lungs, they resemble the salts of silver. As regards this anomaly I would merely observe, that galena and sulphuret of silver are found under the same form.

Such is the evidence with which my researches have furnished me, in support of the law of the analogous action of isomorphous substances on organized beings, and I think it sufficient to justify us in admitting that the molecular reactions that take place between the elements of living bodies and inorganic substances are to a great extent independent of chemical affinity, but are connected with those properties of matter which are expressed by its isomorphous relations. It is evident that this law must lead to important modifications in the investigation of physiological phænomena: in considering the action of unorganized substances on organized beings, it is clear that our attention must not be so exclusively directed to the chemical properties of these substances: it must not be as alkalies or acids or salts that their action on organized beings must be investigated, but as regards their isomorphous relations, or those properties of matter which are evidently connected with the form it assumes, and which have recently been elucidated by the researches of Kopff. But whilst this law would tend to remove the investigation of physiological phænomena from the domain of pure chemistry, it is far from leading us to conclude that the reactions that take place amongst materials of which organized beings are composed are essentially of a different character from those which we observe amongst the simpler forms of matter. The difference between the more simple combinations of the elements with one another and those they form with the more complicated compounds of carbon, hydrogen, oxygen and nitrogen that exist in the living body, seems to be, that in the former instance they combine under the influence of chemical affinity, whilst in the latter it would appear to be a physical polarity that influences the formation of the compound: it is the former power that gives rise to the union of sulphuric acid and soda, whilst the latter causes the compound to assume a definite crystalline form. It would appear, in fact, as if the force of chemical affinity was more or less neutralized in living beings, and that their elements are held together by other forces than those which prevail amongst unorganized compounds. In the present early stage of these researches, I would not attempt to generalize this law beyond that class of facts to which it has been proved experimentally to apply; it may admit of a far more extended application, embracing in its expression not merely the combinations of the compound elements of organized beings, but also the combinations of carbon, hydrogen, nitrogen and oxygen, of which these elements consist. In the present imperfect state of our knowledge, it would be hazardous to offer an opinion on the nature of the compounds that are formed under the influence of this law, when inorganic substances are introduced into the blood; it remains even to be proved if the phænomena they give rise to are owing to the formation of any definite compounds between them and the elements of the blood and tissues. In the absence of all direct proof on this point, I would offer one or two considerations which would tend to indicate that the probability is in favour of the formation of definite compounds between the inorganic element and the blood and tissues.

The researches of Mulder on the composition of albumen and fibrine prove, that the presence or absence of certain elements in very small proportions may essentially alter the properties of the protein compounds. The whole of the fibrine, for instance, in the blood of a small animal does not contain more than two grains of sulphur, which however appears to form as essential an element in its composition as it does in sulphuric acid; if therefore we introduce into the blood any substance which should deprive the fibrine of its sulphur, either by combining with the sulphur itself, or by replacing it in the protein compound, we should immediately have a fluid circulating over the body which would not contain any fibrine, and which might be totally unfitted for carrying on the vital phænomena; two or three grains of baryta for instance, supposing it capable of producing such a reaction, would suffice to defibrinize the whole of the blood. Another consideration that would favour the supposition that isomorphous substances form certain definite analogous compounds with the blood and tissues, is, that we generally find that the different substances belonging to the same isomorphous group give rise to certain physical changes in the blood which are readily recognizable; thus the whole of the magnesian family agree in depriving the blood in a greater or less degree of its property of coagulation; the same remarks will apply to most of the other groups. It is highly probable that these physical changes are owing to the formation of certain definite compounds between the elements of the blood and the substances mixed with it. A careful analysis of the organs on which different classes of substances appear more particularly to act, would probably elucidate this point.

Before concluding, I would offer a remark on the relative poisoning powers of the substances that have been experimented with. The salts of palladium, platinum and baryta are those which prove fatal in the smallest doses; and it is a curious fact, that, under an isomorphous point of view, these three substances are those which have the least analogy with the elements that enter into the formation of the animal solids and fluids; on the other hand, arsenic, which might have been supposed to be rapidly fatal, is so inert when introduced into the blood that it will not speedily produce death, unless indeed it is injected in quantities sufficient to directly coagulate the blood. It remains for future experiments to determine if this is owing to its being isomorphous to one of the elements of the fluids and solids, the phosphorous.

On the Comet of 1843. *By* Dr. von Boguslawski *of Breslau, Corresponding Member of the British Association.*

[A communication made to the Mathematical and Physical Section at Cambridge, and ordered to be printed entire amongst the Reports.]

The great Comet of 1843 was regarded with much interest by the whole world, more particularly by astronomers, and has left us some very important questions to solve; that is, we require to know whether it be periodic or not, and the marvellous appearance of its magnificent tail should be explained. The series of observations of the comet is far too short to enable us to derive from it a calculation on the ellipticity of the orbit. Some attempts have given negative results, and even a hyperbola, which is however less probable than that the observations were imperfect. The review would have promised better success, if there had been any comets in former days whose appearances resembled this, since this inquiry is extremely limited, from unavoidable reasons. The principal are these:—

The comet of 1843 is one of those whose visibility in broad daylight near the sun at the time of perihelion is incontestably proved. In *our* hemisphere it can never be seen near midnight, either before or after. Nor can it ever be seen to the north of the ecliptic; and even in the south of the zodiac there are but few constellations in which it can rise above our horizon; only in Eridanus, or in the feet of Cetus during the months of February and March; and afterwards in Corvus, and in Hydra during the months of October and November.

Guided by these considerations, in the excellent 'Cometography' of Pingré we meet with the comet of 1695, seen in Brazil, in India, at Macao, and in the islands of St. Anne in America, pursuing its path through Corvus into Hydra. The magnificent tail upholds the supposition that the head was in the principal extremity.

On the 7th of February 1106, a comet appeared in Palestine (and was afterwards seen in China) which occupied that part of the heavens in which the sun sets in winter. From it there proceeded a long whitish ray resembling a linen cloth, which came to an end below the constellation of Orion.

Aristotle makes use of nearly the same words in describing (in his 'Meteorology') the comet which appeared 371 years B.C. "In the severest part of the winter," says he, "this prodigious star was seen to appear in the evening. It set soon after the sun; but its light extended something like an avenue of trees over a third of the heavens. It rose up to the belt of Orion and then disappeared." Thus we have *two striking* portraits of the comet of 1843; but resemblance alone decides nothing.

Of the three comets here cited, only that of 1695 affords us details of its apparent path through the heavens. Three Jesuits, who it appears possessed astronomical knowledge,—Father Noel at Macao, Father Bouvet at Surat, and Father Jacob at All Saints' Bay in Brazil,—give us a learned description of it according to the taste of their time; whilst an anonymous observer on one of the islands of St. Anne in America, carefully notes down five or six times, between the 2nd and 19th of November, those stars of Corvus and Hydra through which the head of the comet had continued its route.

Pingré owns that he attempted in vain to combine these observations, in order to derive from them some approximation to the comet's orbit; and yet the whole of them, including the daily progress of the comet, are represented in the most satisfactory manner by the elements of the comet of 1843; that is, supposing the same distance of perihelion, the same longitude for the perihelion and for the ascending node, and the same inclination, and admitting the 24th of October 1695 as the day of the perihelion passage.

The elements of an entirely different orbit, calculated by Mr. Burckhardt from the inedited observations of Mr. Delisle, do not give at all the same results, and perhaps owe their existence to the same cause which M. Bessel has revealed in the 'Ast. Nach.' of Schumacher. The details of my calculations will soon appear in that work, and will prove the great probability of the assertion which, in the presence of this illustrious Association, I have today made for the first time.

Meanwhile I may be permitted to draw the conclusion that the period of the last revolution occupied 147 years and 127 days, and to mention the consequences which result therefrom.

Four anterior revolutions of 147 years and 5 months, conduct us to the comet of the year 1106, of which we have already spoken; and from thence, ten revolutions of 147 years and 9 months, carry us back to the comet of Aristotle, 371 years B.C.

The difference of several months between the earlier times of revolution and those of the present day, far from disturbing our hypothesis, serve to confirm it. It is the effect of the *resisting medium in space*, which has already manifested itself in the comets of Encke and Biela, and which we might expect to find acting with far greater force on a comet which buries itself in the densest beds of æther which surround the sun. This may perhaps afford a new opportunity for studying this interesting force, which, by diminishing the excentricity of the orbits, and constantly decreasing the time of their revolutions, will accomplish in the course of ages the reunion of these celestial bodies, which possess very large resisting surfaces, but very small masses, with the great centre of general gravity.

Other comets have also appeared at intervals corresponding to a number of complete revolutions, the probability of whose identity with that of 1843 is greater or less according to the circumstances which accompany them.

These are,—the great comet of 1548, or that of the Turks; that of 1401, during Lent; the comet which appeared before the death of Pope Innocent IV. in 1254; that of 367 seen in broad daylight; the comet of 219; and finally, that of the year 74 A.D. If I may be allowed to include these, we have accounts of *ten* reappearances of this famous comet from the time of Aristotle up to the present day; and it is worthy of remark that *all* were *seen, as it appears*, ONLY *after the epoch of the perihelion*. Perhaps, when I shall have furnished them with the demonstration of my assertion, astronomers may like to name this comet after Aristotle, and to look upon it as the symbol of that immortal philosopher.

If it is considered that the ellipticity of this comet's orbit is established, it is declaring it at the same time to be both more esoteric and more exoteric than any other vassal of the sun with which we are more closely acquainted.

Immersed on the day of perihelion in the photosphere of the sun itself, our comet hastened, with a velocity of more than 414 English miles in a second of time, to escape from the great attractive force, making the semi-circuit of the sun in the short space of one hour and a half, in order to pursue its distant route in an ellipse, whose length exceeds the breadth by nearly 57 times, the latter not being equal to the diameter of the earth's orbit; whilst the aphelion is 5,316,000,000 English miles from the sun,—nearly three times more than the orbit of the most distant planet discovered by William Herschel of immortal memory.

There our comet proceeded at the very slow pace of $7\frac{1}{3}$ English feet in a second, which however was just the means of reconducting it to the sun. If this be true, our posterity will see it return in the summer of 1990, that is to say, if accident favour it at a season when the comet is never above the horizon during the absence of the sun; but it will be more surely seen in the autumn of the year 2137, when it will present a similar appearance to that of 1695.

I trust I may be allowed to trespass on a little more time, in order to add a few words on the tail of this comet, which reasonably enough attracted so much general attention.

How is it that no one saw either the comet or its magnificent tail *before* the perihelion, neither in Europe, nor even in the tropics? Was it impossible? Not at all. Beginning from the 27th of January, the comet appeared above our horizon, and rose up higher day by day. The visibility of the tail should have commenced still sooner, and with a splendour surpassing that which it assumed in the month of March, increasing daily through the month of February, crossing the meridian every evening with the stars in the constellation Lepus. Nothing of all this occurred. It was seen *suddenly* immediately after the perihelion in full daylight only a few degrees from the sun, five or six degrees in length, which probably answers to more than ten times as much seen in the night time. The spectators of it in tropical countries know not how to find words to express the greatness and magnificence of its appearance. When it unfolded itself to our eyes towards the 18th or 19th of March, it was already much diminished in splendour, as we find by the unanimous assertions of witnesses, and yet it excited general surprise in these countries.

On the 21st of March my pupils observed the tail, already sensibly shortened to the naked eye, as far as η Leporis, whilst I could follow it in the finder beyond Sirius, leaving that star to the south. Thus the naked eye only saw a length of tail $=2\frac{3}{4}$ the distance of the earth from the sun, whilst the finder showed it *six times the radius of the orbit of the earth*, or 581 millions of English miles, being of far greater extent than the orbit of Jupiter. And assuredly my finder would not show the extreme limit of this phænomenon, which manifested on this occasion the common law of all the tails of comets, that of taking a direction exactly opposite to the sun, followed by the comet from the first day of its appearance after the perihelion. But *where* was its tail before this epoch? will be demanded at each reappearance.

Is it always lost during the long absence from the sun, and regained by the reunion? Where is the force which has each time engendered a body of such gigantic dimensions; the force, in a body so feeble and unshapen as the comet, which can project an enormous luminous mass in a short space of time as far as beyond the orbit of Jupiter; to conduct it half round the sun in $1^h\ 30^m\ 39^s$ for the extreme limit perceived by the finder, a route of 1826 millions of English miles? That is a celerity of more than a third of a million of English miles in a second,—a velocity which surpasses that of light by three-fourths! This really pronounces the impossibility of a mechanic nature in comets' tails; it ranges them amongst dynamic appearances.

However, nothing is as yet explained by this assertion. I consider even that only a profound study and perfect knowledge of the works of the late Brandes of Breslau, of M. Bessel's calculations of Halley's comet before the perihelion, and Sir John Herschel's after this epoch (including the aspect of the comet of 22nd January 1836 just like a fixed star), can conduct us to a more or less plausible theory of this most highly interesting phænomenon.

Nevertheless, in such a case it appears to me necessary to endeavour to establish a tolerably probable hypothesis, and which may explain a certain number of the facts according to the new principle. It will serve, not only to show by an example the *possibility* of the new conjecture, but also to guide us, when there is a discordance amongst the observations, to points of view more just and more admissible.

It is now some time since I endeavoured to demonstrate, that, from the circumstance of there being no loss of intensity nor refraction from a ray of light passing through the volume of a comet, the law of the intensity of their light (which as with the planets follows that of the inverse ratio of the square of the distance from the sun, but in an abnormal manner that of the *simple* distance from the earth) leads us to regard these stars *as an accumulation of an immense number of very small bodies*, of which each one possesses sufficient mass to play the part of a central body, and which all move round their common centre of gravity in regular orbits, whilst this *dynamic centre describes the cometary orbit round the sun.*

What we see at the head of the comet is the brightness formed by these numerous particles being lighted up by the sun, each one being too small to be distinguished separately. Thence the cause of the nebulous aspect of comets, resembling that of the accumulations of stars, which often from the same cause are seen as nebulæ. The form of each individual of these corpuscles decides the fact of its having a rotatory movement or not. The form must be amorphous or crystalline, according to the matter and conditions at the moment of the first formation. This formation may be renewed as often as these atoms are put into a state of fusion, or subjected to a species of cementation, which might very possibly occur when a comet passes very near the sun. *Endowed with the facets of crystals, and obliged by their form always to preserve the same direction towards the sun*, these corpuscles may unite all the requisite conditions up to an *entire reflexion* of the solar rays.

He who knows how much may be united in this phænomenon of entire reflexion, will understand the considerable illumination which it may spread to the greatest distance in space.

We have only to admit that the atoms which form the zodiacal light, seen lighted up only by *simple* rays of the sun, are spread over far more distant spaces, to enable us to explain a dynamic origin for the tails, thus placing them amongst the phænomena of the zodiacal light, the parhelia, halos, the rainy bands of the Indian summer, and even the general world of atoms lighted up by the sun.

Thus may comets be perhaps the grand reflectors of our solar system, sent us from time to time by the Creator of the world to throw light upon hitherto unknown parts of his Creation, too immense for our senses, and even for our minds!

Report on the Actinograph. By Mr. Robert Hunt.

Many circumstances have conspired to prevent the author from completing any observations with this instrument. A few rough experiments made with a view of testing the merits of it, comprise all that has as yet been done.

The importance of a method of registering the amount of chemical influence associated with the solar rays, is evident. When we consider the ever-varying conditions of these radiations, producing remarkable phænomena, not merely during the changes of the year, but over the vegetable world, within the brief period of a day—when we find the practical photographist stating that two hours before noon he can produce effects, which he cannot produce two hours after the sun has crossed the meridian, it will be clear to every one, that some accurate means of registering the relations between the amount of light and actinic (chemical) power, which are evidently not in strict ratio to each other, is desirable.

The instrument constructed for the Association, although not yet complete, answers this purpose remarkably well. It consists essentially of a fixed brass cylinder, about which is wound a piece of prepared photographic paper. This paper is so prepared with the bromide of silver, that it is equally sensitive to all the rays of the prismatic spectrum. Over this is placed another cylinder which is driven by clock-work, and it performs a revolution in twenty-four hours. In the moveable cylinder is a triangular slit, the largest part being exactly one hundred times the size of the smallest, which is a mere point, and this opening is divided by bars into one hundred parts. In passing round, the opening exposes regularly to solar influence different parts of the photographic paper,—the smallest part of the opening allowing the influence to be exerted for considerably less than a minute, whilst the largest part admits of the action of the sun's rays for more than an hour. The paper, by experiment, is so adjusted, that the greatest amount of actinic power darkens it completely during the shortest exposure, whilst the weak light of winter is just sufficient to produce the effect during the passage of the longest part of the opening. The degrees between these points become of course, under the ever-varying conditions of solar radiation, unequally darkened, and the paper being carefully marked to the hours of the day, it is quite easy to register *numerically* the varying effects produced. It will not therefore be necessary to have recourse to any plan of fixing the impressions made, which is always an uncertain process. It is hoped that by the next meeting of the Association the author will be enabled to furnish registers complete for twelve months, and he thinks he shall then be enabled to show that the actinic influence is one which must be taken into account in many inquiries, and to prove that the actinic or chemical power, and the phænomena of luminous and thermic action, are not found in any constant ratio in the solar rays, but that they are liable to continual variation.

On Ozone. By Professor Schönbein *of Basle.*

The British Association has done me the honour of inviting me to prepare a report on my researches regarding a peculiar agent to which I have given the name "Ozone." Flattering as such a charge must have proved to me, I undertake its execution with great diffidence, less on account of the subject of the report itself, than in consequence of my being obliged to make use of an idiom which I am not in the habit of speaking. Having fully experienced on former occasions the kindness of the same Association I have now the honour to address, I count upon your indulgence, and am convinced that you will receive with your wonted urbanity the very imperfect communication of a man who is certainly in one respect an alien to this country, but who feels himself nevertheless intimately connected with your land by many ties of friendship and scientific intercourse, and considers old hospitable England as his second home.

Were I not actuated by such feelings, I would not have ventured to come forward on this occasion, and it is to those feelings alone that I owe the courage requisite for a stranger who is to speak before an Association counting amongst its members the very essence of British philosophers. In taking the liberty to give you an account of the results obtained from researches with which I have been occupied these last six years, I shall chiefly keep in view the most novel facts I have been fortunate enough to ascertain, and I shall try to be as concise and clear as possible in stating them. Now and then, as the occasion occurs, I intend to enter into theoretical considerations and draw inferences from the phænomena observed. After having made you fully acquainted with the subject of my report, I need not say how much you will oblige me by making any observation or suggestion calculated to clear up a matter which I readily allow is yet very far from being thoroughly understood and sifted to the bottom. I shall feel myself fully repaid for the many pains I have taken these last five or six years in investigating the nature of the electrical smell, if I happen to succeed in convincing you that my subject is worthy of philosophical research and likely to open a new field of inquiry. First of all permit me to state the reasons which induced me to undertake that series of investigations, the principal results of which will form the substance of my communication.

The peculiar smell developed during electrical discharges and the peculiar odour disengaged by lightning, have been the subject of a good deal of conjecture; but as far as I know, philosophers have not yet succeeded in clearing up the nature of that smell. The obscurity in which that phænomenon is enveloped, and the fact, I think first stated by myself, that on electrolysing water an odour makes its appearance very like to that called the electrical smell, excited my curiosity so much the more, that the circumstances under which the two sorts of smells are produced are apparently so very different from each other.

I made up my mind to investigate the subject as closely as possible, and in spite of its peculiar difficulty and many fruitless endeavours, I succeeded at last in ascertaining some facts which seemed to open a path for further and accurate inquiry.

These facts were,—1, that the odoriferous principle developed during the electrolysis of water is only disengaged at the positive electrode; 2, that the same principle may be preserved in well-closed bottles for any length of time; 3, that this principle polarizes negatively gold and platinum; 4, that the odoriferous substance is destroyed by heat and a number of oxidizable bodies; 5, that the electrical brush has the same odour as the oxygen disengaged at the positive electrode; 6, that the brush has the power of polarizing negatively gold and platinum; 7, that on heating the points out of which electricity is passing into the atmosphere, they no more develope the electrical smell. From these and some other facts, I was inclined to infer that the electrical brush produces the same principle which is disengaged at the positive electrode during the electrolysis of water, and as chlorine, with regard to its voltaic bearings, acts very similarly to this odoriferous principle, I suspected the latter to be a body analogous to chlorine. To decide on the correctness of that conjecture, there seemed to be no other way left open than to isolate the principle in question; but considering the infinitely small quantities in which the odoriferous substance is produced under the circumstances mentioned, the carrying into effect that isolation assumed the appearance of a thing lying beyond the reach of possibility. Yet after many trials undertaken with a view of producing more abundantly and by other than electrical means, my peculiar principle, I succeeded at last in doing so, and phosphorus proved to be the substance most convenient to obtain that end. And from the discovery of the most remarkable action which that body under certain circumstances exerts upon common air, I was led to ascertain the whole series of the curious and rather surprising facts I am about to state, and to arrive, if not at the complete solution of my problem, at least at the opening of the path which will ultimately lead to that goal.

And now I am touching upon that part of my report which, as to its matter of fact contents, is the more interesting one of the whole of the communication I have to make to you, and I beg leave to call your attention to the following statements:—

1. If at a temperature of 32° a piece of phosphorus, having a clear surface, be placed in a bottle filled with common air, a peculiar smell makes its appearance which is considered to be due to the vapour of phosphorus; at the same time that the included air assumes the power of polarizing positively a plate of platinum or gold which happens to be brought in contact with it.

2. Everything remaining in the state indicated, except the temperature being raised to about 60°, a change will very soon take place both with re-

gard to the smell of the air and the electro-motive power of the latter. The former will resemble the electrical smell, and the air will now be able to polarize negatively gold or platinum.

3. Atmospheric air completely deprived of its moisture and put in contact with phosphorus, does not give rise to the production of the electro-negative principle.

4. Atmospheric air, which contains only small quantities of the vapours of æther, alcohol, olefiant gas, sulphurous acid, nitrous acid, sulphuretted, phosphuretted or seleniuretted hydrogen, is not capable of developing the electrical smell, or assuming the state of the electro-negative polarity.

5. A mixture of oxygen and carbonic acid, or of oxygen and hydrogen, acts with regard to phosphorus like the common air, or an artificial mixture of oxygen and nitrogen.

6. Pure oxygen, or nitrogen, or hydrogen, or carbonic acid gas, whether moist or anhydrous, being placed in contact with phosphorus, becomes positively polarized; but none of those substances produce our electro-negative principle or the electrical smell.

7. To generalize the circumstances under which phosphorus is prevented from generating the said principle, it may be said that anything that stops the slow combustion or the emission of light of phosphorus at the common temperature, also renders impossible the development of the electrical smell, whilst the latter is always produced in an atmosphere in which phosphorus exhibits in the dark the phænomenon of a lively emission of light.

8. The positive polarity and alliaceous odour assumed at zero by common air in contact with phosphorus, is most likely due to the vapour of that body, whilst the negative polarity and the electrical smell developed at a higher temperature in the same air, originate in that peculiar principle, which, on account of its strong odour, I have called ozone.

As far as my experiments go they show that ozone enjoys the following properties:—

1. Stripes of blue litmus paper, being plunged into an ozonized atmosphere, are within a very short time completely bleached without being reddened in the least degree. Stripes of paper, having been coloured blue by a solution of indigo, and placed under the same circumstances, turn white. A solution of indigo or of litmus, being shaken with an ozonized air, loses also its colour exactly in the same way as if the solution had been treated by chlorine.

2. Most metals, silver even not excepted, being in a state of minute mechanical division and put in contact with ozone, almost instantaneously destroy that principle at the common temperature. Silver being changed under the circumstances into a compound containing nothing but metal and oxygen, it seems that the other metals are also oxidized by ozone.

3. Iodine put into an ozonized atmosphere is changed into iodic acid.

4. Powder of charcoal very rapidly destroys ozone.

5. Phosphorus quickly takes up ozone, being transformed into phosphoric acid.

6. Sulphuretted, seleniuretted, phosphuretted, carburetted, and ioduretted hydrogen rapidly destroy ozone, and are themselves decomposed by that principle.

7. Sulphurous acid and ozone being mixed together disappear and produce sulphuric acid.

8. Nitrous acid and ozone destroy each other with instantaneous quickness, producing nitric acid.

9. A number of metallic protoxides being put in contact with an ozonized

atmosphere are changed into peroxides. Solutions of the alkaline bases, as potash, soda, baryta, &c., take up rather slowly ozone, producing peroxides. The hydrates of the protoxides of manganese, lead, cobalt, nickel, or silver, being attached to stripes of paper and suspended in an ozonized atmosphere, are rather rapidly changed into the peroxides of those metals. Potash takes up ozone and water too.

10. A solution of iodide of potassium is rapidly decomposed by being treated with ozonized air, iodine being eliminated. At the same time iodate of potash is produced, which production is however preceded by the formation of a peculiar compound most likely consisting of iodide and peroxide of potassium. Hence it comes that paste of starch being mixed up with some iodide of potassium and exposed to ozonized air, instantaneously turns blue, and proves to be the most delicate test for ascertaining the presence of ozone.

11. Crystals of bromide of potassium, put into paste of starch and exposed to the action of ozone, colour that paste orange-yellow.

12. A solution of the yellow ferro-cyanide of potassium readily takes up ozone, yielding the red ferro-sesquicyanide.

13. The white cyanide of iron, being exposed to the action of an ozonized atmosphere, is instantaneously changed into the blue one.

14. The salts of the protoxides of iron and tin rapidly destroy ozone, and are transformed into peroxide salts.

15. A great number of metallic sulphurets, being put in contact with ozonized air, lose their colour and are changed into sulphates; a piece of paper having been written over with a solution of acetate of lead and blackened by sulphuretted hydrogen, rapidly turns white within ozonized air.

16. A number of organic substances, both of vegetable and animal origin, being placed within ozonized air, almost instantaneously destroy the odoriferous principle; for instance, saw-dust, straw, ulmin, vegetable mould, albumen, fibrine, caseous matter, and therefore blood, milk and common cheese.

17. If ozonized air be caused to pass through a narrow tube into the open air, that current, of course, produces all the chemical reactions before mentioned; but if part of the tube of emission is heated not quite red-hot, the peculiar smell of the current disappears at once, and along with it all the chemical and voltaic properties belonging to ozone. Its bleaching and polarizing power, its capability of decomposing iodide of potassium, &c., are gone.

18. Common air, being as richly as possible charged with ozone, has a smell resembling very much that of chlorine, bromine and iodine; but if ozone is much diluted with common air, its smell cannot be distinguished from that developed near points of electrical emission.

19. If common air, strongly charged with ozone, be inhaled only in moderate quantities, effects are produced similar to those caused by the respiration of chlorine, *i. e.* coughing, and an inflammation of the mucous membranes. Small animals put into richly ozonized air die very soon. I saw a mouse, which had been placed in a large bottle filled with strongly ozonized air, succumbing within the space of five minutes. As the quantity of the ozone which killed the animal must have been immeasurably small, it appears that this principle proves highly deleterious to the animal system.

20. Chemically pure water, being acidulated by pure sulphuric acid or phosphoric acid and electrolyzed, yields oxygen charged with the same principle, which is produced when phosphorus acts upon common air; for that oxygen enjoys all the properties belonging to ozone engendered by the agency of phosphorus. To obtain ozone by voltaic means, it is necessary that the acidulated water employed for that purpose be entirely free from any sub-

stance having a tendency to unite with oxygen or ozone, and that besides the temperature of the liquid to be electrolyzed be as low as possible. When the conditions indicated are fulfilled, the disengagement of ozone taking place at the positive electrode will last as long as the current continues to pass through the said liquid. Hence it follows that no production of ozone will take place if the electrodes consist of other metals than gold or platinum, or if the liquid to be electrolyzed contains small quantities of sulphuretted hydrogen, sulphurous acid, proto-sulphate of iron, æther, alcohol, &c. An aqueous solution of potash does not yield a trace of ozone, because free ozone is taken up by that solution.

21. The electrical brush developes, as is well known to philosophers, a peculiar odour which cannot, as I have already mentioned, be distinguished from that of diluted ozone, be that ozone produced by the agency of phosphorus or by the electrolysis of water. But the chemical and voltaic reactions exhibited by the electrical brush are also quite the same as those produced either by chemical or voltaic ozone. Platinum foil being exposed to the action of that brush assumes the state of negative polarity, a piece of litmus paper is bleached, iodide of potassium or hydro-iodic acid decomposed, iodine being eliminated, the ferro-cyanide of potassium transformed into the sesqui-cyanide, the hydrate of protoxide of lead changed into the brown peroxide, provided the substances mentioned be sufficiently long acted upon by the electrical brush. If only small quantities of sulphurous acid, nitrous acid, sulphuretted hydrogen, olefiant gas, or vapour of æther or alcohol are present in the air into which the electrical brush is passing, the latter does not develope the peculiar electrical smell, neither does it produce any of the chemical or voltaic reactions before mentioned. A point of electrical emission being heated not quite red-hot, yields a brush which has no smell whatsoever, has no polarizing or bleaching power, does not decompose iodide of potassium, &c.; but as soon as the point in question is suffered to cool down again below a certain degree of temperature, the peculiar smell reappears, and along with it we obtain again all the reactions peculiar to ozone. From these facts we are allowed I think to draw the inference, that the odoriferous principle disengaged by the electrical brush is identical with the odoriferous substance which is developed at the positive electrode during the electrolysis of water, and identical also with the electro-negative principle resulting from a peculiar action exerted by phosphorus upon the moist atmospheric air.

In order to ascertain the nature of that remarkable principle, I have tried a variety of methods with the view of procuring it in an isolated state, but all my endeavours made to that effect have hitherto failed, and I am not yet able to give quite a decisive answer to the question, What is ozone?

That principle being developed by phosphorus within a mixture of oxygen and nitrogen, but not in pure oxygen; having in many experiments obtained no ozone from electrolyzing water which had been boiled and deprived of its atmospheric air; producing the same principle within the atmosphere by the agency of common electricity; and considering the striking analogy which exists between ozone and chlorine; I was for a time induced to think the former to be an elementary substance forming a constituent part of azote, and to give up my first idea, according to which I considered ozone as a peculiar compound consisting of oxygen and hydrogen.

The impossibility of isolating the principle, and the fact that nothing but oxidizing effects could be obtained from making ozone to act upon a great number of substances, induced me to resume the first view I took of the subject in question, and to institute a series of experiments with the intention of ascertaining more accurately the conditions required for the formation of ozone. In that inquiry I found that the presence of water is quite indispensable for engendering ozone, and that it is the more abundantly produced the larger the quantity of water which is put into contact both with phosphorus and common air. I likewise ascertained that no ozone is formed by phosphorus if free oxygen be excluded. Nitrogen may be replaced by carbonic acid or hydrogen without stopping the generation of ozone. Hence it follows that nitrogen has directly nothing to do with the production of ozone, and that the latter cannot be a constituent part of azote. From the fact that dry ozone passing along a heated tube is found to be destroyed, we must also infer that it is no elementary principle.

Now, taking together all the facts regarding both the circumstances under which ozone is formed and the chemical effects produced by that substance, we can hardly help admitting that the odoriferous principle is a compound consisting of oxygen and water. The experiments made independently of myself by my friend, the excellent and accurate chemist of Geneva, M. Marignac, and by M. de la Rive also, have led to results quite in accordance with the view I originally took of the nature of ozone. Marignac and De la Rive have ascertained that acidulated water, containing not the slightest trace either of free nitrogen or azotic matter, yields ozone as long as a voltaic current is made to pass through that liquid, provided however it be kept as cold as possible. M. Marignac has also found that mixtures of oxygen and hydrogen, or oxygen and carbonic acid gas, charged with aqueous vapour, produce ozone as well as a moist mixture of oxygen and azote. That able chemist has further ascertained that silver in a state of minute mechanical division readily takes up ozone, yielding nothing but a compound of silver and oxygen. Agreeably to my own experiments, M. Marignac has shown that ozone transforms iodide of potassium into iodate of potash.

Now these facts, combined with those ascertained by myself, seem to leave hardly any doubt about the nature of ozone, and confirm the view I took of it six years ago.

Thenard has made us acquainted with a compound consisting of one equivalent of water and one of oxygen. The question now is, whether the known peroxide of hydrogen be identical with my ozone. According to Thenard's own statements, peroxide of hydrogen has no odour, is soluble in water in any proportion, is less volatile than the latter, in decomposing itself it decomposes oxide of silver, reduces the peroxide of lead to a lower degree of oxidation, is not affected by iron, tin, or antimony, does not oxidize silver, but is decomposed by that metal, undergoes a spontaneous slow decomposition at the common temperature, and cannot exist at the boiling-point of water. The experiments of Becquerel and my own have shown that platinum, on being plunged into dilute oxygenized water, assumes the state of positive polarity. On the other hand, ozone has a strong and peculiar odour, is insoluble in water, exists, as far as we know, always in a gaseous state, readily oxidizes iron, tin, antimony, and even silver at the common temperature, changes the hydrates of the protoxides of lead and silver into the peroxides of those metals, seems not to be acted upon at all by gold or platinum, or the peroxides of lead and silver, and can bear a temperature considerably higher than that of boiling water without suffering decomposition; it seems to be stable at the common temperature, is decomposed not only by fibrine, but also by albumen, caseine and a variety of organic substances, and polarizes negatively gold or platinum. Now these facts seem to prove that ozone is different from peroxide of hydrogen. Whether the former contains more or less oxygen than the latter, or whether it is an isomeric modification of oxygenized water, can only be ascertained after having submitted isolated ozone to analysis; I am however inclined to think that ozone will turn out to be a compound isomerical with peroxide of hydrogen, a conjecture which seems to be supported by the fact, that the odoriferous principle acts in so many cases the part of chlorine. On that subject however I shall speak hereafter. As to the production of ozone, we must, as far as our experiments go, account for it in the following manner:—Phosphorus, being placed under certain circumstances, enjoys the peculiar faculty to determine a chemical combination between oxygen and water. The same compound is produced in a secondary way on electrolyzing water; part of the oxygen, being in a nascent state and eliminated at the positive electrode, unites with water, and ozone, being insoluble in the latter liquid, is disengaged along with another part of oxygen that does not combine with water. It is possible that gold or platinum acting the part of the positive electrode may have something to do with the fact, that not the whole quantity of oxygen set free by the action of the current is united with water and transformed into ozone, for it may be that ozone being in a peculiar state (for instance, in the fluid state), happens to be decomposed by the metals mentioned just in the same way as common peroxide of hydrogen is.

Common electricity passing through atmospheric air acts upon that mixture like phosphorus, *i. e.* determines part of the atmospheric oxygen to unite with aqueous vapour to form ozone.

Before concluding the first part of my report, allow me to say a word or two about the well-known phænomenon which phosphorus exhibits when placed in moist atmospheric air. At the common temperature, and under the circumstances mentioned, that substance gives out in the dark rather a lively light, and is changed into a mixture of phosphoric and phosphorous acids. In dry atmospheric air scarcely any emission of light takes place, and in oxygen none at all. My experiments have invariably shown that no ozone is produced if phosphorus does not shine in the dark, and that the emission of light is the more lively the more richly common air or any other gaseous mixture happens to be charged with ozone. As phosphorus, like all other readily oxidizable substances, quickly takes up ozone at the common temperature, there can be entertained hardly any doubt that the shining of phosphorus which takes place within moist atmospheric air chiefly depends upon the reaction exerted by ozone on phosphorus, and that the oxidation of that substance is effected less by the free atmospheric oxygen than by the oxygen contained in ozone. By dint of some peculiar power, phosphorus determines, first, the formation of ozone out of the oxygen and aqueous vapour of the air; and so soon as this compound is generated, part of it begins to act upon phosphorus, and change the latter into acid, whilst another portion of ozone is dissipated into the surrounding air. If the bottle containing common air and a sufficient quantity of phosphorus happen to be completely closed, the production of ozone and its subsequent decomposition effected by phosphorus will continue so long as there is free oxygen present in the air; and we find therefore, after a certain time, in the bottle nothing but nitrogen and phosphatic acid. According to this view, the disappearance of the atmospheric oxygen is not due to the direct oxidation of phosphorus, but to the previous formation of ozone determined by that element, and to the subsequent decomposition likewise brought about by phosphorus. As to the cause of the emission of light alluded to, I am quite confident that it lies in the ozonization of phosphorus, if I am allowed to use that expression, that is to say, in the oxidation of phosphorus being effected by the agency of ozone.

The correctness of that explanation is put beyond a doubt, by the fact that a number of gaseous substances being mixed with common air, phosphorus is prevented from shining in the dark. Gaseous, nitrous, or sulphurous acid, sulphuretted hydrogen, olefiant gas, hydro-iodic acid gas, vapour of æther, or alcohol, have this effect. Now according to the results of my experiments, all the substances mentioned instantaneously take up or destroy ozone, and such being the case, we can easily conceive why those gases and vapours present in the atmospheric air do not prevent phosphorus both from shining in the dark and from being changed into phosphatic acid. No ozone is or can be produced under those circumstances; for if that compound did ever happen to exist in that air, it would be instantaneously destroyed by the agents mentioned. Any gaseous substance therefore which readily unites with free ozone will prevent phosphorus from shining in that atmosphere, and of course also hinder the formation of ozone. Water being an indispensable ingredient for the generation of ozone, we can now easily see why in completely dry air the shining of phosphorus is nearly imperceptible. It is true, under these circumstances, some emission of light takes place, but it is exceedingly slight if compared to that exhibited in moist air. It is possible that that feeble phosphorescence results from a very small portion of oxygen directly uniting with phosphorus.

As ozone, in its action upon metals and a variety of other bodies, exhibits a very striking similarity to that which chlorine exerts upon the same substances, and as the remarkable analogy existing between these two principles extends itself even to the way of producing them, I shall take, on a future occasion, the liberty to submit to you some considerations regarding that subject, and bearing upon the two rival theories which have been founded with reference to chlorine.

On the part which Ozone acts in the Atmosphere.

Paste of starch, being mixed up with some chemically pure iodide of potassium and exposed for some time to the action of the open air, turns blue, whilst the same paste, shut up in a bottle filled with atmospheric air, remains colourless. Pieces of white linen, having been drenched with a solution of pure iodide of potassium, and left for some time in the open air, assume a brownish tint, which is due to iodine set free under the circumstances mentioned. That elimination of iodine does not, as far as my experiments go, take place in air inclosed within a bottle, though that air should contain even half its volume of carbonic acid gas. Iodide of potassium, after having for some time been exposed to the action of the open air, retains traces of a peculiar peroxide of potassium, of iodate and carbonate of potash, whilst in iodide of potassium kept in well-closed vessels nothing of the kind is found. From these facts it appears that the before-mentioned elimination of iodine, and the formation both of peroxide of potassium and iodate of potash, are not due to the action of free atmospheric oxygen nor to that of carbonic acid. According to my former experiments, air having been artificially ozonized, and made to pass through a solution of pure iodide of potassium, eliminates iodine, and causes the production of the said peroxide, iodate and carbonate of potash. Hence it follows that ozone produces, with the iodide of potassium, the same chemical changes as those which are effected by the open air, and between the two actions there is a difference of degree only and not of kind.

Now neither free oxygen, nor azote, nor carbonic acid being able to produce that effect, we must conclude that there is something peculiar in the atmosphere which causes the decomposition of our iodide, and has up to this present moment escaped the attention of chemists. But of what nature is that oxidizing agent? My experiments have shown that during the electrical discharges which we effect by artificial means within atmospheric air, ozone makes its appearance, and from that fact we are allowed, I think, to draw the inference that ozone is also produced as often as the electrical equilibrium of the atmosphere suffers disturbance from natural causes. Now electrical discharges of that description continually taking place in that atmosphere, it follows that the odoriferous principle is continually formed there.

This conclusion, taken together with the before-mentioned fact, that iodide of potassium is changed by ozone exactly in the same way as it is by atmospheric air, renders it highly probable, if not altogether certain, that the peculiar oxidizing agent contained in our atmosphere is nothing but ozone produced by atmospheric electricity. Starting from that supposition, it is very easy to see why the freely circulating air only acts upon the iodide, and why stagnant or inclosed air does not. The quantity of ozone contained in a small volume of air must be exceedingly minute, and large quantities of air are therefore required to pass over a particle of iodide in order to cause a perceptible elimination of iodine.

If ozone is to be considered as a constituent part of our atmosphere, and it be a well-ascertained fact that ozone is capable of oxidizing a great number of substances at the common temperature, we can hardly help ascribing to that subtle agent many slow oxidations which are effected in the atmosphere. As electrical discharges take place not only during a thunderstorm, but daily and hourly, and as those discharges give rise to the production of ozone, that principle would by degrees accumulate to an alarming amount, and so as to endanger animal life, if nature had not taken care to remove it almost as quickly as it is formed. That removal is principally effected by the large quantities of organic matter which cover the surface of the earth, and which are suspended in the waters of the ocean.

Not one single elementary body, and very few oxidizable compounds, combine at the common temperature with free oxygen; oxidizable substances must be more or less heated in order to unite with that element. And it is a well-known fact, that oxygen, being in certain states of combination, is able to combine at the common temperature with a great variety of substances. Such being the case, we must be rather surprised at the facility with which organic substances, placed in contact with the atmosphere, are decomposed and transformed into carbonic acid and water, and that circumstance must strike us still more if we consider that carbon and hydrogen require high temperatures to be united with free oxygen. On account of the facts mentioned, it is rather difficult to admit that it is the gaseous oxygen of the atmosphere which combines with the carbon and hydrogen of organic matters. According to the statements I have made, ozone has the power to destroy all vegetable colours, and is taken up by a variety of organic substances. I think there can be hardly any doubt that the reactions mentioned are due to the oxygen of ozone being thrown upon the oxidizable constituent parts of vegetable and animal matter, and it is therefore very likely that atmospheric ozone acts some part in the slow decomposition which organic substances undergo in the open air, and that atmospheric ozone has also something to do with the common bleaching process. I however do not mean to say that the mentioned oxidations are exclusively to be ascribed to that ozone which is produced by the agency of atmospheric electricity.

We know that ozone may be produced in another than electrical manner, namely, by what the French call *action de présence*, or by the catalytic force of Berzelius. Phosphorus, in its action upon moist atmospheric air, exhibits the most interesting example of the kind, so that we may consider it as a fundamental phænomenon which will best serve us to develope our ideas regarding the course of the slow oxidations which take place in the atmosphere.

Though phosphorus be one of the most readily oxidizable substances, it does not, to a perceptible degree, combine at the common temperature with the oxygen of atmospheric air, if the latter be completely deprived of its moisture. But no sooner has aqueous vapour been added to that air, than the oxidation of phosphorus begins, and along with it the emission of light and the production of ozone. Of that agent we know that it oxidizes readily at the common temperature even silver and iodine, and of course phosphorus too. Hence it appears that ozone, at the very moment of its being formed under the catalytic influence of phosphorus, out of atmospheric oxygen and water, reacts upon phosphorus, and causes both the formation of phosphatic acid and the emission of light.

Every chemist knows the fact that dry atmospheric air is not capable of oxidizing at the common temperature even the most oxidizable metals, and that under the same circumstances dry organic matters are not acted upon by anhydrous atmospheric air. Hence we conclude, that besides the atmospheric oxygen, water acts an important part in the slow oxidations which both the inorganic and organic substances undergo in the open air.

As far as I know, chemists entertain the opinion that in the cases mentioned water acts only a secondary part, that is to say, the part of a solvent for oxygen. It is supposed that the gaseous state of that body weakens considerably its affinity for the oxidizable substances, and it is said that the affinity is much increased by depriving oxygen of its gaseous condition, for instance, by dissolving that body in water.

As long as we had not been acquainted with the remarkable action exerted by phosphorus upon moist atmospheric air, the notions alluded to appeared to be plausible enough, and notably the rapid acidification which phosphorus at the common temperature undergoes in humid air could satisfactorily be accounted for in the way mentioned. But in the present state of science we can no longer keep up that view, and are obliged to admit that the slow combustion which phosphorus undergoes in damp air is principally, if not exclusively due to the exalted oxidizing power of ozone engendered by the catalytic force of phosphorus. Now if phosphorus enjoys the power of determining the atmospheric oxygen to unite with water into ozone, I think the conjecture is not over-bold which ascribes the same faculty to some other oxidizable substances. In this respect shining wood offers a very remarkable case. It is well known that the substance mentioned exhibits the slow combustion under circumstances very similar to those under which phosphorus undergoes the same change. Water being taken away both from atmospheric air and the rotten wood, that wood ceases to shine in the dark, and the formation of carbonic acid is also stopped. Now we cannot say that it is the want of water on account of which the oxidation of the wood is prevented, because out of the product of the slow combustion a protecting film is formed round the combustible matter, as might be said regarding phosphorus; carbonic acid, being a gaseous substance, leaves the wood as soon as it is produced. It seems not unlikely that the peculiar bearing of shining wood is due to the same cause to which phosphorus owes its remarkable properties, and if that conjecture is allowed to be made, we may go further, and admit the possibility that the organic substances which undergo a decomposition in the open air possess the power of producing ozone out of free oxygen and water, and that it is on this account that those substances require, besides oxygen, some water, in order to be resolved at the common temperature into carbonic acid and water.

Why that power is not enjoyed by uncombined carbon or hydrogen we know no more than we can as yet give a good reason for the fact that oxygen, being in a certain state of combination, is more apt to unite with oxidizable substances than uncombined oxygen. The phosphorescence of the sea, which never fails to strike with astonishment every man who witnesses for the first time that beautiful phænomenon, seems to originate in organic matter, which in a state of minute mechanical division is mixed up with the waters of the ocean. If I am not mistaken, one of the first-rate philosophical observers of the day, Ehrenberg, takes that view of the subject. The intensity of this phosphorescence is not everywhere the same; in the tropical climates the phænomenon is more brilliant than in the seas of the colder regions. It is also well known that the phosphorescence of the sea is intimately connected with the motion of its waters, or to speak more properly, that the phænomenon is dependent upon the particles of those waters being brought in immediate contact with the atmosphere. When a ship moves about, or the wind happens to agitate the sea, the surface of the brine is continually renewed, and consequently new particles of organic matter are every moment brought into contact with the surrounding air. As under these circumstances the phosphorescence is always called forth, the German philosopher has come to the conclusion that the phænomenon mentioned is principally due to an action exerted by the atmosphere upon the waters of the ocean, and ingeniously enough Ehrenberg considers that phosphorescence as the effect of a sort of respiration of the sea. If the waters of the ocean were found to contain phosphorus dissolved, nobody would doubt in the least that the phosphorescence in question depended upon the slow combustion of that substance taking place at the surface of the sea, and we could easily see why the motion of its waters, the temperature, &c., exert an influence upon the phænomenon. Now as we have got in shining wood an organic matter which, like phosphorus, undergoes the slow combustion in moist air, and as it is not unlikely that phosphorus and shining wood act in the same way upon atmospheric air, that is to say, that both substances produce ozone out of the oxygen and aqueous vapour of the atmosphere, it appears not improbable that there exist some other organic substances enjoying the property of shining in the dark. The organic matter occurring in the waters of the sea, and originating in the remains of a countless number of animal beings which are daily dying in the depths of the ocean, may very possibly enjoy that property, so much the more as that matter happens to be in a state of extremely minute mechanical division.

According to the conjecture suggested, we may consider that animal matter, with regard to its bearing to the atmosphere, as a representative either of phosphorus or shining wood, and we can account for the phosphorescence of the sea in the same way as we have explained the slow combustion which phosphorus undergoes in moist atmospheric air. Agreeably to that view, the light given out by the waters of the ocean must be considered as the effect of a process of oxidation taking place on a most extensive scale, which process is carried on less by the free oxygen of the atmosphere, than by that of the ozone which we suppose to be produced by the catalytic force of the animal matter of the sea.

It is possible that the glow-worm and other animals shining in the dark generate a matter which acts upon atmospheric air in the same way as phosphorus does.

It is one of the facts best known, that carbonic acid is continually produced in the animal body, and that the formation of that compound is intimately connected both with the functions of respiration and the change of blood. Wherever that carbonic acid may be produced, certain it is that the carbon required for its production comes from the body, and that the oxidation of that element takes place at a temperature at which carbon, being in a free state, does not combine with oxygen. From the large quantities of carbonic acid produced during the respiration of an animal, and the minute quantities of free ozone inhaled, it appears that that carbonic acid cannot be engendered by atmospheric ozone. May we be allowed to suppose that blood being put in contact with atmospheric oxygen acts upon the latter as phosphorus does upon the same oxygen? Is it perhaps to ozone being formed in the way alluded to that the carbonic acid breathed out owes its origin? May we compare, in a chemical point of view, phosphorus placed in atmospheric air to an animal breathing in the same air? Strangely as these questions may sound, we can hardly help putting them, after having discovered in ozone so powerful an oxidizing agent, and found in phosphorus so remarkable a means to produce it.

In spite of the floods of light which recent chemical and physiological researches have thrown upon the function of respiration, we are still very far from understanding thoroughly that phænomenon, and for that very reason every fact which promises to unveil further that mystery is, in my opinion, highly worthy of all the attention both of physiologists and chemical philosophers. And as the subject I have treated of is such as to remind, as it were of itself, of its possible bearings to respiration, I think it will not be left entirely unnoticed.

Considering the great importance of the part which the atmosphere acts in different departments of organic and inorganic nature, it is very desirable that it should become more and more the subject of the most careful and extensive researches, and that chemists in particular should direct their attention to those phænomena which take place in atmospheric air, or are dependent upon the latter; for much as modern science has done in that field of inquiry, it cannot be denied that the greatest mysteries are yet to be unveiled in it. Holding the opinion that the extraordinary action which phosphorus exerts upon atmospheric air discloses to us a fundamental phænomenon, I am inclined to believe that that action, once fully understood, will give us an insight into the cause of a series of phænomena which at this present moment are yet enveloped in utter darkness.

On the Influence of Friction upon Thermo-electricity. By Paul Erman *of Berlin.*

[A communication read to the Mathematical and Physical Section, and ordered to be printed entire amongst the Reports.]

Are the forces that govern the interior constitution of bodies *two* in number, and essentially distinct; or do the effects usually called chemical, proceed from the same cause as those to which we give the appellation of mechanical? The future progress of science depends on the solution of this problem, which the recent development of physics has brought almost entirely within the province of electricity. In this province, the two schools, the chemical and the contact of theorists, rival each other in the sagacity and energy they display in the defence of their tenets. Let us indicate however a strategical position, the importance of which the contact party do not appear to have sufficiently seized. Friction is merely a repeated molecular contact, so that the mathematical expression of its effects would perhaps only consist in higher powers of the quantity that expresses the effect of contact. We have known from time immemorial that it developes heat, without understanding the reason of its so doing; subsequently it was found that it developes the static electricity of isolators; and at length Mr. Faraday has found that it modifies equally the dynamic electricity produced by the contact of thermo-electrical conductors. In spite of the importance of this last fact and the weight of so great a name, it does not appear to have met with sufficient attention in scientific circles. Some observers, who appeal to the authority of Mr. Emmet, express what they consider to be the law of this action, by saying that thermo-electricity of contact is changed invariably into the opposite state by the friction of the two metallic factors. Others, on the contrary, deny *in toto* the influence of friction on thermo-electric phænomena. Thus it was recently adverted to in a scientific journal as a highly paradoxical fact, that in a given case the friction had caused a change of sign in the thermo-electric declination produced by the contact of two heterogeneous metals; but at the same time this "unheard-of" fact, as it was called, was explained by supposing gratuitously that the friction had been effected whilst keeping the metal to be rubbed in the naked hand, and in thus producing an accidental change of temperature. This explanation was offered on the assumption that friction in itself is not capable of producing any effect. Between the two extremes of tribothermo-electric omnipotence and nullity, I have tried to discover the middle course of truth. If I am bold enough to call your attention to some of the preliminary results of these labours, it is solely with a view of contributing to the more general discussion of this question, and with the hope of some observers joining me in these researches, and controlling, rectifying, and extending my experiments.

For the experiments now to be mentioned, one of Nobili's thermo-electric multiplicators of particularly delicate structure is requisite. Being furnished with an instrument of this kind, I proceeded in the following manner. A bar of bismuth was joined to that branch of the rheophore of this instrument where the silver of a voltaic element (silver and zinc) produces an eastern deviation, and a bar of antimony to the other branch of the rheophore. Both these bars were provided with handles, so that they could be employed without undergoing any change of temperature in the manipulation. When, through these being stationed in the same room, the two bars had previously arrived at the temperature of the surrounding space, no deviation whatsoever was produced by their contact, but the slightest friction of either of them against the other gave immediately an eastern deviation. This latter extended even to an entire revolution of the needle in the same sense if the friction proceeded rather more rapidly. By gently raising the common temperature of the two bars to 30° or 35° of Reaum. scale, their contact in a state of repose always produced a stationary eastern deviation of about 30°, which by rubbing was further increased to 60°, and there likewise remained invariable as long as friction continued. At length, when I cooled the bars (below the temperature of the room) by the evaporation of naphtha vitrioli, their contact continually produced a western deviation, which by rubbing was instantaneously changed into a contrary or eastern one of apparently the same amount as before, and this likewise remained stationary as long as the friction continued, but by the interruption of it the western deviation was immediately restored. This simple sketch of the phænomena of changes of intensity or even of sign, which friction at the point of contact gives to the deviation of a multiplicator's needle, will already suffice to exhibit it as a mere consequence of the heat produced by the action of rubbing. Indeed, by joining to the point of contact of the two metals a button somewhat warmed or cooled (in comparison with the surrounding space), the influence on deviation was just as the above-mentioned effects of friction might lead us to expect. I was confirmed in this position by operating on many groups or combinations of the substances which form the thermo-electric series. Thus, for instance, the sulphuret of molybdenum, which when joined to bismuth gives no deviation by difference of temperature, appeared likewise without any influence when rubbed on the same metal. The sulphuret of lead (galena), which alone in the whole series makes bismuth negative by heat, renders it also negative by friction. Omitting for the present some very interesting details, which I reserve for a monograph of tribothermic electricity, it seems evident, therefore, that in these experiments the metallic conductors of electricity are thoroughly devoid of such specific or direct faculty of producing positive or negative electrodynamic actions, as the isolating substances possess for producing electrostatic effects; if you should not incline, with some of our philosophers, to regard even the electricity produced by friction of isolators as but a modification of heat. But postponing this question, let us see in what manner the theory, and perhaps even the practical application of electricity, may be promoted by the researches on tribothermic electrization. For this purpose we must enter into some further details:—1. The tribothermical effect is an instantaneous one. Indeed, at the very beginning of friction of any intensity, the needle moves. There is no trace whatever of the retardation undergone by heat when spreading through the mass of any substance. 2. The tribothermic effect is likewise independent of the masses put in action. The point of a needle rubbed against a considerable heterogeneous mass, gives immediately the deviation; and an increase of extent of the surfaces in friction does not appear even to add materially to the intensity of electrization. 3. The deviation vanishes quite as instantaneously as it commenced, and the immediate return of the needle to its primitive station is even one of the most striking features of the phænomenon. These three facts are very instructive, and seem by far more likely to be effected by a vibratory motion of molecules, than by the continuous efflux of a calorific fluid. Indeed, if we suppose any mass imbued with a given quantity of heat, and producing, when brought into contact with the other elements of a couple, a certain deviation proportionable to this quantity; the slightest increase of deviation would then require a considerable addition of heat, and, such addition taking place, the deviation could but augment very slowly, while, on the contrary, we find by experiment that the slightest friction produces a strong deviation. Moreover, supposing once more that the very quantity of heat, represented by the temperature and by the mass of the whole body, were the efficient cause of the deviation, the increase of deviation produced should be durable, while by experiment we always see it instantaneously vanish when friction ceases, just as should be the case were it produced solely by a molecular action of the rubbing-points. In the event of the refrigerated metal giving a western deviation, which a momentaneous friction inverts into an eastern one, but only as long as the friction lasts, the result is still more paradoxical, and we have probably no other explanation of it, but by admitting a specific difference between the mode of production of heat in this case on the one hand, and in that of heat permanently residing in the body on the other. The type of molecular vibrations will once more, and very naturally, be recalled by this remarkable fact. 4. The tribothermic deviations attain in every case a maximum, which under similar circumstances is different for different couples of metals. Indeed the friction produces, while it exists, new increments of heat which must give rise to increments of deviation. These latter however become more and more insensible, and at length seem only active in causing the persistence of the maximum of deviation. I found the values of the maxima for different couples just in the same proportion as their thermo-electric effects.

The four above-mentioned facts require an assiduous inquiry, supported by numeric determinations. The quantity of permanent heat, which by a friction of given duration accumulates in the metals, should be measured, and it must be ascertained whether this residue is equal in each of them; in other words, whether at the end of a continued friction the needle returns precisely to its primitive position, or only approaches to it; and, if an excess of temperature is denoted, in which of the two metals it has taken place. Any one who knows the difficulty of managing such delicate instruments, will understand why, after innumerable essays, I am not yet able to give a categorical answer to these questions.

After a friction somewhat prolonged the needle does not return immediately to its original position, but the difference is very trifling, and sometimes doubtful or ambiguous. Whenever, by a very efficacious friction, I had carried the deviation to a maximum of 60°, the needle, on the friction ceasing, underwent a vibration of six or eight degrees, but as the slowness of these oscillations enabled the temperature to become equal for the two bars, the first position of equilibrium remained ambiguous. In one apparatus a disc of bismuth was uniformly rubbed during twenty minutes on a disc of antimony. When the friction ceased, I immediately inserted between the two metals a highly susceptible thermopile, and it appeared by this process that antimony was constantly the most heated. Nevertheless, I regard this point as not yet fully proved.

In excusing the defectiveness of my results by the arduous nature of the observations required, I consider it my duty to indicate to the philosophers who would co-operate in the eminently important tribothermical researches, a circumstance which most decidedly contributes to their difficulty. The metals to be examined must be joined to the multiplicator by rheophoric wires, and these are mostly heterogeneous to the metals, as bismuth, antimony and cobalt cannot yet be wiredrawn by any known process. In employing wires of copper, of platinum, or of nickel, we might hope that their specific action on the thermo-electrical elements could be neglected, and that therefore the observed deviation might be assumed to result only from the temperature, or from the friction of the thermo-electric couple. A course of rather tedious experiments has shown me that this supposition is most erroneous and utterly deceptive, when applied to refined investigations and highly susceptible instruments. A multitude of contradictory and incoherent facts accumulated themselves like a chaos, before I arrived at the source of error. Thus, when I broke a bar of chemically pure antimony in the middle, and rubbed against each other the once contiguous surfaces of these two parts, I obtained very sensible deviations, but sometimes positive and sometimes negative. It was the same with the bismuth when similarly treated. It appeared at length that these strange results were merely owing to the action of the thermo-electric metals on their heterogeneous rheophores, for two copper elements with copper rheophores, and two zinc elements with rheophores of zinc, never give the slightest trace of tribothermo-electric effect, whilst any of these two metals produces a strong deviation, when after friction it is singly applied to the button of the multiplicator. A voluminous journal of attempts to decide the questions treated in the former part of this paper was nullified by the unexpected thermo-electric influence of the rheophores destroying its value. The best means I ultimately discovered for reducing this source of error, whose entire elimination is impossible, consists in the interposition of a plate cut from a piece of pure graphite, between the thermo-electric agent and its rheophore. The graphite acts but very feebly by its contact with heterogeneous substances, and at the same time proves an excellent conductor for electricity excited in any other manner. It is desirable that other means may be found to obviate the impediments resulting from the extreme sensibility of the apparatus which must be necessarily employed, as a minute absolute intensity is a characteristic feature of all tribo-electric actions, and can alone explain the reason of their having been so long either unnoticed or erroneously estimated. When, by immersion in a vessel of warm water, the temperature of a bar of bismuth and of another of antimony is elevated to upwards of 45° R., they will give by this contact a very strong eastward deviation, but the friction will not cause it to increase any more in a sensible degree. When, on the contrary, the same two bars are greatly refrigerated by being plunged in triturated ice, their contact gives a strong negative or western deviation, but the friction in this case, far from inverting this effect, is not even able to diminish it in any material degree. The calorific increments produced by friction are in themselves very feeble; the tribothermic multiplicator acts, in respect to them, as a microscopic apparatus; but the fact that its indications are circumscribed within certain limits, and becomes insensible when these limits are passed, is of striking importance. We need only to ascertain by very careful experiments the degrees of heat and of refrigeration given to the metals, by which their friction loses its influence on the needle, in order to obtain for a scale of tribothermic production of heat, two fixed points which can be reproduced in any instance, in exactly the same manner as the fixed terms of our ordinary thermometer. The philosophers who may apply themselves to tribothermic experiments, will not fail to meet with the paradox of two electric currents acting simultaneously in contrary directions. In the frequent cases where the contact produces a deviation of the needle in a certain sense and the friction in the contrary one, we can so modify these actions that the needle remains in equilibrium in an intermediate position, obeying the two currents that travel along the same wire in contrary directions. As to the obscure question of the relation between the direction in which the heat moves, according to the received terminology of the thermo-electric phænomena, and the direction in which electricity proceeds, it is not impossible, although highly improbable, that tribothermo-electric researches may throw some light upon it. The following Table presents the state of this question :—

Being heated.	Being at the temperature of the surrounding space.	
Bismuth.	Antimony ..	The contact gives an *eastern deviation.* Bismuth *loses* heat and *gains* electricity.
Antimony.	Bismuth ..	The contact gives an *eastern deviation.* Bismuth *gains* heat and *gains* electricity.
Being refrigerated.	**Being at the temperature of the surrounding space.**	
Bismuth.	Antimony ..	The contact gives a *western deviation.* Bismuth *gains* heat and *loses* electricity.
Antimony.	Bismuth ..	The contact gives a *western deviation.* Bismuth *loses* heat and *loses* electricity.

The friction increases the *eastern* deviations and changes all the western into *eastern ones*, that is to say, that *bismuth becomes equally positive by an increase or a diminution of heat.* May it be inferred that heat when nascent by the act of friction has a property specifically different from that of heat residing previously in a metal? Are we perhaps on the eve of finding at length something analogous to the brilliant discovery of Peltier, that galvanic electricity produces heat in proceeding from antimony to bismuth, and cold when travelling inversely, by which M. Lenz has produced congelation?

The electric telegraph is becoming popular at present, but it generally requires an apparatus which is variable in its effects and expensive in its employment. It would therefore be advantageous to substitute the purely mechanical principle of the tribothermic telegraph. For by removing the stopper of a wheel-work, a disc of bismuth rubs against another of antimony, and at the same instant the needle at the opposite extreme of the rheophore is put in motion. I have ascertained the instantaneousness of this operation for tolerably considerable distances. Employed as a signal, it would have the advantage, that after the interval of some days or months, when the clockwork is put in motion, the effect of friction would take place, whereas in the voltaic telegraph there would be a chance of the combination having lost its efficacy by the lapse of time.

P.S.—Berlin, August. A highly competent judge (Mr. Grove) being of opinion that I have imperfectly explained the grounds for my suspicion of a possible analogy between certain effects of the heat which is generated in the act of friction and the discovery of M. Peltier, I regret that in my paper I have affected a form too strictly aphoristic. I shall endeavour to remedy this by selecting, among many others, one tribothermo-electric fact, whose very paradoxical character first induced me to suppose such an analogy. Let a *crystal* of sulphuret of lead (galena) be placed at one of the poles of the multiplier, and at the other pole (to be alternately placed in action) of the rheophore a bar of bismuth and a bar of antimony; the bismuth being rubbed against the crystal, takes immediately a negative electric charge. This exception was already known for the same metal heated. From all the analogies hitherto known, it results that antimony being rubbed in the same way should become *positive*, and that to obtain by it a negative declination of the magnetic needle, it ought to be refrigerated. Now I find by experiment that the friction of antimony against a crystal of galena gives absolutely the same declination as the bismuth: in fact, the direction, the intensity and the quickness of the effect, are in the two cases sensibly equal; and we cannot deny that in this very paradoxical case, it appears that an increment of *nascent heat* produces in the antimony the effect of *cooling*. The singular effects which are observed when uncrystallized masses of sulphuret of lead are substituted for the single crystal of galena, confirm the supposition that the effects of friction depend on molecular movements. I am anxious that more practised observers may succeed in obtaining tribothermical effects by simple internal vibration of elastic sound-plates. I have not yet succeeded in this. But the great prize in this race of discovery would fall to him who should discover a difference of thermo-electric action, according as a magnetically polarized bar should be rubbed (that is, molecularly heated) at the one or the other of its poles.

The magnet-stone and the magnetic sulphuret of iron, exert, when rubbed, a strong thermo-electric action. I have employed these substances, as well as magnetic steel bars, in this curious investigation, but hitherto without success.

On the Self-registering Meteorological Instruments employed in the Observatory at Senftenberg. By the BARON SENFTENBERG.

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IF any branch of natural philosophy can derive advantage from comparison of observations made at different localities, this is particularly the case with meteorology. Isolated observations made at one and the same spot may furnish valuable data; but the ultimate benefit that can by them accrue to science, however carefully they be made, is only obtained by their combination with corresponding ones, made at more or less remote stations on our globe, thus establishing a first basis, succeeded by others, to form the links of that chain of arguments which may lead to the discovery of the primary causes of atmospheric changes.

It is by this process that we have already been enabled to ascertain that meteorological phænomena are but the wheels of that great mechanism, whereof change of temperature is the motive power, whence the greater commotions extending over vast regions, as well as also minor local alterations, can be traced. Although the results of phænomena included in the first class are in general of higher importance than those in the second, these latter ones are not the less deserving of minute attention, for the purpose of arriving at a just perception of the process that takes place in the higher regions of the atmosphere, and are even indispensable for ascertaining the effect of local causes, from which each single observation must first be cleared before it can be made use of in comparison with others made possibly under different influences. For this purpose observations made at two observatories at no great distance, but in other respects very differently situated, whereof the one is in a valley, the other on a mountain, or the one on an island surrounded by a great extent of water, the other on an extended level sandy plain, may lead to important results; and such have indeed already been derived from comparative observations made at Geneva and at the Hospice on the St. Bernard. The success to be derived from such observations depends, however, mainly on their regularity and multiplicity at both stations at stated intervals; for phænomena arising from local causes are generally of short duration, and would escape the notice of an observer who makes but two or three observations in the course of a day, and of others he would have seen but the beginning or the end, which would furnish but imperfect data for comparison. It is on this account that *self-registering instruments*, regularly compared with the usual ones, afford great advantages, as no phænomenon, of however transient a duration, can occur without being registered by them. Such instruments have for nearly two years been in use at the Senftenberg Observatory, and the proofs of what can be accomplished by them are detailed in vol. v. of the Magnetic and Meteorological Observations at Prague, which contain, however, only those made with the barometrograph. More recently thermo- and hygrometrographs have also been in active use there. Of course such instruments are complicated in their construction, and require practice in their management, whence the first series of observations are not so regular as those made with the usual ones, nor are the specimens now produced* intended to furnish the foundation for establishing new data or hypotheses; they are only intended as specimens to show what results might be obtained by these means under more favourable circumstances. A detailed description of these instruments is contained in the third and fourth volume of the Magnetic and

* Consisting of a selected series of tables, and diagrams of observations recorded contemporaneously at Prague and Senftenberg.

Meteorological Observations made at Prague; it is therefore deemed sufficient now only to state that they register from five to five minutes the variations of pressure, temperature and moisture of the atmosphere. The appended numerical Tables contain the hourly variations, and are of course only extracts made from the original curves marked from five to five minutes by the autograph, which was deemed sufficient for ascertaining the numerical value of any point of the curve. The series now submitted to observation is selected from and confined to days when considerable atmospheric changes occurred, so as to afford a proof of the advantage to be derived by employing such instruments. On other days, where the variations are more confined to the ordinary rates, fewer observations and at greater intervals are sufficient to make these apparent, as on such days the differences in variation at less distant places are so insignificant that they become scarcely perceptible; no doubt however the medium of extended regular observations would afford the means to appreciate such, but for the present and first attempt and trial, days when the atmosphere was more agitated seem better suited for the proposed purpose. [Table II. contains the Observations for the 18–19th June as an example.]

The two stations where these observations were made are,—1. Senftenberg, which is nearly due east 100 English miles from Prague, a distance quite sufficient to produce variations in these phænomena, which are however increased by other local causes. The observatory there is situated on the centre of the property on the river Adler, 1281 Paris feet above the level of the sea, in latitude 50° 5′ 8″·8, and longitude, east of Greenwich, 1^h 5′ 46″·98. Its immediate site is on lias and mica slate, but at no great distance it is more or less surrounded by higher ground with granite, gneiss and old red sandstone, and considerable forests. 2. Prague, situated in a more level country, and the river Moldau flowing through the town with a breadth of about 200 fathoms, is only 524 Paris feet above the level of the sea, without much woodland in its neighbourhood, the lower strata of the surrounding hills being principally lias, sandstone and argillaceous schist,—all circumstances which may produce influence on the atmospheric variations.

After these preliminary remarks, a little attention to the curves described by both barometrographs will soon convince us that they run nearly parallel, and that it is more particularly the deviation from parallelism which should be more nearly examined. The pressure of the air at Prague being 0·9 inch greater than at Senftenberg, and the curve of Prague being the lower one, their approach towards each other when the curves are rising proves that the *rising commenced earlier at Prague* than at Senftenberg; whereas an approach when the curves are descending denotes a quicker diminution of the pressure at Senftenberg. This is applicable to the extreme bends, or those points of the curve where a maximum in either sense has taken place, where the rising passes into falling, or the reverse; and in those cases when a curve that was before running nearly in a horizontal direction gradually begins to rise or fall; but if two curves continue for a while both to rise or to fall, a gradual convergency or divergency must also be accounted for by the weight of the atmosphere undergoing a change of the same nature at both places, but a greater one in the one than the other. Variations, however, observed during a longer period, embracing a succession of days, are generally so nearly of the same value at both stations, that by present experience no decided opinion can be expressed in which of them the total amount of change is greatest.

The annexed Table shows the amount of barometric variation during forty-five days, by which it appears that the medium at Prague was only 0·005 inch greater than at Senftenberg, a difference so small that no conclusion can by it be arrived at to determine at which of the two stations it was greater.

It may thus be concluded that the deviation of the curves from parallelism is produced by the difference in time at which the maximum and minimum took place at the two stations. By a closer inspection of the curves, it appears that when they are either approaching to or receding from each other, this is produced by a minimum which has taken place sooner at Prague than Senftenberg. Thus the first curve on the 18th and 19th of June at Prague shows a minimum between the hours nineteen and twenty, whilst in the Senftenberg curve it is not perceptible till the hours of twenty-two to twenty-three. This fact becomes still more conspicuous on other days, for on the 24th and 25th of August, where a minimum occurs in Prague at 4 o'clock, and at Senftenberg only at 10 o'clock, on the 29th and 30th of September we find the minimum at Prague already at the eleventh hour, which was only reached at Senftenberg on the nineteenth hour. Further, Oct. 3 and 4, minimum at Prague at the fifteenth hour, at Senftenberg at the sixteenth hour; Oct. 7 and 8, minimum at Prague at the second hour, at Senftenberg at the fifth hour; Nov. 8 and 9, minimum at Prague at the seventeenth hour forty-five minutes, at Senftenberg at the nineteenth hour; Nov. 13 and 14, minimum at Prague at the twelfth hour, at Senftenberg at the thirteenth hour; and Nov. 15 and 16, minimum at Prague at the sixteenth hour, at Senftenberg at the twenty-second hour. [The curves for the 18–19th June, 24–25th June, and 25th–26th June, are given in Plate II. as examples.]

These facts have recurred so regularly, that although the number of observations is not great, the law may be established between the above-named two places of observation with a degree of certainty the more to be relied on, as it invariably takes place whatever the direction of the wind may be. It thus follows that it has its origin in the higher regions, and is independent of local influences. A change in the opposite direction, that is, a transition from rising to falling, does not appear greatly to affect the parallelism of the curves; at all events no decisive proofs to that effect can be traced from the maxima of Sept. 30 and Oct. 1, Oct. 3 and 4, Oct. 4 and 5, Oct. 6 and 7, Oct. 7 and 8, Oct. 14 and 15, and Nov. 15 and 16.

But it is not only the minima terminating a long-continued decrease of a curve that follow the above-mentioned law, but also disturbances that hitherto have been considered as proceeding from local causes, such as transient gales of wind, thunder-storms, sudden changes of temperature and moisture, all which are indicated earlier at Prague than at Senftenberg by the autographs. It must however be owned, that the number of such cases hitherto observed is too small to draw certain inferences from. As an instance, the barometric curve at Prague on the 24th and 25th of June shows between the hours twenty and twenty-one a sudden transitory increase of pressure of the air, occasioned by a storm which came from the west-north-west wheeling round to a breeze from the east-north-east. The barometer at Senftenberg did not begin to rise before the twenty-first hour and thirty minutes, and continued to do so till the twenty-third hour, the wind at east-south-east. On the following day both places were visited by thunder-storms, which greatly affected the state of the barometer, causing it alternately to rise and fall. At Prague the first indications in the curve were perceptible at 7 o'clock, and the undulations extended to 10 o'clock. The phænomenon occupied the southern part of the hemisphere, the wind at south-west. In Senftenberg the thunder-storm lasted from 9 till 11, and at 9 o'clock the wind was north-west. On the 27th of June the thermometrograph at Prague indicated a rapid decrease of temperature between 3 and 4 o'clock, which was also perceived at Senftenberg between 4 and 5 o'clock, and this falling lasted for one hour and twenty minutes. The beginning of this phænomenon was marked so precisely by the autographs, that no uncertainty greater than five minutes could have occurred.

These first trials are only intended as examples to show the method of using such instruments with the view of furnishing dates for the advancement of science. The proposed object to be effected by the hourly observations for thirty-six successive hours, at a fixed time, may by such instruments be more readily and minutely attained. It is hardly to be expected that the phænomena suited for such studies should exactly occur on such days as have been previously selected, whilst by the assistance of such instruments they cannot fail to be registered at all times and whenever they may occur.

The example here furnished may suffice as a first attempt to show in what manner such an apparatus may be applied for the promotion of science by multiplying the materials fit to be studied. If they should be deemed of too voluminous a nature, the consideration should not be lost sight of, that such studies have never suffered from too great a multiplicity of useful data, but frequently from the contrary cause.

TABLE I. Barometric Maxima and Minima at Senftenberg and Prague, August 1844.

	Senftenberg.		Prague.		Difference.			Senftenberg.		Prague.		Difference.	
	Max.	Min.	Max.	Min.	Senf.	Prag.		Max.	Min.	Max.	Min.	Senf.	Prag.
	‴	‴	‴	‴	‴	‴		‴	‴	‴	‴	‴	‴
10.	322·56	321·68	332·50	331·50	0·88	1·00	Oct. 7.	321·47	316·76	331·23	327·01	4·71	4·22
18.	321·88	319·44	331·95	328·71	2·44	3·24	„ 8.	321·61	319·07	331·71	329·88	2·54	1·83
19.	319·28	317·66	328·90	327·61	1·62	1·29	„ 11.	321·32	317·86	331·41	327·21	3·46	4·20
25.	319·33	315·24	328·54	325·05	4·03	3·49	„ 12.	322·14	320·34	332·27	330·80	1·80	1·47
26.	318·25	315·47	328·37	325·78	2·78	2·59	„ 15.	318·42	315·69	328·23	325·33	2·73	2·90
6.	318·79	315·72	328·92	326·70	3·07	2·22	„ 20.	320·15	316·05	330·16	325·56	4·10	4·60
19.	319·48	317·75	329·33	328·00	1·73	1·33	„ 29.	322·16	319·62	332·47	330·16	2·54	2·31
29.	321·69	319·24	332·29	329·00	2·45	3·29	Nov. 1.	321·96	318·71	332·14	328·49	3·25	3·65
30.	319·00	318·64	329·40	328·59	0·36	0·81	„ 2.	318·58	315·62	328·31	325·18	2·96	3·13
8.	321·06	317·34	330·79	328·09	3·72	2·70	„ 3.	315·53	313·95	325·69	323·62	1·62	2·07
9.	319·34	317·76	329·60	328·73	1·58	0·87	„ 8.	319·02	316·30	329·17	325·48	2·72	3·69
11.	319·09	317·50	329·75	326·95	1·59	2·80	„ 9.	316·21	314·42	325·33	324·42	1·79	0·91
14.	318·15	316·21	328·71	325·80	1·94	2·91	„ 9.	316·34	314·42	326·04	324·42	1·92	1·62
16.	318·06	315·63	328·91	325·72	2·43	3·19	„ 10.	318·13	316·25	327·33	326·42	1·88	0·91
22.	319·90	318·94	329·51	328·69	0·96	0·82	„ 14.	322·92	317·75	333·69	327·88	5·17	5·81
25.	321·09	318·62	331·10	328·72	2·47	2·38	„ 15.	325·08	323·04	335·84	333·86	2·02	1·98
28.	324·04	321·82	333·99	331·35	2·22	2·64	„ 15.	325·08	323·09	335·84	332·49	1·99	3·35
29.	321·71	320·00	331·25	329·67	1·71	1·58	„ 16.	322·66	320·73	332·31	331·64	1·93	0·67
30.	323·06	319·60	334·05	329·70	3·46	4·35	„ 16.	322·76	320·73	333·96	331·64	2·03	2·32
1.	323·68	321·89	334·25	331·87	1·79	2·38	„ 17.	324·36	322·97	335·06	334·13	1·39	0·93
2.	321·77	316·49	331·69	326·17	5·28	5·42	„ 20.	324·27	322·13	334·72	332·47	2·14	2·25
3.	317·81	315·49	328·51	326·00	2·32	2·51	„ 21.	321·84	318·59	332·23	329·60	3·25	2·63
4.	321·22	315·30	331·78	326·04	5·92	5·74	Dec. 30.	323·43	320·95	333·54	330·94	2·48	2·60
5.	322·28	320·74	332·23	330·32	1·54	1·91					Sum	119·91	122·58
6.	321·69	320·49	331·42	330·35	1·20	1·07					Mean.	2·498	2·554

TABLE II.

18th June, 1844.

	State of Barometer.			State of Thermometer.			Relative Humidity.			Expansive Force of Vapour.			Direction of Wind.		Force Win
	Senf.	Prag.	P.—S.	Senf.	Prag.	P.—S.	Senf.	Prag.	P.—S.	Senf.	Prag.	P.—S.	Senf.	Prag.	Senf.
h	'''	'''	'''		°						'''				
12.	321·88	331·95	10·07	7·0	+ 9·0	+2·0	76	64	−12	2·86	2·84	−0·02			
13.	21·87	31·94	10·07	6·4	8·6	+2·2	75	64	−11	2·69	2·74	+0·05			
14.	21·86	31·94	10·08	6·0	8·1	+2·1	75	66	− 9	2·60	2·71	+0·11			
15.	21·85	31·87	10·02	5·8	7·6	+1·8	74	71	− 3	2·53	2·81	+0·28			
16.	21·84	31·79	9·95	6·0	7·3	+1·3	76	74	− 2	2·64	2·86	+0·22			
17.	21·83	31·79	9·96	6·0	6·9	+0·9	77	73	− 4	2·67	2·68	+0·01			
18.	21·82	31·60	9·78	7·0	7·1	+0·1	75	72	− 3	2·82	2·74	−0·08	...	S.W.	...
19.	21·81	31·62	9·81	9·3	8·5	−0·8	71	66	− 5	3·20	2·80	−0·40	N.W.	...	0·5
20.	21·68	31·63	9·95	10·0	10·5	+0·5	64	60	− 4	3·00	2·93	−0·07	...	S.W.	...
21.	21·59	31·44	9·85	11·2	11·7	+0·5	55	50	− 5	2·82	2·68	−0·14			
22.	21·49	31·25	9·76	12·0	12·9	+0·9	57	41	−16	3·14	2·42	−0·72	...	S.W.	...
23.	21·38	31·05	9·67	12·8	14·0	+1·2	51	40	−11	2·98	2·56	−0·42			
0.	21·19	30·81	9·62	13·7	15·2	+1·5	54	40	−14	3·37	2·77	−0·60	...	O.	...
1.	20·99	30·44	9·45	14·5	16·4	+1·9	45	39	− 6	2·99	2·64	−0·35	...	O.	...
2.	20·80	30·23	9·43	15·2	16·6	+1·4	48	38	−10	3·36	2·93	−0·43	O.S.O.	O.	1·0
3.	20·65	29·98	9·33	15·5	18·2	+2·7	45	33	−12	3·38	2·91	−0·47			
4.	20·30	29·67	9·37	15·7	18·2	+2·5	41	36	− 5	3·00	3·22	+0·22	...	O.	...
5.	20·22	29·52	9·30	15·0	18·5	+3·5	44	32	−12	3·03	2·89	−0·14			
6.	20·10	29·40	9·30	14·7	17·8	+3·1	50	35	−15	3·38	3·05	−0·33	...	O.	...
7.	20·02	29·22	9·20	14·0	16·5	+2·5	62	42	−20	3·97	3·27	−0·70			
8.	20·00	29·05	9·05	12·0	15·3	+3·3	72	50	−22	3·96	3·97	−0·39	...	O.	...
9.	19·92	28·96	9·04	9·4	14·8	+5·4	85	54	−31	3·86	3·66	−0·20	O.S.O.	...	1·0
10.	19·65	28·87	9·22	8·6	14·3	+5·7	88	59	−29	3·76	3·84	+0·08			
11.	19·44	28·71	9·27	8·8	13·6	+4·8	81	64	−17	3·54	3·96	+0·42			

19th June, 1844.

	Senf.	Prag.	P.—S.	Senf.	Prag.	P.—S.	Senf.	Prag.	P.—S.	Senf.	Prag.	P.—S.	Senf.	Prag.	Senf.
12.	319·28	328·51	9·23	...	+12·9	...	88	70	−18	...	4·13				
13.	18·97	28·32	9·33	...	12·3	...	88	78	−10	...	4·38				
14.	18·81	28·26	9·45	...	11·8	...	86	81	− 5	...	4·38				
15.	18·57	27·95	9·38	...	11·4	...	80	80	0	...	4·19				
16.	18·29	27·85	9·56	...	11·1	...	76	80	+ 4	...	4·09				
17.	18·13	27·80	9·67	...	11·0	...	73	80	+ 7	...	4·05				
18.	17·96	27·65	9·69	...	11·0	...	70	80	+10	...	4·07	...	...	O.S.O.	...
19.	17·80	27·65	9·85	15·2	12·6	...	65	74	+ 9	4·55	4·25	...	S.O.	...	2·5
20.	17·79	27·61	9·92	...	14·1	...	65	71	+ 6	...	4·58	...	...	S.O.	...
21.	17·77	27·69	9·92	...	14·7	...	65	68	+ 3	...	4·59	...			
22.	17·66	27·77	10·11	...	22·7	...	60	77	+17	...	4·51	...	...	W.S.W.	...
23.	17·69	28·10	10·41	...	12·2	...	50	81	+31	...	4·53	...			
0.	17·78	28·21	10·43	...	12·4	...	50	85	+35	...	4·75	...	...	W.	...
1.	17·86	28·57	10·71	...	12·4	...	57	82	+25	...	4·68	...	...	W.	...
2.	18·05	28·65	10·60	...	12·5	...	73	81	+ 8	...	5·19	...	W.N.W.	W.	2·8
3.	18·20	28·75	10·55	...	12·7	...	77	75	− 2	...	4·35	...			
4.	18·35	28·85	10·50	...	12·6	...	80	70	−10	...	4·05	...	...	W.	...
5.	18·50	28·88	10·38	...	12·9	...	80	74	− 6	...	4·36	...			
6.	18·65	28·90	10·25	...	12·6	...	80	78	− 2	...	4·04	...	...	S.W.	...

Second Report on Atmospheric Waves. *By* WILLIAM RADCLIFF BIRT.

THE Report which I have the honour to present to the Association on the present occasion will consist of three portions :—

1st. Of some remarks on the regular monthly altitude of the barometer above 30 inches, as observed at Greenwich by the Astronomer Royal ; the apparent regularity of the flowing of the waves, producing certain of the maxima and their intervals; also the determination of the direction in which they move, from observations at the three stations, Greenwich, Prague, and Munich.

2nd. Of the recurrence of the symmetrical wave observed in November 1842, in November 1843, and October 1844, with the mean wave deduced from combining the three.

3rd. Of an extension of the investigation of the waves A 1 and B 1, forming the subject of the last report. This portion is confirmatory of the views then advanced, and will include evidence of the existence of two larger waves on which those noticed last year were superposed.

Section I.

Rise of the Barometer above 30 *inches.*

In Table IV. of the abstracts of the results of meteorological observations made at the Royal Observatory, Greenwich, 1840 and 1841, Mr. Airy has shown that in every month the barometer rose above 30 inches. The same result is shown in Table V. of the abstracts for 1842. The observations made at the Colonial Observatory at Toronto indicate the same general fact; in every month during 1841 and 1842 the barometer rose above 29·750. The altitudes, when reduced to the level of the sea, agree with those at Greenwich, showing a rise on both sides of the Atlantic above 30 inches in every month. When, however, the dates of the maxima at the two stations are compared, we find in almost all instances considerable difference, that is, the absolute maxima at both stations are generally several days' interval from each other. On turning to the daily records of barometric pressure at both stations, we find maxima occurring at but few days' interval from each other, so that corresponding to the greatest altitude for the month at one, we obtain shortly before or after a maximum at the other. This leads us to a fact of a very interesting nature, and one that is generally borne out by the Greenwich observations, namely, that *twice* in each month the barometer passes a maximum above, or but very slightly depressed below 30 inches, but more usually above.

Upon subjecting the Toronto observations to a closer scrutiny and clearing them from every extraneous influence, so that the pure gaseous pressure may alone be contemplated, the rise to this gauge-point (30 inches, or with the tension of the aqueous vapour deducted 29·900) is much more frequent, and there are but few exceptions to the general fact, that the pressures at the epochs of maxima are confined to small excursions, seldom amounting to ·1 inch above or below the mean—30·030, including those observations that are evidently of an extraordinary character—29·983, excluding them and the lower readings marked (†) in the following Table, which includes all such maxima observed at Toronto during the period of the regular flowing of the waves at Greenwich, hereafter to be noticed. The observations, as recorded in the volume of Toronto observations, have been reduced to the level of the sea; the tension of aqueous vapour has been subtracted in each case, and the gaseous pressures resulting have been corrected for the diurnal and annual oscillations as determined from the two years' observations. During the period embraced by the table at the station Toronto, the gaseous pressure appears to have passed a maximum about or not far removed from the 3rd of each month, and another about the 16th or 17th; intermediate maxima, about the 10th and 27th, have also been observed, but with less regularity. From observations made during so short a period at only one station it would be premature to draw any conclusions. It however appears very desirable that some approximation to the Canadian normal wave should be attempted, by combining the observations in a manner somewhat similar to that which I have adopted with regard to the great November wave (see the second part of this report).

Table I.

Maxima of the Gaseous Atmospheric Pressure observed at Toronto between January 24 and September 15, 1841, corrected for the Annual and Diurnal Oscillations, and reduced to the level of the sea.

Month.	Epoch.	Altitude.	Month.	Epoch.	Altitude.
	d h	in.		d h	in.
January	25 18[a]	29·912	May	18 20	29·900
"	28 8[a]	29·994	"	29 0[a]	29·932
February...	3 22[a]	30·098	June.........	2 20[a]	30·036
"	7 22	30·245*	"	9 0[a]	29·978
"	17 12	29·991	"	16 14[a]	29·999
"	24 0	30·011	"	20 16[a]	29·923
March......	1 22	29·900	July	2 20[a]	30·067
"	4 20[a]	30·345*	"	7 18	29·868†
"	8 18	29·977	"	10 4[a]	29·986
"	9 20[a]	30·019	"	16 22[a]	29·980
"	11 8[a]	30·103*	"	20 4	30·048
"	16 20	30·383*	"	26 0	30·003
"	30 6[a]	30·025	"	27 22	29·988
April	2 18	29·914	August......	1 22[a]	29·950
"	5 22	29·997	"	11 14[a]	29·942
"	15 2	30·410*	"	15 18	29·923
"	22 0	30·245*	"	19 16[a]	29·853†
"	27 18[a]	29·875†	"	23 18	30·156*
May.........	3 6	30·029	September	14 18	30·148*
	6 20	30·011			

Upon carefully collating the Greenwich observations for the same period and reducing all maxima above 29·800 to the level of the sea, we obtain the results recorded in the following Table. The same frequency of rise above the gauge-point (30·000) noticed at Toronto is observable at Greenwich; and to a certain extent there is some agreement in the epochs of the maxima; epochs differing less than 30 hours, both series being reduced to Göttingen mean time, are marked ([a]) in both tables.

Table II.

Barometric Maxima observed at the Royal Observatory, Greenwich, between January 23 and September 20, 1841, reduced to the level of the sea.

Month.	Epoch.	Altitude.	Month.	Epoch.	Altitude.
	d h	in.		d h	in.
January ...	24 22[a]	30·437	June.........	3 22[a]	30·426
"	28 0[a]	·394	"	8 10[a]	·031
"	31 18	·452	"	13 20	·122
February...	3 4[a]	·114	"	15 22[a]	·289
"	10 0	·123	"	21 20[a]	·136
"	21 22	30·452	"	27 14	·179
March......	3 22[a]	29·988	July	2 12[a]	·220
"	10 22[a]	30·572	"	9 12[a]	·019
"	24 0	30·329	"	16 20[a]	·096
"	28 0	29·998	"	24 10	·232
"	30 2[a]	29·998	August	1 20[a]	·014
April	9 22	30·133	"	12 10[a]	·010
"	13 10	·202	"	18 22[a]	·293
"	18 0	·011	"	26 10	·353
"	26 10	·180	September	1 0	·082
"	27 22[a]	·224	"	8 20	·108
"	29 20	·240	"	10 22	·140
May	10 0	·235	"	16 22	·047
"	13 20	·441	"	19 22	30·197
"	23 20	·260			
"	28 22[a]	30·168			

* Maxima more than ·1 inch above 30 in. † Maxima more than ·1 inch below 30 in.

The passages of maxima about or not far removed from the 3rd of each month, appears to have failed at Greenwich for April and May. On turning, however, to the Greenwich records we find maxima within 12 hours of the epochs at Toronto of the following values, when corrected for sea level. April 2, 14 hours, 29·815; May 3, 4 hours, 29·851. It consequently appears that the two series so far agree in the general fact, that about the 3rd of each month for the period included in the tables, the barometer passed maxima on both sides of the Atlantic, the excursions above or below the gauge-point at Greenwich being much greater than those at Toronto.

Upon a still closer comparison of the maxima at both stations, it appears highly probable that, with few exceptions, they are nearly contemporaneous, the excursions at Greenwich being, as just noticed, by far the greatest. It is a matter of regret that at present this most interesting subject cannot be followed out in all its details, and that the announcement cannot extend much beyond the high probability that during nearly eight months of the year 1841 the barometric movements on both sides of the Atlantic (Toronto and Greenwich being at present the extreme stations) were connected, in so far as the observations indicate a tendency to increased pressure at both stations at nearly the same epochs, and that these epochs appear to observe some regularity, exhibiting a periodicity of about 30 days' interval, especially that of maximum pressure, about the 3rd of each month, which is clearly traced at both stations. The greater excursions at Greenwich, the insular station, are perfectly in accordance with facts of a similar character developed in the course of the reduction of meteorological observations (see Sir John Herschel's Report in the volume for 1843).

A comparison of the Table of Barometric Maxima in the Greenwich Abstracts, with a similar table in the 15th volume of the Memoirs of the Royal Academy of Brussels, p. 17, leads to the same result as that obtained from a comparison of the Greenwich and Toronto observations, in so far as the absolute maxima at both stations, Greenwich and Brussels, are not in all cases contemporaneous, or separated only by a short interval. The table alluded to gives only *one* maximum in the month, *the highest reading*. In the Greenwich records we find corresponding maxima to these, with short intervals between the transits at each station. From a consideration of the two series of maxima the following Table has been formed.

Table III.

Exhibiting the symmetrical disposition of Barometric Waves on each side a central Axis, June 3 : 22, 1841.

Month.	Epoch.	Altitude.	Interval.	Wave.
	d h	in.	d h	
March......	10 22	30·572	13 2	6
„	24 0	·329	20 10	5
April	13 10	·202	13 0	4
„	26 10	·180	17 10	3
May	13 20	·441	10 0	2
„	23 20	·260	11 2	1
June	3 22	·426		Axis.
„	15 22	·289	12 0	1
„	27 14	·179	11 16	2
July	9 12	·019	11 22	3
„	24 10	·232	14 22	4
August.....	12 10	·010	19 0	5
„	26 10	30·353	14 0	6

The barometric curve accompanying the Greenwich observations for 1840 and 1841, exhibits a considerable interval between the minima of January and February in the latter year; this interval is 36 days, and may be advantageously compared with a long interval between the maxima of September 19 and October 21, of 31 days 16 hours. This long interval is remarkable for a considerable and *symmetrical* depression of the barometer, nearly midway between the two maxima, namely from October 5, 22 hours 57 minutes to 23 hours 55 minutes; the reading uncorrected for sea level was 28·697. If we consider the point equally distant from the January and February minima to be the summit of a normal wave, we shall have the epoch of its transit January 28 : 18 : now the period from this apex to the depression in October will equal 250 days. The middle point of this period falls on the 2nd of June; on the 3rd of June, 22 hours, the barometer passed a maximum. On each side of this maximum are 6 maxima with a mean interval of 14 days 1 hour. It is interesting to observe, that the minimum of the 16th of February, and that of the 5th of October, are the boundaries of the period of least range; mean range for the seven months 1·029. Upon the hypothesis that the maxima were the crests of waves, it appears that during the period of least range sixteen waves traversed England, having a mean interval between their crests of 14 days 5 hours. The column of intervals clearly exhibits a considerable regularity in the succession of these waves, as well as their symmetrical position relative to the axis, and their altitudes support the same idea. Taking the middle wave June 3 : 22, we find corresponding altitudes on either side; thus the highest wave passed Greenwich on March 10 : 22, altitude 30·572. Six waves on the other side of the axis, we also have the highest reading, namely August 26 : 10, altitude 30·353. The following Table places this regularity both as respects altitudes and intervals in a clearer light.

TABLE IV.

Altitudes of Waves equally distant from the Axis, June 3 : 22.

Wave.	Epoch.			Altitude.	Mean Altitude.	Mean Interval.
		d	h	in.	in.	d h
6th.	March	10	22	30·572	30·462	14 1
	August......	26	10	·353		
5th.	March	24	0	·329	30·169	14 3
	August......	12	10	·010		
4th.	April	13	10	·202	30·217	12 18.
	July	24	10	·232		
3rd.	April	26	10	·180	30·099	12 8
	July	9	12	·019		
2nd.	May	13	20	·441	30·310	11 4
	June.........	27	14	·179		
1st.	May	23	20	·260	30·274	11 13
	June.........	15	22	·289		
Axis.	June.........	3	22	30·426		

On pursuing the investigation beyond the period of least range and extending it into that of the great winter oscillations, the same regularity of perturbation is still apparent; there appears to be a symmetrical movement of the barometer on a large scale, of a somewhat similar character to that of the great November wave. The oscillations on each side the central maximum June 3 : 22 have evidently a symmetrical relation, and are to be distinguished from the monthly maxima before alluded to. It is highly probable that a further examination of the Toronto observations will furnish us with the Canadian type of atmospheric waves, in the same manner as Sir John Herschel found various continental types, and that in some localities (Hanover for instance) the barometric curves were exceedingly anomalous, arising most probably from an interference of different systems of waves. It is also probable that a further examination of the Greenwich observations relative to the monthly maxima will develope the corresponding British type, and that an investigation of the greater symmetrical movements will conduct us to phænomena of a highly interesting character.

Directions of Waves.

The apparent regularity of the flowing of these waves, has induced the hope that by a more detailed examination of the transits of the maxima at distant stations, a tolerable idea may be formed of the direction in which they move, and thus a step may be gained in ascending to their causes. If we take Greenwich, Prague and Munich, as three stations, the *order* of transit will vary, as the direction of the axis of translation of each wave varies. The following appear to be some of the phænomena presented by waves moving in different directions.

I. Waves from W.N.W., or nearly so.—The crests will first pass Greenwich, and at a considerable period after they will pass Munich and Prague; these stations they will pass about the same time; Munich and Prague will therefore have simultaneous maxima.

II. Waves from S.W.—The crests will pass the stations in the following order: Greenwich, Munich, Prague.

III. Waves from S.S.W.—The crests will pass Greenwich and Munich simultaneously, and afterwards Prague.

IV. Waves from S. by W.—The crests pass the stations in the following order: Munich, Greenwich, Prague.

V. Waves from S.—The crests will pass the stations nearly at the same time.

VI. Waves from S.S.E.—The crests pass the stations in the following order: Munich, Prague, Greenwich.

The fact that numerous systems of waves traverse Europe at the same time renders it very difficult to determine the intervals between the transits of two successive maxima of the same system; the only mode appears to be, to arrange *all* the maxima and minima, and to classify and examine those that are moving in the same direction and that transit the stations under the same circumstances.

Table V. exhibits the maxima and minima that passed Munich between the transits of two minima, which apparently marked the passage of the anterior and posterior troughs of a normal wave; the altitudes are converted into English inches and reduced to the level of the sea.

During this period we find three maxima from the S.S.W.; the intervals between them are nearly equal; the first 104 hours, and the second 97 hours. The middle wave is the highest, 30·667; those on each side are nearly of the same altitude 30·304 and 30·275; the central wave is the highest of the series, which opens with a small wave from W.N.W. Table VI. exhibits the features of this wave.

Table V.

Barometric Maxima and Minima observed at Munich during the transit of a supposed normal wave *.

No.	Phase.	Direction.	Epoch.	Munich Time.	Altitude.	Reference.	Wave.
1	Min.	W.N.W.	March.	18 4	30·103	I.	
2	Max.	W.N.W.	,,	18 23	·238	I.	1
3	Min.	W.N.W.	,,	19 4	·171	I.	
4	Max.	S.S.W.	,,	19 14	·304	III.	2
5	Max.	W.N.W.	,,	19 20	·304	I.	3
6	Min.	S.W.	,,	20 15	·238	II.	
7	Max.	S.W.	,,	21 11	·342	II.	4
8	Min.	S.W.	,,	22 4	·218	II.	
9	Max.	S.S.W.	,,	23 22	·667	III.	5
10	Min.	W.N.W.	,,	27 4	·123	I.	
11	Max.	S.S.W.	,,	27 23	·275	III.	6
12	Min.	W.N.W.	,,	30 4	·218	I.	
13	Max.	W.N.W.	,,	30 18	·390	I.	7
14	Min.	S.W.	,,	31 14	·027	II.	
15	Max.	S.W.	April..	1 10	30·095	II.	8
16	Min.	W.N.W.	,,	2 12	29·884	I.	

Table VI.—First Wave from W.N.W.

	Anterior Trough (A).		Crest.		Posterior Trough (P).	
Station.	Epoch of Transit.	Altitude.	Epoch of Transit.	Altitude.	Epoch of Transit.	Altitude.
	d h	Eng. in.	d h	Eng. in.	d h	Eng. in.
Greenwich .	March 17 18	29·501	March 18 14	29·721	March 18 20	29·682
Prague......	,, 18 4	30·009	,, 18 22	30·089	,, 19 1	30·071
Munich	,, 18 4	30·103	,, 18 23	30·238	,, 19 4	30·171

Co-ordinates.

Station.	Altitude from Anterior Trough.	Amplitude in Time.	Diff. Anterior and Posterior Troughs.
	Eng. in.	hours.	P—A. Eng. in.
Greenwich .	·220	26	·181
Munich	·135	24	·068
Prague......	·080	21	·062

It is probable that as the posterior slope of this wave passed off, it was met by the anterior slope of the first S.S.W. wave, so that the true posterior trough was not observed, the minimum being anticipated and the readings being higher than they would otherwise have been. It is also probable that this wave rode on the anterior slope of a normal wave.

The succeeding maxima 4 and 5, from S.S.W. and W.N.W., passed Greenwich and Prague at both stations about the same hour, and Munich within six hours of each other. The posterior troughs of both were obliterated by a well-developed wave from S.W., interval 37 hours, after which the 2nd S.S.W. wave appeared.

* It appears probable that the maxima recorded in Table III. indicated the crests of normal waves. The maxima and minima in this Table are those resulting from secondary waves.

TABLE VII.—Wave from S.W.

Anterior Trough (A).				Crest.			Posterior Trough (P).		
Station.	Epoch of Transit.		Altitude.	Epoch of Transit.		Altitude.	Epoch of Transit.		Altitude.
		d h	Eng. in.		d h	Eng. in.		d h	Eng. in.
Greenwich .	March	20 0	29·672	March	20 22*	29·718	March	21 20	29·420
Munich	,,	20 15	30·238	,,	21 11	30·342	,,	22 4	30·218
Prague	,,	21 2	30·038	,,	21 18	30·112	,,	22 16	29·988

Co-ordinates.

Station.	Altitude from Posterior Trough.	Amplitude in Time.	Diff. Anterior and Posterior Troughs.
	Eng. in.	hours.	A—P. Eng. in.
Greenwich .	·298	44	·252
Munich	·124	37	·020
Prague	·124	38	·050

The next and fifth wave that transited the area was from the S.S.W.; the anterior trough was obliterated, as before noticed; shortly before the crest of the succeeding wave of this system passed; the W.N.W. system again made its appearance; the anterior trough of the third observed wave passed Munich March 27 : 4. The following Table exhibits its features: it is altogether a much larger wave than the first.

TABLE VIII.—Third observed Wave from W.N.W.

Anterior Trough (A).				Crest.			Posterior Trough (P).		
Station.	Epoch of Transit.		Altitude.	Epoch of Transit.		Altitude.	Epoch of Transit.		Altitude.
		d h	Eng. in.		d h	Eng. in.		d h	Eng. in.
Greenwich .	March	26 4	29·631	March	30 2	29·998	April..	1 16	29·596
Munich	,,	27 4	30·123	,,	30 18	30·390	,,	2 12	29·884
Prague	,,	27 6	29·947	,,	30 20	30·071	,,	2 10	29·674

Co-ordinates.

Station.	Altitude from Posterior Trough.	Amplitude in Time.	Diff. Anterior and Posterior Troughs.
	Eng. inch.	hours.	A—P. Eng. inch.
Greenwich .	·402	156	·035
Munich	·506	152	·239
Prague	·397	148	·273

The minimum from W.N.W., March 30:4, appears to have been of a secondary character, that is, it was not a true trough, but was most probably produced by the apex of the third S.S.W. wave which transited during the passage of the anterior slope of the wave. During the transit of the posterior slope, the anterior slope of a small wave from S.W. passed.

The 10th of March was characterized by exhibiting the highest barometrical reading during the year. The two highest readings of the month occurred

* A maximum occurred March 20 : 2, two hours after the transit of the anterior trough, altitude 29·699. The very short interval between the anterior trough and this maximum most probably arose from the depressing influence of the posterior slope of the S.S.W. wave, which passed Greenwich March 19 : 14. The semi-interval of the S.S.W. wave would occasion its minimum to pass Greenwich March 21 : 16, four hours earlier than the posterior trough of this, so that it is highly probable that the great depression then observed resulted from both troughs.

on the 10th and 24th, with an interval of fourteen days; the semi-interval would give the included minimum on the 17th. Upon the assumption that the crest of the normal wave passed the stations on the 24th, the preceding crest having passed on the 10th, we have the normal trough passing on the 17th: the numbers in Table V. appear to indicate a gradual rise and fall preceding and succeeding the highest reading of the 24th, such as might be expected from the transit of a large wave, the anterior and posterior slopes being indented and masked by the transits of smaller waves flowing in various directions. The numbers and directions in the table convey the idea of a certain regularity in the flowing of these secondary and superposed waves. During the transit of the normal wave three systems of waves appear to have traversed the area included by the stations, from W.N.W., S.W. and S.S.W. The crests of the latter system (3 waves) were only observed, but the intervals being so nearly equal, induces the opinion that they succeeded each other with great regularity, and were accompanied with troughs, although those troughs were masked and concealed by the other systems. It is also probable that the altitudes of these waves were nearly equal, the apex of the central wave being elevated by that of the normal. The W.N.W. system appears to have been a system the waves of which were increasing in size; the altitudes do not appear to have been sufficiently high to have occasioned them to ride above the upper portion of the normal wave. The waves of the S.W. system were rather larger than the earliest W.N.W. wave.

If we consider the low readings of the 18th to mark the anterior trough of the normal wave and the maximum of the 24th to indicate its crest, we have the following elements and co-ordinates.

Table IX.—Normal Wave.

Anterior Trough.			Crest.		Co-ordinates.	
Station.	(Supposed) Epoch of Transit.	Altitude.	(Supposed) Epoch of Transit.	Altitude.	Altitude.	Semi-interval.
	d h	Eng. in.	d h	Eng. in.	Eng. in.	hours.
Greenwich	March 17 18	29·501	March 24 0	30·329	·828	150
Munich	„ 18 4	30·103	„ 23 22	30·667	·564	138
Prague	„ 18 4	30·009	„ 25 8	30·400	·391	172

The close of Table V. gives the lowest reading for the period included by it, and did not the barometer continue to fall, we might consider this point as the posterior trough of the normal wave. The following are the altitudes of the wave from this point, with the semi-intervals.

Station.	Altitude.	Semi-interval.
	Eng. in.	hours.
Greenwich	·733	208
Munich	·783	230
Prague	·726	194

It is clear that the above elements of the normal wave, as well as those of the superposed or secondary waves, are greatly modified, the first by the secondary waves, and these again by the normal wave, and by each other. There is great reason to believe that the troughs of the S.S.W. waves were concealed. It will be shown in another part of this report, that by comparing observations at *two* stations and examining their barometric differences, the passage of a crest or trough may be rendered apparent, which by this mode of investigation remains concealed. Nevertheless it is highly probable that, by discussing a long series of observations in this manner, a tolerable idea of the succession and systems of waves may be formed, and the general features of the normal waves made out. The one under consideration appears to have had an interval of fifteen days. The great symmetrical wave of Nov. 1842 had nearly the same interval, and succeeding waves, possessing a similarity of character both in interval and curve, were observed about the same period of the year in 1843 and 1844. The examination of these recurring atmospheric movements forms the subject of the next portion of the report.

Section II.

Recurrence of Symmetrical Wave.

The diagram which accompanies this report (see Plate III.) exhibits three curves to a great extent similar, at least in so far as there is a general tendency in the barometer to rise during the period of the anterior half, and a similar tendency in it to fall during the period of the posterior half. From what has just been advanced, as well as from the discussions which were reported last year, there is great reason to consider the indentations on the anterior and posterior slopes of the curve of 1842 as distinct secondary and superposed waves; the same may be said of the indentations on the curves of 1843 and 1844. Now it is probable that were we to separate the barometric effects of these waves, we should obtain a much clearer conception of the form and general elements of the normal wave which on the three occasions recorded passed London. For this purpose the following steps have been taken. The general contour of the curves indicates that the respective maxima passed about the following dates.

1842.	November	18,	noon.
1843.	„	14,	„
1844.	October	27,	„

These days (noon) are therefore assumed as the axes of the curves, and the altitudes at intervals of two hours have been carefully read off from the original projections, and a mean of the three taken, from which the following Table has been constructed. The table is arranged in two compartments, the first containing the ordinates of the anterior slope, the second those of the posterior. The first column in the first compartment indicates the hours *before* the transit of the crest (—); the second the mean ordinate corresponding to any given hour. In like manner, the first column in the second compartment indicates the hours *after* the transit of the crest (+), and the second the mean ordinate corresponding to any given hour after transit. These numbers have been used in the construction of the fourth curve, which exhibits to the eye the general form of the normal wave, freed to a certain extent of the effects of the superposed waves.

There are several drawbacks to the value of any conclusions that may be drawn from these numbers and projections in their present state:—

1st. They are deduced from unreduced observations. The projections of the three upper curves are laid down from observations as read off from the scale without any reduction whatever, and the mean curve has been obtained from these unreduced observations.

2nd. The observations themselves were made at irregular intervals, so that in deducing the mean, the quantities observed have not been used. The altitudes at the given hours of the curves drawn through the points indicating these observed quantities, are the quantities from which the mean has been obtained.

3rd. The curves, and consequently the mean, consists of two distinct elements, namely, the pressure of the gaseous atmosphere and the pressure of the aqueous vapour. The normal wave of the gaseous atmosphere is therefore greatly modified by the pressure of the aqueous vapour in these projections.

Table X.

Ordinates of the Mean Normal Curve, deduced from the recurring Curves of 1842, 1843, 1844, November.

Hours before Transit.	Altitudes.	Hours after Transit.	Altitudes.	Hours before Transit.	Altitudes.	Hours after Transit.	Altitudes.
hours.	in.	hours.	in.	hours.	in.	hours.	in.
Apex	30·321	Apex	30·321	76 —	29·775	76 +	29·789
2 —	·330	2 +	·302	78 —	·766	78 +	·788
4 —	·331	4 +	·301	80 —	·758	80 +	·771
6 —	·327	6 +	·298	82 —	·758	82 +	·755
8 —	·323	8 +	·295	84 —	·761	84 +	·733
10 —	·321	10 +	·302	86 —	·763	86 +	·717
12 —	·314	12 +	·300	88 —	·760	88 +	·696
14 —	·299	14 +	·296	90 —	·748	90 +	·667
16 —	·274	16 +	·278	92 —	·747	92 +	·630
18 —	·229	18 +	·261	94 —	·735	94 +	·590
20 —	·204	20 +	·236	96 —	·730	96 +	·555
22 —	·169	22 +	·204	98 —	·722	98 +	·543
24 —	·152	24 +	·169	100 —	·712	100 +	·546
26 —	·132	26 +	·130	102 —	·689	102 +	·555
28 —	·106	28 +	·091	104 —	·682	104 +	·562
30 —	·081	30 +	·061	106 —	·687	106 +	·558
32 —	·057	32 +	30·031	108 —	·687	108 +	·565
34 —	·026	34 +	29·986	110 —	·681	110 +	·571
36 —	30·006	36 +	·968	112 —	·675	112 +	·576
38 —	29·991	38 +	·941	114 —	·664	114 +	·583
40 —	·967	40 +	·933	116 —	·669	116 +	·590
42 —	·941	42 +	·934	118 —	·685	118 +	·589
44 —	·919	44 +	·943	120 —	·728	120 +	·578
46 —	·909	46 +	·956	122 —	·744	122 +	·552
48 —	·908	48 +	·950	124 —	·741	124 +	·538
50 —	·900	50 +	·932	126 —	·734	126 +	·498
52 —	·892	52 +	·932	128 —	·722	128 +	·459
54 —	·883	54 +	·924	130 —	·711	130 +	·405
56 —	·866	56 +	·914	132 —	·688	132 +	·332
58 —	·853	58 +	·895	134 —	·659	134 +	
60 —	·843	66 +	·883	136 —	·625	136 +	
62 —	·835	20 +	·871	138 —	·588	138 +	
64 —	·821	64 +	·870	140 —	·532	140 +	·179
66 —	·811	66 +	·862	142 —	·482	142 +	·214
68 —	·809	68 +	·845	144 —	·455	144 +	·240
70 —	·791	70 +	·841	146 —	·428	146 +	·255
72 —	·794	72 +	·829	148 —	29·411	148 +	29·282
74 —	29·791	74 +	29·803				

4th. The curves are projected for one station only. It is not only probable, but in the case of the curve for 1842 it has been ascertained, that even for comparative short distances N.E. and S.W. of the line joining Dublin and Munich, the symmetry is considerably departed from, as will be shown in the further examination of that curve; it is therefore important, as well as deducing the mean normal curve from a combination of the three curves at one station, to examine the character of the superposed waves at several stations previous to drawing any conclusions relative to the normal wave.

5th. The projections are affected by the diurnal and annual variations of gaseous and aqueous pressure, the causes of which are known.

We have however the means of obtaining at four important stations, the elements of this normal wave freed from all extraneous circumstances. At Munich we possess barometric records every hour for the three years; these are reduced to the freezing temperature and accompanied with observations from which the tension of the vapour may be obtained. It will be necessary for the three periods embraced in the diagram to express the barometric altitudes in English inches, and reduce them to the level of the sea. When so reduced the vapour pressure must be deducted, leaving the gaseous pressure only, and this must be further corrected for the diurnal and annual variations of the gaseous pressure; we shall thus obtain three curves representing the variations of gaseous pressure, the causes of which we are seeking, and the mean of these three curves will to a certain extent be freed from those indentations which appear to result from the passage of secondary waves.

The same process must be adopted with respect to the observations at Prague, Brussels and Greenwich; when this is accomplished we shall obtain four normal curves, the comparison of which will be highly instructive and important.

The curve of 1842 is tinted for the purpose of indicating the prevalent wind during the period occupied by one coloured portion. There does not appear much apparent relation between the colours and the flexures of the curve. Two points, however, claim our especial attention,—the change in the direction of the wind to nearly the opposite point, on the transit of the crest,—and the calms intervening between that and other changes nearly of a similar character. N.E. winds are coloured blue, S.W. pink, and S.E. green. The direction has been obtained from the Greenwich observations.

Sir John Herschel has shown in his 'Report on the Reduction of Meteorological Observations' (Report, 1843, p. 99), that there must be a close and purely dynamical connexion between the advancing form of the wave and the molecular movement of the air; the character of the molecular movement will greatly depend on the *order* of the wave. In the absence of data for determining the precise characters of the waves under consideration, it may not be uninteresting to offer a few remarks on the two points to which our attention has been directed:—1st. The calm preceding the reversion of wind on the transit of the crest, Nov. 18th, 1842. A very casual comparison of the direction of the wind at several stations marked on the area, shown in Plate XLII. (Report, 1844), indicates that the molecular movement was directed towards the point of least pressure, a result to be expected, and perfectly in accordance with the beautiful deductions of Col. Sabine (see his Report on the Meteorology of Toronto, Report, 1844). Now in the case of a large wave stretching over an extensive area, the anterior and posterior troughs would mark out parallel or nearly parallel lines of least pressure; the molecular movement would be strongest in these troughs, and directed towards them from each side; at stations removed from them the force of the wind would be greatly diminished, and at the intervening crest it would be so small as to be inappreciable; but however small it might be, upon the crest passing any station, the direction of the wind at that station would be reversed, and it would increase in intensity until the transit of the posterior trough. In this manner it is apprehended that the reversion of the wind, and the calm preceding it, Nov. 18th, 1842, are explained. The Greenwich observations offer a fine illustration of the increase of intensity. November 19th, 6 and 8 hours, the anemometer recorded a pressure of 2 to 4lbs. to the square foot 30 hours after transit. 2nd. The remaining calms in the diagram may be explained in the same way, but the synchronous traversing of different systems of waves masks the effects and prevents the relations between the wind and the advancing wave-form becoming so perceptible, as in the first instance, namely the transit of the crest of the normal wave.

Section III.

Investigation of secondary Waves A 1, A 2, B 1 (*reported last year*).

In my letter to Sir John Herschel published in the last Report, I stated that the coloured projections indicated *three* things as connected with the disposition of the atmosphere:—"1st, the depth or extent of colour will show the depression of the lower station below the upper; 2nd, the intersections of the curves will indicate that at the time of intersection the stations had an equality of pressure; and 3rd, the change of the position of the same colour will point out that the station which exhibited or experienced the higher or lower pressure, afterwards experienced the lower or higher, with its amount." In addition to these three indications, the coloured projections and the barometric differences they exhibit may be very extensively and advantageously used in this investigation, as at the time when any one intersection of the curves shows an equality of pressure at the respective stations, the intersection also indicates that either a *crest* or *trough* was passing between them. Now if, from other considerations, it is found that at any intersection a trough is passing, the next intersection will exhibit the passage of the crest; the differences therefore between the curves, or in other words, the differences of pressure between the stations, will augment and decrease as the *anterior* slope passes, the greatest differences occurring as the middle of the slope transits. The same result will obtain as the *posterior* slope passes, but the *affections* of pressure will be altered; the station which exhibited the *greatest* pressure under the anterior slope will manifest the *least* under the posterior. This principle will indicate the passage of a wave independently of the state (*i. e.* rising or falling) of the barometer at the time. The mercury may be falling from the transit of the posterior slope of a wave passing in a certain direction, and this may occur at both stations; yet, although both curves may be descending from a posterior slope in one direction, the *opening* between them may indicate the transit of an anterior slope in another.

Wave B°.

The last report brought the investigation as far as the determination of the waves A 1 and B 1 (Report, 1844, p. 273). The dimensions and velocity of the latter were given; also the character of the trough between A 1 and A 2. In the note to (24.), page 274, it is shown that these waves, especially B 1, were small waves superposed on much larger ones. The principle just alluded to enables us to determine the phases of the larger wave on which B 1 rolled, not however uninfluenced by the transits of others, but sufficiently well-marked to contemplate it in its individuality as it passed over the area from the S.S.W. This wave we shall call B°.

Wave B°. Between Scilly and Longstone.

	Anterior Trough.	Crest.	Posterior Trough.
1842.	Between	h h	h m
	Nov. 6 : 15.	Nov. 9 : 18 and 19.	Nov. 11 : 0 : 30.
	„ 6 : 21.		

Amplitude in time . . . . . 102 hours (about).
„ space . . . . . 2600 miles „
Velocity, about 25 miles per hour.

N.B. The above determinations subject to correction in examining this wave at other stations.

TABLE XI. Wave B°.

Barometric Differences arising from the Anterior and Posterior Slopes of B°.

Epochs.	Longstone.	Scilly.	Scilly ±.	Phases.
1842.				
d h	in.	in.	in.	
Nov. 6 15	30·316	30·276	− ·040	Anterior trough.
21	·306	M ·324	+ ·018	
7 3	·266	·283	+ ·017	
9	·215	·270	+ ·055	
15	30·054	m ·241	+ ·187	Anterior slope.
21	29·983	M ·273	+ ·290	
8 3	·889	·170	+ ·281	
9	·747	30·066	+ ·319	
15	·470	29·849	+ ·379	
21	·296	·702	+ ·406	Greatest curve of anterior slope.
9 3	m ·225	m ·594	+ ·369	
9	·324	M ·645	+ ·321	
15	·426	·553	+ ·127	Crest.
21	·570	·491	− ·079	Posterior slope.
10 3	M ·590	·286	− ·304	
9	·511	·162	− ·349	Greatest curve of posterior slope.
15	·286	·081	− ·205	
21	29·164	m ·061	− ·103	
11 3	28·990	29·081	+ ·091	Posterior trough.

This Table exhibits the barometric differences arising from the passage of that section of B° which passed the extreme stations of the line given on page 277, Report, 1844. In order to investigate the entire transit of this wave, it will be requisite to commence the examination of the distribution of pressure over the area at least two days earlier than the epoch chosen last year, namely, Nov. 6:15 instead of Nov. 8:15; and this is the more desirable, as during eight days previous to this epoch (Nov. 6 : 15) the barometer had maintained an altitude (with only one exception) above 30 inches. See Plate I. illustrating Sir John Herschel's 'Report on Meteorological Reductions' (Report, 1843). The table shows a very considerable *fall* during the transit of the *anterior* slope of B°. Now should there be no counteracting influence in operation, or in other words, should only *one* wave be passing, the barometer must *rise* during the transit of *its* anterior slope. We are therefore prepared, in accordance with the views advanced relative to the intersection of curves, to find another large wave moving in a different direction; and a comparison of the reduced altitudes at Glasgow, Bardsey, South Bishop, Birmingham, Greenwich and St. Catherine's Point, indicates that such a wave traversed the area, its crest passing the line joining Scilly and Bardsey Nov. 7:21, and its trough Nov. 9:3: this trough has already been noticed. The details of this wave will be presented to the Association on a future occasion. By commencing the examination at this earlier period, we shall include the *whole* of the barometric movements immediately succeeding the state of comparative repose during the eight days already alluded to: the first great disturbance is evidently of a *negative* character, producing a great depression of the barometer, this was followed by those undulations which gave rise to the symmetrical wave exhibited in the diagram, and shown in Plate II. (Report, 1843). Another advantage resulting from the earlier commencement of the investigation, is that the complete transit of the wave producing the bulge noticed in the last report, (3.) (4.) (5.), page 271, is traced completely across the area.

The principal phases of B° are given at the foot of p. 124.

Wave A 1.

A careful comparison of the reduced altitudes at Glasgow, Bardsey, Birmingham, South Bishop, and St. Catherine's Point, from November 6 : 21 to 7 : 21, leads to the very interesting fact that the anterior slope of this wave extended in the direction from Glasgow to St. Catherine's Point. In the Report of last year we have this statement, "that a line cutting the crest of wave A 1 transversely appears to have passed through Geneva and Brussels."—Report, 1844, p. 270 (2.). Now the line joining Glasgow and St Catherine's Point is nearly parallel with that joining Geneva and Brussels, and a line cutting the crest of wave A 1 transversely appears to have passed through Glasgow and St. Catherine's Point at 6 : 21. There can be but little doubt that from results so nearly similar at pairs of stations a considerable distance from each other and at epochs separated by an interval of 48 hours, we have identified a distinct and well-developed wave. It will be the object of future research to trace this wave entirely across the area.

Wave A°.

The large wave alluded to in the remarks on B° is designated A°. Table XII. exhibits the barometric differences or variations at the stations on the line Scilly to Longstone; at November 7 : 21, the stations Bardsey, South Bishop and Scilly, experienced a rise indicating the transit of the crest; the greatest curvature occurred on this line at 8 : 15, and the posterior trough at 9 : 3. By combining these epochs we have the principal phases of the posterior slope of this wave; all these phases occur on the same line, clearly indicating that they are connected, and result entirely from a distinct and different cause to that which produced the bulge or posterior slope of A 1.

TABLE XII. Wave A°.

Barometric Differences every six hours, exhibiting the Phases of A°.

Epochs.	Longstone.	Bardsey.	Sth.Bishop.	Scilly.	Phases.
6 21	− ·010	− ·011	− ·010	+ ·048	
7 3	− ·040	− ·031	− ·010	− ·041	
9	− ·051	− ·020	− ·000	− ·013	
15	− ·161	− ·031	− ·000	− ·029	
21	− ·071	+ ·041	+ ·020	+ ·032	Apex.
8 3	− ·094	− ·311	− ·216	− ·103	
9	− ·142	− ·152	− ·165	− ·104	
15	− ·277	− ·206	− ·126	− ·217	Greatest curvature.
21	− ·174	− ·169	− ·299	− ·147	
9 3	− ·071	− ·073	− ·083	− ·108	Posterior trough.

During the whole of this period B° exerted its elevating tendency.

The projections of the synchronous curves for Munich, Prague, Geneva, Brussels, Paris, Haisboro, Greenwich, St. Catherine's Point, Birmingham, Bardsey, South Bishop, and Dublin, November 8 : 15 to 9 : 3, exhibit four distinct areas of elevation, so that there are only certain curves of the group that intersect from the passage of B°; the remaining differences most probably arise to a great extent from the transit of A°.

The crest of A° passed Scilly to Bardsey, November 7 : 21
The trough passed Scilly to Bardsey, ...November 9 : 3

diff. 30 hours

Half breadth of wave in time .... 30 hours
Altitude of crest at South Bishop .... 30·317
Altitude of trough at South Bishop.................. 29·428

·889 diff.

Altitude of wave from posterior trough .... ·889 inch.

November 9 : 3 we have the following altitudes reduced to the level of the sea :—

November 9 : 3, Munich .... 30·256
November 9 : 3, Bardsey .. .. 29·385
·871 diff.

The close approximation of these differences appears to indicate that the slope from Munich to Bardsey was due to, and a representation of, the form of the posterior slope of A°, and that at this epoch the crest of the wave was situated near Munich ; if so, we have for the first approximate amplitude and progress of this wave the following numbers :—

Amplitude...... 1856 miles
Progress......... 31 miles per hour

Wave A 2.

TABLE XIII.

Barometric Differences arising from the Anterior and Posterior Slopes of A 2.

Epochs.	Dublin.	Bardsey.	Dublin. ±	Phases.
8 21	m29·391	29·458	− ·067	Anterior trough.
9 3	·395	m ·385	+ ·010	
9	·530	·468	+ ·062	9 3 } Anterior slope.
15	M ·576	M ·537	+ ·039	9 21 } Anterior slope.
21	·555	·506	+ ·049	Crest.
10 3	·323	·342	− ·019	10 3 } Posterior slope.
9	·189	·208	− ·019	10 9 } Posterior slope.
15	·021	28·979	+ ·042	Posterior trough.

9 : 15 M Dublin. M Bardsey. Crest of B°.

This Table exhibits the barometric differences at Dublin and Bardsey arising from the transit of wave A 2 ; it is an instance in which the transit of a crest is rendered apparent from the relative changes of pressure at the stations, although the barometer is falling at both from the passage of the posterior slope of B°. The following are the elements of the wave :—

Wave A 2. Between Bardsey and Dublin.

Anterior Trough.	Crest.	Posterior Trough.
1842. November 9 : 2	November 10 : 2	November 10 : 14

Amplitude in time, 36 hours.

Elements of Waves.

In the following Table the elements of the waves hitherto detected are brought together in one view. It is necessary to mention, that, from the nature of the inquiry and the present state of the investigation, these numbers are subject to correction.

TABLE XIV. Elements of Waves, Nov. 6 to 12, 1842.

Wave.	Direction.	Epoch of Anterior Trough.	Epoch of Crest.	Epoch of Posterior Trough.	Amplitude. Time.	Amplitude. Miles.	Velocity. Milesper hour.
		d h	d h m	d h m	h		
B°	Scilly to Longstone.	Nov. { 6 15 / 6 21 }	9 18 0	11 0 30	102	2600	25
B¹	Scilly to Longstone.	" 9 3	9 9 0	....	......	341	25
A°	South Bishop to St. Catherine's Point.	....	7 21 0	9 3 0	60	1856	31
A¹	{ Glasgow to St. Catherine's Pt. / Brussels to Geneva. }	....	....	....	......	....	
A²	Dublin to Bardsey	" 9 2	10 2 0	10 14 0	36	....	

It appears highly probable that the direction of wave A^2 was similar to that of wave A^1 which it succeeded. The direction of wave A^1 is well-determined.

TABLE XV. Exhibiting the Order of Succession of the Crests.

1842.	
Nov. 6 : 21	Crest of A^1 about entering on the area at Glasgow.
„ 7 : 21	„ A^0 entered on the area at Bardsey, South Bishop, Scilly.
„ 9 : 9	„ B^1 entering on the area at Scilly.
„ 9 : 15	„ B^0 extending from Dublin to Geneva.
„ 10 : 2	„ A^2 entered on the area between Dublin and Bardsey.

Should A^2 be found to be the succeeding wave to A^1, the above Table indicates an interval of 3 days 5 hours (about) between these two *successive* crests. The altitudes are very different in consequence of the large posterior slope of A^0.

At the commencement of this investigation, it was stated that the only efficient test that can be brought to bear on the theory that the non-periodic oscillations of the barometer are due to waves, appears to be the comparison of barometric observations reduced to the level of the sea. This view appears to be supported as far as the investigation has yet proceeded. It is characteristic of waves that different systems pass onward without destroying each other; each wave of each system pursues its own path, although crossed by others; and it can be followed in all its individuality. In the course of this inquiry three systems of waves have been detected, or at least three barometric maxima; these maxima have been found to move across the area in three different directions, having on each side a diminution of pressure. The progress of each of these maxima appears to have been quite independent of the others: thus at the opening of the observations, the line of greatest diminution of pressure on the English area was from Glasgow to St. Catherine's Point; at a later period the observations indicated the direction of maxima at right angles to this line, and that a line cutting this transversely passed through Geneva and Brussels; it is in this latter direction that the wave was considered to have been moving. The barometric phænomena in this direction progressed very slowly. While these movements were proceeding over the area, the barometric differences between Scilly and Longstone increased; and the latter station exhibited a much less pressure than the former; at length a decided line of maximum pressure is traced from Dublin to Geneva, after which the barometric affections at the stations are reversed, Scilly being the lowest and Longstone the highest. We have therefore a cause simultaneously operating on the barometer with that which produced the movements from Glasgow to St. Catherine's Point, and from Brussels to Geneva, but evidently distinct, as the phænomena progressed in a different direction, namely from Scilly to Longstone. During the period that these two distinct but contemporaneous causes are in operation, producing certain barometric phænomena in certain directions, and from the last of which we should expect at certain stations, Scilly and Longstone, for instance, a *rising* barometer, we actually find it *falling* rapidly, but not without exhibiting the same phænomena that we apprehend characterizes this fall as resulting from a wave. A decided line of maxima is observed; and in the same line, at a subsequent period, we find a line of minima; we can therefore, as previously remarked, trace each of these distinct sets of barometric phænomena in their own peculiar directions. It is however the reduction of the observations to the level of the sea that alone enables us to do this. The rise and fall at any one station, as exhibited by the curves (times being used as abscissæ), give us the combined effects of the three systems, and unless they are carefully separated, as we have endeavoured to do in the preceding investigation, and which can only be done by taking the distance of the stations into account, we are perplexed with the apparent irregularity and capriciousness of the atmospheric changes.

We have already alluded to the molecular movement of the aërial particles or the wind as connected with these waves, and an opinion has been expressed that it is probable that generally the wind will be found directed towards the troughs. It has also been remarked that the great disturbance of the atmosphere, after the period of comparative repose previous to the 6th of November, was of a *negative* character, producing a great depression of the mercurial column. Now the result of any great increase of temperature at any station would be a diminution of the pressure of the gaseous atmosphere (see Col. Sabine's Report on the Meteorology of Toronto, Report, 1844). A current, or rather currents of air, would be produced in consequence; the barometer would fall, and the wind would be directed towards the line of least pressure (*minima*). This diminution of pressure would not however be confined to the locality in which the disturbance was produced, or even to those lines towards which the wind was directed, or the aërial current moved, it would gradually recede from the point of disturbance, giving rise to a wind in its progress still directed towards the line of least pressure; the phænomena presented would be a rapidly falling barometer with an increasing force in the wind. This receding movement must be in the nature of a wave; indeed it is difficult to conceive of a disturbance of the aërial ocean being immediately confined to the locality in which it originated.

Mr. Scott Russell has determined that a wave of the first order does not diffuse itself equally in all directions around the place of disturbance, but that there is in one direction *an axis* along which it maintains the greatest height, has the widest range of translation, and travels with the greatest velocity. Sufficient progress has not yet been made in this investigation, nor is the area included by the extreme stations of observation extensive enough to enable us to form any idea of the real character of these waves; much light however will be thrown on them by a careful comparison of the wind at each observation; and it appears essential to bear in mind the distinction of Mr. Russell between waves of the first and second order, as any tests that may be applied having reference only to the characteristics of waves of the second order must necessarily fail, should these, especially the larger waves, be found analogous to waves of the first order.

Postscript, Nov. 27, 1845.—Section II. of the preceding Report treats of the recurrence of certain symmetrical atmospheric movements in or near the month of November. These symmetrical oscillations were observed in 1842, 1843 and 1844, and great hopes were entertained that during the present autumn they would again be observed. These hopes have been fully realized, the symmetrical wave has returned and has exhibited all its essential features. The barometric curve on the present occasion more nearly resembles that of 1842 than those of the years 1843 and 1844; the large oscillation forming the crest is very distinctly marked. The apex passed London about noon of the 14th. Observations have been made at nearly thirty stations in the united kingdom.

Sketch of the progress and present extent of Savings' Banks in the United Kingdom. By G. R. Porter, *F.R.S.*

Among the "signs of the times" which it is most satisfactory to contemplate, because it affords at once evidence of social progress, and furnishes the best assurance for its continuance, must be placed the fact, that among the classes of our countrymen who are in circumstances of ease and comfort there has of late arisen a great and growing concern for the well-being of the less favoured and more numerous class—those whose daily subsistence must be acquired by their daily toil. Influences to this end have long been quietly but steadily at work, set in motion by individuals, few in number and, for the most part, of small account in the eyes of the world, who were at first sustained only by the consciousness of duty performed, and who long remained uncheered by any evidences of success; those influences are now, however, openly and even ostentatiously employed, they have found their way into every circle, and have even received the homage of the senate. It has become fashionable to express the desire of promoting the general welfare of the working classes, and even to make some exertion to secure it, and we can hardly conceive that this stage of the question could have been reached, unless through the sense of its importance having taken a firm hold of the public mind, enlisting among its promoters men who, by means of their station and intellectual endowments, must command the attention of society.

The present is not an occasion on which it would be proper to enlarge upon the moral obligation to which allusion has now been made, but it is clearly within the province of statistical inquiry to ascertain, as correctly as possible, the actual condition of those whom we would seek to benefit. Without such inquiries we must always be, as it were, groping in the dark, and liable to make a profitless use of our energies, if even they should not be hurtfully employed.

Various efforts, which have been attended with more or less of success, have been made of late years by our statistical societies, and by means of government commissioners, to place before the world true pictures of the social condition of great masses of our fellow-countrymen, who form what, by a somewhat arbitrary distinction, are called the working classes; and from a variety of journals and parliamentary reports much is to be learned concerning their means of living, as well as the manner in which such means are employed. Our hours of leisure could hardly find better employment than in studying the different volumes in which this subject is authoritatively treated, in weighing the recommendations which they offer, and in helping to carry into execution those among them which appear to call for adoption, and which it may be in our power to forward. The volumes in question are within the reach of every one, and it would be productive of but little good to call away attention from them, by offering an analysis, or pretended analysis, of their contents. There is, however, one subject, intimately connected with the matters of which they treat, and which at the same time has become a thing of national importance, inquiry into which may throw light upon every branch of the subject, and which has not been made the matter of any recent investigation—the progress of savings' banks,—in describing which I would now venture to solicit a few minutes of attention on the part of the Section.

Savings' banks, it is well known, are to be placed among the inventions of the present century. They are of English origin, although, happily, they are not now confined to these kingdoms. We owe their institution to a well-known benevolent lady, Mrs. Priscilla Wakefield, who in 1804 induced six gentlemen, residing at Tottenham, near London, to receive deposits from labourers and servants, and to be responsible for their safety and return when needed to the depositors, with 5 per cent. interest thereon, provided the sum were not less than 20*s.*, and had remained for a year at least in their hands. Deposits of not less than 1*s.* were received. Four years later (1808) eight individuals, of whom four were ladies, took upon themselves the like responsibility at Bath, engaging to pay 4 per cent. interest upon all deposits up to 50*l.*, but limiting to 2000*l.* the whole sum to be deposited. In the same year, the late Mr. Whitbread tried, without success, to procure legislative sanction for a plan, whereby the small savings of the industrious labourer and artisan would be placed under the safeguard of public commissioners.

The first savings' bank, regularly and minutely organized, was "The Parish Bank Friendly Society of Ruthwell" in Dumfries-shire, established through the exertions of Mr. Henry Duncan in 1810, and it was mainly owing to its success, as set forth in the published reports of that gentleman, that many other institutions were formed upon the model of that at Ruthwell, so that before any legislative provision had been made for their encouragement there existed 70 savings' banks in England, 4 in Wales, and 4 in Ireland.

In July 1817 two acts received the royal assent for encouraging the establishment of banks for savings in England and Wales, and in Ireland. It was not until 1835 that these institutions were placed under legislative regulation in Scotland, a circumstance which in all probability is to be ascribed to the facilities given by bankers in that part of the kingdom for the profitable deposit with them of small sums. Under the acts of 1817, the sums deposited were placed by the trustees of each bank in the hands of the Commissioners for the reduction of the National Debt, who thereupon issued debentures for the amount bearing interest at the rate of 3*d.* per centum per diem, or 4*l.* 11*s.* 3*d.* per cent. per annum. It was customary for the trustees to allow 4 per cent. only to the depositors, retaining the balance of the interest received from government to defray the necessary charges of the establishment for office-rent, clerks, &c.

The progress of these savings' banks, after receiving the sanction of the legislature, has become a matter of national importance, not only as affording means for judging concerning the actual and comparative condition, from time to time, of those classes of persons who make deposits, but also as incentives to prudence, and in some degree, too, as security for good citizenship, among a very numerous body, now numbering more than a million of our fellow-subjects, who are thus made to feel that they too have an interest in the stability of government, and something to lose from acts of violence. By this means some slight degree of sympathy in feeling and interest has been created between classes as to whom that link was previously wanting, so that the untaught or ill-taught labourer or artisan who has a small, but to him important, capital arising from his savings and deposited in the savings' bank, can no longer look with the same feelings of estrangement as formerly upon those whose savings, or those of their prudent ancestors, may have exceeded his own.

During the five months that followed the passing of the acts of 1817, viz. to January 5, 1818, the savings deposited with the Commissioners for the reduction of the National Debt amounted to 328,282*l.* In each of the following thirteen years, to January 5, 1831, the sums so deposited were—

Year ending 5th January	1819	£1,567,667
„ 5th „	1820	1,019,612
„ 5th „	1821	707,106
„ 5th „	1822	1,205,960
„ 5th „	1823	1,632,166
„ 5th „	1824	1,932,448
„ 5th „	1825	2,586,219
„ 5th „	1826	1,261,290
„ 5th „	1827	526,155
„ 5th „	1828	979,641
„ 5th „	1829	931,361
„ 5th „	1830	450,137
„ 5th „	1831	549,459

forming an aggregate sum of 15,677,503*l.*, the greater part of which appears to have been permanently lodged, since the sum remaining in deposit on the 20th of November 1830, is stated to have been 13,507,565*l.*, so that the sums withdrawn must have amounted in all that time to but little more than two millions in addition to the interest allowed.

From and after the 20th of November 1829, detailed statements have been made up from year to year, showing the sums remaining in deposit including interest, and the number of depositors in various classes according to the amount of their deposits, in each division and in each county of the kingdom. The aggregate numbers of depositors and sums deposited are shown in the following summary.

Year ending 20th Nov.	England.		Wales.		Ireland.		Scotland.		United Kingdom.	
	Depositors.	Amount.	Depositors.	Amount.	Depositors.	Amount.	Depositors.	Amount.	Depositors.	Amount.
		£		£		£		£		£
1830	367,812	12,287,606	10,204	314,903	34,201	905,056	...	...	412,217	13,507,565
1831	380,130	12,354,617	10,374	322,546	38,999	1,042,332	...	...	429,503	13,719,495
1832	373,704	11,956,289	10,014	301,509	43,755	1,178,201	...	...	427,473	13,435,999
1833	402,607	12,680,512	11,015	329,887	49,170	1,327,122	...	...	462,792	14,337,521
1834	434,845	13,582,102	11,183	336,976	53,179	1,450,766	...	...	499,207	15,369,844
1835	466,862	14,491,316	12,173	356,135	58,482	1,608,653	...	...	537,517	16,456,104
1836	515,444	16,491,949	13,110	422,585	64,019	1,817,264	6,753	74,086	599,326	18,805,884
1837	544,449	17,178,041	13,963	455,846	64,101	1,829,226	13,553	160,902	636,066	19,624,015
1838	595,425	18,566,490	15,232	498,359	69,933	2,048,469	22,646	279,994	703,236	21,393,312
1839	622,468	19,246,221	15,893	525,320	75,296	2,218,239	34,739	436,032	748,396	22,425,812
1840	662,338	20,203,438	15,825	521,918	76,155	2,206,733	43,737	538,961	798,055	23,471,050
1841	695,791	21,036,190	16,220	527,688	78,574	2,302,302	50,619	608,509	841,204	24,474,689
1842	723,374	21,780,373	16,434	531,928	80,604	2,354,906	54,303	652,129	874,715	25,319,336
1843	773,551	23,344,273	17,077	555,849	82,486	2,447,110	62,236	830,083	935,530	27,177,315
1844	832,290	25,112,865	18,690	599,796	91,243	2,749,017	69,824	1,043,183	1,012,047	29,504,861

The number of savings' banks existing in the different divisions of the kingdom on the 20th of November of each year, beginning with 1830, was as follows:—

	England.	Wales.	Ireland.	Scotland.	Total.
1830	379	25	72	—	476
1831	383	22	68	—	473
1832	380	22	70	—	472
1833	380	23	75	—	478
1834	379	22	74	—	475
1835	383	23	75	—	481
1836	387	23	79	2	491
1837	398	23	78	9	508
1838	407	23	80	12	522
1839	418	23	80	20	541
1840	421	23	79	23	546
1841	427	23	76	27	553
1842	434	23	75	31	563
1843	437	23	73	34	567
1844	439	23	73	36	571

In addition to the numbers and the amounts shown in the foregoing summary should be reckoned certain friendly societies, which, during the last five years, have been included in the accounts as being in direct communication and account with the Commissioners for the reduction of the National Debt. These were,—

In the year ending 20th November . .	1840, 332	societies, having deposits amounting to	£1,217,765
"	1841, 354	"	1,306,949
"	1842, 371	"	1,449,244
"	1843, 395	"	1,609,288
"	1844, 428	"	1,770,775

Making the total deposits in those years amount in ..	1840	to	£24,688,815
" "	1841	to	25,781,638
" "	1842	to	26,768,580
" "	1843	to	28,786,603
" "	1844	to	31,275,636

It will be seen, that with the exception of only one year in the entire series, there has been a constantly increasing sum thus deposited. In 1832, doubtless owing to the political ferment in which the nation was then involved, there was a positive decrease in England and Wales, both in the number of depositors and the amount of their balances, viz.—

England....	6,426	fewer depositors	£398,328	less deposits.
Wales	360	ditto	21,037	ditto.

The preceding year, also a time of political excitement, was marked by a much smaller addition than usual to the numbers and amounts of 1830, the increase having been, in

England....	12,318	depositors	£67,011	deposits.
Wales	170	ditto	7,643	ditto.

The increase in 1833, when the public mind had become more tranquillised, was, in

England....	28,903	depositors	£724,223	deposits.
Wales	1,001	ditto	28,378	ditto.

It is worthy of remark, that although the same cause agitated the public in Ireland to which we have attributed this effect in England, it was not accompanied by the same result, possibly because the condition of agitation is one to which the people of Ireland are more accustomed than their fellow-subjects in England. The accounts for those years do not include Scotland. The increase, embracing England, Wales and Ireland, up to 1835, and thereafter including Scotland also, has been

1831	as compared with	1830	£211,930	
1833	"	1832	901,522	
1834	"	1833	1,032,323	
1835	"	1834	1,086,260	
1836	"	1835	2,265,694	including £74,086 Scotland.
1837	"	1836	818,131	
1838	"	1837	1,769,297	
1839	"	1838	1,032,500	
1840	"	1839	1,045,238	
1841	"	1840	1,003,639	
1842	"	1841	844,647	
1843	"	1842	1,857,979	
1844	"	1843	2,327,546	

Including the sums already mentioned as deposited by certain friendly societies, the increase, year by year, since 1840, has been—

1841	as compared with	1840	£1,092,823
1842	"	1841	986,942
1843	"	1842	2,018,023
1844	"	1843	2,489,033

It is impossible not to remark the superiority over the other years of the series of 1836, 1838, 1843 and 1844, all of which were years of great commercial activity, and all, with the exception of 1838, years of cheapness.

It would have added unreasonably to the number of figures with which any statement of this kind must be more or less accompanied, if the depositors had in each year been classified according to the amount of their deposits. This classification for the year 1844 was as follows:—

		England.	Wales.	Ireland.	Scotland.	Total.
Not exceeding	£20 ..	461,195	9,459	41,546	52,442	564,642
,,	50 ..	207,129	5,584	33,298	12,259	258,270
,,	100 ..	91,729	1,998	10,601	3,249	107,577
,,	150 ..	32,083	634	3,024	640	36,381
,,	200 ..	18,551	294	1,583	201	20,629
Exceeding	200 ..	2,914	38	92	....	3,044
		813,601	18,007	90,144	68,791	990,543
Charitable institutions .		9,789	205	677	630	11,301
Friendly societies		8,900	478	422	403	10,203
		832,290	18,690	91,243	69,824	1,012,047
Friendly societies in direct account with Commissioners						428
					Total	1,012,475

The centesimal proportions in which the different classes stand to the whole number of individual depositors are as follows:—

		England.	Wales.	Ireland.	Scotland.	United Kingdom.
Not exceeding	£20 ..	56·68	52·53	46·09	76·24	57·00
,,	50 ..	25·46	31·01	36·94	17·82	26·08
,,	100 ..	11·28	11·10	11·76	4·72	10·86
,,	150 ..	3·94	3·52	3·35	0·93	3·67
,,	200 ..	2·28	1·63	1·75	0·29	2·08
Exceeding......	200 ..	0·36	0·21	0·11	——	0·31
		100·	100·	100·	100·	100·

It thus appears that the largest proportion of small deposits is made in Scotland, more than three-fourths of the whole being in sums under 20*l.*, a circumstance which may be ascribable to the facility afforded by bankers, as already noticed. The smallest proportion of deposits of lowest amount is found in Ireland, a fact which probably results from the extreme poverty of the peasantry, and which deprives them of the power of making any savings, causing the savings' banks to be the resort of classes in more easy circumstances than the generality of those who make deposits in England.

The average balances to the credit of each depositor in the different divisions of the kingdom have been (discarding all fractional parts of a pound)—

	England.	Wales.	Ireland.	Scotland.	Total.
	£	£	£	£	£
20th Nov. 1830	33	31	26	...	33
,, 1831	32	31	26	...	31
,, 1832	31	30	26	...	31
,, 1833	31	29	27	...	31
,, 1834	31	30	27	...	30
,, 1835	31	29	27	...	30
,, 1836	31	29	28	9	30
,, 1837	30	30	28	11	30
,, 1838	30	30	29	11	30
,, 1839	30	30	29	11	29
,, 1840	29	29	29	11	28
,, 1841	29	29	29	11	28
,, 1842	29	29	29	11	28
,, 1843	30	33	30	13	29
,, 1844	30	32	30	14	29

With the exception of the last two years of the series, in which there has been a general increase observable in the average deposits, the above figures exhibit a marked difference between England and Ireland, the average sum having regularly diminished in the former division, while it has as regularly increased in the latter division.

During the fifteen years for which the accounts have been regularly made up, the per-centage increase in the number of depositors and amount of their balances has been—

	Depositors.	Amount.
England	126 per cent. . .	104 per cent.
Wales	83 ,, . .	90 ,,
Ireland	167 ,, . .	203 ,,
Scotland (from 1836)	934 ,, . .	1308 ,,

ENGLAND.

County.	Population in 1841.	Number of depositors.	Amount of deposits.	Average sum deposited.	Proportion of depositors to population.	Sum deposited per individual of the whole population.
			£	£		s. d.
Bedfordshire	107,937	3,584	111,526	31	1 in 30	20 8
Berks	160,226	12,020	359,676	29	1 in 13	44 10
Bucks	155,989	4,657	128,025	27	1 in 33	16 5
Cambridge	164,509	3,831	121,777	31	1 in 43	14 9
Chester	395,300	15,302	554,400	36	1 in 26	28 0
Cornwall	341,269	12,915	492,013	38	1 in 26	28 10
Cumberland...........	177,912	7,538	211,741	28	1 in 23	23 9
Derby	272,202	10,099	321,897	31	1 in 27	23 4
Devon	533,731	49,866	1,492,072	29	1 in 11	55 11
Dorset	174,743	11,470	412,628	35	1 in 15	47 2
Durham	324,277	7,323	201,354	27	1 in 44	12 5
Essex	344,995	14,413	428,202	29	1 in 24	24 9
Gloucester	431,307	25,526	818,157	32	1 in 17	37 11
Hereford	114,438	8,350	211,251	25	1 in 13	36 10
Hertford	157,237	3,785	113,425	29	1 in 41	14 5
Huntingdon...........	58,699	1,765	52,001	29	1 in 33	17 8
Kent....................	548,161	33,392	945,273	28	1 in 16	34 5
Lancaster...............	1,667,064	65,402	1,980,143	30	1 in 25	23 9
Leicester	215,855	6,803	173,581	25	1 in 32	16 1
Lincoln	362,717	18,451	497,509	26	1 in 19	27 5
Middlesex	1,576,616	176,049	4,521,589	25	1 in 9	57 2
Monmouth	134,349	3,099	76,651	24	1 in 43	11 5
Norfolk	412,621	18,336	527,300	28	1 in 22	25 6
Northampton	199,061	8,410	243,600	28	1 in 23	24 5
Northumberland	250,268	12,862	459,390	35	1 in 19	36 8
Nottingham............	249,773	15,763	420,345	26	1 in 16	33 6
Oxford	161,573	10,246	285,713	27	1 in 15	35 4
Rutland	21,340	Not any savings' bank in this county.				
Salop	239,014	16,452	557,190	33	1 in 14	47 0
Somerset	436,002	22,019	679,072	30	1 in 19	31 1
Southampton	354,940	23,942	687,493	28	1 in 14	38 8
Stafford	510,206	15,368	452,306	29	1 in 33	17 8
Suffolk..................	315,129	11,972	348,176	29	1 in 26	22 1
Surrey	582,613	31,250	749,199	23	1 in 19	25 8
Sussex	299,770	15,709	420,570	26	1 in 19	28 0
Warwick	402,121	21,221	468,270	22	1 in 19	23 3
Westmoreland.........	56,469	942	24,719	26	1 in 59	8 9
Wilts	260,007	11,706	413,941	35	1 in 22	31 10
Worcester	233,484	12,218	401,330	32	1 in 19	34 4
York, East Riding ,, North Riding ,, West Riding	1,591,584	69,545	2,105,866	30	1 in 23	26 5

Wales.

County.	Population in 1841.	Number of depositors.	Amount of deposits.	Average sum deposited.	Proportion of depositors to population.	Sum deposited per individual of the whole population.
			£	£		s. d.
Anglesea	50,890	1,990	58,115	29	1 in 26	22 10
Brecon	53,295	1,073	25,045	23	1 in 49	9 5
Carmarthen	106,482	527	14,177	26	1 in 202	2 8
Cardigan	68,380	816	20,637	25	1 in 83	6 0
Carnarvon	81,068	408	11,612	28	1 in 198	2 10
Denbigh	89,291	1,903	46,003	24	1 in 46	10 3
Flint	66,547	2,771	86,683	31	1 in 24	26 0
Glamorgan	173,462	3,695	115,604	31	1 in 47	13 4
Merioneth	39,238	587	15,646	26	1 in 66	7 11
Montgomery	69,220	2,127	58,502	27	1 in 32	16 10
Pembroke	88,262	2,110	66,324	31	1 in 41	15 0
Radnor	25,186	Not any savings' bank in this county.				

Ireland.

County.	Population in 1841.	Number of depositors.	Amount of deposits.	Average sum deposited.	Proportion of depositors to population.	Sum deposited per individual of the population.
			£	£		s. d.
Antrim	360,875	6,168	129,922	21	1 in 58	7 2
Armagh	232,393	2,264	69,492	30	1 in 102	5 11
Cavan	243,158	308	8,904	28	1 in 789	0 10
Clare	286,394	834	24,328	29	1 in 343	1 8
Cork	854,118	15,684	506,246	32	1 in 33	11 10
Down	361,446	4,805	152,380	31	1 in 75	8 5
Dublin	372,773	24,178	683,487	28	1 in 15	36 4
Fermanagh	156,481	1,535	54,303	35	4 in 102	6 11
Galway	440,198	396	10,063	25	1 in 1111	0 5
Kerry	293,880	1,510	37,969	25	1 in 194	2 7
Kildare	114,488	1,018	29,070	28	1 in 112	5 1
Kilkenny	202,420	1,398	48,021	34	1 in 144	4 9
King's County	146,857	1,365	42,937	31	1 in 108	5 10
Limerick	330,029	4,318	146,731	33	1 in 76	8 10
Londonderry	222,174	1,961	49,686	25	1 in 113	4 5
Louth	128,240	3,126	92,413	29	1 in 41	14 4
Mayo	388,887	1,406	43,904	31	1 in 276	2 3
Meath	183,828	1,486	47,324	31	1 in 122	5 1
Monaghan	200,442	926	25,473	27	1 in 216	2 6
Queen's County	153,930	1,128	35,437	31	1 in 136	4 7
Roscommon	253,589	921	32,256	35	1 in 275	2 5
Sligo	181,002	865	27,493	31	1 in 209	3 0
Tipperary	435,552	3,512	111,431	31	1 in 124	5 1
Tyrone	312,956	1,846	54,034	29	1 in 169	3 5
Waterford	196,187	3,782	110,133	29	1 in 51	11 2
Westmeath	141,300	733	33,243	45	1 in 192	4 8
Wexford	202,033	1,457	47,907	32	1 in 138	4 8
Wicklow	126,143	1,214	31,111	25	1 in 103	4 11

Not any savings' bank in Carlow, Donegal, Drogheda, Leitrim, or Longford.

Scotland.

County.	Population in 1841.	Number of depositors.	Amount of deposits.	Average sum deposited.	Proportion of depositors to population.	Sum deposited per individual of the population.
			£	£		s. d.
Aberdeen	192,283	1,710	22,750	13	1 in 112	2 4
Argyle	97,140	240	3,353	13	1 in 404	0 8
Banff	50,076	462	6,733	14	1 in 108	2 8
Berwick	34,427	189	3,177	16	1 in 182	1 10
Bute	15,695	561	8,155	14	1 in 28	1 4
Caithness	36,197	218	3,225	14	1 in 166	1 9
Clackmannan	19,116	140	1,627	11	1 in 136	1 8
Dumfries	72,825	344	4,061	11	1 in 211	1 1
Edinburgh	225,623	23,859	322,346	13	1 in 9	28 6
Fife	140,310	2,972	48,125	16	1 in 47	6 10
Forfar	170,400	4,616	48,006	10	1 in 37	5 7
Inverness	97,615	856	9,341	10	1 in 114	1 11
Kincardine	33,052	1,149	22,549	19	1 in 28	13 7
Kircudbright	41,099	265	2,591	9	1 in 155	1 3
Lanark	427,113	19,774	294,726	14	1 in 21	13 9
Moray	34,994	1,838	27,472	14	1 in 19	15 8
Nairn	9,218	198	2,212	11	1 in 46	4 9
Perth	138,151	4,735	60,721	12	1 in 29	8 9
Renfrew	154,755	2,361	36,107	15	1 in 65	4 8
Ross and Cromarty	78,980	415	4,126	10	1 in 190	1 0
Roxburgh	46,003	804	20,188	25	1 in 57	8 9
Selkirk	7,989	315	4,812	15	1 in 25	12 0
Stirling	82,179	770	9,746	12	1 in 106	2 4

Not any savings' bank in Ayr, Dumbarton, Haddington, Kinross, Linlithgow, Orkney and Shetland, Peebles, Sutherland, or Wigton.

In the preceding Tables the present condition is shown of each county of England, Wales, Ireland and Scotland, respectively, as regards the savings deposited in these banks by the people. Assuming, as the basis for the calculation, the population of 1841, it will there be seen what proportion among them has deposits in a savings' bank, and the sum per head to which those deposits would amount if equally divided among the whole number of inhabitants.

It may appear strange, that with the exception of Middlesex, the metropolitan county, and the great centre of wealth and of the employments which wealth creates, the largest amount of deposits, in proportion to the population, should be found in Devonshire, an agricultural county, in which there were, in a population of 533,460 persons in 1841, fewer than 7000 employed in all kinds of manufactures. This fact is, however, capable of easy and satisfactory explanation. The Devon and Exeter Savings' Bank has been for many years placed under very zealous and able management, and in addition to the constant services of Mr. Lee, its actuary, has received the support of considerably more than a hundred clergymen and gentlemen residing at different places within the county, who have taken pains to make known among the labouring poor in their respective neighbourhoods the benefits to be derived from even the smallest savings, and who have, at the cost of some personal trouble, received such savings and transmitted them to Exeter for investment, an operation which, unaided, the depositors could hardly have accomplished. This fact should serve as a stimulus to others who have the like opportunity of benefiting their poor neighbours, showing as it does that even in the least promising soil they may reap a large harvest of success if the needful labour be not withheld. On the other hand, it may create surprise that Lancashire, at the head of our manufacturing population, should stand so low in the scale with regard to the savings of the working classes, that there should be twenty-five counties of England, the average deposits in which are greater. This too is capable of explanation that must be satisfactory. In towns, and especially in places that are rapidly increasing, as the manufacturing towns and villages of Lancashire and the neighbouring counties have long been, more profitable opportunities present themselves for the investment of small sums than are offered by savings' banks. Among these opportunities building-clubs are common in those localities, and absorb the working man's savings to an extent which few persons who have not inquired into the subject would conceive probable.

The advantage held forth by the government to the working man as an inducement for him to save a portion of his earnings, was greater under the acts of 1817 than it is at present. The rate of interest then fixed was, as already stated, *3d.* per centum per diem, or *4l.* 11s. *3d.* per cent. per annum, out of which the allowance made to depositors was usually 4 per cent., the remaining 11*s.* *3d.* being retained to defray expenses. There was no restriction then placed upon depositors as to the amount of their savings; they might deposit 100*l.* the first year and 50*l.* every year after, so long as they might be inclined or able to do so, and they might make investments in as many different savings' banks as they judged proper and could effect. In time, however, parties not contemplated by the legislature in framing the law, finding that they could thus secure a higher rate of interest than was yielded by the public funds, and at the same time save all risk of fluctuation in the value of their deposits, used the savings' banks to an inconvenient extent, and in 1824 an act was passed limiting the amount that might be deposited the first year to 50*l.*, and all future yearly deposits to 30*l.*, with the further restrictions that no person should receive interest upon any amount beyond 200*l.*, nor should be allowed to leave deposits in more than one savings' bank. In 1828 the rate of interest was reduced to $2\frac{1}{4}$*d.* per centum per diem, or 3*l.* 8*s.* $5\frac{1}{4}$*d.* per cent. per annum; the largest sum to be received in any one year was fixed at 30*l.*, and 150*l.* was adopted as the largest sum upon which interest would be paid to any one depositor. In 1833 the laws relating to savings' banks were extended to the Channel Islands, and in 1835, as already stated, they were made to embrace Scotland. The latest act for the regulation of these institutions was passed in 1844; it further lowered the rate of interest paid by the public to $3\frac{1}{4}$ per cent. per annum, reducing to 2*d.* per centum per diem, or 3*l.* 0*s.* 10*d.* per cent. per annum the allowance to depositors. This change took effect from and after the 20th of November 1844, the day to which the statements now brought forward are made up. Whether or not the allowing of a liberal rate of interest has much influence on the minds of the working classes, leading them to spare a portion of their earnings, is a question which the result of this change may enable us to answer. If that answer should be in the affirmative—if the now diminished allowance for interest should in any degree check the disposition to saving on the part of the classes for whom savings' banks are opened, the economy of parliament in thus restricting that allowance will prove a measure of very doubtful wisdom, and one as to which the legislature cannot too soon retrace its steps.

It is to be regretted that the managers of savings' banks have not generally availed themselves of the opportunities which they possess for throwing light upon the condition and habits of the various classes making deposits, by recording and publishing their occupations. Many years ago the Statistical Society of London addressed circular letters to each savings' bank then existing, accompanied by forms to be filled up, and pointing out the advantage of possessing correct knowledge upon the subject. This well-meant effort proved however wholly abortive. Some few of these establishments are accustomed to publish such information; among these are the "Devon and Exeter Savings' Bank," already mentioned, and the "Manchester and Salford Bank for Savings." As it may be useful to know the result exhibited by the accounts of two establishments, similar in their object but differing so materially in their circumstances, I shall close this sketch by calling attention to their several statements.

Analysis of Depositors in the Devon and Exeter Savings' Bank from 1827 to 1833.

	Number.	Amount of deposits.	Average deposit.
		£	£ s. d.
Male servants	867	43,612	50 6 0
Female servants	3,574	106,022	29 13 3
Children of servants	344	3,284	9 10 11
Total servants	4,785	152,918	31 19 2
Small shopkeepers	503	26,900	53 9 7
Artificers and mechanics	2,365	90,839	38 8 2
Labourers	118	2,916	24 14 1
Females in trade	612	20,269	33 2 4
Apprentices	448	2,615	5 16 9
Carriers, drivers, porters, &c.	194	8,535	43 19 11
Teachers, clerks, and shopmen	470	21,224	45 3 2
Children of the above	3,778	50,840	13 9 1
Total traders and manufacturers	8,488	224,138	26 8 1
Small farmers	788	40,190	51 0 3
Labourers	2,050	65,757	31 18 8
Children of the above	3,844	53,933	14 0 7
Total agriculturists	6,691	159,880	23 17 11
Soldiers, sailors, revenue-officers, &c.	1,080	40,977	37 18 10
Miscellaneous	879	32,654	37 2 11

Classification of Depositors, with the Balance due to each Class at 20th of November 1843, in the Manchester and Salford Bank for Savings.

Description of Depositors.	Total number of accounts opened under each class. Male.	Female.	Total.	No. of accounts of each class remaining open at Nov. 20, 1843.	Total amount belonging to each class, 20th Nov. 1843. £	s.	d.	Average amount due to each individual, Nov. 20, 1843. £
Domestic servants	1,301	7,854	9,155	3,277	86,131	13	1	26
Clerks, shopmen, warehousemen, porters, and wives	4,867	386	5,253	1,794	49,659	12	1	27
Minors	3,514	3,489	7,003	3,458	55,134	6	4	15
Milliners, dressmakers, and needle-women	......	1,530	1,530	534	13,807	11	8	25
Shoemakers, tailors, hatters, and wives	1,551	276	1,827	427	11,984	8	2	28
Cotton-spinners, weavers, and their assistants	3,717	1,431	5,148	1,118	29,273	8	6	26
Silk-spinners, weavers, and their assistants	244	236	480	150	4,263	1	10	28
Calico-printers, bleachers, dyers, packers, makers-up, &c., and wives	1,606	134	1,740	490	14,472	12	11	29
Engravers, pattern designers, &c., and do.	565	45	610	229	7,264	1	9	31
Mechanics and handicraftsmen, and do.	1,293	2,306	3,599	1,109	32,370	4	0	29
Bookbinders and letter-press printers, and do.	224	22	246	86	2,029	18	6	23
Masons, bricklayers, and their labourers, and do.	1,525	176	1,701	428	11,372	0	8	26
Joiners, coach-makers, and cabinet-makers, and do.	2,031	177	2,208	550	16,237	13	4	29
Cab and omnibus drivers, mail-guards, &c., and do.	124	28	152	50	1,597	19	1	32
Policemen, soldiers, and pensioners, and do.	323	28	351	116	3,189	11	10	27
Professional teachers and artists, and do.	648	370	1,018	358	11,739	4	3	32
Tradesmen and small shopkeepers	1,443	848	2,291	664	23,772	11	2	35
Farmers, gardeners, and their labourers, and wives	1,102	133	1,235	509	15,823	18	6	31
Other descriptions not particularly specified	2,160	5,064	7,224	2,186	76,784	4	6	35
	28,238	24,533	52,771	17,533	466,908	2	2	26
Friendly societies	......	......	565	223	16,128	19	5	72
Charitable institutions, including clothing societies	......	......	207	110	5,787	17	7	52
	28,238	24,533	53,543	17,866	488,824	19	2	

Classification of Depositors, with the Balance due to each Class at 20th of November 1844.

Description of Depositors.	Total number of accounts opened under each class. Male.	Female.	Total.	No. of accounts of each class remaining open at Nov. 20, 1844.	Total amount belonging to each class, 20th Nov. 1844. £	s.	d.	Average amount due to each individual, Nov. 20, 1844. £
Domestic servants	1,331	8,641	9,972	3,500	92,302	11	9	26
Clerks, shopmen, warehousemen, porters, and wives	5,290	459	5,749	2,002	57,645	5	9	28
Minors	3,855	3,835	7,690	3,775	*62,747	3	11	16
Milliners, dressmakers, and needle-women	......	1,723	1,723	609	15,968	17	6	26
Shoemakers, tailors, hatters, and wives	1,704	311	2,015	471	13,904	5	6	28
Cotton-spinners, weavers, and their assistants	3,989	1,582	5,571	1,311	37,391	5	11	28
Silk-spinners, weavers, and their assistants	273	274	547	193	5,058	7	3	26
Calico-printers, bleachers, dyers, packers, makers-up, &c., and wives	1,807	199	2,006	680	19,119	8	4	28
Engravers, pattern designers, &c., and do.	609	47	656	238	8,668	0	7	36
Mechanics and handicraftsmen, and do.	3,735	393	4,128	1,601	39,626	0	7	24
Bookbinders and letter-press printers, and do.	250	26	276	97	2,690	11	4	27
Masons, bricklayers, and their labourers, and do.	1,697	229	1,926	566	14,591	3	0	25
Joiners, coach-makers, and cabinet-makers, and do.	2,208	215	2,423	683	19,474	9	5	28
Cab and omnibus drivers, mail-guards, &c., and do.	156	42	198	76	2,164	14	7	28
Policemen, soldiers, and pensioners, and do.	361	41	402	135	3,999	1	2	29
Professional teachers and artists, and do.	709	409	1,118	398	13,982	18	7	30
Tradesmen and small shopkeepers	1,639	1,040	2,679	919	28,970	15	8	31
Farmers, gardeners, and their labourers, and wives	1,171	172	1,343	538	19,354	19	1	35
Other descriptions not particularly specified	2,225	5,248	7,473	2,474	†83,719	1	10	33
	33,009	24,886	57,895	20,266	541,379	1	9	26
Friendly societies	......	......	655	287	19,702	5	11	68
Charitable institutions, including clothing societies	......	......	229	127	7,231	12	7	56
	33,009	24,886	58,779	20,680	568,313	0	3	

* The greatest proportion of this class are no longer minors, the designation as originally entered being retained.

† This class contains a great number of depositors of different trades belonging to the other classes whose callings were not noted in the Register in the early years of the bank.

Report on the Gases evolved from Iron Furnaces, with reference to the Theory of the Smelting of Iron. *By* Prof. Bunsen, *of Marburg, Hesse Cassel, and* Dr. Lyon Playfair, *of the Museum of Œconomic Geology, department of Her Majesty's Woods and Forests.*

In laying before the Association the report which we have now the honour to present, we are desirous, at the commencement of our subject, to examine closely the methods employed in the analyses of gases, not only as an argument in favour of the processes used by ourselves, but also with the hope of improving the present state of eudiometry.

Two distinct methods are employed in the analysis of combustible gases; one of which consists in an exact determination of the volumes of the gas about to be examined, and of those resulting from the combustion of its constituents with oxygen. By the other method, the products of combustion are collected in the liquid and solid form, and estimated directly according to weight.

The last method would doubtless deserve the preference if we had to operate upon a mixture of gases capable of being determined by the products of combustion without reference to the quantity of oxygen necessary to effect it; in other words, when we have to examine a mixture containing only two combustible gases. In such a case, the combustion by means of oxide of copper affords products well-adapted for exact determination by weight. But, on the contrary, when the quantity of oxygen necessary for the combustion must be introduced as an element into the calculation, as is the case with the gases examined by us in the present paper, the method of analysis by weight is not only inexpedient, but also inexact. If that method were to be adopted, it is necessary to determine the loss (often not amounting to above a few centigrammes) sustained by a heavy combustion-tube, by weighing it before and after the experiment, and thus subjecting it to all the sources of error due to a varying hygroscopic condition, and to the loss in weight occasioned by the long exposure of a considerable body of glass to a red heat. Another source of error equally great consists in the necessity for filling the whole apparatus for combustion and condensation with nitrogen gas previous to the commencement of the experiment. The smallest quantity of oxygen which may remain in the gas, or in the porous oxide of copper, or which may be introduced by diffusion, must derange the results, and cause great uncertainty in the determinations. Any error arising from this source is so much the more to be feared, because it does not affect one constituent merely, but extends its influence equally to the ascertained value of all the other ingredients.

We cannot afford better arguments for the reception of our methods of investigation than by briefly reviewing the results obtained by different inquirers in the examination of the gases evolved from furnaces worked by charcoal. It is obvious that the composition of these gases cannot be the same under all circumstances, for the nature of the fuel, the pressure of the blast, and even the shape of the furnace itself, must exert a varying influence in modifying the processes which affect the composition of the gases. But when we consider, at the same time, that these modifying influences have their maximum and minimum in corresponding parts of furnaces treated in a similar manner, we still have a right to expect an elucidation of the law regulating the formation of the gases by a careful comparison of their composition. One of us first endeavoured to solve this problem by an examination of the gases issuing from the furnace of Vickerhagen, although he did not then consider the results obtained in the inquiry as expressive of a general theory of the nature of the processes in the furnace. This research was afterwards pursued in a similar manner, and with confirmatory results, by Scheerer and Langberg in the iron-works of Baerum. Both these chemists have conferred a lasting benefit on this new field of metallurgical inquiry by their elaborate investigations; and as their experiments agree with those performed in Germany, the generality of the law regulating the production and action of the solid and gaseous products of charcoal-furnaces is established. This is shown by a comparison of the results obtained at Vickerhagen and Baerum:—

	Composition* according to volume of the gases at Vickerhagen.						
Height above the tuyère ...	17¾ feet.	16¼.	14¾.	13¼.	11¾.	8¾†.	5¾.
Nitrogen	62·34	62·25	66·29	62·47	63·89	61·45	64·58
Carbonic acid	8·77	11·14	3·32	3·44	3·60	7·57	5·97
Carbonic oxide	24·20	22·24	25·77	30·08	29·27	26·99	26·51
Light carburetted hydrogen	3·36	3·10	4·04	2·24	1·07	3·84	1·88
Hydrogen	1·33	1·27	0·58	1·77	2·17	0·15	1·06
	100·00	100·00	100·00	100·00	100·00	100·00	100·00

	Composition according to volume of the gases at Baerum.					
Height above the tuyère ...	23 feet.	20½.	18.	15½.	13.	10.
Nitrogen	64·43	62·65	63·20	64·28	66·12	64·97
Carbonic acid	22·20	18·21	12·45	4·27	8·50	5·69
Carbonic oxide	8·04	15·33	18·57	29·17	20·28	26·38
Light carburetted hydrogen	3·87	1·28	1·27	1·23	1·18	0·00
Hydrogen	1·46	2·53	4·51	1·05	3·92	2·96
	100·00	100·00	100·00	100·00	100·00	100·00

A simple inspection of the comparison now instituted is sufficient to show that the law, regulating the changes suffered by the ascending column of gas in furnaces supplied with charcoal as fuel, is the same in those of Vickerhagen and Baerum. In both cases the carbonic acid diminishes as we descend from the upper part of the furnace towards the hearth, until it attains a minimum, when it again begins to increase, without however reaching the proportion which it at first possessed. In both cases the carbonic oxide attains its maximum about the middle of the furnace, and diminishes in a greater ratio upwards than downwards. In both furnaces the quantity of carburetted hydrogen remains constant in the upper part, and diminishes, although still relatively constant, in the lower region; and finally, in both cases, an irregularity in the quantity of hydrogen, probably caused by local influences, is observed at all depths. It could scarcely be expected that these phænomena should proceed at proportional heights of furnaces of different sizes; but it would not be difficult to explain the influence exerted upon the maximum and minimum composition of the gases at different positions by the dimensions of the furnace, the nature of the materials, and

* We have found it necessary to correct the calculations given in the original memoir in Poggendorff's 'Annalen,' as they are, almost without exception, erroneously calculated.

† The gas taken from a depth of 8¾ feet is anomalous in composition, but as this is obviously due to one of those disturbances which frequently take place in furnaces of small dimensions, we neglect the consideration of this analysis.

the pressure of the blast, as soon as proper data are furnished by continued inquiries in this field of research.

The great accordance between the results of the two series of experiments now detailed, executed as they were quite independently of each other, the one series in Germany, the other in Norway, renders it surprising that a similar inquiry instituted by Ebelmen on the furnaces of Clerval and Audincourt should have led to results differing so essentially from those now described. This chemist gives the following composition, according to volume, for the gases of the furnace at Clerval:—

Height above the tuyère ...	25½ feet.	22½.	17½.	13⅓.	9½.	8.
Nitrogen	57·79	57·80	58·15	59·14	60·54	63·07
Carbonic acid	12·88	13·96	13·76	8·86	2·23	0·00
Carbonic oxide	23·51	22·24	22·65	28·18	33·64	35·01
Light carburetted hydrogen	0·00	0·00	0·00	0·00	0·00	0·00
Hydrogen	5·82	6·00	5·44	3·82	3·59	1·92
	100·00	100·00	100·00	100·00	100·00	100·00

The difference of these results from those detailed above is very striking, especially when we consider that carburetted hydrogen is entirely absent from Ebelmen's analyses, and that the hydrogen is as great as 6 per cent. The close relation between the nitrogen and oxygen of these gases, and especially the great regularity in the increase and diminution of their respective constituents, would certainly appear to be a guarantee for the accuracy of the analyses. Indeed Ebelmen himself seems so deeply impressed with their value and with their exclusive accuracy, that he has considered it quite unnecessary even to refer to the previous elaborate investigations on this subject in Germany. As he has not honoured one of us, the author of these investigations, with a reference, of course the difference between his results and those of that paper still remain unexplained, and we shall therefore endeavour to fill up this gap in our knowledge.

The analyses of Ebelmen differ from our own in being quite destitute of carburetted hydrogen. It would be a great error to suppose that the absence of this ingredient is not essential. The gas escaping from the furnace at Baerum contains, according to *weight*,—

Nitrogen	58·95
Carbonic acid	31·68
Carbonic oxide	7·28
Carburetted hydrogen	2·00
Hydrogen	0·09
	100·00

The two parts of carburetted hydrogen contained in this mixture give, on combustion, 26938 *units** of heat; and no less than 10·76 parts of carbonic oxide would be necessary to generate the same amount. An error of 2 in the quantity of carburetted hydrogen, with respect to the combustible value of the gas, is equivalent to a loss of 10·76 parts of carbonic oxide gas. But surely a theoretical conclusion must be of small value when based upon an analysis in which there are errors of more than 10 per cent. of the carbonic oxide. It therefore becomes a most important question to determine

* *Unit* of heat is a convenient term to employ in the present report, because it expresses a standard amount. The amount of heat necessary to elevate 2·204 lbs. of water (1 kilogramme) from 0° Cent. to 1° C., we assume as unity.

whether carburetted hydrogen ought to be considered as an essential constituent of the gases, and whether its absence in the cases cited is due to an error in Ebelmen's analyses.

It is well known that ordinary charcoal is very far from being pure carbon, and that it in fact contains about 20 per cent. of foreign matters, which escape as gaseous and liquid products when it is heated to redness. If carburetted hydrogen form, as is generally supposed, an essential constituent of the gases resulting from the distillation of wood-charcoal, it is quite clear that it cannot be absent from the gases of furnaces supplied with that fuel. Although the presence of carburetted hydrogen in the gases obtained by the distillation of charcoal is generally acknowledged, we have thought it not superfluous to put this fact beyond all doubt by a renewed examination. The charcoal subjected to experiment was heated in a narrow glass tube, connected with a long dry tube to retain the liquid products of distillation, and the gases, after passing through this, were collected over mercury. In order to remove any elayl or hydrated oxide of methyl, which might possibly have accompanied the gases, they were conducted through a long tube filled with fuming sulphuric acid, attached to which was another tube moistened with water. The analysis of the gases was then effected in an exact eudiometer, and according to the methods which we describe in an after part of this report.

I. A specimen of very well-burnt charcoal, from beech-wood, yielded a gas of the following composition, according to volume:—

Carbonic acid	23·65
Carburetted hydrogen	11·00
Carbonic oxide	15·96
Hydrogen	49·39
	100·00

II. A good specimen of charcoal from fir-wood, also well-burnt, gave a gas constituted as under.

III. 0·6500 gramme of oak-charcoal, of a similar nature to the last, left behind 0·47 carbon, and yielded 70 cubic centimetres of gas at 0° C. and 0·76 bar., consisting as under.

IV. 0·733 imperfectly burnt beech-wood charcoal, pulverulent, and of a blackish-brown colour, left 0·443 carbon and 250 cubic centimetres of gas at 0° C. and 0·76 bar., which gas was composed as under.

	II. Gas of Fir-charcoal.	III. Gas of Oak-charcoal.	IV. Gas of Beech-charcoal.
Carbonic acid	15·96	19·58	35·36
Carburetted hydrogen	20·32	20·75	20·78
Carbonic oxide	13·62	20·57	14·41
Hydrogen	50·10	39·10	29·45
	100·00	100·00	100·00

If we assume the most unfavourable condition to the calculation, that the charcoal used in the furnace of Clerval was of the most select quality, which could not have been the case, it follows from the analysis and consumption of charcoal at that place, that no less than 479 cubic feet of light carburetted hydrogen must have escaped from the top of the furnace every hour, and yet not a trace of this large quantity is to be found in Ebelmen's analyses. The above experiments prove beyond contradiction that the carburetted hydrogen found by Scheerer and by us in the gases from charcoal, is actually an essential constituent of furnace-gases. The absence of this important ingredient from Ebelmen's analyses might be explained on the supposition that the gases upon which he operated were collected from a part without the column of charcoal, and between it and the lining of the furnace. However, we cannot reproach Ebelmen with drawing a theory of the mutual action of the gaseous and solid products of the furnace from a mixture of gas which had only partially been subjected to this action, because the presence of 7 per cent. of hydrogen indicated by his analyses would be still more inexplicable on this supposition. Hence we must look to another source for the errors in his analyses, and it will be found to lie in the incompleteness of the methods used by him. His method of determining the nature and composition of the combustible gases, was to pass them over red-hot oxide of copper, collecting the products of combustion in the usual way, and forming an opinion of the presence or absence of carburetted hydrogen by the loss in weight of the combustion-tube. In order to show the degree of inaccuracy of this method, it will be best to choose a special case as an example, and as such we select the first analysis of the gases of Clerval. The volume of gas used in his experiments, 1500 cubic centimetres*, contained 87·3 cubic centimetres of hydrogen and 352·65 cubic centimetres of carbonic oxide gas. In order to burn this quantity, the combustion-tube suffered a loss in weight of 0·3160 gramme. If we supposed the whole of the hydrogen to be present as carburetted hydrogen, taking its carbon from a corresponding quantity of carbonic oxide, the 1500 cubic centimetres of gas must have contained 43·65 carburetted hydrogen and 309·0 carbonic oxide; and, on this supposition, the combustion-tube must have diminished in weight 0·3473 gramme, instead of 0·3150 gramme. It will be seen from this calculation, that the question as to whether the mixture of gases contains 5·82 per cent. hydrogen, or *instead of that quantity*, 3·09 light carburetted hydrogen, is entirely dependent upon a difference in weight of not more than 0·0323 gramme. Let us assume that the weight of the combustion-tube and its contents was 80 grammes, then an error of $\frac{4}{10000}$ in the weighing would cause a change in the results from the composition, as found by Ebelmen, to that placed beside it calculated on this supposition:—

	According to Ebelmen.	On the supposition that he was liable to an error of only $\frac{4}{10000}$ in weighing.
Nitrogen	57·79	61·36
Carbonic acid	12·88	13·68
Carbonic oxide	23·55	21·87
Carburetted hydrogen	0·00	3·09
Hydrogen	5·82	0·00
	100·00	100·00

Such uncertainties as these are never to be feared in a eudiometric analysis conducted with proper precautions; for they would imply errors in measurement which could not take place without the most gross negligence. Now when we consider the circumstances which would tend to diminish the loss in weight of the combustion-tube in Ebelmen's experiments, and con-

* In the details of our analyses we always employ the French weights and measures, now universally used on the continent, and by most of our eminent chemists in this country. Their convenience is very great, and as science is universal and not local, English memoirs are more readily adopted on the continent when the translators have not the trouble of reducing our weights and measures. Where the numbers are absolute and not relative, we employ English measures.

sequently diminish the quantity of carburetted hydrogen, while it increased that of hydrogen, we shall be the more inclined to attribute the erroneous results of his experiments to the uncertain methods employed by him in analysis. The smallest quantity of oxygen remaining in the nitrogen with which the apparatus was filled previous to the experiment, the gases retained by the porous copper formed during the reduction, the carbon also retained by this copper, the smallest quantity of foreign substances which may attach themselves to the combustion-tube, softened as it is by heat during the experiment,—all these must tend to increase the chances of an error of $\frac{4}{10000}$ in weighing; a difference so small as even without the operation of these causes almost to be within the errors of observation, and sufficient to account for the erroneous results obtained by Ebelmen. But whatever may have been the grounds which induced Ebelmen to avoid referring to the original investigations in Germany, when we consider the great labour which he bestowed on the inquiry, it will ever remain to be regretted that he did not introduce into his memoir an explanation of the grounds upon which he accorded the preference to his method of analysis, which differs from that of his predecessors in the inquiry more by its tediousness than its accuracy, and which we consider it necessary altogether to avoid in the following research. At the same time it cannot be denied, that eudiometric analysis, as usually performed, is little deserving of high commendation, or of universal adoption, although this is less owing to its incompleteness than to the neglect of the many precautions which should be adopted to procure accuracy.

Before proceeding to our investigation, we thought it necessary to examine with great care all the conditions essential to obtain a proper degree of accuracy. It cannot, therefore, be thought superfluous to describe in detail the methods employed in the inquiry, especially as these must form the foundation for the reception of the conclusions which we draw from the experiments.

The combustion and measurement of the gases is most conveniently and accurately performed in uniform glass tubes of 18–19 inches in length and about 0·6 inch internal and 0·8 inch external diameter; in the closed end of the tube there is inserted by fusion two platina wires of the thickness of horse hair, for the purpose of passing the electric spark. The tube is divided into millimetres, and with this view, is covered with common etching paste, or still better, with a thin layer of wax containing a little turpentine, which may be laid very uniformly on the warmed surface of the glass by means of a hair pencil. The glass is then minutely graduated by a peculiar instrument, and subjected to the action of gaseous hydrofluoric acid, which, when evolved from a paste of fluoride of calcium and concentrated sulphuric acid placed in a vessel of lead slightly warmed, effects the etching in ten to fifteen minutes, and much more legibly than the liquid hydrofluoric acid usually employed in the graduation of thermometers.

The capacity of the tube, which has thus been divided into millimetres, is easily determined by measurement. For this purpose, the tube is placed vertically with the table, its hermetically sealed end being downwards, and is then filled with successive portions of mercury carefully measured. The different lengths occupied by these equal volumes correspond to equal capacities of the tube. If the mercury in the successive parts of the tube *ab*, *bc*, *cd*, *de*, &c. take up the lengths measured on the graduation $L\ L'\ L''\ L'''$, and the short parts of the tube *ab*, *bc*, *cd*, &c. be considered uniform in calibre, we obtain respective values of the divisional marks between *ab*, *bc*, &c. with respect to the volumes corresponding to them expressed by the unity corresponding to the length L, when $L'\ L''\ L'''$, &c. are divided by L. On adding together these quantities, a graduation originally arbitrary becomes a comparable measure corresponding to the capacity of the tube. We obtain by this means a table of correction which gives the true volume of the tube corresponding to each mark.

It is necessary, in order to obviate the parallax on reading from the surface of the mercury, to use a small moveable mirror (Plate IV. fig. 1), which is placed on the opposite side of the tube. If the pupil of the eye seen through the tube in the mirror appears halved by the mark corresponding to the convexity of the mercury, the reading may be considered as exact. If the volume of the measured gas be read, as must always be the case, from the highest point of the convexity of the mercury, we must add to the corrections a small constant quantity deduced from the value found in the plate, and which may be named the fault of the convexity, the necessity for which will be rendered obvious by the following consideration:—If the reading of the volume of the mercury during the measurement of the instrument be at the mark a, the capacity $a\,a\,b$ is not measured, but only the volume $c\,g\,e\,b$ (fig. 2). Now on using the instrument, if we read a volume of gas at the same mark a, while the convexity takes the place $d\,g\,\delta$, this volume as read does not correspond to $c\,g\,e\,b$, but to the real capacity $c\,g\,e\,b + d\,c\,g\,e\,\delta$. Hence the quantity $d\,c\,g\,e\,\delta$ is not measured by the reading, and must therefore be added to the volumes observed, which otherwise would be too small. This quantity may be ascertained by an experiment, and serves for all future corrections. If a dilute solution of bichloride of mercury be placed in contact with the convexity, it disappears immediately, on account of the formation of a thin layer of protochloride of mercury which adheres to the glass. The mercury now shows the horizontal surface $f\,b$. The quantity $c\,a\,a\,e$ is obviously equal to $f\,c\,a\,a\,\beta\,f$, which may be measured directly by the divisions on the tube. Hence the quantity $c\,d\,\delta\,e$ must be equal to $2 \times a\,a\,\beta\,f$, which is the quantity that must be added to the observed volume on every reading.

Another source of error may arise from air bubbles, which are apt to attach themselves to the glass during the filling of the tube, and being loosened when gas is admitted, render the latter impure. If these bubbles of air be visible to the naked eye, it is easy enough to separate them by means of a wire; but the walls still remain covered with microscopic bubbles which cannot be removed in this way. In order, therefore, to prevent altogether this danger to the experiment, it is necessary to clean very carefully with unsized paper the walls of the tube after every experiment, and to introduce the mercury by means of a funnel with a long neck ending in a narrow opening at the lower end, and placed at the bottom of the tube. The mercury flowing from this funnel adheres to the walls of the tube, with a perfectly clear mirror-like surface.

Especial care must be taken that air neither enters nor escapes during the combustion of the gas in the eudiometer. This evil is perfectly avoided by pressing the open end of the instrument, during the explosion, upon a perfectly smooth sheet of caoutchouc placed under the mercury in the pneumatic trough. However, it is quite necessary to take care that the caoutchouc has not carried down with it any air, which might easily find its way into the eudiometer by the diminished tension of the gas. The caoutchouc is therefore moistened with a solution of corrosive sublimate, and very slowly sunk into the mercury; the protochloride of mercury formed between the mercury and the caoutchouc causes such complete adhesion as to exclude all air.

Finally, the reading can only be made exact by using the mirror formerly described, and estimating the position of the level of the column of mercury in the eudiometer above that in the trough, so that the difference may be brought into the calculation. By reading in this manner the error is avoided, which otherwise would result from heating the gases by the hand in adjusting the outer and inner levels, and it also enables us to record the results without touching the apparatus, which thus preserves a constant temperature.

It is quite necessary, in estimating the volumes of the gases, to use the substances for absorption in a bulk as small as possible, and in a form which may easily and completely be removed from the tubes, so that the gases may neither be rendered impure by air introduced, nor their reading rendered erroneous by some of the absorbing substance adhering to the sides of the tube. This is best effected by casting the materials into the form of bullets, by means of a common bullet-mould, into which a thin piano wire has been previously introduced. If there are to be two determinations of carbonic acid, the one before the combustion of the gas, the other after, it is necessary to transfer the gas from one eudiometer to another, after the first determination, in order to avoid the chance of error which might result from potash adhering to the side of the tube during the first absorption; and for this purpose it is obviously of little consequence whether the whole or only a part of the volume of the gas be transferred. The adhesion of air to the piano wire is so insignificant, that it might be completely neglected; but to avoid error, it is better to amalgamate the outer surface of the iron wire; this may be done by rubbing it with an amalgam of potassium and mercury, without destroying its tenacity. Rusty iron wire must not on any account be employed, and equal care must be taken to keep its inferior end under the mercury during the absorption; for if it be exposed to the air, an endosmose and exosmose is effected to such an extent, as in certain cases to endanger the value of the analysis.

In order to estimate olefiant gas and the hydrocarbons accompanying it, we have invented a very simple and efficacious method, which may be usefully employed in the analysis of coal-gas. A little bullet is prepared out of the same materials as those used for making the negative element of the coal battery. For this purpose a bullet-mould, supplied with a platinum-wire having a bent end, is filled with a pounded mixture of two parts of coke and one part of coal, and is then heated before the blowpipe flame. The ball made in this way is afterwards dipped into a concentrated solution of sugar, and heated very strongly in the open reducing flame of the blowpipe; it is now ready, and must be preserved for use carefully protected from moisture. This lump of charcoal, about the size of a small pistol-bullet, is capable of absorbing into its pores 0·5 gramme of sulphuric acid without appearing wet on the surface, and it can be introduced into and withdrawn from the eudiometer without moistening it to any appreciable extent. For the purpose of experiment, it is made to absorb a mixture consisting of one part of anhydrous and two parts of concentrated hydrated sulphuric acid. The proof that the acid contained in the bullet has been sufficient for the absorption of the olefiant gas, is the emission of white fumes in the air after its withdrawal from the mixture of gases, which of course must be quite dry. As the anhydrous sulphuric acid emits vapour possessing considerable tension, and is never obtained free from sulphurous acid, and as the latter gas is also formed by the action of sulphuric acid on the hydrocarbons, an augmentation of the volume of the mixture is thus produced. To remove both these sources of error, after the conclusion of the above experiment, a little dry ball made of gypsum and peroxide of lead is introduced into the eudiometer. This has the double effect of removing both, for while the peroxide of lead absorbs the sulphurous acid, the anhydrous sulphuric acid robs the gypsum of part of its water, thus becoming hydrated sulphuric acid and losing its tension.

When the oxygen is estimated, not by combustion with hydrogen, but by absorption with phosphorus, the precaution must always be taken to separate the vapours of phosphorous acid by a bullet of caustic potash, before effecting the measurement.

As the tension of the aqueous vapour, and in fact every known precautionary means were adopted in our experiments, we believe it to be unnecessary to enter into further detail. But, at the same time, as it is necessary that we should submit to the Association some proofs of the degree of accuracy which we profess to have attained in this mode of analysis, we do not consider it superfluous to lay before it a series of analyses of common air, made with eudiometers such as have been described, but of various sizes, and with air collected at different times, the analyses being made with the precautions recommended by us. And we are less afraid of being accused of unnecessary detail, because these analyses show most decidedly that the presence of nitrogen during the combustion of hydrogen and oxygen does not cause the formation of ammonia, or of any degree of oxidation of nitrogen. We thought this question, involving as it does the whole value of our labours, so important as to be submitted to rigorous experimental research.

The air employed in these experiments was collected in the neighbourhood of Marburg in the open air, and carefully freed from carbonic acid: the measurement of the respective volumes of gases was effected at the maximum of moisture.

I. Experiments with a eudiometer of small dimensions.

1st Experiment, June 14, 1844.

	Volume.	Temp. Cent.	Difference of level.	Barometer.
		°	m	m
Volume of air used	230·1	18·0	0·2075	0·7480
Volume after admission of hydrogen ...	307·1	17·8	0·1343	0·7480
Volume after the combustion	211·8	18·0	0·2250	0·7480
2nd Experiment, June 15.				
Volume of air used	193·9	18	0·2420	0·7476
Volume after admission of hydrogen ...	346·4	18	0·0962	0·7476
Volume after combustion	280·2	18	0·1600	0·7476
3rd Experiment, June 18, with the same air as the last.				
Volume of air used	231·4	16·4	0·1963	0·7451
Volume after admission of hydrogen ...	322·9	16·2	0·1092	0·7433
Volume after combustion	230·8	16·4	0·1969	0·7410
4th Experiment.				
Volume of air used	214·4	17·3	0·2305	0·7467
Volume after admission of hydrogen ...	313·5	17·3	0·1367	0·7478
Volume after combustion	234·3	17·1	0·2224	0·7474

II. Experiments with a eudiometer of larger dimensions, such as that used in our experiments.

5th Experiment, June 30.

	Volume.	Temp. Cent.	Difference of level.	Barometer.
		°	m	m
Volume of hydrogen used.................	146·1	17·1	0·2149	0·7460
Volume after admission of air	313·0	17·1	0·0593	0·7460
Volume after combustion	216·9	17·1	0·1506	0·7449
6th Experiment, July 1.				
Volume of hydrogen used.................	155·6	16·8	0·2069	0·7447
Volume after admission of air	297·1	16·9	0·0750	0·7442
Volume after combustion	214·3	17·0	0·1528	0·7444

III. Experiments with a large, long and wide eudiometer.

7th Experiment, July 1.

	Volume.	Temp. Cent.	Difference of level.	Barometer.
		°	m	m
Volume of air used	663·2	16·0	0·2301	0·7453
Volume after admission of hydrogen ...	881·3	16·2	0·0237	0·7453
Volume after combustion	735·0	16·5	0·1658	0·7448
8th Experiment, July 10.				
Volume of air used	676·8	16·4	0·2160	0·7444
Volume after admission of hydrogen ...	878·7	16·5	0·0225	0·7444
Volume after combustion	716·6	16·2	0·1667	0·7444
9th Experiment, July 12.				
Volume of air used	657·2	16·8	0·2408	0·7457
Volume after admission of hydrogen ...	890·9	16·8	0·0099	0·7457
Volume after combustion	752·8	16·8	0·1460	0·7449

From the preceding experiments, the composition of air is as follows:—

Nitrogen.	Oxygen.	
78·92	21·08	Determined by the smallest eudiometer.
78·93	21·07	
78·98	21·02	
78·99	21·01	
79·10	20·90	Determined by a larger eudiometer, such as that used in our experiments.
79·09	20·91	
79·14	20·86	
79·10	20·90	Determined by the largest eudiometer.
79·19	20·81	
79·05	20·95	

The great agreement of these experiments with one another, and with the results obtained by the extremely careful experimental determination of the composition of air by Dumas, proves that the eudiometric analyses of gases admit of a degree of exactness which certainly is not surpassed by the most minute analytical methods; and they further show, that the presence of nitrogen does not exercise any disturbing influence on the estimation of explosive mixtures of gases.

The nature of the gases ascending through the various parts of an iron furnace is obviously dependent upon the nature of the fuel used in it. Coke, brown coal and wood yield a gas containing as combustible constituents only carburetted hydrogen, carbonic oxide and hydrogen. The analysis of such a mixture offers no difficulties, and the proportion of the gases may be easily calculated if we are acquainted with the volume occupied by the oxygen which disappears, and that of the carbonic acid produced, referring them to the volume of gas employed.

A mixture of gas consisting of	1 vol. H + 1 vol. H_2C + 1 vol. CO	= 3 vol.
requires for combustion	$\frac{1}{2}$ vol. O + 2 vol. O + $\frac{1}{2}$ vol. O	= 3 vol.
and yields	1 vol. CO_2 + 1 vol CO_2	= 2 vol.

If we call any given mixture of gas A, consisting of x hydrogen, y light carburetted hydrogen, and p carbonic oxide; and further call the oxygen necessary for the combustion B, and the carbonic acid produced C, we obtain the following equations:—

$$x + y + p = \mathrm{A},$$
$$\tfrac{1}{2}x + 2y + \tfrac{1}{2}p = \mathrm{B},$$
$$y + p = \mathrm{C};$$

and out of these follow

1. $x = \mathrm{A} - \mathrm{C}.$

2. $y = \dfrac{2\mathrm{B} - \mathrm{A}}{3}.$

3. $p = \mathrm{C} - \dfrac{2\mathrm{B} - \mathrm{A}}{3}.$

But the gas generated, when coal is used as fuel, may contain, in addition to the above gases, olefiant gas, gaseous hydrocarbons of various compositions, and sulphuretted hydrogen. The examination of such a complex mixture of gases offers rare difficulties, which may be overcome by estimating directly the sulphuretted hydrogen and the hydrocarbons differing in composition from light carburetted hydrogen. Sulphuretted hydrogen is easily enough determined, but for the estimation of hydrocarbons, not even an approximative method is known. It is quite true that they may be condensed by free chlorine in the dark; but the necessity of making such experiments over water render the results wholly inexact. This method also gives a source of error, which becomes materially increased by the circumstance that the tension of the substance containing chlorine formed by the condensation cannot be brought into the calculation. We have therefore tried to condense the gases in a proper apparatus by means of perchloride of antimony. In order to be sure of the applicability of this substance, it was necessary to be certain that this compound of chlorine kept back the desired hydrocarbon without acting upon the remaining constituents of the mixture. It may easily be proved that carbonic oxide, light carburetted hydrogen and hydrogen are left quite unchanged by it, for after streaming through the liquid contained in a Liebig's potash apparatus, they are again obtained unaltered in quantity or in properties. But it was not so simple to decide whether olefiant gas and the other hydrocarbons of unknown composition were separated in this way pure and capable of quantitative determination. We have endeavoured to decide this question in a way certainly somewhat tedious, but not the less positive. In the first place, it was necessary to be satisfied of the correctness of the opinion generally received, but, as far as we are aware, unproved, that the gaseous products of distillation of coal, in addition to carbonic oxide, hydrogen, olefiant gas and carburetted hydrogen, still contained other hydrocarbons. If the latter be absent, we are able by a eudiometric analysis to determine the constituents of a mixture of gases containing four ingredients, if we estimate for a given volume of the mixture A, the quantity of oxygen necessary for its combustion B, and the carbonic acid thus formed C, and also the proportion of the latter to the amount of aqueous vapour produced. Thus it requires

A mixture consisting of	1 vol. H + 1 vol. H_2C + 1 vol. HC + 1 vol. CO	= 4 vol.
for combustion	$\frac{1}{2}$ vol. O + 2 vol. O + 3 vol. O + $\frac{1}{2}$ vol. O	= 6 vol.
from which is produced	1 vol. CO_2 + 2 vol. CO_2 + 1 vol. CO_2	= 4 vol.
and also	1 vol. HO + 2 vol. HO + 2 vol. HO	= 5 vol.

If we denote these quantities by the same letters as above, the olefiant gas by z, and the proportion of the aqueous vapour produced by the combustion to the carbonic acid as $\frac{D}{E}$, the following four equations result:

$$x + y + z + p = A,$$
$$\tfrac{1}{2}x + 2y + 3z + \tfrac{1}{2}p = B,$$
$$y + 2z + p = C,$$
$$\frac{x + 2y + 2z}{y + 2z + p} = \frac{D}{E}.$$

The value of the four unknown quantities x, y, z and p, are thus determined:—

$$4.\quad x = 2A + 4B - 3C\left(\frac{D}{E} + \frac{4}{3}\right).$$

$$5.\quad y = -2A - 6B + 5C\left(\frac{D}{E} + 1\right).$$

$$6.\quad z = A + 4B - 3C\left(\frac{D}{E} + 1\right).$$

$$7.\quad p = -2B + C\left(\frac{D}{E} + 2\right).$$

If the mixture of gases contain actually only the four assumed constituents, we obtain positive values for x, y, z and p. If one of these quantities be negative, this is a proof that the mixture must contain other compounds than those assumed.

In order to obtain something conclusive as to the nature of coal-gas, a quantity of coal was heated to redness in a combustion-tube, in such a manner that the gaseous products of distillation were not obliged to traverse the red-hot layers of coal. The gas was first conducted into a cool receiver, where it deposited the liquid products of distillation, after which it was freed from carbonic acid and sulphuretted hydrogen by means of a solution of oxide of lead in potash, and also from water by being made to pass through a tube filled with chloride of calcium, leading into a eudiometer standing over mercury. An indefinite quantity of the gas was also led over red-hot oxide of copper, and yielded 0·23749 grm. carbonic acid and 0·2239 grm. water, which correspond with 120·55 cubic centimetres of carbonic acid, and with 277·27 cubic centimetres of aqueous vapour. The eudiometric analysis gave the following result:—

	Volume.	Temp. Cent.	Pressure.	0° C. 1 m.
Volume of gas used	132·1	2°·3	0·4127 m	54·06
Volume after admission of oxygen	348·7	0·3	0·6289	219·10
Volume after combustion	241·3	0·2	0·5277	127·25
Volume after absorption of carbonic acid	182·8	−3·	0·4794	88·61
Volume after admission of hydrogen	300·3	−2·5	0·5952	180·39
Volume after combustion	106·1	−1·7	0·3987	42·57
Volume after another admission of hydrogen	295·0	−1·7	0·5863	174·04
Volume after combustion	106·2	−1·5	0·4194	44·79

In these data, and also in all those which follow, the tension caused by the aqueous vapour formed during the combustion is never neglected, and the correction necessary for it at the given pressure is already brought into the calculation. A simple consideration of these experiments gives us the following values for the elements necessary to the calculation:—

$$\frac{D}{E} = 2{\cdot}2993,$$

$$A = 54{\cdot}06,$$

$$B = 76{\cdot}02,$$

$$C = 38{\cdot}64.$$

These quantities lead us to the following composition:

Light carburetted hydrogen...	+73·18
Carbonic oxide	+14·08
Hydrogen	− 8·89
Olefiant gas	−24·33

In this case, therefore, the formula leads to an impossible result, which proves that other constituents must be in the mixture of gases. From these facts we may also derive another conclusion. If we deduct in the last four experiments the excess of oxygen left after the combustion from the volume of gas measured after the absorption of carbonic acid, the remainder will give the nitrogen originally contained in the mixture, or that liberated by the combustion. This calculation shows that the nitrogen = 0·01, from which we conclude that the gas from coal, distilled and collected as we have described, does not contain in appreciable quantity nitrogen, cyanogen, or any other nitrogenous substance. Hence it follows that the gaseous mixture must contain, in addition to the hydrocarbons already mentioned, others of unknown composition. It was now quite necessary to ascertain positively whether perchloride of antimony completely effected the separation of the latter as well as of olefiant gas. This question is easily decided by conducting coal-gas freed from carbonic acid and sulphuretted hydrogen through a Liebig's potash tube containing perchloride of antimony, behind which is placed another containing potash for the purpose of arresting the volatile perchloride, and a tube filled with chloride of calcium to prevent the escape of aqueous vapour. The gas treated in this way is collected over mercury, and exploded with the necessary quantity of oxygen, which is determined as well as that of the carbonic acid generated; and the proportion of the latter to the amount of aqueous vapour produced is obtained by leading another portion of the gas over red-hot oxide of copper. With this knowledge we possess all the data for estimating the amount of light carburetted hydrogen, carbonic oxide and hydrogen, not only by the formulæ 1, 2, 3, but also by those afterwards described (4, 5, 6, 7) for calculating the quantities of light carburetted hydrogen, carbonic oxide, olefiant gas and hydrogen contained in a mixture. When both these calculations agree, and when we obtain by the last of them c as the value of the olefiant gas, this result may be viewed as a certain proof of the complete retention of the olefiant gas and other hydrocarbons of unknown composition by the perchloride of antimony without any change in the other gases. An experiment instituted for this purpose gave the following result:—

	Volume.	Temp. Cent.	Pressure.	1 m. at 0°.
Gas used	155·4	° −4·3	0·4497	71·00
After admission of O	343·4	−4·3	0·6351	221·57
After combustion	197·6	−4·3	0·4872	97·81
After absorption of CO_2	122·8	−3·7	0·4109	51·15
After admission of H	330·3	−3·7	0·6171	206·62
After combustion	130·7	−3·7	0·4041	53·53

The relation of aqueous vapour to carbonic acid 0·2035 grm. : 0·2113 grm. The values deduced for calculation are—

$$\frac{D}{E} = 2{\cdot}3488,$$

$$A = 70{\cdot}88,$$

$$B = 99{\cdot}54,$$

$$C = 46{\cdot}66.$$

The formulæ 1, 2, 3 give us the composition,—

Hydrogen	24·22
Light carburetted hydrogen	42·73
Carbonic oxide	3·93
Nitrogen	0·12

The formulæ 4, 5, 6, 7 give, on the other hand,—

Hydrogen	24·50
Light carburetted hydrogen	42·27
Carbonic oxide	3·83
Nitrogen	0·12
Olefiant gas	+0·28

The agreement of these results may be considered as a proof of the applicability of perchloride of antimony for our purposes, as the differences are quite within the errors of observation, and as similar differences might arise by a variation from unity in the third decimal of the expression $\frac{D}{E}$. But to remove every possible doubt as to the accuracy of our results, we have taken the specific gravity of the mixture of gases treated with perchloride of antimony, and compared this result with the theoretical density as calculated from the known composition.

In estimating the specific gravity, it was of importance to operate upon a smaller volume of gas than usual, because it was necessary to have the same gas collected over mercury, not only in the combustion with oxide of copper, and in the eudiometric analysis, but also in taking the density of the gas. We have therefore used in our experiments a plan somewhat deviating from that usually adopted, and which for simplicity and accuracy merits to be followed in other cases. The vessel used for weighing the gas consisted of a flask such as that used for digestion, and of a capacity of 200 cubic centimetres; the neck of this flask was drawn out before the blowpipe until the opening was narrowed to the thickness of a straw, and was then supplied with a well-fitted ground glass stopper. This flask, the capacity of which had been previously accurately determined, was filled with mercury, with the precautions already described (page 148), and the gas to be weighed was then introduced, leaving however the mercury still in the vessel, to the height of one- or two-tenths of an inch. The apparatus, with its mouth placed under mercury, is placed as vertically as possible, and allowed to acquire a uniform temperature. When this has taken place the stopper is introduced, and by means of an etched graduation on the neck, the height of the mercury over the level of that in the trough is accurately noted, in order to deduct this from the column of mercury in the barometer observed at the same time. The flask, removed from the trough, and carefully cleaned on the outside, is then weighed, with all the necessary data for corrections employed in such cases, after which it is filled with dry air, care being taken that none of its liquid contents are lost in doing so; and then it is again weighed. An experiment made in this way with gas purified by perchloride of antimony, gave the following result:—

Volume of the gas weighed at 9° C. and 0·7337 pressure, 211·05 cubic centimetres.

Weight of the flask filled with gas at 9°·9 C. and 0·7557 pressure, 49·0262 grms.

Weight of the flask filled with air at − 3°·5 C. and 0·7557 pressure, 49·1920 grms.

The specific gravity, 0·4073, which results from this experiment, does not differ from 0·41, the density calculated from the above analysis, more than we might expect, from the possibility of error of observation in such experiments.

The experiments now detailed prove that other hydrocarbons must be present, besides olefiant gas and light carburetted hydrogen, but they do not show whether olefiant gas itself is contained in the mixture. Its presence is however easily shown, by the circumstance that the perchloride of antimony used in the absorption yields by distillation with water chloride of elayle with all its characteristic properties.

When a stream of gas, obtained by the distillation of coal, is conducted through a Liebig's tube filled with a solution of oxide of lead in potash, a precipitate falls, consisting of sulphuret and carbonate of lead: sulphuretted hydrogen and carbonic acid gases are therefore constituents of the mixture. But there is not a trace of the vapours of sulphuret of carbon in the gas, for the gas thus purified does not in the least degree smell of sulphuret of carbon, being in fact quite destitute of smell.

The gases evolved from iron furnaces must contain nitrogen, in addition to those described, for this gas enters with the air supplied by the blast. The preceding investigations show us that the gases from furnaces contain the following constituents:—

1. Nitrogen.
2. Ammonia.
3. Carbonic acid.
4. Carbonic oxide.
5. Light carburetted hydrogen.

6. Olefiant gas.
7. Carburetted hydrogen, of unknown composition.
8. Hydrogen.
9. Sulphuretted hydrogen.
10. Aqueous vapour.

An iron furnace must be viewed as an apparatus destined to carry on chemical processes of the most various kind. These operations begin at the top of the furnace, and stretch downwards to its hearth in well-defined succession. The final products of all these operations appear partly at the hearth and partly at the mouth; in the latter in the form of a column of combustible gas, in the former in the liquid form of slag and cast iron. The nature of the combustible gas stands in a relation so intimate to the changes suffered by the materials put into the furnace, that its different composition in the various regions of the furnace indicates the changes suffered by the materials introduced as they descend in their way to the entrance of the blast. Now as the examination of this column of air in its various heights in the furnace must be the key to the questions upon which the theory and practice of the manufacture of iron depend, it is of the first importance to subject it to a rigid examination. The successive changes suffered by the column of gas in its passage can only be elucidated by a direct examination of its composition in the various regions of the furnace. We can however employ a method to ascertain the average composition of the gas escaping from the mouth of the furnace; for although the method does not give the composition itself, it enables us to fix the narrow limits between which it varies. In order, however, to understand the part played by the coal itself in the formation of gas from the furnace, it is necessary to examine closely the phænomena which would ensue were the furnace filled with nothing else except the fuel. On this account we must recapitulate the results obtained in an inquiry formerly instituted in Germany by one of us, as this may be considered established by the repetition of the experiments by others, and by the numerous appliances to practice which have already resulted from them. It was shown by these experiments, which receive renewed confirmation and extension from our present inquiry,—

1st. That the oxygen introduced by the blast is burned in the immediate vicinity of the tuyère;

2nd. That the oxygen is converted into carbonic oxide also in the immediate vicinity of the tuyère; and finally,

3rd. That the coal loses all its gaseous products of distillation much above the point at which its combustion commences.

It is therefore clear that the *gasification* of the coal, if such a term be admissible, must take place in the regular course of the furnace, at two points quite separated from each other. At a certain depth from the mouth of the furnace the gases due to the distillation or coaking of the coal must escape. Further down in the furnace the *gasification* will be completed, because the coal freed from its volatile products must here enter into combustion. These products of distillation and combustion, mixed with the nitrogen of the atmospheric air, forms the column of gas which appears as a combustible gas at the mouth of the furnace. Now when we consider that the quantity of coal which loses its gases in traversing the distillatory part of the furnace must correspond to that burnt before the tuyère by the air introduced in the blast, it follows that the composition of the gases evolved from the furnace will be given if we add the products of distillation of any given quantity of coal to the products of combustion of the coke formed from that coal.

As no further experiments are required to determine the products of combustion, the question as to the constitution of gases evolved from coal furnaces is reduced to the examination of the liquid and gaseous products resulting from the distillation of any given kind of coal. These products will be very different, according as they come in contact with the red-hot coal, or escape without passing over it. In the last case we obtain the immediate products resulting from the decomposition of coal, while in the first we have the products arising from their action upon it. The conditions essential to the production of the first case are more or less combined in furnaces in which the materials are put in in a finely-divided state, and go slowly down from the top to the bottom of the furnace. Under these circumstances the coal becomes heated pretty equably throughout its entire mass by the larger heating surface which it offers to the ascending column of gas; and the tar condensing in the upper parts of the furnace is carried away by this stream of air, before the coals saturated with it reach that point in the furnace where the temperature is sufficient for the further decomposition of the products of distillation. The gases generated from the furnace, under such conditions, must contain a smaller quantity of combustible matter. It is therefore of importance to determine the average composition of the gases formed from the products of distillation unmixed with the substances arising from their action upon the red-hot coal. The composition of a gaseous mixture of this kind is also interesting, because it points out the limits to which the quantity of combustible constituents in furnace gases may be reduced. In order to obtain gases of this kind, the most convenient way is to fill a combustion-tube with the coal to be examined, which is placed in a horizontal layer and heated from the closed end of the tube to the open end, so that the gases are not obliged to traverse over red-hot coal in their escape from the tube. The apparatus used by us in the determination of the liquid and gaseous products of distillation is drawn in fig. 4. *a a* is a common combustion furnace, in which is placed the tube coating the coal. The tube is made of difficultly fusible green glass, about $\frac{3}{4}$ inch wide, and surrounded by a thin sheet of copper containing between it and the glass a layer of powdered charcoal, so that the weight may not alter during the heating. The end of the tube is drawn out before the flame of the blowpipe, and connected by means of a weighed strong caoutchouc tube with the receiver *b*, which is destined to receive the tar and ammoniacal water: *c* is a bent tube filled with chloride of calcium for the double purpose of retaining the water and ammonia which passes over with the gases: *d* is a Liebig's tube filled with a solution of oxide of lead in caustic potash, behind which is placed another tube filled with chloride of calcium for the reception of the aqueous vapour carried off from the potash. This arrangement enables us to determine the amount of sulphuretted hydrogen and carbonic acid, each of which is determined by boiling the black precipitate in a platinum vessel with caustic potash, and then weighing the precipitate thus freed from carbonate of lead. The receiver filled with perchloride of antimony (*f*) serves for the determination of olefiant gas and the volatile hydrocarbons accompanying it. On account of the great volatility of this compound of chlorine, it is necessary to connect it with a potash apparatus (*g*), which itself is connected with an absorbing tube containing sulphuric acid. As the chloride of antimony is apt to become hot during the condensation, and thus cause an escape of a volatile chlorinated hydrocarbon, we prefer to use an alcholic instead of an aqueous solution of potash. If this be neglected, subchloride of mercury is sometimes observed in the succeeding eudiometric analyses. The gases procured after this treatment, consisting of hydrogen, light carburetted hydrogen and carbonic oxide, are entirely destitute of smell, and without action upon mercury. As soon as all the atmospheric air is expelled from the apparatus, which we find by analysis to be effected by the distillation of about 300 grains of coal, the conducting tube (*k*) is dipped under mercury and the gas collected. In order to have it of average composition, the gas is collected over mercury in a glass vessel, of a capacity of 800 to 1000 cubic centimetres.

The glass tubes conveying the gas into the vessel is connected with the rest of the apparatus by means of a caoutchouc joint, and a tube, rather narrowed in the middle. This contracted tube is fused when the receiver is filled, but immediately opened again with a pair of tongs in that part which still remains in contact with the system of absorption, so that the experiment may be continued until the coal ceases to yield gas. As soon as this point is attained, the fire is removed from the combustion furnace, and the distillatory tube opened by cutting away with a diamond its drawn-out neck, so far as it is filled with coal-tar. The part of the absorptive system formerly in connection with the mercurial apparatus is now attached to a hand air-pump, and the apparatus filled with atmospheric air by a few gentle strokes of the pump. The loss in weight of the distillatory tube, after being filled with air, adding the weight of the part cut off, gives the amount of coal left behind by the distillation, and also the total weight of the liquids and gases which have escaped from the coal. The quantity of fluid matter is determined by the weight of the receivers *b*, *c*, and by the loss in weight of the fragment of glass tube when freed from tar. The receivers *d*, *e* give the quantity of carbonic acid and sulphuretted hydrogen, the receiver *f*, *g*, *h* the weight of the olefiant gases and condensable hydrocarbons. By subtracting the weight of these collected products of distillation from the loss sustained by the distillatory tube, the remainder indicates the weight of the non-condensable gases, the composition of which in hydrogen, carburetted hydrogen and carbonic oxide, is easily determined by a eudiometric analysis.

The amount of tar produced by the distillation may be determined by throwing the contents of the first receiver on a weighed filter moistened with water, washing it, and, after drying both it and the moist receiver, the weight of these, added to that of the tar in the cut fragment of tube, gives a very exact result as to its amount. The ammonia contained in the water is best obtained by distilling it with a large excess of potash into a receiver containing muriatic acid, until at least two-thirds of the liquid have passed over, and it is then collected in the usual way by evaporation and precipitation with chloride of platinum, the washing of the double salt being best effected by a mixture of alcohol and æther, according to Varrentrapp and Wills' recommendation. The amount of water is of course known by deducting the weight of the tar and ammonia from the total weight.

In order to draw conclusions as to the composition of the gases of the furnace, it is of importance to ascertain the composition of those absorbed by the perchloride of antimony. To determine this point, a quantity of coal was heated to redness with the precautions already described, and collected in a gasometer filled with milk of lime. This gas, carefully dried by passing over chloride of calcium, was led into perchloride of antimony until the latter was saturated. An indefinite quantity of the black liquid thus obtained was put into a combustion-tube with oxide of copper, the front part of the tube being supplied with copper shavings, and on combustion, 0·1226 water and 0·3626 carbonic acid were obtained, which correspond to

	Found.	Olefiant gas.
Carbon	87·90	85·71
Hydrogen	12·10	14·29
	100·00	100·00

This result agrees so closely with the composition of olefiant gas, that we may calculate the hydrocarbon as that gas, especially as any fault, arising from so doing in the case of gases from furnaces, would be appreciable only in the fourth decimal place. Gasforth coal, analysed in the manner now described, gave the following results:—

			grms.
1.	Weight of the coal used	. . . .	16·7457
2.	„	coke remaining	11·5420
3.	„	distilled gases and liquids	5·2037
4.	„	liquid products themselves	3·3506
5.	„	the water contained in them	1·3027
6.	„	platinum salt obtained from it	0·4592
7.	„	quantity of tar	2·0479
8.	„	sulphuretted hydrogen and carbonic acid .	0·2715
9.	„	sulphuret of lead formed	0·6423
10.	„	condensed hydrocarbons	0·1262
11.	„	the uncondensed gases	1·4554

The results of the analysis of the uncondensed gases have already been used in a former calculation, and gave—

Composition according to volume.

Hydrogen	24·22
Carburetted hydrogen	42·73
Carbonic oxide	3·93
Nitrogen	0·12
	71·00

The 1·4554 grm. obtained by the distillation consist of—

	grm.
Hydrogen	0·0836
Carburetted hydrogen	1·1758
Carbonic oxide	0·1901
Nitrogen	0·0059
	1·4554

Hence the coal examined is converted by dry distillation into the following products:—

Carbon	11·5420	. . 68·925
Tar	2·0479	. . 12·230
Water	1·2674	. . 7·569
Light carburetted hydrogen	1·1758	. . 7·021
Carbonic oxide	0·1901	. . 1·135
Carbonic acid	0·1797	. . 1·073
Condensed hydrocarbons and olefiant gas .	0·1262	. . 0·753
Sulphuretted hydrogen	0·0918	. . 0·549
Hydrogen	0·0836	. . 0·499
Ammonia*	0·0353	. . 0·211
Nitrogen	0·0059	. . 0·035
	16·7457	100·000

* The ammonia which may have passed over without condensing in the water is neglected in this calculation.

These results enable us to determine the composition of the furnace-gases. It is clear that the 68·92 per cent. of carbon found in the analysis will be converted by the blast into carbonic oxide above the tuyère. As we have already seen that the coal loses its gases by distillation near the top of the furnace, a corresponding weight of coke must burn before the tuyère, and hence we require only to add to the composition of the furnace-gases the carbonic oxide produced by the combustion of 68·92 per cent. of carbon and the nitrogen of the air expended in the combustion. This calculation gives—

Nitrogen	64·135
Carbonic oxide	33·758
Light carburetted hydrogen	1·464
Carbonic acid	0·224
Condensed hydrocarbons	0·154
Sulphuretted hydrogen	0·114
Hydrogen	0·107
Ammonia	0·044
	100·000

If we calculate, with reference to these circumstances, and according to volume, the composition of the gases escaping from a furnace filled with Gasforth coal, we obtain—

Nitrogen	62·423
Carbonic oxide	33·163
Light carburetted hydrogen	2·527
Carbonic acid	0·139
Condensed hydrocarbons	0·151
Sulphuretted hydrogen	0·091
Hydrogen	1·431
Ammonia	0·070
	100·000 vols.

The result thus obtained affords a very simple means of determining the influence exerted upon the composition of furnace-gases by the gaseous products of distillation of the coal. If we suppose the coal to be freed from its volatile products, and exposed to the action of a stream of air in a furnace, a volume of air containing 62·423 nitrogen will be converted by the influence of the red-hot coal into a gaseous mixture of the following composition:—

Nitrogen	62·423
Carbonic oxide	32·788

Accordingly, we obtain a gaseous mixture—

Of gases generated by combustion	Nitrogen	62·423
	Carbonic oxide	32·788
Of gases generated by distillation	Carbonic oxide	0·380
	Light carburetted hydrogen	2·527
	Carbonic acid	0·139
	Olefiant gas	0·151
	Sulphuretted hydrogen	0·091
	Hydrogen	1·431
	Ammonia	0·070
		100·000

Thus we see that there is a considerable influence exerted by the gaseous products of distillation on the composition of the gases produced by combustion.

The heat lost in a furnace may be easily compared with that actually realized. The following numbers exhibit the quantities of heat (expressed by the unities which we formerly described) generated during the combustion of the gases, and they show at the same time the part played by each constituent in the development of the heat:—

I.		II.
64·135	Nitrogen yields	00000
33·758	Carbonic oxide yields	84463
1·464	Light carburetted hydrogen yields	19719
0·224	Carbonic acid yields	00000
0·154	Olefiant gas yields	1898
0·114	Sulphuretted hydrogen yields	510
0·107	Hydrogen yields	3713
0·044	Ammonia yields	267
100·000	Furnace-gases yield	110570 units of heat.

The numbers (II.) representing the units of heat are calculated from the data on the heat of combustion found in the posthumous papers of Dulong.

1 kilogramme, or 15444 grains of				
	Carbon burning to CO,	heats 15444 grains of	water to	1499° C.
	,, ,, CO_2,	,,	,,	7371°
	Carbonic oxide ,,	,,	,,	2502°
	Hydrogen	,,	,,	34706°
	Light carburetted hydrogen	,,	,,	13469°
	Olefiant gas	,,	,,	12322°
	Sulphuretted hydrogen	,,	,,	4476°*
	Ammonia	,,	,,	6060°*

The quantity of heat actually generated in the furnace during the escape of the unused 110570 units of heat may be determined by the amount of nitrogen in the gases, which corresponds to the quantity of the air consumed during their escape. The amount of nitrogen found, viz. 64·126, corresponds to 83·29 of atmospheric air, which is able to effect the conversion of 14·367 carbon into carbonic oxide gas. Proceeding on the experiments of Dulong, the quantity of heat thus liberated will be 21536°. Thus it follows that a furnace filled with Gasforth coal could realize in the most favourable conditions only 16·30 per cent. of its combustible material. The remainder, 83·70 per cent., escapes as unused but useful combustible matter. The practical use of these gases does not depend merely upon the quantity of heat generated during their combustion, but involves another equally important consideration, viz. the temperature capable of being attained by their use as fuel. This may be determined without any new experiments, by founding the calculation on the composition of the gas, its combustible value, and the capacity for heat of the products generated during combustion.

1 kil. of the gas gives, by its combustion, as we have already seen, 1105·7 units of heat. The products of combustion weigh 2·1385 kil.; and if this last quantity† consisted of water, the heat liberated would raise it to a temperature $\frac{1105{\cdot}7}{2{\cdot}1385}$. Now as the capacity of heat of water is to that of the products of combustion as 1 : 0·2665, and the elevation of temperature produced in different bodies of equal weight, by equal quantities of heat, is in inverse

* The ammonia and sulphuretted hydrogen are calculated from their constituents.

† In this, and also in other similar calculations, the small quantity of sulphuretted hydrogen has been left out of the calculation.

proportion to their capacity for heat, we obtain, as the expression for the temperature of the mixture of gas burning with air, $\frac{1105\cdot7}{2\cdot1385 \times 0\cdot2665} = 1940°$ C., or 3522° Fahr.

In these calculations we have neglected the influence exerted on the composition of the products of combustion by the gases escaping from the iron ore and limestone. Of course this must differ according to the quantities of materials used in the furnaces, and we therefore select as a basis for the calculation the iron furnaces of Alfreton, belonging to Mr. Oakes, the dimensions of which are given in fig. 6. We proceed on the supposition that the carbonic acid of the limestone and the oxygen of the ore are separated as carbonic acid. The coal used in the furnace was subjected to distillation with the precautions already described, and the composition thus obtained gives us the limits to which the combustible constituent of the gases from the furnace might be deteriorated under the most unfavourable conditions.

		grm.
1.	Weight of the coal used	25·7170
2.	" coke remaining	17·2894
3.	" gaseous and liquid products of distillation	8·4276
4.	" liquid products alone	5·7239
5.	Quantity of tar in the latter	2·4945
6.	" water	3·2294
7.	" chloride of platinum and ammonium from the latter	0·5428
8.	" sulphuretted hydrogen and carbonic acid	0·3574
9.	" sulphuret of lead formed	0·4530
10.	Weight of the condensed hydrocarbons	0·1321

The eudiometric analysis of the uncondensed gases gave the following results:—

	Volume.	Temp.	Pressure.	1 m. at 0° C.
Gas used	119·9	10° C.	0·4739	54·81
After admission of oxygen	304·4	10	0·6542	192·11
After the explosion	189·9	10	0·5335	97·73
After absorption of CO_2	125·9	9·9	0·4801	58·33
After admission of hydrogen	350·1	9·9	0·6850	231·44
After explosion	129·2	10	0·4625	57·64

If we suppose that the very inconsiderable quantity of nitrogen found in the calculation (0·4) was an unavoidable impurity, we obtain, by the use of the formula 1, 2, 3, the following composition for the gas examined:—

	According to volume.	According to weight.
Hydrogen	15·41	0·001377
Light carburetted hydrogen	34·64	0·024656
Carbonic oxide	4·76	0·005954
	54·81	0·031987

The 2·2142 carbonic oxide, carburetted hydrogen and hydrogen found in the analysis consist therefore of—

Light carburetted hydrogen	1·7067
Carbonic oxide	0·4122
Hydrogen	0·0953
	2·2142

Thus 100 parts of the coal were broken up into the following products:—

Carbon	17·289	67·228
Tar	2·494	9·697
Water	3·188	12·397
Carburetted hydrogen	1·707	6·638
Carbonic oxide	0·412	1·602
Carbonic acid	0·293	1·139
Condensed hydrocarbons	0·132	0·513
Sulphuretted hydrogen	0·065	0·253
Hydrogen	0·095	0·370
Ammonia*	0·042	0·163
	25·717	100·000

The 67·228 carbon in the above analysis must escape altogether as carbonic oxide, if a part of it were not converted into carbonic acid at the expense of the oxygen of the iron ore. In order to determine the quantity of carbonic acid thus produced, we must refer to the details of the Alfreton iron-works, in which the following materials are used for the production of 140 lbs. of pig-iron:—

420 lbs. calcined iron ore; 390 lbs. coal; 170 lbs. limestone.

According to the above experiment, 100 parts of the coal used give 67·228 of coke; but this quantity of coke does not correspond exactly to that of the carbonic oxide formed during its combustion. It is necessary before calculating this to deduct the amount of ashes contained in the coal, and the following analysis of the Furnace-coal of Alfreton gives us the data for the calculation:—

Carbon	74·83
Hydrogen	5·10
Oxygen	9·71
Nitrogen	0·18
Hygrometric water	7·50
Ashes	2·68
	100·00

As the 2·68 of ashes must be deducted from the 67·228 of coke, the latter corresponds to 64·548 of pure carbon. Part of this carbon however enters into combination with the iron, and is thus withdrawn from combustion. If we take, according to the analysis of Bromeis †, 3·3 per cent. as the average amount of carbon in cast iron, there must be 1·18 subtracted from the 64·548 of carbon, because the proportion of iron produced to coal used is 35·8 : 100. If we conceive the remainder 63·368 carbon to be burnt with air to carbonic oxide, we obtain as the product of combustion a mixture of—

Nitrogen	285·100
Carbonic oxide	147·858

Of this 147·858 carbonic oxide, part is converted into carbonic acid at the expense of the oxygen in the iron ore. The quantity of cast iron produced from 100 of coal is 35·8, and corresponds to 34·62 of pure iron, for the reduction of which 14·83 oxygen must have been given over to the carbonic oxide gas. By this means 25·952 of the latter would be converted into 40·782

* The ammonia escaping with the gases out of the condensed alcoholic water is neglected in this calculation.

† Bromeis, Liebig's Ann. der Chem. B. xliii. S. 243.

of carbonic acid. The quantity of limestone added to 100 of coal is 43·59. This limestone consists, according to our analysis, of—

Lime	54·4
Carbonic acid	42·9
Magnesia	0·6
Alumina	0·8
Moisture and loss	1·3
	100·0

We must therefore introduce into the calculation, that 18·7 of carbonic acid are evolved from the limestone for every 100 parts of coal. By noticing all these observations the result is obtained, that 100 parts of coal thrown into the mouth of the furnace is reduced to 67·228 coke, by the loss of gaseous matter, and that this quantity, by passing into combustion when it has descended to the tuyère, produces a gas which, mixed with the nitrogen of the air and the carbonic acid from the limestone, passes back to the mouth of the furnace in the form of a gas consisting of—

Nitrogen	282·860
Carbonic acid	59·482
Carbonic oxide	121·906
	464·248

If this quantity be added to the products of distillation of 100 parts of coal, the following composition is obtained for the gases escaping from the furnace:—

	I. According to weight.	II. According to volume.
Nitrogen	59·559	60·907
Carbonic acid	12·765	8·370
Carbonic oxide	26·006	26·846
Light carburetted hydrogen	1·397	2·536
Hydrogen	0·078	1·126
Condensed hydrocarbons	0·108	0·112
Sulphuretted hydrogen	0·053	0·045
Ammonia	0·034	0·058
	100·000	100·000

From the numbers given in I. we may compare the proportion of the heat realized in the furnace during the process with that which escapes in the form of useful combustible matter.

These are generated by the combustion of—

59·559	Nitrogen	0000
12·765	Carbonic acid	0000
26·006	Carbonic oxide	65067
1·397	Light carburetted hydrogen	18826
0·078	Hydrogen	2704
0·108	Olefiant gas	1331
0·053	Sulphuretted hydrogen	238
0·034	Ammonia	208
100·000		88374

And therefore out of 100 of the gases, 88374 units of heat are generated.

The units of heat, 88374, may be considered as the measure of the quantities of heat capable of being realized by the combustion of the furnace-gases. In order to find the proportion of the fuel actually realized in the furnace to that lost, we have only to calculate the units of heat produced in the furnace itself during the development of 100 parts of the furnace-gases. The only source of heat in the furnace is the oxidation of carbon, and this oxidation is effected at the cost of the air introduced by the blast, and that of the oxygen contained in the oxide of iron. Let us now consider the influence on the units of heat occasioned by the combustion of the carbonic oxide at the expense of oxygen in the oxide of iron. From the posthumous results of Dulong on the heat of combustion, it follows that the quantities of heat evolved by the combustion of 1 lit. (61·028 cubic inches) of oxygen with iron or with carbonic oxide is almost quite equal. The first gives 6216 and the latter 6260 units of heat. The trifling difference between these numbers is quite within the limits of error of observation, and therefore we may draw the conclusion, as Ebelmen has already done, that the reduction of the oxide of iron is without influence upon the development of heat in the furnace; for in the reduction of the oxide of iron at the cost of the carbonic oxide a thermo-neutrality takes place. Hence the combustion of the oxygen of the air is the only source of heat in the furnace. It suffices to determine the amount of oxygen which has accompanied the 59·559 nitrogen into the furnace in the form of atmospheric air, in order to fix the amount of heat generated. The carbonic oxide formed by the combustion of this oxygen is the only source of heat realized in the furnace, and corresponds, as will be seen in the following calculation, to 20001. For every 20001 units of heat realized in the furnace, 88374 are lost by the gases which escape.

Hence follows the remarkable conclusion, that in the furnaces of Alfreton not less than 81·54 per cent. of the fuel is lost in the form of combustible matter still fit for use, and that only 18·46 per cent. of the whole fuel is realized in carrying out the processes in the furnace.

The maximum temperature which might be obtained by the combustion of the gases may easily be deduced by the following considerations. 1 kil. (15444 grains) of the gas burned with atmospheric air gives 1·9338 kil. products of combustion, of the following composition and specific heat:—

Nitrogen	68·016	0·1859
Carbonic acid	29·896	0·0661
Aqueous vapour	2·088	0·0176
	100·000	0·2696

If we divide the units of heat, viz. 883·74, arising from the combustion of 1 kil. of the gases, by the number resulting when the quantity of the products of combustion is multiplied by their specific heat ($1·9338 \times 0·2696$), we obtain for the temperature of the flame 1695°·2 C., or 3083° Fahr. It is obvious that the gases escaping from the furnace must be of still more value as fuel than that expressed by our calculations founded upon their composition when of minimum value. They must be of a higher value, from the circumstance that the reaction of the liquid products of distillation on the red-hot coals produces a number of gaseous substances which must necessarily increase their value as fuel. The upper layers of coal, limestone and iron, being cold, cause a condensation of the water and tar, both of which drop back upon the red-hot coals in the inferior layers, and become partly decomposed into hydrogen and carbonic oxide gas; whilst another part of the tar is broken up into hydrogen, light carburetted hydrogen and charcoal. The portions escaping this decomposition are condensed anew by the cold layers above, and finally themselves suffer change. For the purpose of determining the influence exerted by this circumstance on the composition of the gases, we have repeated the experiment on the distillation of the coal, reversing however the mode of heating the tube; we began at the front part instead of the closed end of the tube, so that the products of distillation might have to traverse the red-hot coals, and thus suffer a similar process of decomposition to that which they experience in iron furnaces. The ammonia in this experiment was collected in a Liebig's condenser filled with muriatic acid, and the gases were detained in a gasometer filled with boiled water. The determination of the other data necessary for the calculation was done as in the previous experiments, and the following results were obtained:—

Weight of the coal used	20·4550
" coke remaining	13·6568
" liquid and gaseous products of distillation	6·7982
" liquid products alone	3·5389
" chloride of platinum and ammonium obtained	0·7681
" sulphuretted hydrogen and carbonic acid	0·5159
" sulphuret of lead	0·2500
" gases evolved	3·2593

The quantity of gas collected had the following composition:—

In First Eudiometer.

	Volume.	Pressure.	Temp.	1 m. at 0° C.
Original volume	116·2	0·6321	11°·0	70·61
After absorption of HC	111·9	0·6294	10·8	67·75
In Second Eudiometer.				
Original volume	108·6	0·4441	11·1	46·35
After admission of O	282·1	0·6152	11·0	166·84
After explosion	193·8	0·5308	11·1	98·86
After absorption of CO_2	159·2	0·5040	10·4	77·30
After admission of H	383·5	0·7080	11·1	260·92
After explosion	75·4	0·4201	11·3	30·42

Hydrogen	51·32
Light carburetted hydrogen	28·28
Carbonic oxide	16·35
Olefiant gas	4·05
	100·00

The 3·259 grms. of the gases obtained by distillation must therefore be composed as follows:—

Hydrogen	0·298
Light carburetted hydrogen	1·307
Carbonic oxide	1·327
Olefiant gas	0·327
	3·259

100 parts of the coal distilled in this way gave—

Coke	13·657	65·123
Tar and water	3·480	16·594
Light carburetted hydrogen	1·307	6·233
Carbonic oxide	1·327	6·328
Carbonic acid	0·480	2·289
Olefiant gas	0·327	1·559
Sulphuretted hydrogen	0·036	0·172
Hydrogen	0·298	1·421
Ammonia	0·059	0·281
	20·971	100·000

This result, contrasted with that obtained when the coal was distilled so as to prevent the products of distillation passing over the red-hot coal, enables us to see clearly the influence exerted upon the tar and steam by the glowing fuel. The liquid products of distillation and the coke are diminished in quantity, and in their place we find an increase of carbonic oxide, olefiant gas and hydrogen, arising from the carbon being oxidized at the expense of water, and from the decomposition of tar at an elevated temperature. Now if we calculate the composition of the furnace-gases from the principles now laid down, we obtain the following result:—

	I. According to weight.	II. According to volume.
Nitrogen	58·218	57·878
Carbonic acid	15·415	9·823
Carbonic oxide	23·956	24·042
Light carburetted hydrogen	1·555	2·743
Hydrogen	0·354	4·972
Olefiant gas	0·389	0·392
Sulphuretted hydrogen	0·043	0·035
Ammonia	0·070	0·115
	100·000	100·000

The proportion of the substances in this mixture of gases may be viewed as the limits to which the quantity of combustible constituents may increase, when formed under the conditions such as those existing in the Alfreton iron-works. We observe at the same time, that the increase of combustible materials effected by the reaction of the liquid products of distillation on the red-hot coal, principally depend upon the augmentation of hydrogen and olefiant gas. If we calculate from the above numbers, according to the principles already laid down, the quantity of heat evolved in the furnace by the formation of 100 parts by weight of the gases, and compare it with the heat which might be derived by the combustion of these gases themselves, we obtain the proportion 98583 : 19550, a result showing that in the Alfreton furnaces, under favourable circumstances, only 16·55 per cent. of fuel is realized; while 83·45 per cent. is actually lost by escaping in the form of inflammable gases.

1 kil. of the gas burnt with air gives 1·9290 kil. products of combustion, which consist of

Nitrogen	67·33
Carbonic acid	29·83
Aqueous vapour	2·84
	100·00

The specific heat of the products of combustion calculated from this composition corresponds to 0·2740, from which it follows that the temperature of the flame of this gas burned with air would be 1768° C., or 3214° Fahr.

Thus then the temperature of the gases of the Alfreton furnaces is 3214° Fahr., when generated under conditions approaching to the favourable circumstances in the furnaces themselves.

Theory of the Hot-Blast Furnaces.

The previous inquiries have led us to a knowledge of the average composition of the furnace-gases, as they are produced during the processes in operation in various parts of the furnace. We have endeavoured to point out the influence exerted on the average composition of the gases by the materials introduced into the furnace, the ultimate products of all of which changes appear at the mouth of the furnace. We now proceed to the most important part of our inquiry by endeavouring to elucidate the nature and mutual relation of all the processes in the reduction of iron. To obtain a knowledge of them, it was necessary to become acquainted with the changes suffered by the ascending column of air from the blast to the mouth of the furnace. We have collected the gases from various depths of the furnace in the manner employed by one of us in his inquiries into the theory of German furnaces in which charcoal is used as fuel. This method has been more lately used by Ebelmen, with several changes which we have been compelled to reject, because in them he introduced a source of error which vitiated his results.

The apparatus for collecting the gases in our experiments consisted of a system of tubes twenty-six feet in length, made of soft malleable iron. The tube was one inch in diameter, and consisted of pieces of five feet in length, screwed together so as to be air-tight. The depth of the tube in the furnace was known by white marks placed at the distance of one foot, and we found that about three of these sunk in an hour during the first part of the experiment, although more slowly afterwards. The top part of the tube was furnished with a lead pipe, through which the gases were conducted to a place fit for experiment. The system of tubes was balanced by a chain passing over a block fixed to a stout wooden upright, and fastened by chains round the furnace. The strong heat of the flame issuing from the top of the furnace rendered it necessary to wet the support from time to time, and this was effected by a fire-engine placed at some distance on the platform. The gases themselves were collected in glass tubes four inches long and $\frac{3}{4}$ inch wide, these tubes being drawn out at both ends and connected with each other, and also with the lead tube, by caoutchouc joints. The pressure of the gas, which amounted often to several inches of water, was too powerful to allow the glass tubes to be hermetically sealed while they remained in connection with the lead pipe. We therefore found it necessary to heat the tubes so as to expand the air to a certain extent, then to tie the caoutchouc joints, and not to seal the tubes hermetically until they had cooled down sufficiently to prevent any small explosion during the melting of the glass. A vertical section of the furnace upon which our experiments were made is represented in fig. 6; it is of the usual size of furnaces in this country, and is supplied with air heated to 626° Fahr., 330° C. This air passes into the furnace under a pressure of mercury of 6·75 inches, out of a nozzle of 2·75 inches in diameter. The iron ore melted in this furnace is an aluminous sphareosiderit, which is previously roasted so as to free it from moisture and carbonic acid, and by this means is converted into an argillaceous peroxide of iron. The furnace is supplied with eighty charges in the course of twenty-four hours; each of these charges, as we have already mentioned, consisting of 420 lbs. of calcined ironstone, 390 lbs. of coal, and 170 lbs. of limestone, the product of which is 140 lbs. of pig-iron. The limestone is broken up into pieces about the size of the fist before being introduced into the furnace, but the coal and ironstone are projected in lumps which not unfrequently weigh above twenty pounds. Iron ore and limestone are thrown into the furnace without any previous mixture. We have collected the gases in all the regions below and above the zone of fusion, for in the latter the collection was impossible, owing to the high temperature, which softened the tubes, or melted them completely. Although the gases under the zone of fusion are actually at a higher temperature than they are at that point of the furnace, we succeeded in obtaining them by boring through the *Front* over the hearth of the furnace, and introducing an iron tube*.

The gases collected over the zone of fusion were first examined, and gave the following results:—

Experiment I.

The depth of the tube was five feet below the upper stratum of fuel and materials. The gases issuing from the tube possessed a peculiar smell different to that of coal-gas, but very similar to the characteristic odour of acrolein; they burned with a yellowish red flame, and were not accompanied with brown vapours of tar. Number of charges, 6.

A. Estimation of olefiant gas and carbonic acid.

	Volume.	Pressure.	Temp.	1 m. at 0° C.
Gas used	132·0	0·6558	12·0°	82·93
After absorption of olefiant gas	131·5	0·6550	11·8	82·57
After absorption of carbonic acid	122·4	0·6471	11·0	76·13
B. Examination of the gas freed from olefiant gas and carbonic acid.				
Gas used	125·2	0·4626	11·0	55·67
After admission of O	205·8	0·5452	11·3	107·74
After combustion	179·6	0·5168	11·1	89·20
After absorption of CO_2	149·7	0·4946	11·0	71·17
After admission of H	321·6	0·6537	11·0	202·09
After combustion	179·6	0·5172	11·0	89·29

Nitrogen	55·35
Carbonic acid	7·77
Carbonic oxide	25·97
Light carburetted hydrogen	3·75
Hydrogen	6·73
Olefiant gas	0·43
	100·00

Experiment II.

The depth of the tube was eight feet. The blast had been interrupted for a whole hour previous to the experiment, but the gases were not collected until the furnace had been for some time in tranquil action. The flame and smell were exactly the same as in the first experiment. Number of charges, 14.

* We have already stated that the principal experiments on which our present inquiry is founded were instituted at Alfreton iron-works, the property of Mr. Oakes of Riddings House. The liberality with which this gentleman opened all his processes to our inspection, and the zeal with which he aided us in our inquiry, under circumstances of no ordinary difficulty, cannot be acknowledged by us with sufficient gratitude. A few short months however have deprived industry of a most scientific manufacturer and society of a most amiable man. Our acknowledgments that our success in the inquiry is mainly owing to the facilities which he offered to us must now fall upon the dead instead of upon the living; but we cannot refrain from expressing our thanks to his sons, who aided us materially in our experiments with their practical knowledge, and especially to Mr. C. Oakes, whose well-appointed laboratory and skill in chemical manipulation were placed at our disposal during our residence at Riddings House.

A. Estimation of olefiant gas and carbonic acid.

	Volume.	Pressure.	Temp.	1 m. at 0° C.
Gas used	105·4	0·6254	11°·0	63·36
After absorption of olefiant gas	104·6	0·6248	11·0	62·82
After absorption of carbonic acid	95·5	0·6173	10·1	56·85
B. Examination of gas freed from olefiant gas and carbonic acid.				
Gas used	125·4	0·4623	10·5	55·83
After admission of O	211·9	0·5680	11·0	115·70
After combustion	185·5	0·5221	11·0	93·10
After absorption of CO_2	155·3	0·5032	10·0	75·39
After admission of H	344·8	0·6757	10·5	224·36
After combustion	195·5	0·5342	10·9	100·43

Nitrogen	54·77
Carbonic acid	9·42
Carbonic oxide	20·24
Light carburetted hydrogen	8·23
Hydrogen	6·49
Olefiant gas	0·85
	100·00

Experiment III.

The depth of the tube in the furnace was eleven feet, and the gases evolved were accompanied by vapour of tar, and possessed the smell of coal-gas. The flame was of a clear yellow, with a strong illuminating power. The number of charges was twenty-three.

A. Estimation of carbonic acid and olefiant gas.

	Volume.	Pressure.	Temp.	1 m. at 0° C.
Gas used	108·3	0·6377	9°·0	66·86
After absorption of olefiant gas	107·6	0·6357	9·0	66·22
After absorption of carbonic acid	98·8	0·6274	9·4	59·93
B. Examination of the gas freed from olefiant gas and carbonic acid.				
Gas used	131·0	0·4773	9·4	60·45
After admission of O	218·9	0·5639	9·4	119·33
After combustion	186·4	0·5322	9·4	95·90
After absorption of CO_2	155·7	0·5126	9·3	77·19
After admission of H	290·2	0·6336	9·3	177·82
After combustion	119·9	0·4540	9·5	52·60

Nitrogen	52·57
Carbonic acid	9·41
Carbonic oxide	23·16
Light carburetted hydrogen	4·58
Hydrogen	9·33
Olefiant gas	0·95
	100·00

Experiment IV.

The depth of the tube in the furnace was fourteen feet; the number of charges twenty-six; the smell of the gases was ammoniacal and tarry; vapours of tar were visible, and the flame was yellow, but of small illuminating power.

A. Estimation of olefiant gas and carbonic acid.

	Volume.	Pressure.	Temp.	1 m. at 0° C.
Gas used	124·2	0·6462	7°·5	78·12
After absorption of olefiant gas	121·0	0·6529	7·5	76·89
After absorption of carbonic acid	111·5	0·6430	7·5	69·78
B. Examination of gas freed from olefiant gas and carbonic acid.				
Gas used	147·2	0·4956	7·5	71·01
After introduction of O	232·6	0·5800	7·5	131·31
After combustion	188·4	0·5363	7·7	98·27
After absorption of CO_2	156·1	0·5108	7·4	77·63
After introduction of H	291·6	0·6361	7·7	180·40
After combustion	144·0	0·4927	7·7	69·00

Nitrogen	50·95
Carbonic acid	9·10
Carbonic oxide	19·32
Light carburetted hydrogen	6·64
Hydrogen	12·42
Olefiant gas	1·57
	100·00

Experiment V.

Depth of the tube in the furnace seventeen feet, thirty-two charges; the stream of gas which had been interrupted for a short time possessed a peculiar tarry smell. There were no vapours of tar, and the flame was yellow and only slightly illuminating.

A. Estimation of carbonic acid and olefiant gas.

	Volume.	Pressure.	Temp.	1 m. at 0° C.
Gas used	114·5	0·6414	11°·6	70·45
After absorption of olefiant gas	113·0	0·6412	11·7	69·48
After absorption of carbonic acid	99·0	0·6320	10·9	60·72
B. Examination of the gas freed from olefiant gas and carbonic acid.				
Gas used	125·5	0·4740	12°·0	56·99
After admission of O	213·4	0·5615	11·8	114·86
After combustion	186·2	0·5345	11·8	95·40
After absorption of CO_2	160·7	0·5197	11·5	80·14
After admission of H	332·6	0·6784	11·7	216·38
After combustion	171·4	0·5237	11·8	86·04

Nitrogen	55·49
Carbonic acid	12·43
Carbonic oxide	18·77
Light carburetted hydrogen	4·31
Hydrogen	7·62
Olefiant gas	1·38
	100·00

Experiment VI.

Depth of the tube twenty feet, thirty-eight charges. The gases were not accompanied by vapours of tar, they smelt ammoniacal and burnt with a pale blue flame.

A. Estimation of olefiant gas and carbonic acid.

	Volume.	Pressure.	Temp.	1 m. at 0°C.
Gas used	96·2	0·7284	12·3°	67·05
After absorption of olefiant gas	96·2	0·7274	12·1	67·01
After absorption of carbonic acid	87·0	0·7175	12·2	59·75

B. Examination of the gas freed from olefiant gas and carbonic acid.

	Volume.	Pressure.	Temp.	1 m. at 0°C.
Gas used	113·9	0·4586	12·2	50·00
After admission of O	213·0	0·5590	12·7	113·78
After combustion	192·8	0·5391	12·7	99·32
After absorption of CO_2	169·8	0·5285	12·1	85·93
After admission of H	335·5	0·6777	12·7	117·27
After combustion	130·7	0·4890	12·2	61·18

Nitrogen	60·46
Carbonic acid	10·83
Carbonic oxide	19·48
Light carburetted hydrogen	4·40
Hydrogen	4·83
	100·00

Experiment VII.

Depth of the tube twenty-three feet, forty-two charges. The gas was unaccompanied by tarry vapours, but smelt slightly, although distinctly, of cyanogen, and burnt with a pale blue flame of no illuminating power.

A. Estimation of olefiant and carbonic acid gases.

	Volume.	Pressure.	Temp.	1 m. at 0°C.
Gas used	121·6	0·6517	8·0°	77·02
After absorption of olefiant gas	121·6	0·6517	8·0	77·02
After absorption of carbonic acid gas	113·0	0·6441	8·0	70·71

B. Examination of the gases freed from olefiant gas and carbonic acid.

	Volume.	Pressure.	Temp.	1 m. at 0°C.
Gas used	134·9	0·4817	8·0	63·14
After admission of O	230·9	0·5770	8·0	129·46
After combustion	208·9	0·5560	8·0	112·86
After absorption of CO_2	180·1	0·5312	7·3	93·18
After admission of H	333·6	0·6720	7·7	218·03
After combustion	127·7	0·4730	7·8	58·75

Nitrogen	58·25
Carbonic acid	8·19
Carbonic oxide	26·97
Light carburetted hydrogen	1·64
Hydrogen	4·92
	100·00

Experiment VIII.

Depth of the tube twenty-four feet; the number of charges and character of the gases was the same as in the last experiment.

A. Estimation of olefiant and carbonic acid gases.

	Volume.	Pressure.	Temp.	1 m. at 0° C.
Gas used	141·8	0·6562	10°·9	89·48
After absorption of olefiant gas	141·8	0·6562	10·9	89·48
After absorption of carbonic acid	128·3	0·6523	11·0	80·46
B. Examination of the gases freed from olefiant gas and carbonic acid.				
Gas used	139·7	0·4792	11·0	64·36
After admission of O	207·9	0·5479	11·0	109·50
After combustion	181·6	0·5215	11·0	91·05
After absorption of CO_2	148·1	0·5011	11·0	71·35
After admission of H	286·3	0·6267	11·2	172·36
After combustion	164·6	0·5075	11·5	80·16

Nitrogen	56·75
Carbonic acid	10·07
Carbonic oxide	25·10
Light carburetted hydrogen	2·33
Hydrogen	5·65
	100·00

The gas which we collected within two feet nine inches of the tuyère, possesses such a remarkable composition that we are obliged to devote to it particular attention. The gases, although collected only two feet nine inches above the entrance of air, are entirely free from oxygen, and, what is still more remarkable, do not contain a trace of carbonic acid. Olefiant gas and light carburetted hydrogen could not be present, as the gases produced in the region of the furnace are evolved from materials long exposed to a white heat. Cyanogen, however, was found in the gaseous mixture in such quantity as to be quite sensible by its smell, and by giving the flame its characteristic purple colour.

The analysis of the mixture was effected in the same manner as in the preceding cases, but it is necessary to use the following equations in the calculation of its composition.

We call the quantity of gas used in the analysis A, the quantity of its constituents hydrogen, carbonic oxide, cyanogen, and nitrogen, respectively x, y, z, n; and designate the oxygen used in the combustion as O, and that remaining after combustion as p, and the volumes of gas remaining after the combustion, and then after the absorption of the carbonic acid, as B and C; we then obtain the following expressions:—

$$A = x + y + z + n.$$
$$B = O + n + z + \tfrac{1}{2}y - \tfrac{1}{2}x.$$
$$C = O + n - z - \tfrac{1}{2}y - \tfrac{1}{2}x.$$
$$O - p = \tfrac{1}{2}x + \tfrac{1}{2}y + 2z.$$

The values of the unknown quantities deduced from these equations are—

$$x = O - B + \frac{(C - p + A)}{2},$$
$$y = B - O + \frac{(A - 3C + 3p)}{2},$$
$$z = \frac{C - A + 2O - 3p}{4},$$
$$n = \frac{3C - p + A - 2O}{4}.$$

The gas collected six feet above the hearthstone of the furnace, and two feet nine inches above the tuyère, gave the following results by eudiometric analysis :—

	Volume.	Pressure.	Temp.	1 m. at 0° C.
Gas used	141·3	0·4935	8°·5	67·63
After admission of O	180·1	0·5323	8·5	92·98
After combustion	156·5	0·5083	8·7	77·10
After absorption of CO_2	110·1	0·4688	9·0	49·97
After admission of H	199·2	0·5493	9·0	105·93
After explosion	155·7	0·5077	9·0	76·53

The composition of this gas, calculated out of the preceding numbers by the equations just given, is—

Nitrogen	58·05
Carbonic oxide . . .	37·43
Hydrogen	3·18
Cyanogen	1·34
	100·00

If we calculate the proportion of the nitrogen (including also that in the cyanogen) to the oxygen contained in the gas, after subtracting a quantity corresponding to the hydrogen, we obtain the numbers 79·2 : 22·8, which differ only 2 per cent. from the quantity of oxygen in atmospheric air. Now by calculating this gaseous mixture on the supposition that it does not contain cyanogen and consists merely of nitrogen, carbonic oxide, carburetted hydrogen and hydrogen, using the formulæ which we have provided for such cases, the following composition would result, which is not admissible under the circumstances in which the gas is formed :—

Nitrogen	59·39
Carbonic oxide	38·33
Carburetted hydrogen .	1·79
Hydrogen	0·49
	100·00

Hence this calculation leads us to a composition in which nearly 2 per cent. of light carburetted hydrogen is present, an assumption which at once proves its inaccuracy, when we consider the point of the furnace at which the gas was collected. A consideration of the previous analyses explains the change suffered by the column of air in its ascent in the furnace.

Depth under the top	I. 5 feet.	II. 8.	III. 11.	IV. 14.	V. 17.	VI. 20.	VII. 23.	VIII. 24.	IX. 34.
Nitrogen	55·35	54·77	52·57	50·95	55·49	60·46	58·28	56·75	58·05
Carbonic acid	7·77	9·42	9·41	9·10	12·43	10·83	8·19	10·08	0·00
Carbonic oxide	25·97	20·24	23·16	19·32	18·77	19·43	29·97	25·19	37·43
Light carburetted hydrogen	3·75	8·23	4·57	6·64	4·31	4·40	1·64	2·33	0·00
Hydrogen	6·73	6·49	9·33	12·42	7·62	4·83	4·92	5·65	3·18
Olefiant gas	0·43	0·85	0·95	1·57	1·38	0·00	0·00	0·00	0·00
Cyanogen	0·00	0·00	0·00	0·00	0·00	0·00	trace.	trace.	1·34

A glance at the tabulated results shows that light carburetted hydrogen must be considered an essential constituent of the gaseous mixture, even at a depth of twenty-four feet in the furnace. Now as one of us has elsewhere shown that carburetted hydrogen can neither be formed by the direct combination of carbon with hydrogen, nor by the decomposition of water at the expense of the coals, it must be viewed as a product of distillation, a fact of considerable importance in the theory of the process of smelting in this country, and which leads to the following conclusion,—That the region of the furnace in which the coking of the coal is effected extends to a depth of twenty-four feet from the mouth.

When we consider that the coals are thrown into the furnace in large masses, sometimes 20 lbs. in weight, it will scarcely excite surprise that the space required by the coal, before being converted entirely into coke, is above one-half of the whole depth of the furnace.

The tabulated composition of the gases further shows that the quantity of nitrogen in the gaseous mixture, taken at a depth of fourteen feet, is at a minimum, while the olefiant gas, carburetted hydrogen and hydrogen is at a maximum. As the latter gases are formed from coal only under the influence of an elevated temperature, we draw from this circumstance the conclusion, that the process of distillation of the coal reaches its maximum at a depth of fourteen feet. We remarked, in describing the experiments in detail, that the gases were free from the vapours of tar to a depth of fourteen feet, but that they became richly laden with them on attaining a depth of seventeen feet. The absence of these vapours from the upper part of the furnace proves that they suffer decomposition as they pass through the upper layers of red-hot coal. The water ascending through these layers must also suffer decomposition, and this fact explains the irregularity in the proportions between the carbonic acid and carbonic oxide.

When we compare with each other the different quantities of carbonic oxide and carbonic acid at various depths of the furnace, we see a complete absence of any mutual dependence, contrary to what was observed to be the case in the smaller German furnaces fed with charcoal. In order to understand this phænomenon, it is necessary to consider attentively the conditions under which the materials are exposed.

We have already seen that the coal has to travel twenty-four feet, from the mouth to the *boshes* of the furnace, before it is deprived of its volatile carbonaceous products, hygroscopic water, and water formed by the distillation. Now even if we admit that the temperature in this part of the furnace is never so much lowered by the uninterrupted gasification of the coal as to prevent the reduction of the iron ore, by which carbonic oxide is converted into carbonic acid, still the ore would always be exposed not only to the deoxidizing influence of the furnace-gases, but also to the oxidizing powers of the steam evolved from the coal, which has escaped being coked. The projection of the coal into the furnace in large pieces has therefore the effect of subjecting the ore to a simultaneous reduction and oxidation, on account of which the relation between the carbonic acid, carbonic oxide and hydrogen is made to depend upon local circumstances in the upper part of the furnace. Now when we further consider that the carbonic oxide and carbonic acid escaping from the mouth of the furnace, and from the part superior to the boshes, are almost in equal proportion, we are compelled to look for the cause of reduction of the ore in a region of the furnace still deeper. However, all doubt as to this fact disappears when we refer to the proportion between the nitrogen and oxygen of the gases collected. If the reduction of the ore and evolution of carbonic acid from the limestone had been completely effected above the point of the furnace to which we reached, the gases formed below would have contained their nitrogen and oxygen in the same proportion as in air, and would not have become richer in oxygen gas. But it will be seen that this is really not the case by the following table of the varying proportions of oxygen and nitrogen in the gases collected from the various depths:—

Nitrogen...........	79·2	79·2	79·2	79·2	79·2	79·2	79·2	79·2	79·2
Oxygen	24·9	23·6	24·6	19·5	25·7	23·7	28·2	27·7	27·8

We see from this series of numbers, that the relation of the gases, as regards their proportions from the mouth of the furnace downwards, is quite the reverse of that observed in the German furnaces. At first sight the circumstance strikes us as very inexplicable, because we do not know any chemical process in the furnace capable of diminishing the amount of oxygen contained in the gases; but we are enabled to explain this anomaly on an attentive consideration. The diminution of oxygen begins chiefly at the point where the gases generated by the combustion of coal become developed. The proportion of these gases to each other, shows that, when liberated from the coal, they cannot mix quite uniformly with the column of air ascending from the lower parts of the furnace. Hence the gas collected at this region of the furnace is richer in the gaseous products of distillation of coal than would correspond to its average composition; the hydrogen, for example, actually increases to above 12 per cent. If we suppose, as we have done in the above numerical series, that the hydrogen is derived from the decomposition of water at the expense of the carbon, the quantity of oxygen could not decrease, whatever may be the proportion of the gases generated in this way at the various points of the furnace. But if, as we must suppose, the hydrogen is principally derived from the olefiant gas and empyreumatic oils decomposed by the high temperature, the calculation leads us to a smaller quantity of oxygen than really represents the truth. This fact warrants the conclusion,—That the mean composition of the gases *cannot* be determined at that point of the furnace where the evolution of gas by distillation is at its maximum.

The source of this uncertainty disappears in the deeper parts of the furnace, where the olefiant gas and the higher hydrocarbons are no longer present. The result obtained at the depth of twenty-three and twenty-four feet, giving the constant mean proportion 79·2 : 27, proves that under the twenty-four feet, there is an evolution of carbonic acid caused either by the reduction of the ore, or by the escape of carbonic acid from the limestone, or perhaps by both causes together. Now we conclude, from the average composition of the gases evolved from the materials used in the furnace, that this evolution of carbonic acid is really owing to the reduction of the ore, and that the process of reduction takes place only in the boshes. The average composition must be somewhere between the following numbers:—

Nitrogen	60·907	....	57·878
Carbonic acid	8·370	....	9·823
Carbonic oxide	26·846	....	24·042
Light carburetted hydrogen .	2·536	....	2·743
Hydrogen	1·126	....	4·972
Olefiant gas	0·112	....	0·392
Sulphuric hydrogen	0·045	....	0·035
Ammonia	0·058	....	0·115
	100·000		100·000

This mixture of gases contains,—

1. The products of distillation of the coal.
2. The products of its combustion.
3. The carbonic acid generated during the reduction of the ore, and expelled from the limestone.

The proportion of nitrogen to oxygen, as deduced from these analyses, is 79·2 : 27·33, and 79·2 : 26·67, or an average of 79·2 : 27. The products of combustion of the coal give the proportion existing in atmospheric air 79·2 : 20·8. Now as the amount of oxygen in the products of distillation of the coal is quite insignificant, and may be safely neglected in the calculation, the increase of oxygen from 20·8 to 27 must depend upon the carbonic acid of the limestone, and the oxygen of the ore given to carbon during the reduction. But the gas collected at twenty-three and twenty-four feet deep, contains 27·6 and 26·5 oxygen to 79·2 nitrogen. Hence at this depth the gas must have already accumulated all the oxygen of the iron, and the carbonic acid of the limestone. These facts warrant us in drawing the following conclusion,—That in hot-blast furnaces fed with coal, the reduction of the iron and expulsion of carbonic acid from the limestone takes place in the boshes of the furnace.

We cannot define by direct observation the exact region of the furnace in which the melting of the iron and formation of the slag are effected, but as the large masses of ironstone cannot enter the hearth in any form except as a liquid, we may safely assume that the point of fusion is at the top of the hearth in hot-blast furnaces.

With the object of rendering these processes more intelligible, we have shaded a section of the furnace so as to represent the different parts employed in their special functions, the drawing being made to an exact scale. A B is the space in which the distillation proceeds, B C and C D show the region in which the reduction of the ore and evolution of the carbonic acid are effected, and in which the materials attain the temperature necessary for fusion.

The marked difference between the results obtained in the continental furnaces and those in this country will cease to excite surprise, when we bear in mind the different nature of the fuel employed. The principal reason of the great depression of the region of reduction in the furnaces of this country, is that almost all the body of the furnace is taken up in the process of coking; and hence the point of reduction must be still further lowered if the pieces of coal be of a large size. These pieces, often in bulk equal to a cubic foot, must remain a long time before the heat penetrates thoroughly through them, and the column of air ascending through this material must yield its heat in order to render gaseous above 30 per cent. of the fuel. Hence the depression of the temperature of the upper half of the furnace becomes so great that it does not suffice for the reduction of the ore, nor is it sufficient for the expulsion of carbonic acid from the limestone. Another important cause lowering the region of reduction, is the high pressure at which the blast is thrown into the furnace, the pressure being six or seven times the amount of that used in Germany. The materials, on this account, traverse through the furnace much more speedily, and therefore require to pass through a larger space to become heated. All these circumstances have much less influence in the German and Swedish furnaces. The charcoal with which the latter are fed is a fuel almost completely coked, and the materials, being in small fragments and thoroughly mixed, offer a heating surface at least a hundred times greater than that exposed in English furnaces.

The small pressure of the blast also effects a slow combustion, so that the fuel frequently takes twice or three times the period to pass through the same region of the furnace.

On the application of Furnace-Gases to practical purposes.

In this division of the subject we have to consider the useful purposes to which these gases may be applied when employed as fuel. Their practical value does not so much depend on the amount of heat capable of being generated by their combustion, as upon their maximum temperature; and both these conditions may be exhibited by examining the composition of the various mixtures of gases obtained from different depths in the furnace. But it would be erroneous to suppose that the values thus obtained by calculation expressed in all cases the average practical effects capable of being derived by their application on the large scale, for such a conclusion would only be justifiable when the numbers obtained by analyses expressed the average value. That this is not the case has been shown in the above considerations as to the proportion between the nitrogen and oxygen, for we observed at the depth of fourteen feet, when the gases were richest in combustible materials, this relation was the least observed. Even in the highest layer of the gaseous mixture, the constituents of which may be viewed as most intimately mixed, we obtain a combustible value more than one-third greater than the above, when we estimate it according to the composition of the materials thrown into the furnace, and the products of distillation of the coal. In order, therefore, to found our calculations on a firm basis, we will estimate the practical value of the gases according to the results obtained in our former calculations, as to the limits of variation in the value of the gases, when deduced from the composition of the materials with which the furnace is supplied. This mode of proceeding will safely lead us to numbers expressing the average value, and will enable us to repose upon them with confidence, from the assurance that the results capable of being obtained on the large scale, must be much greater than those expressed by calculation.

Our experiments have proved the combustibility of the entire column of gas, even when cold, from a depth of twenty-four feet to the mouth of the furnace. Hence it follows that the gas collected from any point to this depth is capable of being applied as fuel. It would be objectionable, however, to conduct the gas from a deep region of the furnace, because we should thus draw off the heat necessary to support the process of coking the coal in its upper part. The gas might be collected from the upper part of the furnace without any detriment to the process, and with additional advantage as fuel, because, while it contains all the combustible products of distillation, it is not deteriorated by having taken up any incombustible ingredients. This circumstance greatly facilitates the application of the combustible gases, for it removes the obstacle to their use in furnaces fed with charcoal. In the latter, the zones of distillation and reduction lie more closely together, and the proportion of ore and limestone to the coal is so much greater than in this country, that the amount of carbonic acid evolved obliges the withdrawal of the combustible gases from a low region of the furnace, where the reduction of the ore and evolution of carbonic acid have been completed. But the withdrawal of the gaseous fuel from a region below that of the reduction necessarily produces such disturbance in the operations of the furnace, that only a small part of these gases dare be removed, while the largest portion must still be allowed to remain and administer to its necessities. The advantage to be derived from the use of the gaseous fuel in this country will therefore be the more obvious, when we consider that its application cannot derange any of the processes

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essential to the reduction and smelting of the ore. In furnaces fed with charcoal, the gaseous fuel has been collected and applied without any great difficulty, by building into the wall of the furnace a circular channel supplied in the inner part with a grating so as to prevent its obstruction by the materials introduced into the furnace. The gases stream freely through this channel, even though the furnace is left entirely open, and though the pressure is so inconsiderable as scarcely to affect a water manometer. The great pressure of blast used in English furnaces led us to the conviction that in them the column of gas must be much more compressed, and we have confirmed this opinion by a series of measurements on a water manometer attached to the tube through which the gases were collected for experiment. The pressure of the gases expressed by the height of the column of water at various depths is as follows:—

5 feet	. . . 0·12	inch.
8 „	. . . 0·40	„
11 „	. . . 1·10	„
14 „	. . . 1·60	„
20 „	. . . 1·80	„
23 „	. . . 4·70	„
24 „	. . . 5·10	„

This table proves that even in the highest portion of the gaseous column, the pressure is considerably greater than in that region of the furnace from which the gases are withdrawn in Germany.

Hence it follows that hot-blast furnaces fed with coal are peculiarly well-adapted for the economy of gaseous fuel, which may be conducted from the furnace and applied without in any way interfering with its operations.

We have already shown, on the very lowest calculation, that at least 81·54 per cent. of valuable fuel must escape from the mouth of the Alfreton furnace. Now as about fourteen tons of coal are used in that furnace every twenty-four hours, it follows, according to our experiments, that 11·4 tons of coal are lost every twenty-four hours by escaping in the form of gases still capable of being used as excellent fuel.

We have previously shown, that the temperature capable of being attained by the combustion of these gases is 3083° Fahr. (1695°·2 C.), and, by using a blast sufficiently heated, this could easily be raised to 3632° Fahr. (2000° C.). Now as Pouillet has shown that cast iron melts at 2192° Fahr. (1200° C.), it follows that the gases of hot-blast furnaces fed with coal, when burned with hot air, would yield a temperature more than sufficient to melt iron.

The gases of our furnaces fed with coal contain a very valuable constituent, which is entirely absent from the charcoal furnaces of the continent. This substance is ammonia, which is present in such abundance, as to be sensible to the smell in the gases collected from the deeper parts of the furnace. We have therefore devoted our special attention to this valuable ingredient, and have arrived at the conclusion that it is possible to economise it in the most simple manner. The ammonia may be obtained in the form of sal-ammoniac, if the gas previous to its application as fuel be conducted through a chamber containing muriatic acid. In collecting the ammonia in this manner, there need be little fear of any considerable deposition of tar, for the product of distillation flows back upon red-hot coal, and is so completely decomposed, that the tube, thirty feet long, used by us for a period of twelve hours in collecting the gases, scarcely contained a trace of tar, although its temperature was not sensibly higher than that of the surrounding air.

If the solution of sal-ammoniac produced by the condensation of the ammonia be allowed to flow into an evaporating pan, over the surface of which a small part of the flame of the combustible gas is allowed to play, a convenient arrangement of the liquid and of the burning stream of gas would enable us to obtain a constant flow of a concentrated solution of sal-ammoniac as an auxiliary in the manufacture. The advantage of its collection is, that without any further consumption of fuel, or any considerable expenditure of labour, a valuable commercial ingredient would be economised. Hence it is of importance to estimate how much ammonia we might hope to obtain in this way; and this is easily determined by the quantity generated during the distillation of coal. We have subjected the furnace-coal of Alfreton to various trials, both by distilling it *per se*, and along with a mixture of soda and lime, and then by separating the ammonia in the usual way from the liquid products of distillation by means of chloride of platinum.

I. 2·887 furnace-coal of Alfreton, heated with soda and lime, yielded 0·0801 chloride of platinum and ammonia.

II. The experiment repeated with 5·687 coal gave 0·175 chloride of platinum and ammonium.

III. 20·455 grms. distilled *per se*, gave a product collected in muriatic acid, which, after separation of the tar, yielded 0·7681 chloride of platinum and ammonium.

Hence 100 parts of the furnace-coal of Alfreton yields the following quantities of sal-ammoniac:—

I. Experiment . . .	0·666
II. " . . .	0·739
III. " . . .	0·902
Mean	0·769

Now, as 280 cwt. of coal are consumed in the Alfreton furnace every twenty-four hours, it follows that more than 2 cwt. sal-ammoniac might be obtained from it as a subsidiary product, without increasing the cost of manufacture, or in the slightest degree disturbing the process of smelting.

We have confined ourselves in this examination principally to the consideration of the furnace-coal of Alfreton, but we may naturally expect considerable differences as to the amount of nitrogen in other coals used in this and in other countries. The estimation of the nitrogen, with regard to the possibility of applying the ammonia generated by their distillation, thus becomes a question of considerable importance. We therefore reserve for ourselves the prosecution of this inquiry in a succeeding paper. Before leaving this subject, however, we have to allude to some experiments, showing the facility of condensing the ammonia.

As the gases from the upper parts of the furnace are saturated with aqueous vapour, which condenses along with the ammonia in the lead tube with which they were collected, we have taken the proportion of the ammonia carried away in the gases, so as to compare it with that which had suffered condensation. For this purpose, the gases flowing through the iron and lead pipes, sunk from eight to ten and a half feet beneath the charging-plate, were conducted through muriatic acid for two hours seven minutes. We determined the volume of the gas passing through the acid by collecting it at various times during the experiment in a balloon made of gold-beater's skin, of the capacity of 380·8 cubic inches, observing the time which was required to fill the balloon. The mean result, which deviated only slightly from the individual trials, showed that the gas required 1′ 7″ to fill the balloon, and therefore that 43304·76 cubic inches have passed through the muriatic acid. The examination of the muriatic acid used in the experiment gave 0·198 grm. chloride of platinum and ammonium, corresponding to 0·0152 ammonia. If we assume as the composition of the gases that formed at a depth of eight feet, we can easily calculate the quantity of coal necessary to produce the above 43304·76 cubic inches of gas. According to analysis, 1000 cubic centimetres of this gas contain 547·7 cubic centimetres of nitrogen. We have already seen that nitrogen is not produced from the materials introduced into the furnace, and hence all the amount present must have been introduced by the blast as atmospheric air, which, burning before the tuyère, mixed with the gaseous products of distillation in the upper parts of the furnace, and produced the above 547·7 cubic centimetres of nitrogen. But as this amount of nitrogen is derived from atmospheric air, it implies that 143·84 cubic centimetres, or 0·2066 grm. of oxygen has been consumed in the lower part of the furnace by uniting with 0·1549 grm. of coke, in the formation of carbonic oxide. But, as has already been shown by a previous experiment, 0·2304 grm. of coal must have been distilled to produce the 0·1549 grm. of coke; and as the above quantity of coal is required to generate one litre of the above gaseous mixture, 163·5 grm. must have been employed in the generation of the 43304 cubic inches of gas washed by the muriatic acid. Hence it follows that only 0·0093 grm., or 3·77 per cent. of the ammonia generated from 100 parts of the coal (which according to our experiments amounts to 0·2463 grm.) pass over along with the gases; so that the remaining 0·2370 grm., or 96·23 per cent. of ammonia, must have been condensed in the water of distillation found in the tube. In fact we ascertained that the lead tube contained a clear liquid so strongly charged with ammonia as instantly to render blue reddened litmus paper held over it. These experiments prove how easily the ammonia might be condensed, even without the intervention of an acid.

It will be observed that the gases from the inferior parts of the furnace contain cyanogen, the presence of which is highly interesting, not only in a theoretical, but also in a practical point of view. This gas appears immediately over the point of entrance of the blast, and again disappears at a small elevation above it, so that at the top of the boshes only traces of it are observed. The compound of this substance with potassium appears to play a most important part in the furnace, although its functions have apparently been altogether overlooked. This is the more surprising, as it has long been known that cyanide of potassium effloresces on the walls in certain states of the furnace. We have been fortunate enough to elucidate the conditions of its formation and to fix its region in the furnace. In obtaining information with regard to the formation of this cyanogen gas, it was necessary to withdraw the gases from the vicinity of the hearth of the furnace, and through the kindness of Mr. Oakes we were enabled to bore a hole over the *Front* of the furnace two feet nine inches above the level of the tuyère. As soon as this hole was made a gas issued from it possessing strong illuminating powers, and burning with a yellow flame, from which came abundant vapours of white smoke. On introducing an iron pipe into the hole, without allowing it to pass into the furnace, it was retained sufficiently cool to prevent its fusion, and we were enabled to collect the volatile products. The gases which poured out of this tube under a pressure of several feet of water were so richly laden with vapours of cyanide of potassium, that we were obliged to use precautions in approaching its opening, so as not to suffer injurious consequences from this poisonous material. Although the conducting-tube was twenty-two feet in length, the amount of cyanide of potassium carried along with the gas was so considerable as to fill in a very short time glass tubes of one-eighth of an inch in width, and we therefore endeavoured to obtain an approximative result as to the amount which thus passed over with the gases and escaped condensation in the long tube. The opening of the iron tube was connected with an empty Wolf's-bottle, to which another was attached containing water, in such a manner that the gas had to stream through a layer of four inches of the latter. The first of these bottles became quickly filled with a rich white sublimate of dry cyanide of potassium, while the water in the second became a tolerably concentrated solution of the same substance. It was now necessary to determine the quantity of gas which passed through the bottles, and this we ascertained by accurately noting the time employed in the experiment and the exact period necessary to fill a balloon of known capacity attached to the second bottle.

1. Duration of the experiment, 24 minutes;
2. Mean time required to fill the balloon, 25 seconds;
3. Capacity of the balloon, 380·8 cubic inches.

Hence it follows that 21933 cubic inches of gas passed through the bottle. The cyanide of potassium in the Wolf's-bottles and their connecting tubes were made into one solution, which weighed 381·024 grms., and 129·211 grms. of this solution yielded 0·62208 grm. cyanide of silver, which was easily decomposed by fuming sulphuric acid. Hence, in the 21933 cubic inches of gas which had passed through the flasks, there must have been 0·8944 grm. of cyanide of potassium held in mechanical suspension. We have already seen that the gas possessed the following composition:—

Nitrogen	58·05
Carbonic oxide	37·43
Hydrogen	3·18
Cyanogen	1·34
	100·00

The 21933 cubic inches of gas, admitting only its approximative estimation, its temperature being neglected, must contain 1192·97 grains of carbon, corresponding to 1774·79 grains of coal. Hence out of 100 parts of coal, at least 0·778 of cyanide of potassium are generated; and as 31200 pounds of coal are consumed every day in the furnace, it is obvious that at least 224·7 lbs. of cyanide of potassium are generated daily in the Alfreton furnace and hitherto have been altogether lost.

When the iron tube used in the experiment was withdrawn from the furnace, it was found to be encrusted with melted cyanide of potassium, which speedily deliquesced in the air. On bringing it in contact with water, a considerable quantity of hydrogen gas was evolved, obviously due to the presence of reduced potassium, or to its compound with carbonic oxide. In the tube itself at least three or four times the amount of cyanide of potassium was condensed, so that we may be quite certain that the amount formed is far more considerable than we have stated. With these unexpected results before us, it became of importance to determine the origin of the large quantity of potassium in the furnace. At first we conceived that it might be present in the limestone, which not unfrequently contains carbonate of potash, according to the researches of various chemists; but on examining as much as 30 grammes, we were unable to detect in it the smallest trace. However, we were informed by Mr. Charles Oakes that he had detected the presence of potash in the iron ore, and we are glad to be able to confirm the result of this talented young chemist. We have subjected an average sample of the calcined ore to analysis, according to the methods usually employed in such cases. The quantity used in the analysis was 2·324 grms., which yielded 1·400 peroxide of iron, 0·153 alumina, 0·145 carbonate of lime, 0·202 phosphate of magnesia, and 0·599 silica. In order to estimate the amount of potash, 17·936 grms. were ignited with carbonate of barytes, dissolved in muriatic acid, and the bases, after separation of the silica, were as much as possible precipitated by carbonate of ammonia. The solution was then freed from barytes by means of sulphuric acid, and the excess of the latter removed by evaporation with chloride of strontium. In this way the remaining bases were converted into chlorides soluble in alcohol, and the solution mixed with chloride of platinum and evaporated to dryness in the water-bath left a residue, which, treated with alcohol to dissolve out the other chlorides, consisted of pure chloride of platinum and potassium, and weighed 0·689 grm. This analysis gives the following composition for the calcined ore:—

Silica	25·775
Peroxide of iron	60·242
Alumina	6·583
Lime	3·510
Magnesia	3·188
Potash	0·743
Manganese	traces.
	100·000

Another source of the potash was found to be in the coal, although to a less extent than in the ore: 1·627 grm. of the coal, dried at 212°, yielded 0·122 grm. of water; 0·2865 grm. gave 0·7865 grm. of carbonic acid and 0·153 grm. of water; 2·887 grms., heated with the mixture of soda and lime, gave 0·0801 of chloride of platinum and ammonium. The experiment, repeated with 5·687 grms. gave 0·175 of the above salt; 13·059 grms. of coal yielded 0·3505 grm. of ashes, which did not effervesce with acids; and this quantity of ashes, treated as in the case of the iron ore, gave 0·046 grm. of chloride of platinum and potassium. The coal therefore is composed as follows:—

Carbon	74·98
Hydrogen	4·73
Oxygen	10·01
Nitrogen	0·18
Water	7·49
Silicates	2·61
Potash	0·07
	100·00

The quantity of ironstone consumed by the furnace every twenty-four hours is 33600 lbs., and that of coal 31200 lbs., so that the furnace receives every day in these materials 271·48 lbs. of potash, corresponding to 377·3 lbs. of cyanide of potassium. Thus these analyses render intelligible the large quantity of potash which we observed in the inferior parts of the furnace.

But we have yet to discuss the most interesting and important question bearing upon the presence of cyanide of potassium, viz. the origin of its cyanogen. We know how easily ammonia in contact with carbon at high temperatures is converted into cyanide of ammonium. Hence we should be apt at once to admit that the formation of cyanogen is due to the ammonia so freely evolved from the coal during its distillation; and if this view were correct, the existence of one must arise from the destruction of the other. But when we view more closely the circumstances under which the cyanogen is produced, we are compelled to admit that the ammonia cannot take part in its formation. The hearth, at which the formation of cyanogen takes place, is the deepest and hottest part of the furnace, and it would be absurd to suppose that the coal which reaches this part could contain a trace of ammonia, exposed as it has been for eighty hours to a red heat, and in one part to a temperature sufficient to reduce potash. Hence we are compelled to adopt the only remaining conclusion, that the nitrogen of the air introduced by the blast combines directly with carbon to form cyanogen. This direct formation has been argued for by various chemists, and supported in this country by the experiments of Fownes and Young. But as it has been objected to experiments of this kind, that they were instituted without reference to the ammonia of the air, which is apt to be taken by most substances exposed to it, it is scarcely to be wondered at that the direct generation of ammonia is still doubted by distinguished chemists. We have therefore thought it necessary to determine this disputed question by an experiment which seems to banish all sources of error. We have led simultaneously, and under exactly the same conditions, a stream of carbonic acid and another of nitrogen, at a very high temperature, over a mixture of two parts of charcoal from sugar and one part of chemically pure carbonate of potash, and have subjected the products to careful examination. The apparatus used by us in these experiments is represented in fig. 9: *a* is a gasometer, from which a uniform stream of air is made to pass through a bottle filled with sulphuric acid (*b*), and then through a gun-barrel (*c c*) filled with copper turnings. The gun-barrel is kept in a furnace, so that the air passing through it is thoroughly deprived of oxygen and passes into the gun-barrel (*d d*) filled with the mixture of charcoal and potash, and heated to a temperature sufficient to reduce potassium. In the same furnace is placed another gun-barrel (*e e*), filled with the same mixture, and over which is passed a stream of dry carbonic acid from the apparatus *f g*. When both the systems were completely filled, one with nitrogen, the other with carbonic acid, the streams of gas were allowed to pass slowly over the mixture of potash and charcoal, both the tubes in the same furnace being kept at a temperature sufficient to reduce potassium. The gas passing out of the tube filled with carbonic acid had all the characters of pure carbonic oxide, being transparent, inodorous, and burning with a pale blue flame, without depositing any kind of sublimate. The tube over which nitrogen passed emitted a gas richly laden with a white smoke of cyanide of potassium, which sublimed in such quantity as to stop the conducting-tube. When the nitrogen was passed so slowly through the sulphuric acid that the bubbles passed only once in a second, its absorption by the potash was complete, and no gas appeared at the mouth of the gun-barrel; but as soon as the temperature was lowered, so as to be under that necessary for the reduction of potassium, the absorption of nitrogen ceased. The contents of the tube over which carbonic acid had passed were examined after cooling without the detection of the smallest trace of cyanide of potassium. The mixture treated with nitrogen, on the other hand, dissolved (with the exception of its charcoal) with a very powerful odour of hydrocyanic acid. The solution exhibited all the reactions of cyanide of potassium, and yielded 6·982 grms. of cyanide of silver, which dissolved (with decomposition) in fuming sulphuric acid without leaving any residue of chloride of silver after being diluted with water. Hence we cannot for a moment demur to the following conclusion,—That a considerable quantity of cyanide of potassium is formed in iron furnaces immediately above the point where the blast comes in contact with the glowing fuel, and that it owes its formation to a direct union of carbon with potassium and nitrogen of the air.

Our experiments have further shown that cyanide of potassium is volatile at high temperatures, and this property is of much influence in the part which it takes in the reducing process of the furnace. Carried up by the ascending current of gas, the cyanide of potassium, partly in a state of vapour, partly as a solid, reaches the region of the furnace in which the reduction is effected, and here it exerts its well-known reducing power. In consequence of this it is decomposed into nitrogen, carbonic acid, and carbonate of potash, the former of which passes up with the ascending gaseous column to the mouth of the furnace, while the latter, not being volatile, falls back with the other materials in the furnace to that point where it is again converted into cyanide of potassium, under the influence of the carbon and nitrogen. Hence a large quantity of ore may in this way be reduced in the lower part of the furnace, by comparatively a small quantity of regenerated cyanide of potassium. The importance of this view of the part played by cyanide of potassium, although previously entirely neglected, will be seen when we consider that this powerful reducing agent must accumulate in the furnace to a considerable extent. The region of the furnace where the highest temperature prevails forms a limited space, beyond which the cyanide of potassium cannot extend to the lower parts of the furnace until its quantity is so much increased by the potash descending in the materials supplied that the excess of cyanide of potassium escapes volatilization and reaches the blast, where it is burnt and converted into nitrogen, carbonic acid and carbonate of potash, the basis of which unites with the slag. We have already shown that the relation of the nitrogen to the oxygen in the gaseous mixture, collected only two and a half feet over the tuyère, is 79·2 : 22·8, after deducting a quantity of oxygen corresponding to the hydrogen. If the gas generated at this place contained only the nitrogen and oxygen due to the air, the proportion would be 79·2 : 20·8; and hence it follows that the gases at this point must either have obtained oxygen from a source independent of the air, or that a proportion of nitrogen has been abstracted from them. Any one who has had the opportunity of observing the temperature of the furnace at this part will at once agree with the opinion that the excess of oxygen cannot be derived from the carbonic acid or iron ore. A simple inspection of the materials enables us to reject such an explanation as erroneous, for the fused materials flowing from the furnace do not evolve gas, although they come from a point in the immediate vicinity of that where the oxygen has been taken up.

We must therefore admit that this phænomenon is connected with the formation of cyanide of potassium in the furnace. The potash, as it yields its oxygen to carbon during its conversion to cyanide of potassium, assumes for every volume of oxygen lost by it two volumes of nitrogen in the form of cyanogen, and consequently the proportion of nitrogen to oxygen is necessarily increased.

Report on the Ichthyology of the Seas of China and Japan. By John Richardson, *M.D., F.R.S., F.L.S., &c., Medical Inspector of Naval Hospitals.*

The following report is essentially a list of the fish which are known to inhabit the waters of the Chinese empire, to which I have added the Japanese species that have been named in the 'Fauna Japonica' of Siebold, edited by Temminck and Schlegel, and now in the course of publication. The position of the southern islands of Japan, in the same parallels of latitude with the northern coasts of China, and with only a narrow sea intervening, would lead us to believe that the species of fish which resort to the opposing shores of the two kingdoms are the same, and such is the fact as far as our evidence goes. Accurate local catalogues of animals are of much utility to the zoologist, being indispensable instruments for eliciting the geographical distribution of forms and species; but in respect of documents of this kind, ichthyology is far behind the other departments of natural history. We have ample lists of the quadrupeds, birds, reptiles and plants of most of the larger districts of the globe, but out of Europe we cannot refer to an enumeration of the fish of any country that can be said to approach completeness, with the exception of the ichthyology of the Red sea, which has been made known by the labours of Förskål, Ehrenberg and Rüppell. The fish of Madeira have been catalogued by the Rev. R. T. Lowe, and those of the Canaries, collected by Webb and Bertholet, have been described in the ichthyological part of their work by M. Valenciennes. The fish of British India also have been extensively figured by Russell, Buchanan-Hamilton and McClelland; but much comparative examination of the species of that wide country is still required to enable us to distinguish those which are common to other countries or districts of the ocean from those which are peculiar to it. Some of the northern states also of the North American union have very laudably caused catalogues to be formed of the animals of their respective territories, and from the great 'Histoire des Poissons' of Cuvier and Valenciennes, we may extract lists, though by no means full ones, of the Acanthopterygian fish that inhabit the coasts of Brazil, the Caribbean sea, Polynesia, and the Malay archipelago; but of the ichthyology of the extra-tropical seas of the southern hemisphere, and of the whole range of the North and South American coast washed by the Pacific, it is almost silent. About a score of Japanese and Chinese fish were discovered in the time of Linnæus by Lagerstroëm, Houttuyn, Osbeck and others, and a few were added by Langsdorff, who accompanied the Russian admiral in his voyage to the isles of Japan and the South Sea. With these exceptions, the fish of the eastern coasts of Asia, from the sea of Ochotsk down to Cochin China, were, till very recently, known to European naturalists merely by drawings of native artists, several collections of which are to be found in the British and Paris libraries*. Within the last two years Temminck and Schlegel have commenced the publication, which we have already alluded to, of Siebold's ichthyological researches in Japan, and have carried on the work to the eighth fasciculus, and through the great families of *Percidæ*, *Triglidæ*, *Sciænidæ*, *Sparidæ* and *Scomberidæ*. Several novel and interesting forms have been already illustrated in this important work, most of them ranging to the southern coasts of China, and not unknown to English ichthyologists, though published for the first time in the 'Fauna Japonica.' For upwards of fifteen

* A paper published in the third volume of the Chinese Repository, and partly reprinted by Dr. Cantor in his account of the Flora and Fauna of Chusan (Annals and Mag. of Nat. Hist., vol. ix.), gives a more detailed account of what has been done by Europeans in illustration of the natural history of China.

years materials for an ample account of the fish of China have existed in England. John Reeves, Esq., who was long resident at Macao, filling an important office in the employ of the India Company, with an enlightened munificence, caused beautiful coloured drawings, mostly of the natural size, to be made of no fewer than 340 species of fish which are brought to the markets at Canton. These drawings are executed with a correctness and finish which will be sought for in vain in the older works on ichthyology, and which are not surpassed in the plates of any large European work of the present day. The unrivalled brilliancy and effect of the colouring, and correctness of profile, render them excellent portraits of the fish they are intended to represent; but further details of a technical kind, such as the distribution of the teeth in the roof of the mouth, the numbers of the gill-rays, and the fine serratures and denticulations on the edges of the opercular pieces, are required for the location of the species in their proper genera. Such minute characters, which can be detected, in many instances, only by aid of a lens, require to be exaggerated to be shown in a drawing, and indeed, when the serratures of the gill-pieces were sufficiently large to be conspicuous to the naked eye, the Chinese artist has seldom failed to represent them. Mr. Reeves had four copies of these drawings made. One set, which he presented to General Hardwicke, is bound up with that officer's large collection of sketches of Indian fish, in four folio volumes, which he bequeathed to the British Museum. These volumes have been inspected by many English and foreign ichthyologists, and, among others, by Müller and Henle, who refer to them in their excellent 'Plagiostomen.' Another copy, left by Mr. Reeves at Macao with Mr. Beale, formed the groundwork of the enumeration of Chinese fish in Bridgman's 'Chrestomathy,' in which, by the way, very numerous mistakes in the generic names occur. A third copy, which he liberally lent to me, is the foundation of this report*. The Banksian library also contains a work entitled 'Figuræ Piscium Sinensium a Pictore Sinensi pictæ,' which is referred to by M. Valenciennes in the sixteenth and seventeenth volumes of the 'Histoire des Poissons,' treating of the *Cyprinidæ*; the same library possesses a Japanese treatise on fishes, with their Chinese names appended, and with coloured plates; and a manuscript work entitled, "Descriptions of Animals," being an account, in the Linnæan method, of the various species, both terrestrial and marine, observed in a voyage to India and China, with pen and ink figures of small size, but well-executed. The author is unknown. There are also several Chinese works in the library of the British Museum containing figures of fishes, but they are far inferior to the others we have mentioned, and look more like fanciful designs than natural history

* General Hardwicke began his collections of illustrations of Asiatic zoology in the last century, and continued them till his final return to this country in 1818. He lost many specimens and the fruit of much labour by three several shipwrecks; but this, instead of damping his ardour, roused him to fresh exertions, and he was busy up to the time of his death in preparing his collections for publication, the scientific part having been undertaken by Mr. Gray. Among the drawings of fish which he procured, there are some by Major Neeld, others by Major Farquhar, and a considerable number copied from the drawings of Buchanan Hamilton, by that gentleman's consent, and by the same artists which he employed. This is mentioned because a charge of piracy has been made in the Calcutta Journal against General Hardwicke, who was however too high-minded to appropriate to himself the labours of others without due acknowledgement; and the careful references in his own writing on the drawings of Buchanan Hamilton, show that he had no intention of claiming anything that belonged to that distinguished naturalist. The General bequeathed his specimens and the whole of his collections of drawings, amounting to twenty folio volumes, to the British Museum, and also set apart a sum of money to defray the expense of publishing the scientific description of them. His collections have been deposited, as he wished, in the national institution, but his intentions respecting the publication have been entirely frustrated by a chancery suit, which was instituted soon after his death.

illustrations. Mr. Reeves deposited in the British Museum specimens of Chinese fish, both dried and preserved in spirits, part of them the very examples which are figured in his drawings. His son, J. R. Reeves, Esq., has likewise presented various fish procured at Macao to the British Museum; among which are several species not figured in his father's drawings. The Rev. George Vachell, who was Chaplain to the India Company at Macao fifteen years ago, collected about 100 species of fish there, and presented them to the Philosophical Institution at Cambridge, in whose museum they are preserved in spirits, and mostly in good condition. One or two small collections made at Chusan have reached the India House from officers serving there during the late war, and several have been sent to Haslar Hospital by the naval officers employed on various parts of the coast, more especially by R. A. Bankier, Esq., surgeon in the Royal Navy, and Captain Sir Edward Belcher, whose specimens are figured in the 'Ichthyology of the Voyage of the Sulphur,' recently published by aid from the Treasury under the auspices of the Government. The College of Surgeons of London also possesses a small number of Chinese fish, procured by Sir Everard Home in the estuary of the Yang tsze keang, the great river which falls into the entrance of the Yellow sea. An assemblage of Chinese fish, exceeding all these in number, exists in the Chinese collection, made by Mr. Dunn, and now exhibiting at Hyde Park. The proprietor most liberally permitted me to examine this important collection; but owing to my residence at a distance from London, and the way in which the bottles holding the fish are secured in screwed-up cases, I have not been able to avail myself of this permission to the necessary extent for the identification of known species or the description of new ones. In the same collection there are also many coloured drawings of fish. The following list is drawn up from these various sources. Looking to the number of species which it includes, I cannot but consider it as a pretty full enumeration of the fresh-water and marine fish of the eastern coasts of the Chinese empire, and it will furnish the inquirer into the geographical distribution of forms with several important facts. The ichthyology of China forms a material link in the evidence by which we are enabled to trace the variations in the numbers and grouping of species from the seas of Ochotsk, Kamtschatka and Behring's Strait southwards, by the Philippines, Malay archipelago, Javan sea and Torres Straits to the coasts of Australia. The 'Ichthyology of the Voyage of the Erebus and Terror,' under the command of Sir James Clark Ross, another work which owes its existence to the support of Government, will contain a much fuller account of the fish of the higher southern latitudes than any previous ichthyological publication, together with figures of at least 100 new species, some of them taken beyond the 71st parallel. In fact, the gradual disappearance of the arctic forms in the seas of Japan and the north of China, their replacement by other assemblages in the warmer latitudes, and their re-appearance on the coasts of Van Diemen's Land, the southern islands of New Zealand, the Aucklands and other antarctic lands, may be followed with equal, if not more accuracy than similar gradations can be traced through the Atlantic ocean.

General ichthyology has not made sufficient progress to enable us to deduce the laws by which the geographical distribution of species is regulated. The only modern work which professes to describe all the species is yet in progress, and judging from the numerous additions of new species made by every scientific expedition that has left Great Britain or France since the publication of the first ten or twelve volumes of the 'Histoire des Poissons,' we are assured that very many fish remain to be incorporated in it when it sees a new edition, or in any other work that embraces the same objects: and in regard to the extent of range of the described species, the alterations will be no less important. I shall not therefore attempt more in this paper in reference to the geographical distribution of fish than merely to mention one or two facts that have some bearing on opinions at present entertained by geologists. Much stress has been laid upon the existence of tropical forms of fish in the ancient deposits of northern latitudes as a proof of the high temperature of the earth in former ages; but I believe that the range of intertropical species is less restricted than it has been supposed to be. Among the Bermudas, on the 32nd parallel, the *Chætodontidæ* are so abundant that they are preserved in basins inclosed from the sea as an important article of food for the garrison and inhabitants; and a considerable number of fish range northwards from the Brazils to the coasts of the United States, some of them even to the banks of Newfoundland. It is probable that the gulf-stream has something to do with this, as fewer tropical forms seem to reach the same parallels on the coasts of Europe. If so, there is probably a current of a similar kind setting to the northward on the coasts of China, for many species which abound in the Indian ocean range as far north as Japan. M. Agassiz says, "Les Xiphioïdes de Sheppy ont tous le bec arrondi comme le Tetrapture et les Histiophores; or ces derniers ne quittent jamais les mers du Sud." (Rep. Br. Ass. for 1844, p. 305.) Yet M. Bürger has discovered a *Histiophorus* on the south-west coasts of the Japanese isles, and the same or another species exists in the seas of New Zealand.

Several remarkable generic forms described in the 'Fauna Japonica,' such as *Hoplegnathus* or *Scarodon*, *Histiopterus*, *Melanichthys* or *Crenidens* and others, have been detected also in the Australian seas. In short, from the 42nd degree of south latitude to the same parallel north of the equator, between the meridians which include Australia, New Zealand, the Malay archipelago, China and Japan, there is but one ichthyological province, though towards the respective extremes there is a mingling of antarctic and arctic forms with a corresponding diminution in the numbers of the intertropical ones. But in the middle portion of this province its dimensions in longitude are vastly extended. Very many species of the Red sea, the eastern coast of Africa, Madagascar and the Mauritius, range to the Indian ocean, the southern seas of China, the Malay archipelago, the northern coasts of Australia, and the whole of Polynesia,—the almost continuous ranges of islands apparently favouring their distribution. A comparatively small number of these species enter the Atlantic, and such as do are mostly Scomberoids, Scopelines, Lophobranchs, Plectognathes or Sharks. It is repeatedly remarked in the 'Histoire des Poissons,' that few species of fish cross the Atlantic. From this observation, the Scomberoids which skim the surface of the high seas ought perhaps to be excluded; and some allowance must also be made for South American species discovered on the African coasts and islands since the time that the passages in the 'Histoire des Poissons,' to which I allude, were written. But with these qualifications, the remark appears to be well-founded, and the great bulk of species on different sides of the Atlantic are different. When we seek for some cause which may explain this difference in the distribution of the fish of the two oceans, we observe that the bounding shores of the Atlantic run north and south, with a deep sea between them, and no transverse chains of islands. On the other hand, we have from Africa eastward, within the warmer districts of the ocean, a continuous range through the Indian ocean and archipelago, the Malay archipelago and Polynesia, which embraces three-fourths of the circumference of the globe; there being no points of continent which cut through that great zone and project into the colder regions to the southward*. Could we suppose so extensive a belt, having a breadth of sixty degrees of latitude, to be suddenly elevated, we should find the remains of fish scattered over it to be everywhere nearly alike;—the species having a local distribution being comparatively few and unimportant. These spoils of fish would of course, if the opinions of Professor E. Forbes be well-founded, be associated with assemblages of mollusks and other marine animals, varying according to the depth at which the deposit took place. When we advance northwards in the Atlantic, beyond the 44th parallel, the number of species common to both shores increases. The salmon of America is identical with that which frequents the British Isles and the coasts of Norway and Sweden, and the same is the case with the codfish and several other members of the Gadoid family, and also with some Cottoids. The Cottoids increase in number and variety as we approach the Arctic circle, and this is the case also in the northern arm of the Pacific, though the generic forms differ from those of the Atlantic. From the near approach probably of the Asiatic and American coasts at Behring Straits, the fish on both sides are nearly alike, down to the sea of Ochotsk on the one side, and Admiralty inlet on the other. In the sea of Japan, and the neighbouring coasts of China, we find northern forms associated with many common to the temperate and warmer parts of the ocean. In the colder regions of the southern hemisphere there is again a predominance of the Cottoid and Gobioid families, but with a dissimilarity in some of the generic forms, though there are also many genera identical with those of the northern ones. We again find in the southern seas codfish much like those of the north, and *Notacanthus* and *Macrourus*, two very remarkable Greenland genera, which inhabit deep water, and are seldom procured except when thrown up by storms, have recently been discovered on the coasts of New Zealand and South Australia. Several genera are peculiar to the southern hemisphere, such as *Notothenia*, *Bovichthys* and *Harpagifer*; and of these we find the same species at the Falklands, Cape Horn, Auckland Islands and Kerguelen's Land; in fact, in the whole circle of the high latitudes. The fish of the New Zealand seas differ little from those of Van Diemen's Land and South Australia.

From what has been stated, it appears that the ichthyology of the Australian seas has an Asiatic character † as opposed to the Atlantic or South American assemblages of species. The fish of the Pacific coasts of America

* Neither the objects nor the limits of this report admit of a full consideration of the manner in which an archipelago extending in longitude favours the diffusion of many species of fish; but I may remark cursorily, that the multiplication of places of deposit for spawn on the shores of the islands and intervening coral banks, and the appropriate food that many fish find in such places, may have much influence. The *Chætodontidæ*, *Labridæ*, *Balistidæ* and other groups of littoral fish, are among the most remarkable for the extensive range of species. Some of the *Lophobranchi* who inhabit floating beds of sea-weed, to which they adhere by their prehensile tails, have also an extensive range; the moveable and extensive beds of *Sagasso* being, in fact, as far as they are concerned, so many islands.

† Mr. Gray informs us, that setting aside the Marsupials of Australia, which are of a different group from the South American ones, the ordinary quadrupeds, of which many species are now known, have an Asiatic character; and that all the Australian reptiles are like those of the Old World, while those which inhabit the Galapagos belong to American groups. The genera, he goes on to remark, of the Australian reptiles are mostly peculiar, but belong to Asiatic, or at least to Old World families. One species, named *Gecko verus*, is common to Australia and to India and its islands, and the *Plestiodon* 5-*lineatum*, which is very common in North America, exists also in Australia and Japan, and may perhaps have been introduced. The genus, which is a very natural one, and well-characterized, consists of five species, viz. the cosmopolite one that we have mentioned, a second one inhabiting America, a third one belonging to North Africa, and two to China. Specimens from different localities have been carefully examined by Mr. Gray, who considers the diffusion of the species of this genus as an anomaly in the geographical distribution of reptiles.

are too imperfectly known to enable us to ascertain how many of them range to the other side of the great ocean. Is there a marked change either in generic forms or species between the eastern limits of Polynesia and the American coasts?

The desultory observations I have thrown out respecting the distribution of fish apply more particularly to the marine osseous fish, but those which compose the sub-class of *Cartilaginei* have even a more extensive range. The sharks of the China seas and of Australia are for the most part identical. One of them, the *Cestracion*, has attracted the attention of geologists on account of the teeth of an ancient species having been found in European deposits, associated with fossil palms and other plants of the warmer regions. But whatever inference may be drawn from the character of the plants, no great reliance ought to be placed on the teeth of the Cestracion as an indication of the temperature when the deposit was made. The Australian species, or one differing from it chiefly in colour and little in form, inhabits likewise the seas of China and Japan; and when deposits now forming are revealed to the eyes of future geologists, its spoils will be found associated with the Huon pines of Van Diemen's Land, the *Eucalypti* of New Holland, the fern trees of New Zealand, or with the vegetation of the temperate parts of Asia, according to the locality that is explored.

With regard to *freshwater fish*, China agrees closely with the peninsula of India in the generic forms, but not in species. It abounds with *Cyprinidæ*, *Ophicephali* and *Siluridæ*. As in the distribution of marine fish the interposition of a continent stretching from the tropics far into the temperate or colder parts of the ocean separates different ichthyological groups; so with respect to the freshwater species, the intrusion of arms of the sea running far to the northwards, or the interposition of a lofty mountain chain, effects the same thing. The freshwater fish of the Cape of Good Hope, and the South American ones are different from those of India and China. The remarkable mailed Siluroids of intertropical America are unlike any freshwater fish of Africa or Asia, while the *Ophicephali* are almost exclusively Asiatic; a genus of the same family being found at the Cape of Good Hope but none in America. The *Cyprinidæ* have been said to be wanting in Polynesia and Australia. In the coral islands of Polynesia their absence is clearly owing to the want of lakes or rivers, and of Australia it may be said that the rivers have not been sufficiently explored. They exist in the larger islands of the Javan chain, and it is likely that the same species will hereafter be detected in the northern parts of Australia. And the Cyprinoid family is not altogether unknown in Australia. A curious marine Cyprinoid, the *Rhynchana greyi* (Ichth. of Voy. of Erebus and Terror), is not rare in the seas of New Zealand and South Australia. It has been a prevalent opinion that the *Cyprinidæ* are exclusively freshwater fish, but the *Catastomi* of North America frequent the estuaries of the rivers which fall into the Arctic sea, living indifferently in the salt and fresh water, and thriving wherever they find proper food. The anadromous Percoids differ very slightly in form from others that are purely inhabitants of fresh waters; and many examples of the same kind might be adduced from among the marine fish *. The common anadromous salmon (*Salmo salar*) does not descend beyond the 41st degree of latitude on the eastern coast of America, and it is probably restrained within similar bounds on the eastern coast of Asia, for we find no representations of it among the

* In the genera *Ambassis* and *Apogon*, there are species truly marine, with others closely resembling them, that inhabit fresh waters and even thermal springs of high temperature. Most of the *Coregoni* pass their whole lives in inland waters, but many individuals, carried down to the sea by river floods, live and thrive in the brackish or salt waters of the estuaries: and the brackish lagoons of Port Essington on the north coast of Australia furnish full-grown examples of *Carangi*, *Mesopriones*, and other fish considered to be purely marine.

Chinese drawings. It is said by ichthyological writers to be an inhabitant of all the northern part of the Old World, from the entrance of the Bay of Biscay northwards, by the North Cape, along the Arctic shores of Asia and down the coasts of Kamtschatka to the sea of Ochotsk, including the Baltic, White sea, Gulf of Kara and other inlets *. Other kinds of salmon abound in the estuaries of Kamtschatka, and on the opposite coast of America down to the Oregon, but none appear to descend to China.

In the following list Mr. Reeves's drawings are quoted by their original numbers in his portfolio, and also as they are now placed in the volumes bequeathed by General Hardwicke to the nation. A few of Mr. Reeves's drawings, which are not in General Hardwicke's collection, are also quoted. When I have seen Chinese examples of any of the species enumerated in the list, I have seldom omitted to mention the museum in which they are deposited; and when nothing is said of specimens, it is to be understood that the species is named from the inspection of Mr. Reeves's drawings, or when there is no figure on the authority of the authors quoted. The Chinese names are in some cases written from sound and not from sense †. The sounds in English characters and the translations were furnished to me by Mr. Reeves and Mr. Birch, of the British Museum.

Mr. Reeves informs me that few of the fishes represented in the drawings are brought to the tables of foreigners. Soles are almost constantly presented at breakfast, and the *Sciæna lucida* generally forms a part of that meal. The *Leucosoma*, or White Bait of the residents, and a *Serranus*, are regular dinner dishes; and the *Polynemus* called Salmon-fish and the *Stromateus* or Pomfret, when in season. Sturgeon is occasionally seen. The Chinese eat all kinds, from a shrimp to a shark; but Carp, Bream, *Siluri*, *Ophicephali* and Gobies, are the principal fish seen in the markets of Canton.

In drawing up the list I have received much aid from John Edward Gray, Esq., Keeper of the Zoological Department of the British Museum, who had commenced a work on the subject; and great facility in consulting the books and specimens of that institution. With the same want of reserve the Museum of the Cambridge Philosophical Institution was opened to me; and I have already mentioned the liberality of the late proprietor of the Chinese collection at Hyde Park.

Sub-classis Cartilaginei.

Ordo Squali.

Fam. Scylliidæ.

Scyllium maculatum, Gray, Hardw. Illustr. Ind. Zool. t. 98. f. 1. Müller und Henle, Plagiostomen, seite 5. taf.; *Icon.* Reeves, 264; Hardw. Cartil. 38. Chinese name, *Laou hoo sha*, "Tiger shark" (Birch); *Laou hoo sha*, "Tiger shark" (Reeves).

The British Museum possesses a Chinese specimen presented by General Hardwicke. Mr. Reeves's figure measures 2 feet 4 inches, and is the portrait of an individual which was 3 feet long.

Hab. China sea. Indian ocean. Canton.

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* Professor Nilsson mentions that salmon inhabit the freshwater lakes of Sweden named Wenern and Siljan during the winter and spring, and then ascend the rivers to spawn, returning to the lakes again to recruit, as salmon of other rivers do to the sea. The same habit has been ascribed to the salmon of Lake Ontario.

† That is, when the proper character is a complex one, the writer will substitute one of the same sound but of a more simple form, hence the apparent want of meaning of some of the English translations. See note, p. 200.

Scyllium burgeri, M. und H., seite 8. taf. 2.

Hab. Sea of Japan.

Chiloscyllium plagiosum, Bennett (*Scyllium*), Life of Raffles, p. 693; M. und H. p. 17. *Scyllium ornatum*, Gray, Hardw. Ill. t. 98. f. 2. *var.* 2. M. und H.; *Icon.* Reeves, 252; Hardw. Cartil. 45. *var.* 3. M. und H. Chinese name, *Pan chŭh sha*, "Striped bamboo shark" (Birch, Reeves); *Icon.* Reeves, *a.* 2; Hardw. Cartil. 44; Chinese name, *Ta sha*, *var.* 4 M. und H.

The British Museum possesses an example of the second variety which was brought from China by John Reeves, Esq., and there are others in the collection of the Cambridge Philosophical Society, also obtained at Canton by the Rev. George Vachell. Figure 252 in Mr. Reeves's portfolio measures 2 feet 4 inches, and β 2 nearly 14 inches.

Hab. Seas of Japan and China, the Indian ocean and the coasts of the Brazils! (M. und H.)

Crossorrhinus barbatus, Lin. (*Squalus*); M. und H. 21. taf. 5. Watt's shark, Phillips's Voy. to Bot. Bay, p. 168. pl. 43. *Le squale barbu*, Brouss. Lacép. i. p. 247. *Squalus barbatus et lobatus*, Bl. Schn. pp. 128, 137. *Scyllium lobatum*, Cuv. Règ. An. ii. p. 387.

Hab. Seas of Japan and Australia. An Australian specimen exists in the museum at Haslar.

Fam. Carcharidæ.

Carcharias [Scoliodon] acutus, Rüpp. Chondr. p. 5. taf. 18. f. 4; M. und H. 29. *Scoliodon russellii*, Gray. *Icon.* Reeves, *a.* 5; Hardw. Cart. 50 & 47. Chinese name, *Sha tsze*, "Sharkling" (Birch); *Sha yu*, "Sharkfish" (Reeves); *Sha u* (Bridgem. Chrest. 184).

The British Museum possesses a specimen of this shark from Canton, presented by John Reeves, Esq.

Hab. China seas. Canton. Javan sea. Indian ocean and Red sea.

Carcharias [Prionodon] dussumieri, Valenc.; M. et H. 47; *Icon.* Reeves, *a.* 1; Hardw. Cartil. 51. Chinese name, *Tse tow sha*, "Regular head shark" (Birch); *Chae tow sha*, "Even-headed shark" (Reeves) (Bridgem. Chrest. 186).

Hab. China sea. Canton. Indian ocean.

Carcharias (Prionodon) melanopterus, Quoy et Gaim., Freyc. Voy. pl. 43. f. 12; Bennett, Life of Raffl. p. 693; Rüpp. Chondr. p. 3; M. und H. 43. *Sq. requin*, Lacép. i. p. 169. pl. 8. f. 1; *Icon.* Reeves, *a.* 3; Hardw. Cart. 49. Chinese name, *Woo yih sha* (Birch); *Woo yih sha*, "Black-finned shark" (Reeves); *U sih sha* (Bridgem. Chrest. 187).

Hab. China sea. Waigiou. Javan sea. Timor. Australian seas. Red sea.

Sphyrna zygæna, Rondelet, p. 389; Ray; Lin. Bloch, 117 (*Squalus*). *Koma sorra*, Russ. 12. *Zygæna malleus*, Valenc. Mém. du Mus. ix. p. 223. pl. 11. f. 1; Yarrell, ii. p. 406. *Z. lewisii*, Griff. An. Kingd. pl. 50. *Sphyrna zygæna*, M. und H. 52; *Icon.* Reeves, *a.* 4; Hardw. Cart. 59. Chinese name, *Kung tsze sha* (Birch); *Kung tsze* means children's toys (Reeves); *Kung tsz mo sha* (Bridgem. Chrest. 189).

Hab. China seas. Canton. Indian ocean. Brazilian coasts. Mediterranean. Coasts of France and English channel.

Fam. Galeidæ.

Galeus japonicus, M. und H. 58.

Hab. Sea of Japan.

Fam. Scylliodontidæ.

Triakis scyllium, M. und H. 63.

Hab. Sea of Japan.

Fam. Mustelidæ.

Mustelus vulgaris, M. und H. Smooth hound, Yarr. ii. p. 333.

Hab. Japanese and China seas. Australian coasts. Cape of Good Hope. Atlantic. Mediterranean. English channel.

Fam. Lamnidæ.

Lamna cornubica, Lin. (*Squalus*), Gmel. 1497; Goodenough, Lin. Tr. iii. p. 80. pl. 15. *Porbeagle*, Borlase, Cornw. p. 265. pl. 26. f. 4; Yarr. p. 384, and Beaumaris shark, p. 387. *Sq. monensis*, Penn. iii. pl. 7; Shaw, Zool. v. p. 350. *Lamna cornubica*, Cuv. Règn. An. ii. p. 389; M. und H. 67.

Hab. Coasts of Norway. The Sound. English channel. Mediterranean. Atlantic. Sea of Japan.

Fam. Cestraciontidæ.

Cestracion zebra, Gray, Zool. Misc. p. 5; *Icon.* Reeves, 174; Hardw. Cart. 52. Chinese name, *Maou urh sha*, "Cat-shark" (Birch); *Mau e sha*, "Kitten-shark" (Reeves); *Mau i sha* (Bridgem. Chrest. 185).

Specimens of this fish from China exist in the British Museum and in the museum at Haslar. They are all banded transversely, and very differently from the Australian specimens of *C. phillipi*. We have compared drawings of recent examples of this fish with Mr. Reeves's of *zebra*, and find them to be very dissimilar in their markings, but the species are very much alike in form. Müller and Henle most probably consider them to be identical, as they mention *C. phillipi* as an inhabitant of the Japanese seas. Small examples of *zebra* may be found in the Chinese insect-boxes.

Hab. Sea of China.

Fam. Notidanidæ.

Heptanchus indicus, Cuv. Règn. An. p. 39; Agass. iii. tab. E. f. 1. (*Notidanus*), M. und H. p. 82. tab.

Hab. Seas of China, Australia, and the Indian ocean.

Ordo Raiæ.

Fam. Rhinobatidæ (*Squatinoraiæ*, M. und H.).

Rhina ancylostomus, Bl. Schn. p. 352. t. 72; Gray, Hardw. Ill. Ind. Zool. pl. 102. f. 2, The jaws. *Icon.* Reeves, β. 74; Hardw. Cart. 69, 70, 71; Owen, Odont. pl. 23, The teeth. Chinese name, *Pe pa sha*, "Guitar shark" (Birch); *Pe pa yu*, "*Pe pa* shark." "The *pe pa* is a musical instrument like the guitar" (Reeves). *Pe pa u* (Bridgem. Chrest. 164).

Mr. Reeves deposited a Chinese specimen of this fish in the British Museum.

Hab. Seas of China (Reeves). Indian ocean (Bl.).

Rhinobatus schlegelii, M. und H. p. 123. tafel.

The British Museum possesses one of Bürger's specimens, which differs a little from the figure in Müller and Henle's work, in having larger eyes, and somewhat differently shaped spout-holes.

Hab. Sea of Japan.

Rhinobatus hynnicephalus, Richardson. *Icon.* Reeves, α. 7; Hardw Cart. 63. Chinese name, *Le tow shă* (Birch); *Lae tow sha*, "Plough-headed *sha*" (Reeves); *Lai tou sha* (Bridgem. Chrest. 186).

I have seen no specimen of this fish, but after a careful comparison with the description and figures of the species of the several sub-genera composing this genus, as constituted in the 'Plagiostomen' of Müller and Henle, it was not found to correspond with any of them.

The disc is wider than that of *R. schlegelii*, the length being in proportion to the breadth as 7 : 6 : it is more undulated on the fore edge, there being a conspicuous widely-rounded lobe opposite the eyes, and the snout is acuminated, but yet blunt at the point. A single acute tooth on the hinder edge of the spout-holes. The width of the disc somewhat exceeds one-third of the whole length of the fish. Colour shining yellowish-brown, with specks of a darker tint of the same, arranged for the most part so as to form small sub-circular areas. Length of the figure 19½ inches.

Hab. China seas. Canton.

PLATYRHINA SINENSIS, M. und H. p. 125. *Raie chinoise*, Lacép. i. p. 34 et 157. pl. 2. f. 2; *Icon.* Reeves, 182; Hardw. Cart. 74. Chinese name, *Hwang teen poo**, "Yellow spotted ray" (Birch).

A Chinese specimen exists in the British Museum.

Hab. Seas of China and Japan. Canton.

Fam. TORPEDINIDÆ.

NARCINE TIMLEI, Bl. Schn. (*Torpedo*), p. 359; Henle, Narc. p. 34. taf. 2. f. 4; M. und H. p. 130.

Hab. Indian ocean and sea of Japan.

NARCINE LINGULA, Richardson. *Icon.* Reeves, 227; Hardw. Cart. 72. Chinese name, *Muh cho poo*, "Wooden ladle handle ray" (Reeves); *Muh cheoh po* (Bridgem. Chrest. 240); *Themilly yar*, Hindostanee.

Mr. Reeves's drawing shows only the upper surface of the fish, but I possess another figure executed by the late Dr. Wight in India, which gives a view also of the under disc, and shows that this *Torpedo* belongs to the sub-genus *Narcine*. The upper lip is entire with a slight point at the central bridle, and the dental plates turn out over the upper and under jaw. In the outline of the disc it resembles the *Nalla temere* of Russell (pl. 2), but in this fish the ground colour is white and the spots more round and regular.

The width of the disc is to its length as six to seven, and as it is widest posterior to its middle, it has a very broadly ovate form, without any angles, the snout being rounded. The breadth of the disc is equal to the length of the tail from the anus to the tip of the caudal fin. The ventrals have a slightly convex edge with the fore and hinder corners only moderately rounded. The claspers project beyond its edge. First dorsal rather larger than the second. The distance between the eyes and edge of the snout is equal to a fourth of the width of the disc, and the spout-holes, which are larger than the orbits and have smooth edges, are contiguous to them. Colour of the upper surface reddish-brown, with larger and smaller dark liver-brown spots, the largest being placed on the middle line of the back and tail. Some of the spots which lie round the electrical apparatus run into curved bars, and there are two longitudinal dark bars on the ventrals. The under surface is white, with reddish and purple tints round the edges of the various parts. Length of the figure 13 inches. Breadth of the disc 5·2 inches.

Hab. China seas. Canton (Reeves). Indian ocean. Madras (Wight).

Muh cho poo, Reeves, 6; Hardw. Cart. 73.

This figure has the same Chinese name with the preceding one, and much the same colours and spots, but it presents such difference in form, that, looking to the general accuracy of Mr. Reeves's admirable collection of drawings, prevents me from considering it as a representation of the same fish; yet the discrepancies are not sufficient in the absence of specimens to induce me to name it as specifically distinct. The general proportions of length and breadth do not differ greatly from those of *lingula*, but the disc is more widely rounded anteriorly, and more gibbous just behind the eyes, making an approach, though a slight one, to the sub-rhomboidal form of *N. indica*. The posterior corners of the disc overlap the ventrals rather more, and the latter are considerably larger with a more rounded outline. They extend backwards to the middle of the first dorsal. The second dorsal is drawn a trifle larger than the first. The eyes also are proportionally nearer to each other and to the fore-edge of the disc than in *lingula*. There are some slight differences in the spots, but scarcely so much as to require description. The posterior lobes of the disc are deeply tinged with arterial blood-red, but the colours in other respects are the same. The fish represented was a female, as no claspers are shown. Length of the figure 16 inches, width 8·3 inches.

Hab. China sea. Canton.

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* The term *poo* comprises a Chinese genus, which may be generally translated as "ray."

Fam. Raiidæ.

Raia kenojei, "Bürger," M. und H. p. 149. tafel; *Icon.* Reeves, 198; Hardw. Cart. 77. Chinese name, *Păng sha poo* (Birch), "Butterfly *Poo* ray" (Reeves).

Müller and Henle describe the colours of the dried fish as uniform. In Mr. Reeves's drawing the ground colour is clove-brown, shaded obscurely with liver-brown, and with a reddish-brown tint before the eye. There are also many paler wood-brown spots, which are sprinkled with dark dots. Exterior to the eyes on each side, six of the smaller pale spots are arranged so as to form a ring round a central one: similarly arranged spots occur near the margin of the widest part of the disc on each side, and also more posteriorly, while nearer the mesial line on each side there is an uninterrupted pale ring with a central spot, and a like ring exists on the posterior lobe of the disc. The edges of the under surface, which are partially shown in the drawing, are purplish-red. The spines correspond better with the letter-press description than with the figure given in the 'Plagiostomen' of Müller and Henle. Length of figure 14 inches, width 8½.

Hab. Seas of China and Japan. Canton.

Fam. Trygonidæ.

Trygon uarnack, Rüppell, Atl. p. 51; Chondr. taf. 19. f. 2 (*Pastinachus*). M. und H. p. 158. *Tr. omescherit*, Forsk. 9; Rüpp. Atl. p. 51. *Tryg. russellii*, Gray, Ill. Ind. Zool. 100; *Icon.* 89. Hardw. ined. (a drawing of *Tr. russellii*); *Icon.* Reeves, *a.* 37; Hardw. Cart. 91 (*Fœmina*). Chinese name, *Hwa kin*, "Variegated ray" (Reeves); *Icon.* Reeves, 279? Hardw. Cart. 90 (*Mas*)?

A specimen in spirits and a dried skin from the Indian seas were bequeathed by General Hardwicke to the British Museum.

Hab. Sea of China. Indian ocean. Red sea and Cape of Good Hope.

Trygon akajei, "Bürger," M. und H. p. 165. tafel.

Hab. South-west coast of Japan.

Trygon zugei, "Bürger," M. und H. p. 165. tafel.

Hab. Sea of Japan and China. Macao (Belanger). Indian ocean.

Trygon bennettii, M. und H. p. 160. tafel; *Icon.* Reeves, *a.* 45; Hardw. 87 & 88, which is a duplicate. Chinese name, *Hwang poo*, "Yellow ray" (Reeves, Birch).

A Chinese specimen exists in the British Museum.

Hab. China sea. Caribbean sea! (M. und H.)

Trygon carnea, *Icon.* Reeves, 226; Hardw. Cart. 86. Chinese name, *Pĭh yŭh poo*, "White jade-ray" (Birch); "White-fleshed ray" (Reeves).

This ray has much resemblance in form to the *Tr. walga*, as figured by Müller and Henle, and still more to the *Tenkee shindraki* of Russell (pl. 5), or to *Tr. bennettii*, M. und H.; but it has a considerably longer tail than either, and slight indications of both an upper and an under short hem-like seam on the tail. The form of the disc is obovate, with a sharp point to the snout, but no incurvature of the fore-edge, nor any decided convexity. Its breadth at the hinder edge of the spout-holes is equal to its length, excluding the ventrals, and the tail measures fully twice as much. The eyes are distant from the point of the snout one-quarter of the length of the disc, and less than that from each other. Two small spines (or perhaps pores) are situated side by side between the posterior edges of the spout-holes on the middle line. Colour, pale flesh-red, almost white in parts; the tail darker towards the point. It is possible that this may be merely a variety of *Tr. bennettii.* Mr. Reeves thinks that it is the young of some species. Length or breadth of disc, 2¾ inches.

Hab. China sea. Macao.

Pteroplatea micrura, Bl. Schn. (*Trygon*), p. 300; M. und H. p. 169. *Tenkee kunsul*, Russ. 6. *Raia pœcilura*, Shaw, 291. *Trygon pœcilura*, Bennett, Life of Raffles, p. 694; *Icon.* Reeves, 209; Hardw. Cart. 80 (*Fœm.*); and Reeves, *a.* 48; Hardw. Cart. 78, 81 dupl. (*Mas*). Chinese name, *Peih yu*, "Shoulder-fish" (Reeves); this var. has three spots on each pectoral fin. *Icon.* Reeves, 235; Hardw. Cart. 82; Chinese name, *Fe peih poo*, "Flying shoulder ray;" this is a monstrosity with pectorals divided, so that it appears to have four fins.

Hab. China and Javan seas. The Indian ocean and Red sea.

Fam. MYLIOBATIDÆ.

MYLIOBATES NIEUHOFII, Bl. Schn. p. 364 (*Raia*). M. und H. p. 177. *Mookarra-tenkee*, Russ. 7. *Fasciated ray*, Shaw, Zool. 286. *Myliobates aquila*, Bonap. F. It. *Raia macrocephala*, *Icon.* Parkins. in Bib. Banks. 48; *Icon.* Reeves, *a.* 38; Hardw. Cart. 97. Chinese name, *Chang ying*, "Spread kite" (Birch); "Broad eagle" (Reeves); *Cheung ung* (Bridgem. Chrest. 157).

Hab. Chinese and Australian seas (Reeves, Solander). Indian ocean. Mediterranean (M. und H.).

MYLIOBATES MACULATUS, Gray, Hardw. Ill. Ind. Zool. pl. 101; M. und H. p. 178; *Icon.* Reeves, 212; Hardw. Cart. 99 & 100 (duplicate). Chinese name, *Hwa teën chang ying*, "Long ray" (Birch); *Fa teem chang ying*, "Flowered-spotted long ray" (Reeves); *Ta tim cheung ang* (Bridgem. Chrest. p. 158).

Hab. China sea. Indian ocean.

MYLIOBATES VULTUR, M. und H. p. 179.

The British Museum contains an example of this species from China.

Hab. Chinese seas.

? MYLIOBATES OCULEUS, *Icon.* Reeves, 281; Hardw. Cart. 98; *Ein Myliobatis (oder Aëtobatis) der vielleicht nur eine Varietät des M. maculatus ist.* M. und H. p. 129 (*in notâ*).

In this drawing the disc of the fish is thickly covered with eyed spots, which are inclosed in blackish-green reticulations. Each spot has a pale silvery central disc, surrounded by a blackish ring, which is shaded off, and is itself enchased in a broader pale wood-brown border. The disc is rounded on each side in front, and falcate behind, with a small acute point forming its interior tip. The figure is about 22 inches long, of which 16 inches is tail. The width of the disc from tip to tip is 8⅝ inches. I have met with no specimen of this fish.

Hab. Sea of China. Canton.

? AETOBATES FLAGELLUM, Bl. Schn. 361. tab. 73?; M. und H. 180; *Icon.* Reeves, 273; Hardw. 101. Chinese name, *Hih jow chang ying*, "Black-fleshed spread kite" (Birch); *Hah yoh chang ying*, "Black-bodied long Eagle" (Reeves).

Hab. China seas. "Indian ocean. Red sea."

Obs. Icon. Reeves, 236; Hardw. 102. Chinese name, *Hung tsuy ying*, "Red-lipped kite" (Birch); *Hung tsuy ying*, "Thick-nosed ray" (Reeves). This is, perhaps, a violet-coloured variety of *Aëtobates? flagellum.*

Hab. Macao, in July.

Ordo STURIONES.

Fam. STURIONIDÆ.

ACIPENSER CHINENSIS, Gray, Hardw. Ill. pl. 98. f. 5.

Hab. China. Spec. Br. Mus.

It is probable that some species of *Chimæra* or *Callorrhynchus* exists in the seas of China and Japan. We have seen a small figure of the latter, which was sketched at Bow Island; but we have not met with a *Petromyzon* in any of the collections of Chinese fish or drawings.

Sub-classis OSTINOPTERYGII, *MacLeay.*

Ordo PLECTOGNATHI.

Fam. TETRODONTIDÆ.

DIODON PUNCTATUS, Cuv. Règ. An. ii. p. 367. *D. attinga*, Bl. 125. *D. hystrix*, Bl. 126.

Sir Edward Belcher brought several small specimens from the Chinese seas.

Hab. Sea of China. Malay archipelago. Indian ocean and Red sea.

TETRODON BIMACULATUS, Bennett (*nova sp.*), Zool. of Beechey's Voy. p. 50; Richardson, Ichth. of Sulph. Voy. p. 119. pl. 57. fig. 7–9. *Tet. fasciatus*, M'Clelland, Cal. Journ. p. 412. pl. 21. f. 2 (non Bl. Schn.).

Specimens were brought from China by Sir Edward Belcher, and others exist in the Chinese collection at Hyde Park.

Hab. Sea of China.

TETRODON OCELLATUS, Osbeck (*Diodon*), Eng. trans. i. p. 365; Bl. 145; *Icon.* Reeves, 271; Hardw. Cart. 15. Chinese name, *Yu po* (Reeves); *Yu paou*, "Jade bubble" (Birch); *Kaï po y* (Osbeck); Rich. Ichth. of Sulph. Voy. p. 120. pl. 58. f. 1, 2.

Specimens of this fish, in spirits, exist in the British Museum and Chinese collection at Hyde Park, and its dry skins are very common in the insect-boxes sold at Canton.

Hab. China. Canton. Chusan. Japan. It is said in Bl. Schn. to inhabit fresh waters near the sea.

TETRODON OCELLATUS, var. *guttulatus*, Richardson, Ichth. of Sulph. Voy. p. 121. pl. 58. f. 3; *Icon.* Reeves, 96 o; Hardw. Cart. 13. Chinese name, *Ke paou*, "Fowl bubble."

A specimen was deposited by Mr. Reeves in the British Museum. The colour in the drawing is honey-yellow on the back, with the large spots above the pectorals, and at the root of the dorsal dark umber-brown, the small ones silvery.

Hab. China.

TETRODON ALBO-PLUMBEUS, Richardson, Ichth. of Sulph. Voy. p. 121. pl. 58. f. 6, 7. Japanese fishes, Br. Mus. No. 17.

A specimen exists in the British Museum, which may be readily confounded with the var. *guttulatus* of *ocellatus*. It is distinguished by the course of the porous lines on the snout, and the distribution of the spines on the body. The figure in the Japanese fishes, which I have supposed to represent the adult of this species, has much resemblance to the *T. honckenii* of Bloch. 143.

Hab. China and Japan.

TETRODON SPADICEUS, Richardson, Ichth. of Voy. of Sulphur, p. 123. pl. 58. f. 4 & 5.

The British Museum possesses a specimen presented by Mr. Reeves, and there are others in the Chinese Collection at Hyde Park.

Hab. China. Canton.

TETRODON LATERNA, Richardson, Ichth. of Voy. of Sulphur, p. 124. pl. 61. f. 2; *Icon.* Reeves, 99; Hardw. Cart. 14. Chinese name, *Tăng lung paou*, "Chinese lantern-bubble" (Birch); *Tsung lung paou*, "Bladder lantern" (Reeves); *Tsang lung pau* (Bridgem. Chrest. 239).

A pencil sketch made by Ellis in 1780, on Cook's last voyage, at Pulo Condore, China, most probably refers to this species. He states the rays to be D. 11; A. 11; C. 9; P. 17.

Hab. China.

TETRODON HISPIDUS, Lin., Amœn. Acad. Chinens. Lagoerstr. Dec. 23, 1754 (non Lacép.).

Hab. China.

ORTHAGORISCUS SPINOSUS, Cuv. Règ. An. ii. p. 370; Richardson, Ichth. of Sulph. Voy. p. 125. pl. 62. f. 10–12. *Orth. hispidus*, Bl. Schn. p. 511. *Diodon mola*, Pall. Spic. Zool. viii. p. 39. t. 4. f. 7; Kœlr. Nov. Com. Petr. x. pl. 8. f. 3.

A specimen exists in the British Museum, which was brought from the Chinese seas.

Hab. Sea of China.

ORTHAGORISCUS OBLONGUS, Bl. Schn. p. 511. t. 97. Yarr. Br. Fishes, ii. p. 534. pl. *Tetrodon truncatus*, Penn. Br. Zool. iii. p. 170. pl. 22. Donov. pl. 41. *Tetrodon lune*, Lacép. i. pl. 22. f. 2; *Icon.* No. 29. Japanese fishes, Br. Mus.

It is possible that several species may be confounded under the appellation of "oblong sun-fish," a point which must be determined by a comparison of specimens from various quarters of the ocean. Mr. Yarrell's figure is not so high as Bloch's, which, according to Cuvier, was drawn from a fish taken at the Cape of Good Hope. Lacépède's figure corresponds with this in form, but it is variously striped, and is made a distinct species in the 'Règne Animal' under the name of *O. varius*. Mr. Yarrell however observes, that the British examples acquired beautiful waved stripes after death. The Japanese figure has the form of Bloch's.

Hab. The whole Atlantic. Cape of Good Hope. Chinese seas. Japan.

OSTRACION CORNUTUS, Lin., Bl. 133; Bl. Schn. p. 500; *Icon.* Reeves (*nullo numero non Hardw.*).

Hab. Chinese seas. Canton. "India. Barbadoes" (Bl. Schn.).

OSTRACION ACULEATUS, "Houttuyn, in Haarl. 20 Deel. ii. 346;" Bl. Schn. p. 500.

Not having seen a drawing or specimen of this, I do not know how far it differs from the preceding species.

Hab. "*In mari Japonico*" (Bl. Schn.).

OSTRACION HEXAGONUS, "Thunberg, N. S. A. xi. 101. f. 3;" Stock. Trans. 1790. p. 107; Bl. Schn. 502.

Hab. "*Mare Japonicum*" (Bl. Schn.).

OSTRACION STELLIFER, Bl. Schn. 499. tab. 97. f. 1. Japanese Fishes, fig. 36.

Hab. Seas of China and Japan. Specimen in the British Museum.

Fam. BALISTIDÆ.

BALISTES STELLARIS, Lacépède (*Le Baliste étoilé*), i. p. 350. pl. 15. f. 1; Bl. Schn. 476. *Somdrum yellakah*, Russ. 23 ?. *Balistes occultator*, Hard., *Icon.* ined. *B. oculatus*, Gray, Hardw. Illust. pl. 90. f. 1.

Specimens were brought from the Chinese seas by Sir Edward Belcher. Russell's figure shows fewer and proportionally larger spots, and less star-like than those exhibited by the specimens.

Hab. Sea of China (Belcher) and the Indian ocean (Hardw.).

Sir Edward Belcher's collection also contains *Balistes aureolus* (Richardson, Ichth. of Sulph. Voy. p. 126. pl. 59. f. 1, 2), and *B. castaneus* (id. pl. 59. f. 5, 6), which may possibly be from the Chinese sea; but the locality of their capture was not noted.

BALISTES VETULA, Lin. Chinensia Lagoer. Amœn. Acad. 1754; Bl. 150; Less. Voy. de la Coq. pl. 9. f. 2.

Hab. Sea of China. Indian ocean. Atlantic. Island of Ascension (Osbeck).

BALISTES HIHPÉ, Richardson, Ichth. of Voy. of Sulph. p. 127. pl. 60. f. 2; *Icon.* Reeves, *a.* 35; Hardw. Cart. 22. *Hĭh pe yang*, "Black-skinned yang or ocean-fish" (Reeves, Birch)*.

Hab. China seas. Canton.

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* Of this Chinese name, with that of *Monacanthus chinensis*, the artist writing down from *sound* has used two characters with different meanings for the same idea.

Balistes frenatus, Commerson apud Lacép. (*Baliste bridé*), i. p. 335 et 381. pl. 15. f. 3; *Icon.* Reeves, 229; Hardw. Cart. 23; Rich. Ichth. of Sulph. &c., p. 129. pl. 62. f. 1.

Hab. China seas. Canton.

Balistes vachellii, Richardson, Ichth. of Sulph. Voy. p. 129.

A specimen exists in the collection of the Cambridge Philosophical Society, presented by the Rev. George Vachell.

Hab. Sea of China. Canton.

Balistes albo-caudatus, Commerson apud Lacép. i. p. 336 et 382. pl. 18. f. 2 (*Baliste armé*). Rüppell, Neue Wirlb. pl. 16. f. 1; *Icon.* Reeves, 265; Hardw. Cart. 21 & 23. *Bal. subarmatus*, Gray, Hardw. Ill. Ind. Zool. pl. 90. f. 3?

Hab. Sea of China (Reeves). Indian ocean (Hardw.). Red sea (Rüpp.).

Balistes conspicillum, Bl. Schn. 474. *Le Baliste Americain*, Lacép. i. p. 377. pl. 16. f. 2; Quoy et Gaim., Uranie, pl. . f. 1; Less. et Garn. Voy. de la Coquille, pl. 9; *Icon.* Reeves, 285; Hardw. Cart. 20.

Hab. Sea of China. Malay archipelago. Indian ocean. Mauritius and sea of Madagascar.

Balistes ringens, Bl. 152. f. 2. *Le Baliste silonné*, Lacép. i. p. 370. pl. 18. f. 1. *B. nigra* (*ringens*, Lin.), Osbeck, Voy. Eng. tr. ii. p. 93. *B. niger*, Bl. Schn. 471.

Sir Edward Belcher brought a specimen from China.

Hab. Sea of China. Sumatra. Indian ocean. Isle of Ascension (Osbeck).

Monacanthus chinensis, Osbeck (*Balistes*), Voy. i. p. 177, Eng. tr.; Bl. 152. f. 1; *Icon.* Reeves, 89; Hardw. Cart. 31 (*et ab Indiâ*, 28?). Chinese name, *Hĭh pe yang*, "Black-skinned goat" (Birch); "Black-skinned sheep" (Reeves); *Hah pe yeang* (Bridgem. 50).

Specimens exist in the British Museum and Chinese collection at Hyde Park.

Hab. Sea of China (Reeves). Indian ocean (Hardw.). Australia (Ichth. of Er. and Terr.).

Monacanthus bifilamentosus, Lesson, Voy. de la Coq. p. 109. pl. 8; *Icon.* Reeves, 266; Hardw. Cart. 32.

A specimen presented by Mr. Reeves, obtained at Canton, is preserved in the British Museum.

Hab. Seas of China and the Moluccas.

Monacanthus japonicus, "Tilesius (*Balistes*), Mém. de Moscou, ii. pl. 13;" Cuv. Règn. An. ii. p. 373; *Icon.* Reeves, 275; Hardw. Cart. 33. *Tabaduck*, Draw. by Dep. Ass. Comm. Gen. Neill, of King George's Sound fish, No. 51, Br. Mus.

Not having access to the Memoirs of the Natural History Society of Moscow at present, the identity of Tilesius's fish with specimens brought by Sir Edward Belcher from the sea of China, and with others from South-west Australia, and also with the drawings above quoted, is to be considered simply as a conjecture.

Hab. Seas of China. Japan and Australia.

Monacanthus lineolatus, Richardson. *Rad.* A. 34; C. 12; P. 13.

A specimen of this fish was sent from Hong Kong to Haslar Museum by Surgeon R. A. Bankier, of the Royal Navy. It has lost the dorsal fin by friction, but is otherwise in good condition. Its height at the tip of the pelvic spine is equal to half its total length, and its greatest thickness is rather less than one-third of the height. The profile is an irregular oval, beyond which the short trunk of the tail projects not more than a tenth of the whole length. The face ascends in a straight line to the dorsal spine, whose height is equal to one quarter of the height of the body. The space between this spine and the second dorsal, corresponding in length to the spine, is horizontal and somewhat depressed. The pelvic bone is not capable of being stretched much out of the oval, and the membrane behind it is thin, not capable of lateral distension, and without rays, but having the small scales narrower and farther apart than on the body, and thus admitting of a slight folding-up. The edge of the membrane is convexly curved. The skin is covered with small scales which are each composed of a dozen or more minute spines that appear to stand out on every side, but the skin feels rough only when the finger is drawn towards the head. These scales do not appear to differ in size on any part of the head or body when viewed by the naked eye, but on the lateral parts of the tail the numerous spines of each scale are seen through a lens to be replaced by one, two, or three fine recurved bristles. All the fin-rays are rough, with minute points, and the dorsal is armed on each side by a row of pretty strong recurved spinous teeth, its front being rough like the other rays. The small trigger-ray in its axilla can be detected only by dissection. The point of the pelvic bone is a knob set with spines somewhat coarser than those of the scales. The pectoral fin is small and the gill-opening does not descend below the base of its first ray. There is no peculiarity in the scales which border this opening. The colour, after maceration in spirits, is purplish-gray, with about twelve interrupted horizontal dark lines on the body, running from the head to the caudal fin. There are also some spots on the face. No lateral line can be detected. There are two dark vertical bands on the caudal. This species is readily distinguished from *M. bifilamentosus* and *chinensis* by the want of the strong curved caudal spines, and from *M. japonicus* by the profile, the form of the scales and dewlap, and by the horizontal dark streaks. It differs from the *monoceros* of Osbeck (Voy. i. p. 173) in the anal rays being only thirty-four instead of fifty-one. Indeed I believe that the species alluded to by Osbeck, and also his *scriptus* (p. 174), are referrible to the *Aleuteres* mentioned below. Length of the specimen 5 inches. Height of body 2½ inches.

Hab. Coasts of Hong Kong.

Aleuteres lævis, Bl. 414. (*Balistes*), Richardson, Ichth. of Sulph. Voy. p. 131. pl. 61. f. 3. *Balistes monoceros*, Solander; *Icon.* Parkins. No. 64, Bib. Banks. *Balistes scriptus*, Osbeck, i. p. 174, Engl. tr.?

Hab. China seas? Canary islands. Caribbean sea.

Aleuteres berardi, Lesson, Voy. de la Coq. Ichth. p. 107. pl. 7; Richardson, Voy. of Sulph. p. 132. pl. 61. f. 1; *Icon.* Reeves, 173; Hardw. Cart. 34. Chinese name, *Sha mong*, "Sand dog" (Reeves); *Sha mang* (Bridgem. Chrest. 49).

Specimens were brought from China by Sir Edward Belcher.

Hab. Seas of China and New Guinea.

Triacanthus biaculeatus, Bl. 148. f. 2. (*Balistes*), Cuv. Règn. An. ii. p. 374; *Icon.* Reeves, A. 24; Hardw. Cart. 36. Chinese name, *Pe yang* (Birch); *Po pe yang*, "Naked skin" (Reeves); *Moh pe yeang* (Bridgem. Chrest. 48).

Specimens of this exist in the Chinese collection at Hyde Park, the British Museum, and the museum at Haslar. Examples from different localities vary in the comparative height of the body and a little in the distribution of the black marks. An Indian example has a broad black stripe on the preorbitar.

Hab. Seas of China, the Malay archipelago, Australia, and the Indian ocean.

Ordo Lophobranchii.

Fam. Syngnathidæ.

Syngnathus hardwickii, Gray, Hardw. Ill. pl. 89. f. 3.

Dried specimens, tied up in bundles, are brought in numbers from China, and many examples exist in the British and Haslar Museums.

Hab. Seas of China and India.

Syngnathus biaculeatus, Bl. 121. f. 1, 2; Bl. Schn. p. 515. t. 1.

Hab. Seas of China and the Philippines; and the Indian ocean. Spec. Br. Mus.

Other species inhabit the Chinese seas, but we have not yet had time to determine what they are.

Fam. Pegasidæ.

Pegasus laternarius, Cuv. Règn. An. ii. p. 364. *in notis.*

Common in the Chinese insect-boxes. Many examples in the British Museum and at Haslar Hospital.

Hab. Sea of China and Japan.

Pegasus latirostris, Richardson.

Specimens exist in the British Museum, and are occasionally to be met with in the Chinese insect-boxes. They have the general form of *P. draco*, but the beak is nearly as broad as it is long. As in the others, the beak is grooved in the centre above and below, and the edges of the upper groove are elevated so as to form a furrowed crest with an irregular outline. The flat lateral plates of the snout are transversely ridged, and toothed on the edges by the points of the ridges. In *laternarius* the edges of the inferior groove of the beak are elevated, and the mesial line above is partially so, making seven ridges. The whole is shorter and much narrower than that either of *draco* or *latirostris*, yet specimens of the latter with the lateral edges of the beak mutilated may be mistaken for it.

Hab. Sea of China.

Solenostomus paradoxus, Pallas, Spic. viii. p. 32. t. 4. f. 6 (*Fistularia*). Seba, 3. 34. f. 2; Bl. Schn. p. 114. t. 30. f. 2.

Hab. Amboyna. Probably China? Some Chinese drawings appear to be extravagant representations of this fish.

Ordo Ctenobranchii.

Fam. Lophiidæ.

Lophius setigerus, Wahl, in skrivter af naturh. iv. p. 215. tab. 3. f. 5, 6. *L. viviparus*, Bl. Schn. p. 142. t. 32. *L. setigerus*, C. et V. xii. p. 383; *Icon.* Reeves, 161; Hardw. 299. Chinese name, *Shin ma yu*, "Quivering flax-fish" (Birch); *Chin ma yu* (Reeves); *Chan ma u* (Bridgem. Chrest. 51). *Rad.* D. 3–8; A. 9; C. 9; P. 17; V. 1|5.

Small specimens of this fish, pinned down and dried, abound in the boxes of insects sold at the Chinese ports to foreigners. The museum at Haslar contains several of a larger size, taken in the China seas by Sir Edward Belcher, but they have been unfortunately considerably injured by friction during their voyage to England. Mr. Reeves's drawing of the recent fish leaves however little to be desired. In form it agrees with Bloch's figure, but the latter exaggerates the spines of the head. The humeral or coracoid spine is alike in both representations. The general colour is hair-brown, finely marbled by a lighter tint on the upper surface of the body and pectoral fins. A blackish mark speckled with white occupies the pectoral axilla. The caudal is less sharply banded than in Bloch's figure; a pinkish hue spreads over the anal, which, like the dorsal, is unspotted.

Hab. The Japanese and China seas. Canton.

Cheironectes raninus, Tilesius, Mém. de Moscou, xi. pl. 16. *Ch. marmoratus*, Cuv., Less. et Garnot, Voy. du Duperrey, pl. 16. f. 2; C. et V. xii. p. 402.

M. Valenciennes considers the New Guinea *Cheironectes*, procured by the naturalists of *La Coquille*, to be the same with that previously discovered on the coasts of Japan and named by Tilesius.

Hab. Coasts of Japan and New Guinea.

Halieutea stellata, Wahl. (*Lophius*), Mém. d'Hist. Nat. de Copenh. iv. p. 214. t. 3. an. 1797; Tilesius, Voy. de Krusenst. pl. 61. f. 3 et 4. *Lophius muricatus*, Shaw, Zool. pl. 162; *Icon.* Reeves.

Dried specimens of this fish exist in almost every ichthyological museum. Under surface coloured, in Mr. Reeves's figure, of a bright lake-red. Upper surface aurora-red, clouded with reddish-brown, with many specks of lake and groups of small black spots, the whole having a freckled appearance. Fins bright lake-red with black edges.

Hab. China and Japan.

Tribus Cyclopodi (Müller).

Fam. Echeneididæ.

Echeneis naucrates, Lin. Bl. 171; Russell, 49. Australian remora, Griff. Cuv. 10, plate opposite to p. 504. *Echeneis vittata*, Rüpp. Neue Wirlb. seite 82; *Icon.* Reeves, 97*h*; Hardw. Malac. 286, 287.

On comparing specimens from the Caribbean and African seas, Polynesia, Western Australia, and Bass's straits, no difference of any importance was detected, except in the number of fin-rays and valves of the sucking apparatus, which I have found however to vary as widely among individuals from the same locality, so that the ray-formula might be given as D. 2|33 to 38; A. 2|32 to 38; Discal valves 23 to 26. A young Chinese specimen which was presented to the British Museum by Mr. Reeves, has the following numbers: Br. 9; D. 2|38; C. 17; P. 21; V. 1|5; Discal valves 24. It agrees with a specimen of the same size in the same museum which was captured at Tenasserim. Dr. Rüppell observes, that the many individuals which he had an opportunity of observing in the Red sea presented constant differences in the numbers of the fin-rays and in colour from the Atlantic fish. In regard to the latter, I have stated above the variations of the rays that exist in the few specimens furnished by the museum at Haslar; and in respect to colour, I may add that the patterns they present appear to be infinite. I have seen on the western coast of Africa some hundreds attached to the bottom of a ship, and darting off in a dense body to partake of the washings of the cook's coppers or any other greasy matter that was thrown overboard. All had, it is true, a very disagreeable-looking livid ground colour and a dark band on the cheek more or less extensively prolonged on the flanks, but the rest of the dark marks seemed to be alike in no two individuals. Specimens 6 or 8 inches long have a trapezoidal caudal fin, but when they attain 18 inches or more the end of the fin is lunate, and the curve seemingly increases in older individuals, as it is pretty considerable in a specimen 2½ feet long.

Hab. Seas of China, the Malay archipelago, Australia, Polynesia and India. The Red sea and the Atlantic on both sides.

Fam. Cyclopteridæ.

Gobiesox tudes, Richardson, Ichth. of Voy. of Sulph. p. 103. pl. 46. f. 1–3.

Hab. China seas? Spec. in Sir E. Belcher's collection.

Fam. Gobiidæ.

Forster, in his 'Faunula Sinensis,' which comprehends the discoveries of preceding ichthyologists, enumerates only four members of this family, under the names of *Gobius niger* (Osbeck), *G. eleotris*, *G. anguillaris*, and *G. pectinirostris* (L.). These will be noticed under their respective heads.

Gobius fasciato-punctatus, Richardson, Ichth. of the Voy. of the Sulphur, p. 145. pl. 62. f. 13, 14; Descript. of Anim. p. 148. fig. 98. *Icon.* Reeves, 146; Hardw. Acanth. 278. Mus. Brit. Chinese name, *Sun hong* (Reeves). *Rad.* D. 6|–1|9; A. 1|8; C. 19; P. 17; V. 1|5–1|5, united.

This species belongs to a group of Gobies which have the depressed head and general aspect of *Philypnus dormitator*, and is very nearly allied to *Gobius russelii* (C. et V. 12. p. 75). It strongly resembles *G. kokius*, pl. 14. f. 1. of Jacquemont, Voy. dans l'Inde, which may be the same, though there are some differences. A specimen was presented to the British Museum by John Reeves, Esq., and there are examples of it in the Chinese collection at Hyde Park and in the museum of the Cambridge Philosophical Society.

Hab. Canton. Runs with great swiftness over the paddy-grounds at Whampoa.

Gobius chinensis, Osbeck, p. 260, Trad. Allem. *G. eleotris*, Lin. ed. xii. in Chin. *Sinn-haoo* (Hist. de Poiss. xii. p. 138); *Icon.* Reeves, f. 89. "*Rad.* B. 5; D. 6|–11; A. 8; C. 12; P. 18; V. 8, united." The Chinese name is written *Sinn-has* in the English translation, ii. p. 32.

In Mr. Reeves's drawing the back is mottled blackish-green, with clusters of grass-green and golden specks on the sides. The belly is grayish and silvery, the pectorals clay-coloured, the ventrals blackish-gray, and the vertical fins hair-brown, with two darker bars on the second dorsal.

Hab. Macao.

Gobius platycephalus, Richardson. *Icon.* Reeves, l. 94. *Rad.* D. 6|–9; A. 1|9; P. 15; C. 25. (Spec. Cam. Ph. Inst.)

A single specimen of a Goby, not in very good condition, exists in the museum of the Cambridge Philosophical Institution, having been brought from China by the Rev. George Vachell. It belongs to the group of *kokius*, but I have not been able to identify it with any of those described in the 'Histoire des Poissons.' It has a depressed head with the eyes almost touching, an advancing lower jaw and a rounded caudal. Teeth setaceous, not crowded, and disposed much like those of a *Serranus*. The outer row on the lower jaw is composed of somewhat taller recurved ones. Four of the very short upper and under caudal rays appear to be not jointed. Scales large, ciliate, with flabellate streaks on the disc. Cheeks and perhaps the gill-cover naked. General colour dark or blackish, mottled with pale irregular spots, lower jaw spotted with liver-brown and white. Dorsal mottled by rows of black specks on the rays. Mr. Reeves's drawing shows irregular blackish-green specks thickly spread over the olive-green ground colour of body and head, with an admixture of reddish-orange on the lower part of the sides and belly, the whole having a dark hue. Vertical fins olive-green and hair-brown obscurely mottled. Pectorals gall-stone yellow, with a blackish mark on the scaly base. The figure shows seven rays in the first dorsal.

Hab. Macao.

GOBIUS RIPILEPIS, Richardson. *Rad.* D. 6|-1|10; A. 1|10; C. 17$\frac{6}{6}$; P. 21; V. 1|5-1|5, united.

This species is of the group headed in the 'Histoire des Poissons' (xii. p. 85) by *G. venenatus*. The height of the head is equal to half its length, which is contained four times and a quarter in the whole length of the fish, or thrice and a half when the caudal is excluded. Belly prominent behind the ventrals, and the height there equals the length of the head. Lower jaw rather longest. Small eyes more than a diameter apart. Teeth in broad villiform plates, with those in the outer row a little taller, especially on the sides of the upper jaw and front of the lower one. A small canine on the middle of each limb of the lower jaw. Scales ciliated, with strong streaks diverging from the free apex of their exposed rhomboidal discs. Head scaly, forward to the eyes. A porous curved line beneath the eye, a longitudinal one crossing the middle of the cheek, and another on the upper edge of the interoperculum. First dorsal about twice as high as the second one. Caudal fenestrated by clear points, but its colours have perished. Six rows of roundish or arrow-headed clear specks correspond with the rows of scales on the sides, and there is a series of pale curved muscular marks along the lateral line. The Rev. G. Vachell's specimen, deposited in the museum of the Cambridge Philosophical Society, measures 3$\frac{1}{3}$ inches.

Hab. Macao.

GOBIUS MARGARITURUS, Richardson. *Rad.* D. 6|-1|12; A. 1|10; C. 17$\frac{6}{6}$; P. 17; V. 1|5-1|5, united.

Another species of the same group, deposited in the same institution by the Rev. G. Vachell, is distinguished by a series of silvery specks running down the middle of the tail. These specks, six in number, are irregular in form, and the first is placed over the vent, a narrow silvery stripe coincident with the spinal column preceding it. There are also a few silvery specks on the nape, one on the temples, another on the gill-cover, and two lines of pores on the cheek. The scales are pretty large, ciliated and faintly streaked. The body has a linear form, its height being about the eighth of the whole length of the fish. Head bluntly rounded in profile at the snout, with the jaws equal. Teeth minute, but the outer row taller, the villiform inner ones being very low and much crowded. A recurved canine in the middle of the limb of the lower jaw. Eyes a full diameter apart. Caudal pointed.

Hab. Macao.

GOBIUS FILIFER, C. et V. xii. p. 106; *Icon.* Reeves, 276; Hardw. *Rad.* D. 6|-1|10; A. 1|8; C. 21; P. 17; V. 1|5-1|5, united.

The Indian fish described under this name in the 'Histoire des Poissons' is made the type of a group of Gobies which have short bodies and minute scales buried in the skin. Specimens in good order have been deposited in the British Museum and with the Cambridge Philosophical Society by John Reeves, Esq. and the Rev. George Vachell, which show that the fish when alive is very handsomely and gaily ornamented.

Hab. The Indian ocean, China seas, and Malay archipelago. Macao.

GOBIUS OMMATURUS, Richardson, Ichth. of the Voy. of the Sulphur, p. 146. pl. 55. f. 1. 3; *Icon.* Reeves, 147; Hardw. Chinese name, *Chang yaow* (Birch); *Chang yaou neen*, "Long-waisted" (Reeves); *Cheung in nain* (Bridgem. Chrest. 74). *Rad.* D. 9|-20; A. 1|17; C. 37; P. 22; V. 1|5-1|5, united.

A specimen in the British Museum, from John Reeves, Esq.

Hab. Macao.

GOBIUS STIGMOTHONUS, Richardson, Ichth. of Sulph. p. 147. *Rad.* D. 9|-1|13 vel 14; A. 1|11; C. 35; P. 18; V. 1|5-1|5, united.

Much like the last, and like it distinguished from the other Gobies by a greater number of rays than usual in the first dorsal. In this species that fin has a black mark. The Cambridge Philosophical Institution has two specimens, collected by the Rev. George Vachell.

Hab. Macao.

GOBIUS LAGERSTROEMIANUS. *Gob. cleotris*, Lin. Amœn. Acad. Dec. 1754. "*Rad.* B. 5; D. 11|–10; A. 9; C. 9! P. 20; V. 10." (Lin.)

In the paper above quoted, which is entitled "*Chinensia Lagerstroemiana*," Linnæus characterises a Goby in the following terms:—"*Lingua lævis. Dentes parvi acuminati. Oculi a tergo capitis. Radiis pinnæ dorsi primæ acuminatis mollibus simplicibus. Pinnæ ventrales ferè infundibuliformes. Cauda integra, rotundata. Piscis totus una cum pinnis nebulosus.*" It seems to be allied to the preceding two species by the large number of rays in the first dorsal.

Hab. China.

GOBIUS TANNOAO, Osbeck, Voy. to China, Engl. tr. i. p. 201. "*Rad.* B. 4? D. 11|–10; A. 13; C. 18; V. 12. funnel-shaped." (Osb.)

Osbeck, in the account of his voyage to China, performed in 1751, but not published till 1757, and after his specimens had been examined by Linnæus, mentions a Goby, which is called *Tannoao* by the Chinese, and which he considers to be the same with the *G. niger* of Linnæus. This mistake is pointed out in the 'Histoire des Poissons' by M. Valenciennes (xiv. p. 16), but in quoting the rays of the first dorsal from Osbeck, there is a misprint of 1| for 11|. At page 188 of the volume of the work just quoted, this fish is suspected to be a variety of the *Periophthalmus kœlreuteri*; and it is possible that both this and the preceding species may actually belong to that genus. In the German translation of Osbeck's 'Voyage,' this species appears to have been named *Apocryptes cantonensis* (C. et V. *l. c.*).

Hab. Canton.

GOBIOIDES MELANURUS, Broussonnet (*Gobius*), MSS.; Descript. of Anim. p. 147. fig. 158. "*Rad.* D. 18; A. 9; C. 13; P. 14; V. 7." (Id. *l. c.*)

The figure here quoted has a general resemblance to *Gobioides broussonneti* of Lacépède (C. et V. pl. 348), but the single dorsal and the anal occupy less space. The name of *Gobius melanurus* was written by Broussonnet himself over the figure, and he mentions the species by the same appellation in his first decade. The pectorals appear to be funnel-shaped, but their rays have most probably been incorrectly counted. The unknown author of the work gives us merely the following notice of the characters in addition to the numbers of the rays quoted above:—"Nearly cylindrical. Head roundish. One dorsal. Tail pointed with a black spot on the base of the fin" above the middle. "Eight inches long."

Hab. "In Canton river. Eaten by the Chinese."

APOCRYPTES SERPERASTER, Richardson. *Icon.* Reeves, β. 55; Hardw. 239. Chinese name, *Pih-shay*, "White snake" (Birch); *Pak hop*, "White frog" (Reeves); *Pak kop* (Bridgem. Chrest. 73). *Rad.* D. 6|–27; A. 27; C. 23; P. 23; V. 1|5–1|5, united.

This fish is very commonly carried about the streets for sale. Two specimens, now in the museum of the Cambridge Philosophical Institution, were brought from China by the Rev. George Vachell. They have less resemblance to Osbeck's figure of *Apocryptes pectinirostris* than what is shown by a *Boleophthalmus*, obtained in the same seas by Mr. Vachell and noticed below. *A. serperaster* has a long pointed caudal, and scales sufficiently visible to the naked eye, but not ciliated, or only sparingly and deciduously so. A skinny preorbitar lip. Three canines on each intermaxillary, and one interior one on each side of the symphysis below. Twenty-one side teeth on each limb of the upper jaw, and sixteen horizontal ones with incurved tips on each limb of the lower jaw. Five rays of first dorsal nearly of equal length, the sixth very short, and omitted in Reeves's figure. The last ray of the second dorsal and anal divided to the base. Colour dirty wood-brown with darker patches at intervals. Paler and silvery on the sides and belly. The figure shows none of the spots or blue lines on the dorsals which exist in Osbeck's *pectinirostris*. Length of the specimens 6 inches, of the caudal nearly 1½ inch. Length from snout to anus 2·2 inches.

Hab. Macao.

TRYPAUCHEN VAGINA, C. et V. xii. p. 153; *Icon.* Reeves, β. 57; Hardw. Acanth. 283. Chinese name, *Hung lae*, "Red lae" (Reeves, Birch, Bridgem. Chrest. 230).

Rad. B. 4; D. 6|41; A. 40; C. 17. (Spec. Mus. Haslar.)
D. 6|42; A 42; C. 17. (Spec. Mus. Brit.)
D. 6|46; A. 46; C. 17. (Spec. Mus. Camb.)
B. 4; D. 6|49; A. 1|45; C. 17. (Hist. des Pois.)

The fin-rays of this fish when shrivelled in spirits are counted with difficulty, but after much pains in examining a considerable number of specimens, I find the above variations without any other marked difference in form to indicate a plurality of species. Chinese examples have been brought to this country by John Reeves, Esq., Commander Dawkins, R.N., Sir Edward Belcher, Sir Everard Home, and the Rev. George Vachell.

Hab. The Indian ocean and China seas. (Hong Kong, Macao, Chusan, and Woosung at the mouth of the Yang tse kiang).

AMBLYOPUS RUGOSUS, Richardson. *Icon.* Reeves, *β.* 7; Hardw. Acanth. 282. Chinese name, *Shay king*, "Warp snake" (Reeves, who states that *king* signifies the warp of a web); *She kang* (Bridgem. Chrest. 231). *Rad.* D. 6|39; A. 40; C. 17; P. 17; V. 1|5–1|5, united.

Two Chinese species of this genus have been named by ichthyologists. One, the *Tænioide hermannien* of Lacépède, was originally described from a Chinese painting, and is most probably the *Shay king* of Mr. Reeves's portfolio, but as the specific name has been appropriated in the 'Histoire des Poissons' to an Indian fish, which is certainly distinct if Hamilton Buchanan's figure 9, pl. 5, be correct, confusion will be best avoided by giving it another name. Three specimens, brought from Macao by the Rev. George Vachell, exist in the museum of the Cambridge Philosophical Society, which are remarkable for the sharply-elevated, crenated, cuticular ridges on the face and lower jaw. Four of these ridges radiate from the eye as a centre, and five diverge from a spot on the cheek. These are connected by longitudinal ridges, and there are several less prominent and more distinctly porous ones on the gill-pieces. The lower jaw is crossed transversely by short ridges as prominent as those on the face. Neither from the figures nor descriptions of other species do we learn that they have facial ridges approaching to these in distinctness. The upper jaw shows about fourteen more or less acute compressed teeth in its circumference. The lower jaw is armed by about six teeth longer than the upper ones, and in both jaws there are several rows of much smaller, crowded, acute teeth, well-separated from the outer ones. The head is contained 7½ times in the total length, the vent is rather behind the anterior third, and the caudal fin forms a ninth of the whole length. The dorsal fin is somewhat highest about the middle of the tail, where it rather exceeds half the height, and the anal, in which no spine could be detected, is half as high as the dorsal. The fins are fleshy, so that the rays are not to be counted without difficulty. Mr. Vachell's specimens and Mr. Reeves's figure have a contraction at the junction of the vertical fins, as if a string had been tied tightly round them, and it is probable that they are so usually carried by the fishermen. Ventrals spoon-shaped, with short stout spines. Scales very minute, deeply imbedded and distant from each other. Length, total 6·25 inches; of which the distance between mouth and anus is 2·38 inches, and the length of caudal 0·72 inch. Another specimen measures 8¾ inches, and a third 3½ inches.

Hab. Macao.

AMBLYOPUS ANGUILLARIS, Lin.? (*Gobius*). *Rad.* D. 6|39; A. 37 vel 38; C. 17*.

Two specimens in the Cambridge Philosophical Society's museum, brought from Macao by the Rev. George Vachell, agree tolerably with the short characters given by Linnæus of his *anguillaris*, received from the same quarter. As compared with other *Amblyopi*, indeed the pectoral fins could not be said to be "*valdè parvæ*," but they may be so described in reference to the Gobies, with which Linnæus grouped this fish. The difference in the enumeration of the rays of the dorsal and anal will be lessened, if instead of twelve rays given to the caudal in the 'Systema Naturæ,' we reckon seventeen. This species is whitish or colourless in spirits, with translucent integuments, permitting the contents of the belly to shine through, and the fine membranes are more delicate, so that the rays can be more readily seen. The minute black eyes are easily seen on the white head. The caudal is larger and more lanceolate than in *rugosus*, and the pectorals longer and more acute. The porous lines on the face are scarcely elevated,

* There are either several species of *Amblyopus* in the Chinese waters, or the numbers of the rays differ in the same species. In the 'Descriptions of Animals,' which we already quoted, f. 15 represents an *Amblyopus*, which Broussonnet has considered as the *anguillaris* of Linnæus. The author enumerates the rays as D. 47; A. 42; P. 8; V. 6; and says that the fish dwells in the muddy banks of the river at Canton, and is eaten by the natives.

and the dentition differs from that of *rugosus*. There are four, five, or six slender cylindrical teeth on each limb of each jaw, rather acute, with brown tips, and not all of one length. The interior ones are in a single row, small and pearly, a few near the angle of the upper jaw being slightly larger. Length 4·80 inches, of which the caudal is 1·12 inch, the head 0·60 inch, and the length from mouth to vent 1·48 inch.

Hab. Macao.

PERIOPHTHALMUS MODESTUS, Cantor, Annals of Nat. Hist. vol. ix. p. 29. "*Rad.* B. 2? D. 15|-1|12; A. 1|11; C. 13; P. 11; V. 1|5-1|5, united."

"*P. brunneus, cinereo-marmoratus; abdomine albo-cærulescenti, alis pallide flavis; dorsali anteriori fasciis nigris duabus ornatâ; radiis alarum nigro-punctatis.*"

"*Hab.* Chusan, along the coasts of banks and canals." (Cantor, *l. c.*)

BOLEOPHTHALMUS BODDAERTI, Pallas (*Gobius*), Spic. Zool. viii. p. 11. t. 2. f. 4, 5; Bl. Schn. 66; C. et V. xiv. p. 199. *Gobius striatus*, Bl. Schn. 71. t. 16. *Icon.* Reeves, β. 38; Hardw. Acanth. 295. Chinese name, *Hwa ya* (Birch); *Fa yu* (Reeves); "Flower-fish;" *Tau* (Bridgem. Chrest. 77); *Icon.* Reeves, Hardw. 291, 292, 293, & 294. Descript. of Anim. p. 150. fig. 100. *Rad.* D. 5|-24 vel 26; A. 25 vel 26, &c. (Spec. Brit. Mus.)

Specimens, procured at Macao by John Reeves, Esq. and the Rev. George Vachell, are deposited in the British Museum and with the Cambridge Philosophical Society. Mr. Reeves's figure omits the vertical bands which are conspicuous in his specimen, and are perhaps rendered more apparent by maceration in spirits; on the other hand, the brilliant pale-green specks on the body of the drawing are nearly effaced in the specimens. Distorted figures of this fish, with swollen gill-covers and a round open mouth, are drawn in its proper colours on the Chinese earthenware. Mr. Reeves's figures 291, 292, 293 and 294, show the fish as used for this purpose.

Hab. Indian ocean, Malacca, Moluccas and China seas. Macao. At certain seasons it is hawked through the streets of Canton.

BOLEOPHTHALMUS PECTINIROSTRIS, Lin. (*Gobius*), Chinensia Lagerstroem. Amœn. Acad. Dec. 1754. Osbeck, Voy. 1757. Engl. transl. p. 200. *Apocryptes chinensis*, Osbeck, Amœn. Acad. iv. pl. 3. f. 3. *Ap. pectinirostris*, C. et V. xii. p. 150. Chinese name, *Fay-ye* (Osbeck, Eng. tr.); *Fai-ja*, (French tr.). *Rad.* D. 5|-25; A. 26; C. 21; P. 19; V. 1|5-1|5, united. (Cambr. spec.)

A specimen brought from Canton by the Rev. G. Vachell and deposited in the Cambridge Philosophical Institution, corresponds with the few particulars mentioned in the passages regarding this species quoted above, except that the colours have suffered from long maceration in spirits, and can no longer be well made out. As the pectorals are mounted on an arm-like basis, though it is short and not bent, I have referred this fish rather to *Boleophthalmus* than to *Apocryptes*. The dentition does not seem to distinguish the two genera as established in the 'Histoire des Poissons,' at least I can perceive no essential distinction between the teeth of *Ap. dentatus* (C. V. xiv. p. 148) and of a *Boleophthalmus*. The rays of the first dorsal of *pectinirostris* are all filamentous, the central one being tallest and the others graduated. The membrane dark purple. Pectorals lanceolate. Ventrals small, infundibuliform. Fins generally tipped with wood-brown, and a diffused brownish spot on the second dorsal. Body brownish-gray, spotting effaced. Belly white. Scales very minute, the integument swelling over them like papillæ. Three canine teeth on each side of the symphysis of the upper jaw are followed by eighteen very minute lateral ones. Twenty-seven horizontal teeth with brownish truncated tips, which are not incurved, arm each limb of the lower jaw, and there is a stronger interior tooth on each side of the symphysis. A small obtuse lobe projects from the preorbitar lip behind the canines on each side. The eyes touch each other, and their upper lids are granulated. Length, total 2·80 inches; length of head 0·62, length of caudal 0·50 inch.

Hab. Canton.

BOLEOPHTHALMUS AUCUPATORIUS, Richardson, Ichth. of Voy. of Sulph. p. 148. pl. 62. f. 1-4; Descript. of Anim. p. 149. fig. 99; *Icon.* Reeves, β. 53; Hardw. Acanth. 295. Chinese name, *Kan ke pang*, "Pursuing fowl-staff" (Reeves); *Kong kai pang* (Bridgem. Chrest. 72). *Rad.* D. 5|-26; A. 1|25 vel 27; C. 17; P. 21; V. 1|5-1|5, united. (Spec. Coll. of Surg.)

Examples of this species exist in the British Museum and in the collection of the Cambridge Philosophical Society, procured at Macao by John Reeves, Esq. and the Rev. George Vachell. The College of Surgeons also possesses specimens obtained at Woosung in the estuary of Yang tse kiang by Sir Everard Home. The species has much resemblance to the *Gobius viridis* of Buchanan Hamilton, pl. 32. f. 12 (*Boleophthalmus viridis* of the 'Histoire des Poissons,' xii. p. 213), in form and also in the spotting, but the colours differ, and the Indian fish has a higher profile. It is probably the species noticed from a Chinese painting in the 'Histoire des Poissons' (xii. p. 215) as bearing a resemblance to *B. histiophorus.*

Hab. China seas. Macao. Muddy places, Whampoa. Woosung.

BOLEOPHTHALMUS CHINENSIS, C. et V. xii. p. 215.

Described solely from a Chinese painting as having a high pointed first dorsal, and a gray body sprinkled with brown specks, and more scattered clusters of white and green points; also four deep gray bands on the bases of the pectorals.

Hab. Canton.

BOLEOPHTHALMUS SINICUS, C. et V. xii. p. 215.

Also described from a drawing. It is grayish-brown, dotted finely with the same, and marked by scattered green spots and points. The pectorals are tinged with orange.

Hab. Canton.

BOLEOPHTHALMUS CAMPYLOSTOMUS, Richardson. *Icon.* Reeves, *β.* 52; Hardw. Acanth. 290. Chinese name, *Peih kow kow*, "Bent-mouth dog" (Birch); "Broken-mouthed dog" (Reeves); *Mah hau kau* (Bridgem. Chrest. 71).

Of this fish we have seen no specimen, and it may eventually prove to be one of the preceding two species, but the colours and markings do not correspond with the little that is said of them. It is a less slender fish than the *B. aucupatorius*, and has a comparatively low first dorsal, with a shorter though acute caudal fin. It has a yellowish-brown colour above the middle line, with crowded darker specks of the same and a flesh-red tint below, also mottled on the flanks with darker purplish dots. The belly before the vent and the cheeks are unspotted. The base of the pectoral is dark, the ventrals and anal are ochraceous, and the other fins are pale gray or dilute broccoli-brown. A single black spot tips the second dorsal posteriorly.

Hab. Canton.

ELEOTRIS FLAMMANS, Cantor, Ann. Nat. Hist. ix. p. 29. "*Rad.* B. 6; D.6|–1|10; A. 1|9; C. 15; P. 18; V. 1|5." (Cantor.)

"*E. superne violaceo-brunneus; alâ dorsali anteriori fasciis tribus undulatis violaceis, flammeo-marginatâ; posteriori fasciis undulatis quatuor nigris, radiis alarum aurantiacis, apicibus nonnullis flammeis, aliis nigris; alâ caudali violaceo-canescenti, fasciis tribus cæruleis, radiorum flavorum apicibus flavis; alâ anali aurantiacâ, fasciis quinque nigris undulatis, radiorum brunneorum apicibus nigris; alis ventralibus pectoralibusque pallidè violaceis, radiorum flavorum apicibus nigris.*"

"*Hab.* Chusan, canals and estuaries." (Cantor, *l. c.*)

ELEOTRIS CANTHERIUS, Richardson. *Icon.* Reeves, 114; Hardw. Acanth. 279. Chinese name, *Neen yu* (Reeves); *Neen u* (Bridgem. Chrest. 76). *Rad.* D. 6|–9; A. 8; C. 14; P. 12; V. 1|5 (ex figurâ).

The ground colour of this fish is deep yellowish-brown with blackish-brown reticulations, corresponding in size to the scales, and defined above by a dark line running from the eye along the upper quarter of the height to the caudal. The areas of the meshes are paler. A short blackish bar runs backwards from the lower part of the eye to the preoperculum, and there are some crowded blackish-brown dots on the gill-plate. The dorsals, anals and ventrals have a pale neutral tint colour (bluish or pearl-gray). The first dorsal is crossed by three branching and undulating lines, and the second dorsal by eight pairs of blue waving lines. The anal and ventrals are marked along each ray by a crowded series of small blue arrow-heads or chevrons. The caudal is also marked with chevrons, but they are orange-brown and umber, and the ground tint of the fin corresponds with that of the body. The pectoral is wood-brown or buff, with blackish dots on the rays.

Hab. Macao.

Philypnus sinensis, Lacépède (*Le bostryche chinois*), iii. p. 141. pl. 2. *Gobius sinensis*, C. et V. xii. p. 94. *Philypnus ocellicauda*, Richardson, Zool. Sulph. pp. 59 & 149. pl. 56. f. 15, 16; *Icon.* Reeves, β. 8; Hardw. Acanth. Chinese name, *Neaou yu*, "Bird-fish" (Birch); *Oo yu*, "Black fish" (Reeves); *Ow yu* (Bridgem. Chrest. 7).

In the 'Zoology of the Voyage of the Sulphur' I have described and figured a Chinese specimen of this fish, which was presented to the British Museum by John Reeves, Esq., but I was not then aware that it had been previously named by Lacépède, who had merely seen a Chinese drawing of it. His designation is here restored in right of its priority.

Hab. Canton.

Tribus Percina.

Fam. Callionymidæ.

Callionymus reevesii, Richardson, Ichth. of Voy. of Sulph. p. 60. pl. 36; *Icon.* Reeves, 180; Hardw. Acanth.

Rad. D. 4|–9; A. 8; C. 11; P. 19; V. 1|5. (Male.)
D. 4|–9; A. 9; C. 10; P. 19; V. 1|5. (Females.)

Since I described a male of this species in the work above quoted, I have examined two examples brought from Macao by the Rev. George Vachell, which I consider to be females, and to justify my quotation of Mr. Reeves's figure as appertaining to this species. The latter drawing is a good representation of these specimens, except that it shows but a small portion of the black mark between the third and fourth rays of the comparatively low first dorsal, the fin-membrane of the individual placed before the Chinese artist having evidently been torn. Neither of the specimens has an anal tubercle: both of them have three recurved teeth on the upper side of the long preopercular spine, and one of them has moreover a strong basal tooth beneath pointing forwards, while the other has merely a slight indication of an under-tooth near the middle of the spine.

Hab. Hong Kong, Macao.

Callionymus japonicus, Houttuyn, Stockholm Trans. 1790. p. 107; Bl. Schn. p. 40. "*Rad.* D. 4|–10; A. 9; C. 10; P. 19; V. 5," *loc. cit.*

"*C. capitis spinâ simplici posticè interius serratâ, margine orbitarum elevato acuto, pinnâ dorsali primâ brevissimâ, ocello nigro notatâ, pinnis nigro maculatis, caudali valdè elongatâ.*" (Schn.) I strongly suspect that Houttuyn's fish is identical with that which I have considered to be the female of *C. reevesii*, though the caudal fin is longer than in Mr. Vachell's specimens, and shorter than that of the male figured in the 'Ichthyology of the Voyage of the Sulphur.'

Hab. Japan.

Callionymus punctatus, Langsdorff, Mus. Berol. *C. japonicus*, C. et V. xii. p. 299.

M. Valenciennes considers a Japanese *Callionymus*, deposited by M. Langsdorff in the museum of the University of Berlin, to be specifically the same with the *C. japonicus* of Houttuyn noticed above, but as he states that M. Langsdorff's fish has a curved preopercular spine, with three spreading upper spinous teeth turned forwards (*en patte d'oie*), this can scarcely be reconciled with the description of the spine of *japonicus*. *C. punctatus* has a small tooth on the hinder part of the orbit which does not exist in *C. reevesii*.

Hab. Japan.

Callionymus hindsii, Richardson, Ichth. of Voy. of Sulphur, p. 64. pl. 37. f. 3, 4.

A Macao specimen of this fish was presented to the Cambridge Philosophical Institution by the Rev. George Vachell. It does not possess the post-orbital tooth of *punctatus*.

Hab. Pacific ocean (Sir E. Belcher). China seas. Canton (Vachell).

Hoplichthys langsdorfii, C. et V. iv. p. 265, t. 81.

Schlegel states, in the 'Fauna Japonica,' that the anatomy of this fish shows its real affinities to be with *Callionymus*. In the text of the 'Histoire des Poissons,' the initial *H.* of the generic name has been inadvertently omitted, but the word is correctly printed "*Hoplichthys*" in the table of contents at the beginning of the volume.

Hab. Japan.

Fam. URANOSCOPIDÆ.

URANOSCOPUS SCABER, Lin., C. et V. iii. p. 287. *Rad.* B. 6; D. 3|–1|12; A. 13; C. 10$\frac{4}{4}$; P. 17; V. 1|5.

Sir Edward Belcher brought an Uranoscope from China, which on a careful comparison with a Mediterranean specimen of *scaber*, presented no difference of form. Its colours were effaced.

Hab. China seas.

URANOSCOPUS ASPER, Temm. et Schlegel, Faun. Jap. Sieb. p. 26. pl. 9. f. 1; *Icon.* Reeves, 162 & 166; Hardw. Acanth. 87, 88. Chinese name, *Koh yu*, "Horned fish" (Reeves); *Koh u* (Bridgem. Chrest. 39). *Rad.* B. 6; D 5|–12 vel 13; A. 13 vel 14; C. 11$\frac{4}{4}$; P. 18; V. 1|5. (Spec. Bürger.)

This species is distinguished from the preceding, which it closely resembles, by having a tooth fewer on the under edge of the preoperculum and by other slight differences in form. I have had an opportunity of comparing Sir Edward Belcher's Chinese specimen of *scaber* above mentioned with one of Bürger's Japanese examples of *asper* belonging to the British Museum. The text of the 'Fauna Japonica' quotes the rays of *asper* as D. 5|–11; A. 15, &c.; but a specimen in the museum of the Cambridge Philosophical Society, procured at Macao by the Rev. George Vachell, and Bürger's one authenticated by Schlegel, present the formula which we have given above. The last two rays of the dorsal and anal are approximated and may be reckoned as branches or separate rays, making the numbers 12 or 13 and 13 or 14, according to the way in which they are viewed.

Hab. South coasts of Japan and the coasts of China down to Canton.

URANOSCOPUS BICINCTUS, Temm. et Schlegel, in Fauna Jap. Siebold, p. 26.

Hab. Japan.

URANOSCOPUS INERMIS, C. et V. iii. p. 310. t. 65; Temm. et Schl. in Fauna Japon. p. 27.

Hab. Indian ocean and sea of Japan.

URANOSCOPUS ELONGATUS, Temm. et Schl. in Fauna Jap. Sieb. p. 27. t. 9. f. 2.

Hab. Sea of Japan.

PERCIS PULCHELLA, Temm. et Schl. in Fauna Jap. 24. t. 10. f. 2. "*Rad.* B. 6; D. 5|–22; A. 1|17; C. 16; P. 15; V. 1|5." (Fauna Japon.)

A specimen collected by the Rev. George Vachell exists in the museum of the Cambridge Philosophical Institution, which ought, I think, to be referred to this species, though its fin-rays are as follows:—*Rad.* B. 6; D. 5|–20; A. 16; C. 13$\frac{6}{5}$, &c. The caudal fin has the second long ray from the top lengthened as in *pulchella*; there are four rows of white spots on the anal; and the streaks on the head are nearly as exhibited in the 'Fauna Japonica,' particularly a black crescentic mark behind each eye. The dots on the dorsal are mostly effaced.

I have some suspicion of the Japanese fish being merely a variety of the *Percis nebulosa* (C. et V. iii. p. 260), and that the *Dentex fasciatus* (Solander, Pisces Australiæ), or *Percis emeryana* (Richardson, Icones Piscium, t. 1. f. 1), is another variety; in which case the fish inhabits the ocean from Japan down to Australia.

Hab. Japan and China.

PERCIS SEXFASCIATA, Temm. et Schl. Fauna Jap. p. 25.

Hab. Japan.

It appears to me that the peculiar forms of the rays of the anal, as well as of some of the other fins, and many other particulars of structure, ally this group more closely to the *Triglidæ* than to the *Percidæ*. The *Trachinus vipera* has the suborbitar united by a bony bridge to the upper limb of the preoperculum, and other members of the group show more or less of that projection of the suborbitar chain which characterizes the following family.

Fam. COTTIDÆ.

SYNANCEIA EROSA, Langsdorff, C. et V. iv. p. 459. t. 96; Temm. et Schl. Fauna Jap. Sieb. p. 45. t. 16. f. 1.

Hab. Japan.

APLOACTIS ASPERA, Temm. et Schl. in Fauna Jap. Sieb. p. 51. t. 22. f. 3 et 4; Richardson, Ichth. of Voy. of Sulphur, p. 72.

This fish appears to have been first noticed by Tilesius on the Japanese coast. See Pallas, 'Zoogr. Rossica,' p. 129, note to *Cottus villosus*.

Hab. Seas of Japan.

APLOACTIS BREVICEPS, Richardson (*Synanceia*), Ichth. of Voy. of Sulphur, p. 71.

Mr. Reeves presented one specimen to the British Museum, and the Rev. George Vachell three to the Cambridge Philosophical Society.

Hab. Sea of Macao.

PELOR JAPONICUM, C. et V. iv. p. 437. t. 93; Temm. et Schl. F. Japon. Sieb. p. 44. t. 18. f. 2; *Icon.* Reeves, 140; Hardw. Acanth. 119. Chinese name, *Meaow yu* (Birch); *Maou yu* (Reeves), "Cat fish;" *Mau u* (Bridgem. Chrest. 181). Japanese name, "*Oniogose*" (Fauna Jap.). *Rad.* D. 17|6; A. 2|10; C. $11\frac{2}{2}$; P. 10 et 2; V. 1|5. (Spec. Bürger).

Two specimens of this fish exist in the British Museum; one of them brought from Canton by John Reeves, Esq., and the other sent by Bürger from Japan to Berlin, whence it was transferred to England. Mr. Reeves's fish differs from the Japan one in having eight soft rays in the dorsal with much smaller white spots on the body and fins. Although the 'Fauna Japonica' contains the following passage, "*l'anal a douze rayons et point d'épineux,*" we have found two pungent anal rays in Bürger's specimen which was named at the Berlin Museum.

Hab. Seas of Japan and China.

PELOR AURANTIACUM, Temm. et Schl. Fauna Jap. p. 44. t. 18. f. 1. Japanese name, *Kiwogose*.

Hab. Seas of Japan.

PELOR CUVIERI, Gray, Hardw. Illustr.; Richardson, Ichth. of Voy. of Sulph. p. 72. pl. 39; *Icon.* Reeves, 164; Hardw. Acanth. 124 & 125. Chinese name, *Hwang-yu*, "Yellow panther-fish" (Birch); *Wong paou yu*, "Yellow-spotted fish" (Reeves); *Wong pau u* (Bridgem. Chrest. 179).

The British Museum is indebted to John Reeves, Esq. for a specimen of this fish. The low ridge connecting the posterior edges of the orbits is straight, while in *Pelor japonicum* it bends forwards.

Hab. Canton.

PELOR SINENSE, C. et V. ix. p. 468.

Hab. Canton.

PELOR TIGRINUM, Richardson. *Icon.* Reeves, β. 42; Hardw. Acanth. 118. Chinese name, *Laou hu yu*, "Old tiger-fish" (Birch); *Laou hoo yu*, "Tiger-fish" (Reeves); *Lo tu yu* (Bridgem. Chrest. 177).

The Cambridge Philosophical Institution possesses a specimen which was procured by the Rev. George Vachell at Canton, and is correctly represented by Mr. Reeves's figure, except in the dorsal fin. In this the first three dorsal spines are a little separated from the others, and the coarse membrane of the rest of the fin is notched to half the depth of each spine and forms a thick lobulet to every tip. The soft dorsal is crossed obliquely by a dark brown bar, and there are three approximating brown bars on its base, which also cross the posterior spinous rays obliquely. The caudal has a brown membrane, and its rays are ringed by about six white marks alternating with brown ones. The body is brown with whitish spots more mottled than in the figure, and the intermediate spaces are paler. The form of the head is well rendered, and fringed barbels depend from almost every salient point. Two small ones hang from the chin, and a large one with a basal branchlet from the middle of each limb of the lower jaw. A thin smooth transverse ridge unites the orbits behind; there is a compressed knob behind each eye, and three knobs flank the nape on each side and include three rays of the dorsal. The lateral preocular depressions are deep. A short, stout, and not very pungent preopercular spine can be felt through the skin.

Hab. Canton.

APISTES ALATUS, C. et V. iv. p. 392; Temm. et Schl. F. Jap. p. 49. *Trigla worra-minou*, Russell, 159; *Icon.* Reeves, 169; Hardw. Acanth. 136.

I have seen no Chinese examples of this fish, but Mr. Reeves's figure, notwithstanding the omission of the suborbitar and preopercular spines, agrees so well with Russell's, that I have no hesitation in referring them both to the same species. The Chinese drawing shows a silvery head, a pale orange-brown body, black pectorals, a large black patch on the spinous dorsal with gray mottlings on the rest of the fin; five dark bars on the soft dorsal, as many on the caudal, and two incomplete ones on the anal. Ventrals pinkish, spotless.

Hab. Seas of China and Japan, and the Indian ocean.

APISTES TRACHINOIDES, C. et V. xii. p. 401. t. 92. *Rad.* D. 3|–12|4; A. 3|4; C. 12; P. 9 et 4; V. 1|4.

A Chinese specimen, collected by the Rev. George Vachell, exists in the museum of the Cambridge Philosophical Society, and the collection of Sir Edward Belcher contains another example, which is most probably also from the China seas. They agree with the description and figure in the 'Histoire des Poissons,' except that there are four unbranched rays in the pectoral, and that the dark dorsal bands are prolonged across the body.

Hab. Javan and Chinese seas.

APISTES RUBRIPINNIS, Temm. et Schl. F. Jap. p. 49. pl. 22. f. 2.

Hab. Coasts of Japan.

APISTES LONGISPINIS, C. et V. iv. p. 408. *Apiste à longue épine*, Quoy et Gaimard, Voy. de l'Astrol. pl. 11. f. 4. *Rad.* D. 14|8; A. 3|5; C. $7\frac{6}{6}$; P. 11; V. 1|4. (Spec. Mus. Brit.)

The British Museum possesses Chinese specimens presented by John Reeves, Esq., and Indian ones received from General Hardwicke.

Hab. Indian ocean, the Moluccas and sea of China.

MINOUS WOORA, C. et V. xii. p. 421. *Trigla woora minoo*, Russell, 159, A. *Rad.* D. 10|11; A. 1|9; C. 11; P. 11; V. 1|5. (China spec.)

Dried examples abound in the Chinese boxes of insects, and there is one in the museum of the Cambridge Philosophical Institution preserved in spirits, which was brought from Canton by the Rev. George Vachell. I have not established their specific identity with the Indian fish from the want of specimens from the latter country.

Hab. The Mauritius, the Indian and China seas.

Fam. TRIGLIDÆ.

PTEROIS VOLITANS, Gmel. (*Scorpæna*), C. et V. iv. p. 352. pl. 88. *Scorpæna volitans*, Benn. Ceylon, pl. 1. *Scorpène mahè*, Lacép. iii. p. 278, et ii. p. 290; *Icon.* Reeves, β. 1; Hardw. Acanth. 120; Reeves, 261; Hardw. Acanth. 121. Chinese name, *Kew yu*, or *Mow yu* and *King yu* (Birch, Reeves).

Mr. Reeves's figure β 1 was not done from the recent fish like his other drawings, but copied from a painting by Mr. Millet, in which the supra-orbitar cirrhi had been omitted. The cirrhi under the eye were added when the fish figured in drawing 261 was procured.

Hab. Seychelles, Mauritius, Indian ocean and Archipelago, Javan sea and coasts of China: also Japan according to Lacépède. It is said to ascend into brackish or fresh water, and to be reared in ponds at Batavia.

PTEROIS LUNULATA, Temm. et Schl. Fauna Jap. p. 45. pl. 19; *Icon.* Reeves, 165; Hardw. Acanth. 123. Chinese name, *Lung seu yu*, "Dragon's beard-fish" (Birch, Reeves); *Lung su u* (Bridgem. Chrest. 178). "Japanese name, *Jamonakami*" (Fauna Jap.).

A specimen now in the museum at Haslar was obtained on the Canton coast by Sir Edward Belcher.

Hab. Coasts of Japan and China.

CHIRUS HEXAGRAMMUS, Steller (also *Hexagrammus asper*, MSS.). *Labrax hexagrammus*, Tilesius, Mém. de l'Ac. de Pétersb. ii. pl. 23. f. 3; Pallas, Zoogr. Ross. p. 284; Temm. et Schl. F. Jap. p. 53. pl. 23. "Japanese name, *Abramee*" (Fauna Jap.).

I have seen no representation of a *Chirus* in Chinese drawings, but the genus is not uncommon on both shores of the Northern Pacific. A species closely resembling this one, if not actually the same, inhabits the harbour of Sitka. (*Ch. denarius*, Richardson, Ichth. of Voy. of Sulph. p. 78. pl. 44. f. 2.)

Hab. Coasts of Japan and Kamtschatka.

CHIRUS AGRAMMUS, Temm. et Schl. (*Labrax*), F. Jap. p. 56.

Hab. Sea of Japan.

SEBASTES INERMIS, C. et V. iv. p. 346; Temm. et Schl. F. Jap. p. 47. pl. 21. f. 3 and 4.

Hab. Japan.

SEBASTES VACHELLII, Richardson. *Icon.* Reeves, 69?; Hardw. Acanth. 114? Chinese name, *Shih kow kung*, "Stony dog" (Reeves); "Rock-dog gentleman" (Birch); *Shih kow kong* (Bridgem. 137).

In the museum of the Cambridge Philosophical Institution there is a small *Sebastes* which was brought from China by the Rev. George Vachell, that I have not been able to identify with any described species, neither am I confident that Mr. Reeves's figure ought to be referred to it; but it agrees better with it than with any other that I have seen.

Eyes approximated with elevated orbital plates and a ridge dividing the furrow between them. Three acute, falcate teeth on the edge of each orbit, three larger ones behind the orbit, and a small one on the temples. Nasal spines small and acute. Under edge of the preorbitar straight, ending in a spinous tooth pointing backwards. A thin unarmed ridge is continued from this tooth across the cheek to the root of the preopercular spine, where it is met by another ridge coming from the under edge of the orbit. These converging lines or ridges enclose a smooth disc, the rest of the cheek being scaly. Operculum armed by two small, flat spinous points and three angular corners. Opercular spines flat, weak and small, with no visible ridges extending from their roots. Gill-cover scaly. Maxillaries and jaws without scales. Angular ridges and points of the supra-scapulars and supra-axillary plate of the coracoid bone neither strong nor conspicuous. Scales of the body small, oblique and ciliated. Colours of specimen faded. From the uncertainty of the drawing belonging to this species I do not describe its tints in connection with it.

Hab. Canton.

SEBASTES PACHYCEPHALUS, Temm. et Schl. F. J. p. 47. pl. 20. f. 3; *Icon.* Reeves, 218; Hardw. Acanth. 115. Chinese name, *Shih gaou yu*, "Proud stone-fish" (Reeves). *Rad.* D. 13|12; A. 3|6; P. 7 et 12, &c.

A specimen exists in the Chinese collection at Hyde Park. The colours are not described in the 'Fauna Japonica;' but the following are the leading tints exhibited in Mr. Reeves's figure:—The body generally is brownish-red, paler and more lively on the under parts, and very dark towards the dorsal line. It is dotted throughout by darker points, apparently one to each scale, and there are several large, pale or bluish round spots on the sides. The head above and on the cheeks is like the body, and beneath it is unspotted. A crimson or reddish-orange is the general tint of the vertical fins, which, except the anal, have also two or three rows of dark round spots. The pectorals are orpiment and reddish-orange, with rows of black dots on the upper or branching rays. The ventrals are reddish-orange without spots.

Hab. Seas of China and Japan.

SEBASTES LONGICEPS, Richardson. *Rad.* D. 13|10; A. 2|6; P. 17; V. 1|5.

In the boxes of insects which are brought from China I have found examples of two species of *Sebastes* which appear to be undescribed. One of them has some resemblance to *S. pachycephalus*, but differs from it, and the rest of its congeners, in the greater comparative length of its head, which is contained twice and a half in the total length of the fish, caudal included. The nasal spines are very small, and there are three small teeth on the slightly raised upper edge of the obit, four or five minute serratures in its middle part, and three larger jagged teeth at its posterior corner. The two low, rounded intra-orbital ridges are separated from each other by a narrow mesial furrow, and the whole space between the eyes does not exceed two-thirds of the diameter of the orbit. The ridge which flanks the top of the cranium is a regular saw with five teeth; but the temporal ridges, though equally prominent, are more irregularly toothed. A low, thin, irregularly incised edge crests the infra-orbitar ridge, and three minute teeth arm the posterior edge of the preorbitar. The preopercular spine is very short, and is not bigger than the compressed tooth which overlies it. Only two teeth or angular corners exist on the edge of the bone below the spine. The operculum shows the usual two low ribs ending in short spinous points, but there are no serratures on the suboperculum, interoperculum or lower jaw. Small scales cover the top of the head to the nostrils, the cheek and gill-covers; but none can be detected on the maxillaries, which are most probably scaleless in the recent fish. The scales are minutely toothed on the edge.

Hab. China.

SEBASTES SERRULATUS, Richardson. *Rad.* B. 7; D. 13|11; A. 3|5; C. $14\frac{4}{4}$.

This *Sebastes*, also discovered in an insect-box, is not armed on the head by rows of spines like others of the genus, but presents in place of them very low, thin and serrated crests. A low double crest skirts the upper edge of the orbit, and is followed on each side of the cranium by a rather higher single one. Two ridges, nearly as high as the edges of the orbit, run forward between the eyes to the nostrils, their tips being the only substitutes for the usual nasal spines. The small preorbitar has an irregular but obscurely stellate cancellated disc, with two small descending spinous teeth on its under edge. The second suborbitar, which crosses the cheek, shows two thin, finely serrated crests that include a rugose disc. The edge of the preoperculum is serrated throughout, but it is only by aid of a lens that a minute spine can be detected at its angle, and clusters of spinous points on the usual sites of the four angular corners. The temples are roughly bony, and each limb of the lower jaw is traversed by three serrated crests higher than the cranial ones. A triangular operculum ends in a minute spinous point*, the suboperculum being prolonged beyond it to a fine tip. A few crenatures exist on the suboperculum where its edge meets the interoperculum.

Top of the head nearly on a line with the back, the orbits being close to the profile, but not elevated. The interorbitar space exceeds half the diameter of the orbit in breadth, and is scaly between the ridges. Scales cover the whole side of the head except the ridges, and also the disc of the maxillary, and like those which cover the body, they are coarsely ciliated. Minute villiform teeth arm the jaws and the very small acute chevron of the vomer; but the palate bones appear to be toothless. This points to a generic difference from *Sebastes*. Many of the rays have been mutilated and the specimen is otherwise much injured, so that we cannot complete the description. The dorsal spines are slender, moderately tall, and grooved on the sides. The first two are contiguous to each other, and the penultimate one is much shorter than the last one. The pectorals reach to the beginning of the anal fin; and the third anal spine is one-fourth longer than the second one. The head forms nearly a third of the entire length, which in our specimen is 4 inches.

Hab. Sea of China.

SEBASTES MARMORATUS, C. et V. iv. p. 345; Temm. et Schl. F. J. 46. pl. 21. f. 1 and 2.

The British Museum possesses one of Bürger's specimens, which I have not been able to identify with any of Mr. Reeves's drawings.

Hab. Japan.

SEBASTES ALBO-FASCIATUS, Lacépède (*Holocentrus*), iv. p. 372; C. et V. iv. p. 344.

The authors of the 'Fauna Japonica' consider this to be merely a variety of *marmoratus*.

Hab. Seas of China and Japan.

SEBASTES SINENSIS, M'Clelland, Calcutta Journ. Nat. Hist. iv. p. 397. pl. 21. f. 3.

Mr. M'Clelland thinks that this may belong to the preceding species. His figure differs in profile from that of *S. marmoratus* in the 'Fauna Japonica.'

Hab. Chusan.

SCORPÆNA CIRRHOSA, Thunberg (*Perca*), Mém. de Stockh. 14. pl. 7. f. 2.

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* Most of the *Sebastes* and *Scorpænæ* have their bony operculum strengthened by two diverging ribs, whose points are spinous. In this species a vestige of a single rib only can be detected.

An. 1793; C. et V. iv. p. 318; Temm. et Schl. F. J. p. 42. pl. 17. f. 2, 3. "Japanese name, *Oiarakabu*."

The British Museum possesses one of Bürger's Japanese specimens.

Hab. Indian ocean and sea of Japan.

SCORPÆNA NEGLECTA, Temm. et Schl. F. J. p. 43. pl. 17. f. 4. *Rad.*
D. 12|9; A. 3|5; C. 11; P. 9 et 11; V. 1|5. (Fauna Jap.)
D. 12|10; 3|5; $13\frac{5}{5}$; P. 8 et 8; V. 1|5. (Dried spec.)

To this species I am inclined to refer five or six small specimens which I picked out of the China insect-boxes, chiefly because they have a black spot between the seventh and ninth dorsal rays. The spines, intra-orbitar ridges, &c., correspond with the descriptions and figure in the 'Fauna Japonica;' but the length of the lower preorbitar, which almost equals that of an *Apistes*, is not noticed in that work. The specimens are much damaged, though the barbel between the posterior superciliary spines is still visible. The cheek is not scaly, and in this the species differs from the *Scorpæna militaris* (Ichth. Ereb. and Terr.) of Van Diemen's Land, which in most other respects it closely resembles. Edge of the palate-bones and chevron of the vomer set with teeth. Scales finely ciliated.

Hab. Coasts of China and Japan.

SCORPÆNA LEONINA, Richardson. *Icon.* Reeves, 66; Hardw. Acanth. 116. Chinese name, *Shih sze tsze*, "Stone-lion," such as are placed before houses (Birch); "Stone-lion's whelp" (Reeves); *Shih tz tsz* (Bridgem. Chrest. 116).

This species much resembles a *Platycephalus*, in the flatness of its head and the manner in which the rows of its strong spines are tiled upon each other. A pretty tall-feathered barbel rises from the posterior third of the orbit, and there are many others on the lower jaw and under corner of the maxillary and preoperculum, also numerous small ones on the flanks. The ground tint of the sides, which is reddish-brown, is clouded by largish masses of dark umber, the belly being paler and the summit of the back dark. The vertical fins are irregularly and obliquely barred with umber, and the pectorals are marked also by three cross bars formed by umbrine spots on the rays. Iris and tip of the caudal reddish. These particulars are noted solely from Mr. Reeves's figure. A specimen of the fish exists in the Chinese collection at Hyde Park, but I have not as yet examined it.

Hab. Canton.

CENTRIDERMICHTHYS UNCINATUS, Temm. et Schl. (*Cottus*), F. J. p. 38; Richardson, Ichth. of Voy. of Sulph. p. 74. pl. 54. f. 6–10 (*C. ansatus*). *Rad.* B. 6; D. 8|-19; A. 17; C. $9\frac{10}{11}$; P. 17; V. 1|4.

It is very probably a fish of this genus, which was observed by Steller at Cape Cronok and the mouth of the Itschia, and named by him *Cottus villosus* (Pall. Zoogr. Ross. p. 129). He states that it has three barbels on the lower jaw, and compares it to a *Platycephalus*, which *Centridermichthys* in fact considerably resembles. Tilesius, on the other hand, seems to have mistaken for *Cottus villosus* the *Aploactes aspera* noticed above, which is by no means like a *Platycephalus*.

Several specimens of *Centridermichthys uncinatus*, procured at Woosung in the estuary of the Yang tsee kiang kew by Sir Everard Home, were presented by him to the College of Surgeons. Another species inhabits the American coasts on the opposite side of the Pacific, viz. *C. asper* (Richardson, Fauna Boreal. Amer. pl. 95. f. 1).

Hab. China seas.

HEMILEPIDOTUS TILESII, C. et V. iv. p. 276. t. 85. *Cottus hemilepidotus*, Tilesius, Mém. de Pétersb. iii. p. 262. pl. 11. *Cottus trachurus*, Pallas, Zoogr. Ross. p. 138.

Hab. Japan, Sagalien, sea of Ochotsk, Kurile islands and north-western shores of America.

PLATYCEPHALUS INSIDIATOR, Bloch, Schn. p. 59. *P. spatula*, id. p. 59. *Batrachus indicus*, id. p. 43. *Callionymus indicus*, Lin. *Cotte madecasse*, Lacép. iii. p. 248. pl. 11. f. 1, 2. *Pl. insidiator*, C. et V. iv. p. 227; Temm. et Schl. F. J. p. 39. pl. 15. f. 1; *Icon.* Bl. pl. 424; Russell (*Irrwa*), pl. 46.

The Rev. George Vachell brought a specimen from Canton, which is now in the museum of the Cambridge Philosophical Society.

Hab. Red sea, Indian ocean, Moluccas, and seas of China and Japan.

Platycephalus guttatus, C. et V. iv. p. 224; Temm. et Schl. F. J. p. 39. pl. 15. f. 2; *Icon.* Reeves, 65; Hardw. Acanth. 110. Chinese name, *Sha kea* (Birch); "Pebble armour" (Reeves); *Sha kap* (Bridgem. Chrest. 40). Japanese name, *Notschi* (Langsdorff); *Onigotschi* (Fauna Japonica).

A Canton specimen of this fish exists in the museum of the Cambridge Philosophical Society, to which it was presented by the Rev. George Vachell.

Hab. Coasts of China and Japan.

Platycephalus cultellatus, Richardson. *Icon.* Reeves, β. 28; Hardw. Acanth. 109. *Rad.* D. 1|-7|-13; A. 13, &c. (Figure.)

Mr. Reeves's drawing here quoted resembles no figure of a *Platycephalus* with which I am acquainted, nor does it correspond to any of the numerous species described in the 'Histoire des Poissons.' It is remarkable for the length of its flat head, which forms nearly a third of the total length. Its small eyes are placed far forward and almost two diameters apart. Their orbits and the buccal ridges are unarmed. The cranial ridges (two on each side) are armed by a series of recumbent spines without any of the parallel or diverging lines which exist on the same parts in *P. insidiator*. The preopercular spines are equal, or the upper one rather exceeds the other. There are no spines on the lateral line. The colour of the fish, as is usual in the genus, is brownish, with numerous darker specks on the head, shoulders, pectoral and ventral fins. The body is without spots, but the back is crossed down to the lateral line by four deep brown bars, one under the first dorsal, two under the second, and the fourth behind the latter fin. The caudal is marked by five bars, the outer pair on each side being oblique; but there are no markings on the dorsals and anal. In the number of bars on the back this figure agrees with the *Pl. crocodilus* of Krusenstern, pl. 59. f. 2, which I have not as yet had an opportunity of consulting. In the 'Histoire des Poissons' and 'Fauna Japonica,' Krusenstern's plate is conjectured to be a bad representation of *Pl. guttatus*, from which Reeves's well-executed drawing is decidedly distinct.

Hab. Canton.

Platycephalus japonicus, Tilesius, Krusenst. Atlas, pl. 56. f. 1; C. et V. iv. p. 256; Temm. et Schl. F. J. p. 40. pl. 16. f. 3.

Sir Edward Belcher brought a specimen of this fish from the China seas.

Hab. Seas of Japan and China.

Platycephalus asper, C. et V. iv. p. 257. pl. 82; Temm. et Schl. F. J. p. 40. pl. 16. f. 4, 5.

The same officer brought two examples of this fish from the same quarter.

Hab. Seas of Japan and China.

Platycephalus spinosus, Temm. et Schl. F. J. p. 40. pl. 16. f. 1, 2; *Icon.* Reeves (non Hardw.).

I obtained a Chinese specimen of this fish from the insect-boxes above mentioned.

Hab. Seas of Japan and China.

Platycephalus endrachtensis, Quoy et Gaimard, Voy. de Freyc. p. 353; C. et V. iv. p. 240.

We have compared a specimen of this fish, which was taken at Chusan by Dr. Cantor, with one obtained on the north-west coast of Australia by Surgeon R. A. Bankier, R.N., and can detect no difference whatever, except that the two preorbitar teeth are less prominent in the Chinese specimen, which is smaller. The species is perhaps the most depressed of the *Platycephali*.

Hab. Seas of China and Australia.

In the 'Histoire des Poissons' the *Siluris imberbis* of Houttuyn (Mém. de la Soc. de Harlem, t. xx. p. 338), or the *Centranodon* of Lacépède, is shown to be a *Platycephalus*, and it is almost certainly one of the species above enumerated, but the description does not enable us to determine which of them.

Bembras japonicus, C. et V. iv. p. 283. pl. 83; Temm. et Schl. F. J. p. 41. pl. 16. f. 8.

Hab. Japan.

Bembras curtus, Temm. et Schl. F. J. p. 48. pl. 16. f. 6, 7.

Hab. Japan.

ASPIDOPHORUS SUPERCILIOSUS, C. et V. iv. p. 215. *Cottus et Phalangistes japonicus*, Pall. Spic. p. 31. pl. 5. *Agonus japonicus*, Bl. Schn. 105.

Hab. Sea of Japan, northward to the Kourile Islands.

ASPIDOPHORUS ROSTRATUS, Tilesius (*Agonus*), Mém. de l'Acad. de Pétersb. iv. pl. 14; C. et V. iv. p. 212. *Phalangistes fusiformis*, Tilesius in Pallas' Zoogr. Ross. iii. p. 116.

Hab. Sea of Japan. Gulf of Aniva. Sagalien. Kourile islands.

ASPIDOPHORUS LÆVIGATUS, Tilesius (*Agonus*), Mém. de Pétersb. iv. p. 436; C. et V. iv. p. 214. *Syngnathus segaliensis*, Tilesius, Mém. de la Soc. Imp. de Moscou, ii. p. 216. pl. 14.

Hab. Jesso.

Three other *Aspidophori* inhabit the coasts of Kamtschatka, Sagalien, or the Kourile Islands.

COTTUS INTERMEDIUS, Temm. et Schl. F. J. p. 38.

Hab. Jesso.

The sea of Ochotsk nourishes five other *Cotti*, viz. *C. minutus, jaok, stelleri, mertensii* and *marmoratus*, all noticed in the 'Histoire des Poissons.'

PERISTEDION ORIENTALE, Temm. et Schl. F. J. p. 37. pl. 14. f. 5, 6.

Hab. Japan.

DACTYLOPTERUS ORIENTALIS, C. et V. iv. p. 134. pl. 76; Temm. et Schl. F. J. p. 37.

Hab. Seas of Japan and China. Specimens are frequently to be found in the Chinese insect-boxes.

TRIGLA BURGERI, Temm. et Schl. F. J. p. 35. pl. 14. f. 1, 2; *Icon.* Reeves, *β.* 3; Hardw. Acanth. 106. Chinese name, *Hung keo*, "Red horn" (Reeves, Birch); *Hung koh* (Bridgem. Chrest. 79).

It forms a part of almost every collection of Chinese fish that we have seen.

Hab. Coasts of China and Japan. Hong Kong.

TRIGLA PAPILIONACEA, Solander, Pisces Australiæ, ined. p. 23; *Icon.* Parkinsonii in Bib. Banks, ii. t. 104. *Trigla kumu*, Less. et Garnot, Voy. de la Coquille, pl. 19; C. et V. iv. p. 50; Temm. et Schl. F. J. p. 37; *Icon.* Reeves, 159; Hardw. 107. Chinese name, *Lan yih yu*, "Green wing or fin" (Birch); *Lam e yu*, "Blue-finned fish" (Reeves); *Lam yih u* (Bridgem. Chrest. 78).

We have compared the Chinese and Australian specimens.

Hab. Seas of Japan, China, New Zealand, Van Diemen's Land, and the Cape of Good Hope.

TRIGLA HEMISTICTA, Temm. et Schl. F. J. p. 36. pl. 14. f. 3, 4. *Trigla alata*, Houttuyn, Mém. de la Soc. de Harlem, xx. p. 336?.

The Haslar Museum possesses an example of this species, which was brought from China by Captain Dawkins, R.N.

Hab. Seas of China and Japan.

TRIGLA SPINOSA, M'Clelland, Calcutta Journ. Nat. Hist. iv. p. 396. pl. 22. f. 2.

Mr. M'Clelland's figure has a more sloping profile than that of *Tr. papilionacea*, and the fin-rays differ in number, otherwise there is nothing in his description to distinguish it from that species. It is not, as he is inclined to think, the *Tr. alata* of Houttuyn, since it wants the rostral spines.

Hab. Chusan.

Fam. POLYNEMIDÆ.

POLYNEMUS TETRADACTYLUS, Shaw, Zool.; C. V. iii. p. 375. *Trigla asiatica*, Lin. *P. quadrinarius*, Solander, Pisces Austr.; *Icon.* Parkinsonii in Bib. Banks, serv. 101. *Maga jellee*, Russell, 183. *P. teria*, Buchanan Hamilt. pp. 224, 381. *Icon.* Reeves, *β.* 29; Hardw. 91; Acanth. 93 & 94. Chinese name, *Ma yew* (Reeves), "Salmon-fish" of the foreign residents (Reeves); *Ma yau* (Bridgem. Chrest. 105).

Hab. Indian ocean and rivers. Javan archipelago. Coasts of Australia and China.

Figure 242 of Mr. Reeves's collection (Hardw. 89) may represent the young of the preceding. It differs in having a more prominent belly and a shorter anal fin, though with as numerous rays as the anal of the preceding. It also wants the fine black lines which run through the centres of each row of scales above the lateral line, which are represented in the preceding figure. The four free pectoral rays have the same relative length.

POLYNEMUS PLEBEIUS, Broussonnet, Ichth.; C. et V iii. p. 380; Temm. et Schl. F. J. p. 29. pl. 11. f. 1. *P. lineatus*, Lacép. v. pl. 13. f. 2. *P. sele*, Buch. Hamilt. Ganges, p. 226 & 381. *Trigla asiatica*, Forst. Descr. Anim. p. 236; *Icon.* Georgii Forst. in Bib. Banks, serv. 241. f. 1.

Hab. Mauritius, Indian ocean, sea of Japan and Polynesia.

POLYNEMUS XANTHONEMUS, C. et V. vii. p. 517; *Icon.* Reeves, *a.* 15; Hardw. Acanth. 90. Chinese name, *Ma keaou lang* (Reeves); *Ma kau long* (Bridgem. Chrest. 114).

The figure has a zigzag blackish line above the base of the pectoral, which is not noticed in the 'Histoire des Poissons,' but in other respects it agrees with the description in that work.

Hab. Indian ocean and China sea. Canton.

Fam. MULLIDÆ.

UPENEUS CHRYSOPLEURON, Temm. et Schl. F. J. p. 29. pl. 12. f. 1; *Icon.* Reeves, 268; Hardw. Acanth. 98. Chinese name, *Hung te neaou* (Birch.); *Hong te new*, "Red-coated mullet" (Reeves).

This species is established in the 'Fauna Japonica' solely from a drawing of M. Bürger's, no specimen having reached the authors. Mr. Reeves's drawing is more elaborately coloured, and differs from that in the 'Fauna Japonica,' more in minute details than in general effect. The edges of the scales have an olive tint, and their discs are occupied by flexuose, red veins. The end of the snout, a circle round the eye, and the upper edge of the preorbitar are of a brighter vermilion, as is also the gill-cover. A bluish streak marks the base of the pectoral.

Hab. China and Japan.

UPENEUS SUBVITTATUS, Temm. et Schl. F. J. p. 30. *Rad.* D 7|-1|9; A. 1|6; V. 1|5. (Camb. spec.)

I am inclined to refer to this species a fish presented to the Cambridge Philosophical Society by the Rev. George Vachell. Narrow villiform bands of fine short teeth arm the jaws, acute chevron of the vomer and the palate-bones. The limbs of the preoperculum meet in a right angle, the extreme corner being slightly rounded and crenated. The barbels reach to the edge of the gill-opening. Reticulated and strongly ciliated scales cover the body, and the thirty-two which compose the lateral line are each traversed by a tube having three short branchlets on its upper side and one below. The line passes the anal before its curve is complete. Most of the colours have perished, but two faint bars remain on the dorsal, one of the bars having a black spot in it. Length of fish, 4 inch. Height, 0·9 inch. Length of head, 0·95 inch.

Hab. Seas of Japan and China.

UPENEUS BIACULEATUS, Gray (J. E.), Cat. of the Brit. Mus.; *Icon.* Reeves, *a.* 22; Hardw. Acanth. 101. Chinese name, *Fei te tseo* (Birch); *Fe te tso*, "Flying crying tso" (Reeves); *Fi tai tseuh* (Bridgem. Chrest. 228). *Rad.* D. 8|-9; A. 7; P. 14; V. 1|5.

An example of this species, brought from Canton by John Reeves, Esq., exists in the British Museum. It belongs to the tribe "without palatine teeth, and with the jaw-teeth widely set in a single row;" but it has no black spot on the tail. The very short anterior spine of the first dorsal is not represented in the figure. All the rays of the second dorsal and anal are jointed. Opercular spines conspicuous, the upper one being short and blunt, the lower one longer and acute. A dense bushy cluster is formed by the tubes on each scale of the lateral line. The barbels reach to the inferior part of the gill-opening, and the jaw-teeth are short-conical. Olive-green is the chief tint on the back and upper parts of the sides, deepest on the edges of the scales, whose discs, as they approach the flanks, acquire more and more of a pale reddish hue. These are so arranged as to form two indistinct longitudinal reddish stripes.

The belly is tile-red, while the fins have a colour approaching more to carmine, but the membranes of the ventrals and anal are mostly orpiment-orange. A dull reddish-brown tinges the front of the head, and a more lively carmine the lips and corners of the mouth. Along the middle of the olive-coloured preorbitar there is a dark streak, and another marks out its lower edge. A peach-blossom red spot is placed on the top of the tail immediately behind the second dorsal.

Hab. Canton.

Upeneus russelii, C. et V. iii. p. 465. *Rahtee goolivinda*, Russell, pl. 157. *Mullus indicus*, Shaw, Zool. iv. p. 614; *Icon.* Reeves, *a.* 36; Hardw. Acanth. 102. Chinese name, *Tsing fei te* (Birch); *Ching fe te* (Reeves). *Rad.* D. 9|-9; A. 1|7; C. 14$\frac{4}{4}$; P. 16; V. 1|5. (Brit. Mus. spec.)

An injured specimen of this fish, procured at Canton by the Rev. George Vachell, exists in the museum of the Cambridge Philosophical Society, and there are two from the same place in the British Museum, presented by John Reeves, Esq., which differ from the drawing merely in the black spot on the top of the tail being a little further back. The species belongs to the same group with *biaculeatus*, which it resembles in figure, and the Chinese appellation is the same with a distinctive epithet added.

The first spine of the dorsal is very short and incumbent on the base of the second, while the last spine is very small, recumbent and not easily detected, so that only seven may be reckoned, unless on minute inspection. Joints exist at top of the first ray of the second dorsal, and the point of the anal spine is flexible. The operculum has two small spinous points, and its anterior border is striated. The scales are granular and reticulate on their outer margin, minutely pitted on the disc, and furrowed and granulated towards the base. Each scale of the lateral line is marked by a little torch, that is, a cluster of many simple or merely forked short branchlets supported on a thickish tubular stem.

The colours are pretty well described by Russell. In Mr. Reeves's figure a short blue line runs from the orbit to the nostril, another borders the preorbitar beneath, and three descend from the temples to the cheek and gill-cover. The large anterior lateral spot is of a bright gamboge, and the posterior one is purplish-black. Five orange-coloured streaks cross the anal obliquely.

Hab. Indian and China seas.

Upeneus bensasi, Temm. et Schl. F. J. p. 30. pl. 11. f. 2. "Japanese name, *Bensasi*."

Hab. Seas of Japan.

Upeneus tragula, Richardson. *Icon.* Reeves, *a.* 21; Hardw. Acanth. 105. Chinese name, *Yang tswan*, "Ocean borer" (Birch); "Sea arrow" (Reeves); *Yéung tsün*, (Bridgem. Chrest. 229). *Rad.* D. 7. vel 8|-1|8; A. 1|6, &c.

This species is allied to *sub-vittatus*, *dubius* and others of the same group which have banded caudals. Mr. Reeves presented a Canton specimen to the British Museum, and I have received two from Surgeon R. A. Bankier, R. N., procured at Hong Kong. The short tubes on the scales of the lateral line are for the most part divided, and one of the branches is generally notched at the end, while the other emits very short transverse branchlets. The whole cluster on each scale looks to the naked eye to be merely a club-shaped tube. Narrow bands of minute, slender but bluntish teeth, arm the jaws and edges of the palate-bones, and there are still smaller ones on the chevron of the vomer. The barbels reach to the preoperculum. A more slender fish than *vittatus* and less so than *tæniopterus*. Blackish-green; upper half of the body traversed by a pale streak, commencing at the eye and coincident at first with the lateral line, but running above it in its course through the tail. Round purplish dots are distributed equally over the whole body, but are most conspicuous on the lower silvery parts. On the cheeks, the specks are dark umber, smaller and not round. The dorsals are darkish, especially towards their tips, with obscure bars in the specimens, and on the second the darker colour forms a large blotch. Six dark brown bars cross the caudal. The anal and ventrals are roseate with round dots, which are deep reddish-brown on the ventrals.

Hab. Canton.

Upeneus dubius, Temm. et Schl. F. J. p. 30. pl. 11. f. 3.

Hab. Seas of Japan.

There remains two of Mr. Reeves's figures, which we are unable to place in their proper groups from ignorance of their dentition. One of them, named *Yang chuey*, "Foreign mullet" (*Icon.* Reeves, *a.* 44; Hardw. 103), has the external form of *Up. bensasi*, which enters the first division of the genus, but it wants the bands and spots on the fins of that species.

The other (*Icon.* Reeves, 250; Hardw. 104) resembles *Up. bilineatus* of Quoy and Gaimard, in having two longitudinal streaks, but differs in its more oblique profile and greater number of fin-rays. Both these and the rest of the species figured by Mr. Reeves, were procured at Canton.

Fam. PERCIDÆ.

APOGON NOVEM-FASCIATUS, C. et V. ii. p. 154; Temm. et Schl. F. J. p. 2. pl. 2. f. 2; *Icon.* Reeves, β. 9; Hardw. Acanth. 8. Chinese name, *Hung so ho*, "Red-flowering water lily" (Reeves); *Hung soo ho* "Red-combed water-lily" (Birch).

Hab. Seas of Japan, China, the Moluccas, Java and Floris.

APOGON SEMILINEATUS, Temm. et Schl. F. J. p. 4. pl. 2. f. 2.

Hab. Sea of Japan.

APOGON LINEATUS, Temm. et Schl. F. J. p. 3.

Hab. Sea of Japan.

APOGON NIGRIPINNIS, C. et V. ii. p. 152; Temm. et Schl. F. J. p. 3.

Hab. Indian ocean. Seas of Java and Japan.

APOGON CARINATUS, C. et V. ii. p. 157; Temm. et Schl. F. J. p. 3.

Hab. Japan.

APOGON TRIMACULATUS, C. et V. ii. p. 156? Less. et Garnot, Voy. du Duperrey, p. 237? *Icon.* Reeves, 70; Hardw. Acanth. 9. Chinese name, *Yâng sun ho* (Reeves); *Yéng tsün* (Bridgem. Chrest. 229). *Rad.* D. 7|-1|9; A. 2|8; C. $16\frac{6}{6}$; V. 1|5. (Chinese spec.)

Mr. Reeves has deposited the specimen from which his figure was drawn in the British Museum. It has the form of *Ap. trimaculatus*, but scarcely any traces are discernible of the three black dorsal spots, and the figure wants these spots entirely, having a bronzed umber colour on the back, with pale sides. The pectoral is orange, and the other fins brownish-purple, all without spots. The Chinese fish has a great similarity to *Ap. rex-mullorum*, but its body is a little higher. The spine of the second dorsal is strong. The preoperculum is serrated nearly all round, and the villiform bands of teeth on the jaws are shorter and finer than those of *Ap. rex-mullorum.*

Hab. Seas of Java? and China.

AMBASSIS VACHELLII, Richardson. *Rad.* D. 7|-1|9; A. 3|9; P. 13; V. 1|5.

A Canton specimen of this fish, collected by the Rev. George Vachell, belongs to the Cambridge Philosophical Institution, which differs from the three noticed in the 'Histoire des Poissons,' that have no more than nine soft rays in the second dorsal, in having four teeth reclining backwards on the hinder part of the orbit. Scaly nape, convexly coped with an acute mesial line; the scales coming to a point between the posterior parts of the orbits. Gill-cover entire and scaly, a single row of large ones on the inter-operculum, which is also entire. Two acute edges of the lower limb of preoperculum beautifully serrated, and the posterior edge of the upper limb rather openly and slenderly toothed. The corner is rounded, and the fore-edge of the upper limb is vertical and smooth. Whole edge of the preorbitar spinously toothed. Eye large; lower jaw ascending.

A recumbent, concealed pre-dorsal spine. The spines of the dorsal are curiously beaded, as if jointed; and the ventral spine also is torulose. The lateral line, composed of about thirty scales, is arched anteriorly in a brown band, which descends from the first dorsal, and is there diffracted and resumed two scales' breadth lower, whence it is continued in a silvery stripe to the tail. Length of fish, 2·50 inches. Height of body, 1·68 inch.

Hab. Canton.

DIPLOPRION BIFASCIATUM, C. et V. ii. p. 137. pl. 21; Temm. et Schl. F. J. p. 2; *Icon.* Reeves, α. 27; Hardw. Acanth. 5. Chinese name, *Hwang te yu*, "Hwang te's fish," named after one of the judges of Hades (Reeves); "Yellow emperor's fish" (Birch). *Rad.* D. 8|-15 ad 19; A. 2|12; C. $15\frac{5}{4}$; P. 16; V. 1|5.

Specimens exist in every collection of Chinese fish, and small ones are common in the insect-boxes sold at Canton. Recent colour bright lemon-yellow, with spinous dorsal, ventrals and lateral mark black; also a very narrow edging of the same to the bright yellow vertical fins. The body is crossed vertically by upwards of twenty narrow bars, bent *en chevron*, and differing slightly from the ground tint.

Hab. Japanese, Chinese and Javan seas.

NIPHON SPINOSUS, C. et V. ii. p. 131. pl. 19; Temm. et Schl. p. 1. pl. 1. f. 1.

The British Museum possesses a specimen sent from Japan by Bürger.

Hab. Sea of Japan.

LATES NOBILIS, C. et V. ii. p. 96. pl. 13. *Pandoomenoo*, Russell, 131. *Coius vacti*, Buchan. Hamilt. Ganges, pp. 86, 369. pl. 16. f. 28; *Icon.* Reeves, *a.* 10; Hardw. Acanth. 7. Chinese name, *Tsao yu* (Birch); *Tso yu* (Reeves); *Tso u* (Bridgem. Chrest. 166).

Mr. Reeves's specimen from Canton, deposited in the British Museum, and other examples in the Chinese collection at Hyde Park, agree exactly with Indian ones; but Mr. Reeves's figure is not so happy as the rest of his admirable drawings, being inexact in the numbers of the soft rays and in the anal spines.

Hab. Indian ocean and sea of China. Ganges. Canton. It is not mentioned in the 'Fauna Japonica.'

LATES CALCARIFER, C. et V. ii. p. 100; Bl. 244? *Icon.* Reeves, *a.* 11; Hardw. Acanth. 64. Chinese name, *Hĭh tsaou* (Birch); *Hih tso*, "Black tso" (Reeves); *Hak ts'o* (Bridgem. 128). *Rad.* D. 8|11; A. 3|8.

The figure in Mr. Reeves's portfolio above quoted, has the same defects with that of *Lates nobilis*, but a mounted specimen, brought by that gentleman from Canton and deposited in the British Museum, has the number of rays given above, and four teeth on the humeral bone. Its length is 10·25 inches, of which the head measures 2·50 inches. Bloch's figure is not accurate in the details. The lateral line in this species is more boldly arched above the pectoral than in *L. nobilis*.

Hab. Coasts of China.

The *Ta loo*, "Variegated ——" (Reeves, 88), *Ta lo* (Bridgem. Chrest. 172), much resembles these *Lates* in form, but it has too many spines for any described species either of that genus or of *Labrax*. The Chinese generic epithet belongs to *Labrax*.

LABRAX JAPONICUS, C. et V. ii. p. 85. *Perca-labrax japonicus*, Temm. et Schl. F. J. p. 2. pl. 2. f. 1. *Holocentrum maculatum*, M'Clelland, Calcutta Journ. Nat. Hist. p. 400. pl. 21. f. 1. *Lates punctulatus*, Cantor, *fide spec.*; *Icon.* Reeves, 135; Hardw. Acanth. 43. Chinese name, *Pan tsaou* "Striped tsaou" (Birch); *Pan loo* (Reeves); *Páns lò* (Bridgem. Chrest. 217).

We have had an opportunity of comparing one of Bürger's Japanese specimens, now in the British Museum, with others from various parts of the Chinese coasts. Mr. Reeves's figure is that of the young fish. One Chinese specimen, said to have been transmitted to London by Mr. M'Clelland, is labelled *Lates punctatus*, but I do not know whether it has been published by that name or not. Specimens exist in the British Museum, India-House and Haslar museums, and in the Chinese collection at Hyde Park.

Hab. Seas of Japan and China. Hong Kong, Canton, Peiho, Chusan, &c.

Fam. BERYCIDÆ (Low Fishes of Madeira).

MONOCENTRIS JAPONICUS, Houttuyn (*Gasterosteus*), Mém. de Harlem, xx. p. 329; C. et V. iv. p. 461; Bl. Schn. pl. 24; Temm. et Schl. F. J. p. 50. pl. 22. f. 1. *Sciæna japonica*, Thunberg, Mém. de l'Acad. des Sciences de Swede, xi. p. 102. pl. 3. *Lepisacanthe*, Lacép. iii. p. 321.

Hab. Sea of Japan.

MYRIPRISTES JAPONICUS, C. et V. iii. p. 173. pl. 58; Temm. et Schl. F. J. p. 22.

Hab. Sea of Japan.

MYRIPRISTES PRALINUS, C. et V. iii. p. 170 et vii. p. 486. *Rad.* D. 10|13; A. 4|11; C. 19$\frac{5}{5}$; V. 1|7.

A Canton specimen was presented to the British Museum by John Reeves, Esq.

Hab. Coasts of China. Canton.

HOLOCENTRUM SPINOSISSIMUM, Temm. et Schl. F. J. p. 22; *Icon.* Reeves, 84; Hardw. Acanth. 84. *Holocentre à bande blanche*, Lacép. iv. p. 372, 373? Chinese name, *Tseuen Keun Keā*, "Tseang Keun's armour;" "Tseang Keun is a military officer" (Reeves); *Tseúng kwan káp* (Bridgem. Chrest. 93). *Rad.* B. 8; D. 11|13; A. 4|7, &c.

Mr. Reeves's Canton specimen is deposited in the British Museum. Lacépède, on the authority of Japanese drawings, named one species of this genus *Holocentre à bande blanche*, and another *Holocentre blanc-rouge*. On the supposition that the only two *Holocentra* which I have met with in collections of Chinese fish are the same two which frequent the seas of Japan, I have considered his *bande blanche* as identical with the *spinosissimum* of the 'Fauna Japonica,' because of its white stripes. Our enumeration of the fin-rays differs from that recorded in the work in question; but it is difficult in this genus, without dissection, to distinguish between entire rays and branches, especially of the anal fin, and two observers will scarcely reckon alike. Caudal and anal yellow, the front of latter and sides of former red. Edge of dorsal yellow.

Hab. Coasts of Japan and China.

HOLOCENTRUM ALBO-RUBRUM, Lacép. iv. p. 372; *Icon.* Reeves, α. 19; Hardw. Acanth. 83. Chinese name, *Kin lin kea*, "Scaly metallic armour" (Reeves); *Kam lun káp* (Bridgem. Chrest. 94). *Rad.* B. 8; D. 11|14; A. 4|9; P. 1|12, &c.

For the reason given above I have referred this Chinese fish to the species named by Lacépède. Specimens from Canton exist in the British Museum, presented by John Reeves, Esq., and in the museum of the Cambridge Philosophical Society, by the Rev. George Vachell. There are also examples of it in the Chinese collection at Hyde Park. Cuvier was inclined to think that the Japanese painting referred to by Lacépède, was a representation of *H. orientale*, but a careful examination of the specimens causes me to doubt the correctness of this opinion and to have recourse to Lacépède's prior appellation.

The infraorbitar chain is finely fringed and unequally toothed throughout, the anterior point of the preorbitar being armed by one strong curved tooth followed by five or six small conical ones, differing in appearance from the rest, which are more setaceous. Interoperculum armed by six or seven teeth, the posterior three being largest. Ribs or longitudinal streaks of operculum ending in four or five slender points; the two spines strong and slightly divergent. Vertical edge of preoperculum strongly toothed above the thick, smooth spine; under edge also toothed; the disc smooth. Under jaw and maxillaries streaked in two directions. Temporal plate streaked and toothed. Posterior frontal rusticated; from seven to ten striæ on each side of the hind head; supra-scapular and scapula finely toothed and furrowed. An acute tooth of the nasal bone overlies the edge of the intermaxillary; and there are streaks and a small tooth on the supra-axillary plate of the coracoid bone; thirty-seven scales on lateral line. There is none of the yellow colour on the fins which the preceding species shows.

Hab. Seas of China and Japan.

Fam. SILLAGINIDÆ.

SILLAGO JAPONICA, Temm. et Schl. F. J. 23. pl. 10. f. 1; *Icon.* Reeves, β. 40; Hardw. Acanth. 3. Chinese name, *Sha tswan*, "Sand spear" (Reeves); *Shá tsün* (Bridgem. Chrest. 202). *Rad.* B. 5; D. 11|-1|22; A. 3|21, &c.

John Reeves, Esq. and the Rev. George Vachell brought specimens from Canton, which are deposited in the British Museum and with the Cambridge Philosophical Institution. The numbers of rays, as given above, correspond with the figure but not the text of the 'Fauna Japonica.' They were reckoned in one of Mr. Vachell's specimens. The second spine of the first dorsal is rather taller than the first, and the curve of the lateral line is exaggerated in Mr. Reeves's drawing.

Fam. SCIÆNIDÆ.

SCIÆNA JAPONICA, Temm. et Schl. F. J. p. 58. pl. 54. f. 1.

Hab. Sea of Japan.

Sciæna lucida, Richardson, Ichth. Voy. of Sulphur, p. 87. pl. 44. f. 3, 4; *Icon.* Reeves, β. 6; Hardw. Acanth. 130. Chinese name, *Hwang pe tow* (Birch); *Wang pe tow,* "Yellow-skin head" (Reeves); *Wang pi tau,* (Bridgem. Chrest. 98).

The *Sciæna lucida* forms part of all the collections of Chinese fish that we have examined, and is one of the most common fish on the breakfast tables of the foreign residents at Macao. *Wang pe* is the fruit of the *Cookia punctata.*

Hab. Seas of China. Chusan. Ningpo. Canton.

Sciæna crocea, Richardson. *Icon.* Reeves, 139; Hardw. Acanth. 131. Chinese name, *Hwang hwa* (Reeves); "Yellow paint" (Birch); (Bridgem. Chrest. 169?) *Rad.* D. 9|–1|33; A. 1|8; C. 17$\frac{4}{4}$; P. 16; V. 1|5.

This fish is intermediate in form, as well as in the numbers of its fin-rays, between *Sc. lucida* and *Sc. pama* (Buch.), and differs considerably in character from the two Atlantic species and from *Sc. japonica,* having more the aspect of a *Johnius.*

The following particulars are noted from a Canton specimen presented to the British Museum by John Reeves, Esq.:—Outer teeth of the upper jaw widely set, short, subulate, acute; a canine tooth a little stouter than the others on each side of the symphysis; and a villiform band within. On the lower jaw, the subulate teeth are a little taller and slightly curved, with numerous small ones amongst them, but no distinct interior villiform bands. The maxillary is strengthened anteriorly by a smooth rib which projects at the tip. Four pores at the end of the lower jaw; and five teeth pointing upwards on the upper limb of the preoperculum. Two thin, flat, triangular, acute and flexible tips to the operculum, with a cartilaginous prolongation of the suboperculum extending much beyond them. Anal spine having about one-third of the length of the soft rays. Scales soft and nacry, the curve of the lateral line terminating at the tip of the pectoral, but less boldly arched than in the figure. Pectorals, under-parts of the body, sides of the head, and ventral spine saffron-yellow, the anal showing a reddish-orange hue. The fish attains a considerable size.

Hab. Sea of China. Canton.

Otolithus aureus, Richardson. *Icon.* Reeves, 234; Hardw. Acanth. 129. Chinese name, *Kin lëen hwo,* "Gold scale hwo" (Birch); *Kinn lin han,* "Golden-scaled han" (Reeves). *Rad.* D. 10|–1|25; A. 2|9; P. 17; V. 1|5.

John Reeves, Esq. presented two Canton specimens of this fish to the British Museum. They have five pores at the tip of the lower jaw; a row of subulate teeth on the upper jaw, a card-like or villiform band within, and a canine tooth near the symphysis. On the lower jaw there are no villiform bands within the subulate teeth, but two or three rows of minute ones exterior to them. Maxillary striated, truncated. Preorbitar and snout scaly. Preoperculum streaked on its border and slightly crenato-dentate. Bony operculum ending in two narrow, acute, triangular flat points, separated from each other by a deep oblique fissure. First anal spine almost concealed; second slender, half the length of the soft rays. Colour generally dark with much brown, unspotted on body. Two rows of spots between the rays on second dorsal; pectorals and lower fins orange.

Hab. Canton.

Otolithus reevesii, Richardson. *Rad.* D. 10|–1|31; A. 2|7; C. 17; P. 19; V. 1|5.

This species has the general form of the preceding, but differs from it in having a more blunt, rounded, and prominent snout, a shorter rounded caudal, approaching less to a rhomb, and the preoperculum spinously toothed on the upper limb and rounded corner, where the teeth are large. On its under limb the teeth have the usual crenato-dentate character observed in this genus. The dorsal is more deeply divided than in *aureus,* and the two equal tips of the bony operculum are shorter and stronger. The second anal spine, though shorter than the soft rays, is stout and finely striated; dentition and pores on chin as in *aureus.* On the upper half of the body there are oblique lines which pass some way below the lateral line. The number of anal rays forbid us to refer this fish to the *bispinosus* of the 'Histoire des Poissons,' and it does not agree with the others described in that work. The British Museum possesses a Chinese specimen obtained from Mr. Reeves, but he does not appear to have had a drawing made of it.

Hab. Canton.

OTOLITHUS ARGENTEUS, Kuhl et Van Hasselt, apud C. et V. v. p. 62? *Icon.* Reeves, 200; Hardw. Acanth. 133. *Rad.* D. 10|–1|28; A. 2|7; P. 17; V. 1|5. (Chin. Spec. Cam. Ph. Inst.).

In the absence of specimens or figures of the Batavian *O. argenteus*, the Chinese fish can be referred to the same species only with doubt. An example of the Chinese fish was presented to the Cambridge Philosophical Institution by the Rev. George Vachell.

An outer row of short, equal subulate teeth, moderately widely set, arm both jaws, and within the upper ones there is a narrow microscopical villiform band, but none such are perceptible on the lower jaw. A long, curved, and not stout canine stands on each side of the symphysis of each jaw, the upper ones being widely apart, so as to receive the inferior pair between them. The lower jaw is slightly longer than the snout. Curve of the lateral line completed opposite to the anus and middle of the second dorsal. The bony operculum is traversed by two fine ribs whose ends project slightly, the notch between them being inconspicuous. The second anal spine is slender, weak, and only half the length of the soft rays; the first one is a mere point. Length of specimen, 6·55 inches; length of head, 1·55 inch; length from snout to anus, 3·55 inches; from snout to caudal, 5·50 inches; height of body, 1·25 inch.

Hab. Canton. Straits of Malacca? (Major Farquhar). Javan sea? (K. et V. H.)

OTOLITHUS TRIDENTIFER, Richardson. *Icon.* Reeves, *β*.54; Hardw. Acanth. 132. Chinese name, *San ya* (Birch); *San nga* (Reeves), "Three-teeth;" *Sám ngá* (Bridgem. Chrest. 142). *Rad.* D. 10|–1|27; A. 2|6; P. 15; V. 1|5. (Spec. Br. Mus.)

Two strong curved canines above and one below near the symphysis, with an equal row of lateral subulate teeth on both jaws, more closely set in the lower one. By aid of a lens, a narrow band of villiform teeth can be detected within the others above; and beneath there are a few intermixed with the principal ones. Some striæ are visible on the end of the maxillary; and there are depressions on the lower jaw, but no pores could be detected. The preoperculum is armed feebly by small acute teeth, and the bony operculum shows two narrow points separated from each other by a fissure. The fish is pale and silvery, with a light bluish gray tint along the back. The lower half of the caudal, front of the anal, ventrals, and the pectorals are gall-stone yellow. The rest of the fins are pale and spotless, the upper half of the caudal alone being deeper and approaching to blackish-gray.

Hab. China seas. Canton.

CORVINA GRYPOTA, Richardson. *Icon.* Reeves, *β*. 12; Hardw. Acanth. Chinese name, *Hwo tow* (Reeves, Birch); *Wák tău* (Bridgem. Chrest. 127). *Rad.* D. 10|–1|29; A. 2|7 vel 8; C. 18$\frac{1}{8}$; P. 18; V. 1|5. (Spec. Hasl. Mus.)

Most of the collections of Chinese fish that we have examined contain examples of a *Corvina*, which with the general aspect of *C. coitor* of Buchanan Hamilton (pl. 27. f. 24), has a straighter profile and a shorter and blunter snout that curves downwards from the nostrils, much like that of *Umbrina vulgaris*; it seems to be allied to *Sciæna lucida.* Upper jaw armed by a concave densely villiform plate of teeth with a stronger subulate outer row, brownish at the tips, which are even; on the lower jaw the villiform plate is boldly convex. Minute pores exist on the snout, and there are five large pores at the end of the lower jaw. The scaly preorbitar receives beneath its edge, the entire maxillary and all the intermaxillary except the dental margin. A deep recess exists on the outside of the maxillary pedicles, and a little triangular point of the preorbitar lip hangs over it. The limbs of the lower jaw are scaly, and thin bony ridges of the suborbitar chain cross the scaly cheek. The preoperculum is bounded towards the cheek by a smooth bony edge; its posterior edge is free and is widely set with slender subulate teeth, the most distinct ones being the tips of ribs which cross the disc of the bone. Interoperculum entire, mostly concealed beneath the preoperculum; suboperculum also entire, rather narrow. Two low even diverging ribs cross the operculum and end in points which are scarcely pungent, and the edge of bone between them is nearly even. Lateral line formed by a series of simple tubes, boldly arched anteriorly, and becoming straight in the tail by a gradual sweep ending opposite the beginning of the anal. Scales tender, nacry, and very deciduous. Second anal spine not strong, a little shorter than the soft rays. Caudal subrhomboidal. Ventrals with a short filamentous tip. Colour mostly silvery, with some yellow tints on fore part of anal, ventrals, and pectorals. Length about 7 inches.

Hab. Canton.

CORVINA SINA, C. et V. v. p. 122; Temm. et Schl. F. J. p. 58. pl. 24. f. 2; *Icon.* Reeves, 94; Hardw. Acanth. 130. Chinese name, *Hwang Hwă*, "Yellow Pichere"? (Reeves); *Hwang hwŏ* "Yellow hwŏ fish" (Birch); *Wong wák* (Bridgem. Chrest. 99).

The figure of the *hwang-hwa* is the nearest in Mr. Reeves's portfolio to the plate of the 'Fauna Japonica' quoted above, but it does not agree exactly with it, the profile of the forehead differing a little, and the anal spine being rather stronger. We have seen no specimen that could be referred to this species.

Hab. Japan, China, and the Indian ocean.

Corvina catalea, C. et V. v. p. 128. *Lutjan diacanthe*, Lacépède, iv. pp. 195 et 244. *Katchelee*, Russell, 116; *Icon.* Reeves, 207; Hardw. Acanth. 128. Chinese name, *Man yu* (Reeves); *Man ü* (Bridgem. Chrest. 174). *Rad.* D. 10|-1|21; A. 2|7; P. 19 vel 20; V. 1|5. (Chin. Spec. Brit. Mus.)

A Chinese specimen of this fish, 9½ inches long, has been deposited in the British Museum by John Reeves, Esq. The spots are as in Russell's plate, with a few more of them descending below the lateral line, but there are also two rows of spots on the first dorsal, which are only obscurely indicated in Mr. Reeves's figure.

Hab. Indian ocean. China sea. Canton.

Corvina nalla-katchelee, Russell, 115; *Icon.* Reeves, 225; Hardw. Acanth. 134. Chinese name, *Ma-man* (Birch); *Ma pin* (Reeves). *Rad.* D. 10|-28; A. 2|7; P. 16; V. 1|5. (Chin. Spec. Brit. Mus.)

The British Museum possesses a mounted specimen of this fish and one in spirits, both brought from Canton by Mr. Reeves. Russell says that the Coromandel fishermen take this to be the male of *C. catalea.* The differences in the numbers of the rays of the fins seem to render it expedient to keep them distinct; the snout of this is more obtuse; like the preceding, it has five pores on the lower jaw; the second anal spine is only half the length of the soft rays.

Hab. Indian and China seas. Canton.

Corvina? albiflora, Richardson. *Icon.* Reeves, β. 48; Hardw. Acanth. Chinese name, *Pih hwa* (Birch); *Pih fa* (Reeves), "White flower;" *Pák sfá* (Bridgem. Chrest. 129).

This is apparently a *Corvina* with stronger teeth than the other species in Mr. Reeves's portfolio, but we have seen no specimen that can be referred to it, nor can we identify it with any one described in the 'Histoire des Poissons' by the short accounts of the species therein mentioned. The base of the second dorsal is marked by a row of black dots, one on each ray. The general colour is silvery with pale bluish-gray on the discs of the scales, the gray tint deepening along the dorsal line. Pectorals, fronts of the ventrals and anal and lobes of the caudal, more or less deeply tinged with orange or yellow. First dorsal darker than the other fins, but there are no spots except the row on the base of the second dorsal.

Hab. Canton.

Umbrina russelii, C. et V. v. p. 178; *Qualar-katchelee*, Russell, 118; *Icon.* Reeves, β. 37; Hardw. Acanth. Chinese name, *Săng seu hwa* (Birch); "Live pencil-beard" (Reeves); *Shang ssú wák* (Bridgem. Chrest. 175). *Rad.* D. 11|27; A. 2|7; C. 15$\frac{6}{6}$; V. 1|5. (Spec. Camb. Ph. Inst.)

The Cambridge Philosophical Institution is indebted to the Rev. George Vachell for a Canton specimen of this fish. It has a mesial barbel on the chin, with a deep pore on each side of it, and fifty scales on the lateral line. The whole fish is brightly nacry with a pale reddish-brown tint along the dorsal line; pale yellow second dorsal, pectorals, and ventrals; and front of anal yellow or orange.

Hab. Indian and China seas. Canton.

Fam. Hæmulonidæ.

Diagramma cinctum, Temm. et Schl. F. J. p. 61. pl. 26. f. 1; *Icon.* Reeves, 82; Hardw. Acanth. Chinese name, *Hwa juen shin*, "Flowery soft lips" (Birch); *Fa juen shen* (Reeves); *Fá un shan* (Bridgem. Chrest. 95).

The Chinese collection at Hyde Park and the British Museum contain several specimens of this fish, which we have compared with a specimen of Bürger's from Japan, also belonging to the latter institution. The bands of colour, and indeed the whole form of the fish, are singularly like those of *Diacope sebæ* (Russell, 99; C. et V. ii. p. 411), but there are no spots on the latter. The markings still more closely resemble those of *Hapalogenys maculatus* (Reeves, *a.* 49). Mr. Reeves's drawing represents both the Chinese and Japanese specimens more faithfully than the figure published in the 'Fauna Japonica,' but the profile of neither is quite steep enough.

Hab. Coasts of China and Japan.

DIAGRAMMA GATERINA, Forskal (*Sciæna*), C. et V. v. p. 301. pl. 125. *Holocentre gaterin*, Lacép. iv. p. 347; Rüppell, Atl. 32. f. 1; *Icon.* Reeves, *a.* 50; Hardw. Acanth. 50. Chinese name, *Hung teen tseu* (Birch); *Hung teen tso* (Reeves), "Red-spotted tso fish." *Rad.* D. 14|15; A. 3|7, &c. (Spec. Chin. Collect.)

Notwithstanding the difference in the numbers of the dorsal rays, I have ventured to refer this Chinese fish to the *Sciæna gaterina* of Forskal. Rüppell's figure differs from the one in the 'Histoire des Poissons' considerably in the steepness of the profile. Mr. Reeves's drawing is in this respect most like the latter, but in the form and distribution of its spots it has more resemblance to Rüppell's figure. The Chinese collection at Hyde Park contains a specimen of this fish.

Hab. Red sea and coasts of China.

DIAGRAMMA PICTUM, Thunberg (*Perca*), Nov. Mém. de Stockh. xiii. p. 141. pl. 5; C. et V. v. p. 315; Temm. et Schl. F. J. p. 62; Hardw. Acanth. 138.

A specimen sent to the museum at Haslar from Hong Kong, by Surgeon R. A. Bankier, R.N., differs from the description of the species in the 'Histoire des Poissons,' in its first dorsal being black with a white edge, which is the extension of the mesial frontal band.

Hab. Seas of Japan, China and Malay archipelago, and the Indian ocean.

DIAGRAMMA PŒCILOPTERUM, C. et V. v. p. 314; Seba, iii. pl. 27. f. 17; Temm. et Schl. v. p. 314; *Icon.* Reeves, 190; Hardw. Acanth. 65. *Rad.* D. 10|21; A. 3|6, &c. (Chin. Spec.)

Specimens exist in the Chinese collection at Hyde Park, and we have found dried ones in the Chinese insect-boxes.

Hab. Seas of Japan, China, Malay archipelago, and India.

DIAGRAMMA PUNCTATUM, Ehrenberg, C. et V. v. p. 302; Temm. et Schl. F. J. p. 60; Quoy et Gaim. Voy. de l'Astrol. pl. 12. f. 2; Rüppell, Atl. pl. 32. f. 2; *Icon.* Reeves, 78; Hardw. Acanth. 30. Chinese name, *Yaou we*, "Want tail" (Birch); *Yaou ne* (Reeves); *Yap mí* (Bridgem. Chrest. 214).

The colouring of Mr. Reeves's drawing corresponds closely with the description in the 'Fauna Japonica,' and approaches nearer to the plate in the 'Voyage of the Astrolabe' than to that in Rüppell's 'Atlas.' The Chinese collection at Hyde Park contains a specimen. It has three pairs of pores on the lower jaw.

Hab. Red sea, Malay archipelago, and seas of China and Japan.

PRISTIPOMA KAAKAN, C. et V. v. p. 244; Rüppell, Neue Wirlb. p. 123. pl. 30. f. 1; *Icon.* Reeves, 201; Hardw. Acanth. 52. Chinese name, *Tow loo* (Birch, Reeves); *Tau lò* (Bridgem. Chrest. 134). (Chin. Spec.)

A specimen from China has been deposited in the British Museum by John Reeves, Esq.

Hab. Red sea, Indian ocean, Malay archipelago, and China sea.

PRISTIPOMA NAGEB, Rüppell, Neue Wirlb. p. 124. taf. 30. f. 2; *Icon.* Reeves, 244; Hardw. Acanth. 62. Chinese name, *Sing loo* (Reeves); "Starry loo fish" (Birch). *Rad.* D. 12|12 ad 15; A. 3|7; &c. (Chin. Spec.)

John Reeves, Esq. has deposited a specimen of this fish in the British Museum. The Rev. George Vachell presented another to the Cambridge Philosophical Institution, and there are several in the Chinese collection at Hyde Park.

Hab. Red and China seas.

PRISTIPOMA PIHLOO, Richardson. *Icon.* Reeves, *a.* 29; Hardw. Acanth.

135. Chinese name, *Pih loo*, "White loo fish" (Reeves, Birch); *Pak lo* (Bridgem. Chrest. 135). *Rad.* D. 11|14; A. 3|8; C. 17¼; P. 16; V. 1|5.

Mr. Reeves's China specimen is in the British Museum. It greatly resembles *nageb*, but has a more convex profile, and differs in its markings. It has a row of seven roundish dark spots or short transverse bars along the back above the lateral line, in which respect it differs from *P. guoraca*, whose form is not dissimilar. No pores were detected on the lower jaw. The teeth on the jaws are villiform, the dental surface being narrower on the upper jaw, and bounded by an outer row of short subulate teeth. The roof of the mouth is toothless. Space round the nostrils and jaws nacry; all the opercular pieces and the cheek scaly. Disc of preoperculum broad, its outline parabolic and its posterior edge toothed, the teeth being more remote at the corner. The figure, which is otherwise a good representation of the specimen, does not bring the curve of the preoperculum far enough back. A band of small scales crosses the nape from one scapula to the other; the second anal is longer and stronger than the third one. This species is similar in its markings to *Mesoprion johnii*, Bl. 318, but the specimen has no vomerine nor palatine teeth. (C. et V.)

Hab. Canton.

Pristipoma japonicum, C. et V. v. p. 288; Temm. et Schl. F. J. p. 60. pl. 26. f. 2; *Icon.* Reeves, 202; Hardw. Acanth. 71. Chinese name, *Hae tseih* (Birch); *Hae tseik* (Reeves), "Sea-tsaou;" *Hoi tsik* (Bridgem. Chrest. 223). Japanese name, *Jousaki* (Langsdorff). *Rad.* D. 15|16; A. 3|7; P. 17, &c. (Chin. Spec. Brit. Mus.)

The figure in the 'Fauna Japonica' represents a fish with a considerably lower body than the Chinese, which we have referred to that species on account of its agreement in all other respects with the characters of the species. The British Museum received a Chinese specimen from John Reeves, Esq. Second and third anal spines equal and striated. The scales are small.

Hab. Coasts of China and Japan.

Pristipoma? chloronotum, Richardson. *Icon.* Reeves, 231; Hardw. Acanth. 77. Chinese name, *Tsing pei cha*, "Green-backed tseu fish" (Birch); *Ching keae tso* (Reeves). *Rad.* D. 12|22 vel 23; A. 3|12; &c. (from the drawing.)

Of this fish we have seen no specimen. It has the thickish lips and preoperculum of a *Pristipoma* and the even dorsal of *Pr. japonicum.* The scales are larger than in that species, and the second anal spine is conspicuously longer and stronger than the third one. A greenish-gray tint, approaching where most intense to olive-green, pervades the upper parts of the body and the vertical fins, being deepest on the discs of the scales, which have silvery margins. The sides are paler and are glossed by auricula-purple, and the lips, cheeks, and pectoral and ventral fins are lavender-purple without spots anywhere.

Hab. Seas of China. Canton.

Pristipoma? gallinaceum, Richardson. *Icon.* Reeves, β. 22; Hardw. Acanth. 44. Chinese name, *Ke yu*, "Fowl-fish" (Reeves, Birch). *Rad.* D. 14|18; A. 2?|7, &c. (from the figure.)

Of this also I have seen no specimen: judging from the figure, it seems to approach *Pr. japonicum*, but its scales are larger and its dorsal more notched. Its lower fins are orange and its caudal lobes tipped with carmine, the body generally silvery and the fins unspotted. It is possible that this may be the *Hæmulon* mentioned by Dr. Cantor as frequenting the estuary of the *Peiho.* It has carmine blotches on the lips like *Hæmulon.*

Hab. China seas. Canton.

Pristipoma? grammopœcilum, Richardson. *Icon.* Reeves, a. 9; Hardw. Acanth. 56. Chinese name, *Zuen chin lă*, "Soft-mouthed lă fish" (Birch); *Quen shin la*, "Flexible-finned lap" (Reeves); *Un shan lap* (Bridgem. Chrest. 96). *Rad.* D. 14|20; A. 3|9 vel 10, &c. (from the figure.)

This fish has a different physiognomy from any of the preceding ones, and we cannot assign it to a genus with confidence, from not having seen a specimen. It has the even dorsal of *Pr. japonicum*, but much larger scales, which are silvery. The cheeks and side of the head are streaked by nine or ten reddish stripes, and the whole back and sides are dotted with red spots about the size of partridge shot. The fins are dark and without spots; the parts about the mouth are carmine, as in *Hæmulon*.

Hab. Canton.

Fam. SERRANIDÆ.

MESOPRION UNIMACULATUS, C. et V. ii. p. 441; Quoy et Gaim. Zool. de Freyc. p. 304. pl. 5. f. 3. *Doondiawah*, Russell, 97; *Icon.* Reeves, *a.* 25; Hardw. Acanth. 21. *Hwang tsaou*, "Yellow tsaou fish." Chinese name, *Hwang tso*, "Yellow tso" (Reeves); *Wang tso* (Bridgem. Chrest. 133). *Rad.* D. 10|13 vel 14, A. 3|7, &c. (China spec. Brit. Mus.)

The specimen collected at Canton by John Reeves, Esq. is deposited in the British Museum.

Hab. Indian ocean, Malay archipelago, and China seas.

MESOPRION HOTEEN, Richardson. *Icon.* Reeves, *a.* 28; Hardw. Acanth. 66. *Ho teen.* Chinese name, *Ho teen yo*, "Burn-spotted" (Reeves); *Fo tim tso* (Bridgem. Chrest. 220). *Rad.* D. 10|13; A. 3|8, &c. (Spec. Brit. Mus.)

Several examples of a Chinese fish strongly resembling the preceding exist in the Chinese collection at Hyde Park and in the British Museum, but differing from it in having a preopercular notch and subopercular knob, both slighter than is usual in *Diacope*. Neither the specimens nor drawing agree sufficiently with Russell's figure 110 (*Mesoprion quinquelineatus*, C. et V.), nor 98 (*Diacope notata*, C. et V.), nor with Bloch's *M. johnii* (318), to be referred to either of them.

The canine teeth in the upper jaw are acute and well-apart. In the lower jaw there is a short one in the middle of the limb on each side. The vomerine and palatine teeth are covered by the horizontal velum. The preorbitar and lower jaw are studded with minute pores. A small pit exists on the chin. The scales of the cheek form an oval oblique band extending from the temples to near the corner of the mouth, bounded above by smooth integument, which spreads over the preorbitar and below by the disc of the preoperculum. Preoperculum having a broad disc coarsely toothed at the corner, some of the inferior teeth pointing forward; under limb serrated; operculum with two obtuse lobes. The darker discs of the scales form rows of faint spots. Second and third anal spines about equal in length, the second one a little the stoutest, and neither of them equal to the soft rays in length.

Hab. China seas. Canton.

MESOPRION ANNULARIS, C. et V. ii. p. 484. et iii. p. 497. *Diacope annularis*, Rüppell, Atl. p. 74. taf. 24. f. 2; Quoy et Gaim. Astrol. pl. 5. f. 4. *Rad.* D. 11|14; A. 3|8; C. $16\frac{\pm}{+}$; P. 15; V. 1|5. (Spec. Camb. Ph. Inst.)

The Rev. George Vachell presented a Canton specimen to the Cambridge Philosophical Institution.

Hab. Indian ocean. Javan and China seas.

DIACOPE CALVETII, Quoy et Gaim. Voy. de l'Uranie, pl. 57. f. 1; C. et V. ii. p. 429; Temm. et Schl. F. J. p. 14.

Hab. Japan. Timor.

DIACOPE SPARUS, Temm. et Schl. F. J. p. 14.

Hab. Japan.

DIACOPE BORENSIS, C. et V. ii. p. 436. *Diacope tiea*, Lesson, Voy. de Duperrey, p. 231. pl. 23; *Icon.* Reeves, 196; Hardw. Acanth. 68. Chinese name, *Heung yu*, "Cock," or "Male fish (Birch);" *Hung u* (Bridgem. Chrest. 167). *Rad.* D. 11|14; A. 3|9, &c. (Reev. spec. Brit. Mus.)

Hab. Polynesia. China sea. Canton (Reeves). Society isles (Lesson).

DIACOPE OCTOLINEATA, C. et V. ii. p. 118; Temm. et Schl. F. J. p. 12. pl. 6. f. 2. *Holocentrus quinquelinearis*, Bl. 239. *H. bengalensis*, Bl. 246. f. 2. *Perca vittata*, Solander, *Icon.* Parkins. Bibl. Banks. *Perca polyzonias*, Forst. Animal. cura Lichtenst. p. 225; *Icon.* Georg. Forster, Biblioth. Banks; *Icon.* Reeves, 93; Hardw. Acanth. 29 & 33. Chinese name, *Hwa mei tsaou* (Birch); *Hwa mei tso*, "Painted eye-brow" (Reeves); *Wa mii tso* (Bridgem. Chrest. 68).

A common Chinese fish, and in all the collections. Most of the Chinese specimens have the fifth line below the pectoral, which is often wanting in examples from other quarters; and one specimen in the Chinese collection at Hyde Park has the lateral black mark so frequent in the *Diacopes*.

Hab. Red sea, Mauritius, Polynesia, Australia, Malay archipelago, Chinese and Japanese seas.

Plectropoma leopardus, Lacépède (*Holocentrus*), iv. p. 332 et 337. *Plectropoma leopardinum*, C. et V. ii. p. 392. t. 36; Temm. et Schl. Faun. Japon. Sieb. p. 12.

Hab. Seas of Japan and Australia.

Plectropoma susuki, C. et V. ii. p. 404; Temm. et Schl. F. J. p. 11. pl. 4. f. 1 (upper figure); *Icon.* Reeves, *a.* 34; Hardw. Acanth. 25. Chinese name, *Tsing shĭh pan* (Birch); *Ching sheh pan*, "Blue garoupa" (Reeves); *Shik pan u* (Bridgem. Chrest. 59).

Mr. Reeves states this to be the commonest of the *Serrani* or Garoupas on the Chinese coast.

Hab. Coasts of China and Japan.

(*Merous.*)

Serranus altivelis, C. et V. ii. p. 324. t. 25; *Icon.* Reeves, 267; Hardw. Acanth. 67. Chinese name, *To yu*, "Carrier fish" (Birch); *Ming yu* (Reeves). *Rad.* D. 10|18 vel 19; A. 3|9 vel 10; P. 15. (Spec. Brit. Mus.)

The British Museum possesses a specimen obtained in one of Cook's voyages, and one brought from China by John Reeves, Esq. Sir Edward Belcher also obtained one in his voyage in the Sulphur.

Hab. Javan and Chinese seas.

Serranus gilberti, Richardson, Ann. Nat. Hist. March 1842. vol. ix. p. 19; *Icon.* Reeves, 257; Hardw. Acanth. 26. Chinese name, *Hwă paou yu*, "Spotted leopard fish;" *Fa kou yu*, "Spotted garoupa" (Reeves). *Rad.* D. 11|17; A. 3|9; C. $15\frac{3}{3}$; P. 17; V. 1|5. (Spec. Brit. Mus.)

This is one of the *Serrani* which bear a close resemblance to *merra*, and are perhaps merely varieties of that species. It is a common fish in the southern seas, yet I have not been able to identify it with any of the numerous species or varieties described in the 'Histoire des Poissons.' In the British Museum there are examples from China and North Australia which do not differ from each other.

Hab. Torres straits. China seas.

Serranus megachir, Richardson. *Icon.* Reeves, 113; Hardw. Acanth. 28. Chinese name, *Tae mei pan*, "Tortoise-shell garoupa" (Reeves). *Rad.* D. 11|15; A. 3|8; C. $12\frac{6}{6}$; P. 15; V. 1|5. (Spec. Brit. Mus.)

This is another *merou*, almost identical in the markings of its body and fins with *gilberti*, but distinguished from it and from *merra* by the greater size of its pectoral fin, which is edged with black and reaches beyond the anus. The only species described in the 'Fauna Japonica' which resembles this, is the *S. epistictus*, and that has the spots on the fore part of the body ranged in three rows, which coalesce into one row posteriorly. The "tortoise-shell merou" grows to the length of a foot. There are examples of it in the Chinese collection at Hyde Park and in the British Museum, the latter presented by Mr. Reeves.

Hab. Coasts of China.

Serranus epistictus, Temm. et Schl. F. J. Sieb. p. 8.

None of Mr. Reeves's drawings correspond with the description of this species, nor have we seen any Chinese specimens of it.

Hab. Japanese sea.

SERRANUS AKA-ARA, Temm. et Schl. F. J. p. 9. pl. 3. f. 1.
Rad. D. 11|15; A. 3|8. (Bürger's Spec. Brit. Mus.)
D. 11|16; A. 3|8; C. 17; P. 15; V. 1|5. (F. Jap.)

The British Museum possesses one of Bürger's specimens of this fish, which was labelled *kazzo ara.*

Hab. Sea of Japan.

SERRANUS SHIHPAN*, *Icon.* Reeves, 71; Hardw. Acanth. 39. Chinese name, *Shih pan* (Reeves); *Shik pan u* (Bridgem. Chrest. 59). *Rad.* D. 11|16; A. 3|8; C. 17$\frac{4}{5}$; P. 16 vel 17; V. 1|5. (Spec. Brit. Mus.)

I have been strongly inclined to consider this fish as identical with the preceding one, but nothing is said in the 'Fauna Japonica' of the dark bars which cross the body, and which are very evident both in the dried specimens and in those preserved in spirits. The species appears to be common in the China seas and to attain the size of 16 or 18 inches. We have seen examples of it in the Chinese collection at Hyde Park, the British Museum, and the Cambridge Philosophical Institution.

Teeth rather small, each intermaxillary armed by a curved canine. In the lower jaw the canines are longer, and the outer row is composed of subulate teeth set widely. The chevron of the vomer is acute and small, and the dental bands of the palate bones are narrow and feebly toothed. The limbs of the preoperculum meet at rather less than a right angle, the upper one slightly convex and acutely toothed, the lower one almost straight, with microscopical crenatures. In some specimens, the coarse teeth at the angle of the bone are divided by a notch into two groups, in others there are two strong divergent teeth at the angle; the bone is densely scaly up to the teeth. In Mr. Reeves's figure the preoperculum is shown of too parabolic a form. The operculum ends in three acute teeth, the middle one being the largest; the tip of the gill-cover is slender and acute; small scales cover the lower jaw, and the scales on the body are strongly ciliated; the lateral line is conspicuous and formed of a series of tubes, one on each scale inclined upwards, and the fins are scaly to near their tips. Five or six dark bars cross the sides, two of them running up on the spinous dorsal, and two on the soft fin, which is also traversed in the middle by a cross-bar. The bars are irregular in form, and the caudal fin is crossed by two or three less distinct ones. The body and head are marked by round red spots, much as *aka-ara* is represented to be in the 'Fauna Japonica,' and there are some larger faint red marks on the spinous dorsal. The anal and pectoral are both crossed by dusky bars or clouds, and the ventrals are edged with the same. All the under-parts of the head and body are aurora-red. The Chinese name has been attached to this species as a provisional designation until the suspicion above-mentioned of its identity with the *aka-ara* be proved or disproved.

Hab. China seas. Canton (Reeves, Vachell, &c.).

SERRANUS VARIEGATUS, *Icon.* Reeves, 87; Hardw. Acanth. 22. Chinese name, *Ta shih pan*, "Variegated garoupa" (Reeves). *Rad.* D. 11|10; 2|7, &c. (Reeves's drawing.)

Were it not for the small number of rays in the soft dorsal indicated in the figure here quoted, I should have no hesitation in saying that it is the representation merely of a young individual of the *shih pan.* The cross bands, however, are fewer, broader and fainter. The buff-coloured ground tint and the deep orange-red spots are the same in both. In the *variegatus* these spots form two rows on both the spinous and soft parts of the dorsal, and also on the upper half of the tail; and there are two black spots with pale borders on the latter fin. All the vertical fins are obscurely clouded or banded, and the pectorals are buff-coloured with orange borders and black bases. We have seen no specimen that corresponds to this figure, which measures 5$\frac{1}{2}$ inches.

Hab. China seas. Canton.

SERRANUS AWO-ARA, Temm. et Schl. F. J. Sieb. p. 9. pl. 3. f. 2. *Rad.* D. 11|16; A. 3|8. (Spec. of Bürger's, Brit. Mus.)

One of Bürger's specimens, now in the British Museum, has been carefully compared with Mr. Reeves's drawings, and not identified with any of them. The yellow borders of the fins distinguish this fish when recent.

Hab. Sea of Japan.

SERRANUS URA, C. et V. ii. p. 332. *S. ara*, Temm. et Schl. F. J. Sieb. p. 9.

Having seen neither specimens nor figures of this fish, we are unable to say, from the short

* The words *shih pan* means "stone-coloured stripe."

descriptions of it in the works we have quoted, what are the characters that distinguish i from the other Chinese species.

Hab. Sea of Japan.

SERRANUS AREOLATUS, Forskal (*Perca*), C. et V. ii. p. 350. *Perca taurina*, Geoff. Saint-Hilaire, Egypt, pl. 20. f. 1; Is. Geoff. p. 201. *Serranus areolatus japonicus*, Temm. et Schl. F. J. Sieb. p. 8.

The Japanese fish is stated to differ from the species in the Red sea only in having the pectorals of an uniformly yellow hue and the caudal slightly rounded. We have seen no specimen of it.

Hab. Red sea. Sea of Japan.

SERRANUS REEVESII, Richardson. *Icon.* Reeves, 211; Hardw. Acanth. 32. Chinese name, *Fa pan*, "Variegated garoupa" (Reeves); *Fa pan u* (Bridgem. Chrest. 62). *Rad.* D. 11|14; A. 3|8, &c. (*ex figurâ.*)

The spots of this figure are singularly like those of *S. hexagonatus* (Forster, C. et V. ii. p. 330), but the angles of the meshes want the bright white spots; there is a more decided notch in the preoperculum, and the third anal spine is longer than the second. The ground colour is pale aurora-red, the spots orange-brown, and the head and body are clouded by about twelve large brown patches on each side. The spots are equally crowded on all the fins, but are rather rounder than on the body. They are slightly deeper than the ground tint on the pectorals, which is like that of the body, but clearer. The other fins have a brownish hue, and the spots on the dorsal and ventrals are umber-brown, and on the caudal and anal auricula-purple; the ground tint of the latter fins being also dark. The upper tip of the caudal is lighter: that fin is truncated or slightly rounded. The lower jaw projects considerably beyond the upper one. Length of the figure 10 inches.

Hab. Sea of China. Canton.

SERRANUS STIGMAPOMUS, Richardson. *Icon.* Reeves, 72; Hardw. Acanth. 24. Chinese name, *Hĭh shĭh pan*, "Black garoupa" (Reeves); *Hak shik pau* (Bridgem. Chrest. 59). *Rad.* B. 7; D. 9|17; A. 3|8; C. 19, &c.

The individual from which Mr. Reeves's drawing was made was presented by that gentleman to the British Museum. It agrees singularly well with the description of *Serranus kawa mebari* in the 'Fauna Japonica,' in all that relates to colours and markings; but that species differs in the number of rays, and is said to belong to the true *Serrani* with naked jaws, while this is a *Merou*.

The teeth are small and fine, but with a canine on each side of the symphysis of the upper jaw. No scales on the upper jaw or maxillary, but the snout is scaly even before the nostrils, and scales exist on the preorbitar and suborbitars, and cover the preoperculum to its extreme edge. The lower jaw is furnished with small, deeply imbedded scales. Preoperculum curved in the arc of a circle, and minutely toothed in a pectinated manner on its upper limb, a little coarser at the angle. Gill-cover very obtuse, or cut nearly vertically with a slightly projecting tip opposite the central spine, which is thin and flat. Lateral line considerably arched. Fins rounded and covered with small scales. The anal has three stout spines, shorter than the soft rays.

The colour is pale chestnut, with eight well-defined and regular, darker vertical bands, which encroach a little on the dorsal. The head and fins are mostly of the colour of the bands; the tips of the dorsal and edges of the pectoral and anal dark. The soft dorsal has a pale edge, and the upper edge of the caudal is pale, the under one dark. A round black spot occupies the membrane filling the sinus between the two upper opercular spines.

Hab. China seas. Canton (Reeves). North-west coast of Australia? (Lieut. Emery.)

SERRANUS NEBULOSUS, C. et V. ii. p. 313. *Rad.* D. 11|16; A. 3|7 vel 8 (second spine longest). (Spec. Brit. Mus.)

There are two specimens of this fish in the British Museum, which were brought from Canton by John Reeves, Esq., and one whose origin is unknown.

Hab. China seas.

SERRANUS TRIMACULATUS, C. et V. ii. p. 331; Temm. et Schl. F. J. Sieb. p. 8. *Epinephelus japonicus*, Krusenst. Voy. pl. 64. f. 2. *Rad.* D. 11|17; A. 3|7; C. $15\frac{4}{4}$; P. 17; V. 1|5. (Several spec.)

In the 'Histoire des Poissons' the numbers of the rays being quoted from Krusenstern's figure are erroneous. There seems however to be some variation in their number. In one of

Bürger's Japanese specimens in the British Museum we reckoned D. 11|15, the last divided so deeply that it might be taken for two, and A. 3|8. In the 'Fauna Japonica' the numbers are stated to be D. 11|16; A. 3|8, &c., and we have given above the numbers we found in Chinese specimens brought from Canton by John Reeves, Esq. and the Rev. George Vachell.

Hab. Seas of China and Japan. Canton.

SERRANUS PŒCILINOTUS, Temm. et Schl. F. J. Sieb. p. 6.

Hab. Japanese seas.

SERRANUS OCTOCINCTUS, Temm. et Schl. F. J. Sieb. p. 7.

Hab. Japanese seas.

SERRANUS LATIFASCIATUS, Temm. et Schl. F. J. Sieb. p. 7.

Hab. Japanese seas.

SERRANUS MYRIASTER, C. et V. ii. p. 365; Rüppell, Atl. pl. 27. f. 1. *Mérou mille étoiles*, Quoy et Gaim. Voy. de l'Astrol. pl. 3. f. 1; Voy. de la Coquille, pl. 37. *Rad.* D. 9|16; A. 3|8; C. 15$\frac{3}{3}$; P. 17; V. 1|5. (Chin. Spec.)

A specimen of this fish was brought from the Chinese seas by Sir Edward Belcher, which is much better represented by Rüppell's figure than by those given in the other works we have quoted. The figure in the 'Voy. of the Coquille' wants the blue edging of the fins, and has more resemblance even in the colouring to the *Serranus rogaa* of Rüppell than to *myriaster*. We have seen examples from Australia which differ in no respect from the Chinese ones.

Hab. Sandwich islands. Polynesia. New Guinea. Australia. China and the Red sea.

SERRANUS CYANOPODUS, *Icon.* Reeves, 249; Hardw. Acanth. 69. Chinese name, *Tsing te* (Birch); *Ching te*, "Blue foot" (Reeves). *Rad.* D. 11|20; A. 3|7, &c. (*ex figurâ.*)

This drawing has a general resemblance to *S. myriaster*, but with a more arched nape, a higher spinous dorsal, a projecting point at the corner of the preoperculum, much smaller and differently disposed dots. The general colour is flax-flower-blue, deepening to indigo on the back, and having purplish tints on the face and breast. The spots are small, bluish-black, and extend to all the fins, except the pectoral and anal. They become gradually less on the lower parts of the sides and disappear on the breast and belly. The pectorals are yellowish-gray, with blue bases; but the rest of the fins are blue like the body, the extremity of the caudal being also tinged with blue and the anal with purple. The fins do not show the marginal streak so evident in *myriaster*. The caudal is truncated.

Hab. China seas. Canton.

SERRANUS FORMOSUS, Shaw (*Sciæna*), Zool. Misc. pl. 1007; C. et V. ii. p. 311. *Rahtee bontoo*, Russell, pl. 129; *Icon.* Reeves, *a*. 46; Hardw. Acanth. 31. Chinese name, *Hĭh kwei tsze*, "Black-spirit thorn" (Birch); *Hih kwei tze*, "Black spirit" (Reeves). *Rad.* D. 9|17; A. 3|8, &c.

Minute scales cover the entire surface of the maxillary, except the folds of the lips; and the fins are densely scaly. The general tint of the body, dorsal and base of the anal is reddish-orange, the gill-cover being tinged with siskin-green. The body is traversed by numerous china-blue lines, which are oblique on the back, but horizontal on the sides. They run out upon the dorsal and anal, changing to sap-green. Six of the blue lines cross the face, radiating from round the orbit, and there are some blue spots before the eye and on the lips. The rays of the ventrals are partly blue, partly green; the outer half of the anal is green, and it has a border of blue and black. The pectorals and anal are dark prussian-blue, their rays being paler. Russell's plate omits the lines on the spinous dorsal, gives a wrong direction to those on the anal, and represents all the lines as too broad. Mr. Reeves's drawing is an excellent representation of a specimen in the Chinese collection at Hyde Park.

Hab. Indian ocean. Sea of China. Canton.

SERRANUS MARGINALIS, Bloch, 328 (*Epinephelus*); C. et V. ii. p. 301. *Holocentre rosmare*, Lacép. iv. pl. 7. f. 2. *S. tsirimenara*, Temm. et Schl. F. J. p. 8; *Icon.* Reeves, 246; Hardw. Acanth. 27. *Rad.* D. 11|15 vel 16; A. 3|8, &c. (Spec. Brit. Mus.)

The *tsirimenara* of the 'Fauna Japonica' is distinguished by the authors from *marginalis* by its possessing a row of five or six irregular, whitish and indistinct spots on the flanks. Mr. Reeves's figure shows vertical bands in pairs, faint, and merely a little paler than the rest of the red colour, but no spots. There are Chinese specimens in spirits in the British Museum and Chinese collection at Hyde Park, which offer no tangible difference when compared with a dried specimen of Bürger's, also in the British Museum. Neither could we detect any discrepancy betwixt the Chinese specimens and one obtained at Copang, in the island of Timor, by Mr. Gilbert.

Judging solely from the description of *S. oceanicus* in the 'Histoire des Poissons,' in the absence of authentic specimens or good figures, it appears to be the same with *marginalis*; but the *Perca fasciata* of Forskal, referred by Cuvier to *oceanicus*, is probably a different species. Its dorsal and anal fins are edged with yellow, and it is evidently the same with the *Perca rubescens* of Solander, of which a drawing by Parkinson (No. 61) exists in the Banksian Library.

Hab. Javan, Chinese and Japanese seas.

We have seen no specimen corresponding with Mr. Reeves's drawing 255 (Hardw. Acanth. 23), which looks like a less carefully executed representation of a young *S. marginalis.* Its anal spines are however proportionally larger, and its cheek and gill-cover are glossed with green. The Chinese name is *Hing pau yu*, "Red garoupa."

Serranus moara, Temm. et Schl. F. J. Sieb. p. 10. f. 2. *lower figure* (which is erroneously numbered).

Hab. Sea of Japan.

Serranus dermopterus, Temm. et Schl. F. J. Sieb. p. 10.

Hab. Sea of Japan.

(*Serrans propres.—Perches de mer.*)

Serranus vitta, Quoy. et Gaim. Voy. de Freyc. pl. 58. f. 3; C. et V. ii. p. 239; Temm. et Schl. F. J. Sieb. (*Diacope*), p. 13. pl. 6. f. 1; *Icon.* Reeves, *β*. 27; Hardw. Acanth. 51. Chinese name, *Ho tsaou* (Birch); *Ho tso*, "Fire tso" (Reeves); *Fo tso* (Bridgem. Chrest. 132).

Two young individuals of this species, which Surgeon Bankier has sent from Hong Kong, have the lateral stripe darker than in older individuals, and a black mark swelling round that part of it which is under the middle of the soft dorsal, as in some Diacopes and Mesoprions. There is scarcely any notch in the preoperculum either in the young or old, and the subopercular knob is very indistinct. The dental plate of the vomer is rhomboidal, and the habit of the fish is not that of *Serranus*, neither is it more like *Diacope*.

Hab. North coast of Australia. New Guinea. Javan, Chinese and Japanese seas. Hong Kong (Surgeon R. A. Bankier).

Serranus kawamebari, Temm. et Schl. F. J. Sieb. p. 5. "*Rad.* D. 12|12; A. 2|10," &c. (Fauna Jap.)

This is compared with *hepatus* in the 'Fauna Japonica,' and is described as possessing a round black spot between the two upper opercular spines.

The British Museum possesses a Canton specimen presented to it by Mr. Reeves, which we are inclined to consider as the *kawamebari*, though it wants the black opercular spot. It has the scaleless jaws and narrow, naked preopercular disc of the true *Serrani.* The upper limb of the preoperculum is nearly vertical, slightly arched, finely toothed, with four or five stronger divergent teeth at the squarish angle, and a horizontal toothless under limb. Lateral line slightly arched. Fins delicate, rounded. Ground colour pale brown, marbled with irregular darker confluent spots. The sides are traversed by six bars inclining forwards as they descend, and rendered paler by the absence of the spots which fill the interspaces. On the head the same colours, but the pale bands are longitudinal. Three dark lines cross the cheek obliquely from the eye to the angle of the gill-cover. The dorsal is obscurely clouded with a dark point behind the tip of each spine: the soft dorsal and anal are darkish, the pectoral nearly colourless. Length of specimen 6 inches.

Hab. Seas of Japan and China. Canton (Reeves).

(*Les Barbiers.*)

Serranus oculatus, C. et V. ii. p. 266. pl. 32; Temm. et Schl. F. J. Sieb. p. 5.

Hab. Japanese and Caribbean seas.

Caprodon, Temm. et Schl. F. J. Sieb. p. 64. pl. 30.

This fish is placed with doubt as to its true position among the *Sciænidæ* by the authors of the 'Fauna Japonica,' but though it is stated to have only five gill-rays, I cannot help thinking that its true affinities are with the Barbers, and its dentition is indeed exactly similar to that of the *Tang* or *Taa*, a South Australian *Serranus*.

Hab. Japanese seas.

Centropristes hirundinaceus, C. et V. vii. p. 450; Temm. et Schl. F. J. Sieb. p. 14. pl. 5. f. 1.

Hab. Sea of Japan.

Aulococephalus, Temm. et Schl. F. J. Sieb. p. 15. pl. 5. f. 2.

The British Museum possesses two examples of this fish from the Mauritius.

Hab. The coasts of the Mauritius and the Japanese sea.

Glaucosoma bürgeri, Temm. et Schl. F. J. Sieb. p. 62. pl. 27; Richardson, Ichth. of Voy. of Erebus and Terror, p. 27.

The discovery in the Australian seas of a second species of this genus has rendered a specific appellation necessary for the Japanese one, and we have named it in honour of Bürger, whose description and drawing are the authorities for the species.

Hab. Sea of Japan.

Fam. Theraponinæ.

Hapalogenys nitens, Richardson, Ichth. of Voy. of Sulph. p. 84. pl. 43. f. 1 & 2; *Icon.* Reeves, 92; Hardw. Acanth. 164, 165. Chinese name, *Yin pe lă* (Reeves); *Yan pi lap* (Bridgem. Chrest. 101).

The specimen from which Mr. Reeves's drawing was made was deposited by that gentleman in the British Museum.

Hab. China sea. Canton.

Hapalogenys analis, Richardson, Ichth. of Voy. of Sulph. p. 85. pl. 43. f. 3; *Icon.* Reeves, 91; Hardw. Acanth. 167. *Pristipome mucronè*, Eydoux et Souleyet. t. . f. 1. Chinese name, *Shih tseu* (Birch); *Shi kea ha* (Reeves); *Shik kip lap* (Bridgem. Chrest. 97).

Mr. Reeves's specimen of this fish also is in the British Museum.

Hab. Sea of China. Canton.

Hapalogenys maculatus, Richardson. *Icon.* Reeves, *a.* 49; Hardw. Acanth. 42. Chinese name, *Kin sih* (Reeves); *Kin fung*, "Gold-wind" (Birch). *Rad.* D. 11|15; A. 3|9; C. $17\frac{2}{2}$; P. 16; V. 1|5.

In general form and in the distribution of its coloured bands and spots, this species bears a singular resemblance to *Diagramma cinctum*, as has been already noticed (*supra*, p. 226). Body thickest a little below the arched lateral line, and thinning off above to the acute nape and dorsal line. The belly is obtuse, and the top of the cranium widens gradually until it becomes flat between the fore parts of the orbits. Chin and edge of the lower jaw covered by a soft papillose lip; upper lip less coarsely papillose. Four small pores on the chin and two on each limb of the lower jaw, whose articulation is under the fore part of the orbit. Jaw-teeth villiform, the outer row short-conical and acute. Roof of the mouth toothless, lined with plaited, villous membranes, the villi being densely crowded behind the crescentic velum.

Maxillary truncated with a small point at the fore corner. Preoperculum strongly and rather widely toothed on both limbs, the teeth at the corner coarser. Gill-cover short and triangular, with a sub-acute, triangular bony tip, and an oblique, acute notch above it. No scales on the lower jaw, but the fore part of the maxillary and the preorbitar and suborbitar chain, with the rest of the side of the head up to the extreme edges of the gill-cover, are finely scaly. Supra-scapular spinously toothed.

The scales are rough like those of a *Priacanthus.* The lateral line is arched to under the third dorsal spine, when it descends, and is a little undulated under the soft dorsal. No scales on the spinous dorsal; but the bases of the soft dorsal, anal, pectoral and caudal are scaly. A stout recumbent spine precedes the soft dorsal. Second anal spine much stronger and larger than the third, which does not much exceed the first one.

Scales generally bright and silvery: a bright silvery border edges the lower part of the operculum, and the cheek is also bright, but the rest of the head has a dark neutral tint or bluish-gray. The upper half of the body, the tail and the vertical fins are marked by round spots of the same. There is also a bluish-gray band on the hind head, another descending from the nape to behind the pectoral, and a third, descending from the anterior half of the spinous dorsal, curves when it reaches the lateral line backwards along the tail, much like the curved band of *Diacope sebæ.* The ground colour of the pectorals, spinous, dorsal and caudal is sienna- or ochre-yellow; that of the soft dorsal and anal olive-green. Ventrals hair-brown, edged like the spinous dorsal with brownish-black. Length $4\frac{1}{4}$ inches.

Hab. China seas. Canton. (Spec. Brit. Mus.)

HAPALOGENYS NIGRIPINNIS, Temm. et Schl. (*Pogonias*); F. J. Sieb. p. 59. pl. 25. *Rad.* B. 6; D. 11|16 vel 17; A. 3|8 vel 9, &c.

A specimen of Bürger's in the British Museum, which is doubtless an example of this species, though it was labelled when received from Berlin *Pogonias melanopterus*, differs from the figure in the 'Fauna Japonica,' in having a rather less concave profile and a somewhat differently shaped profile. It has a recumbent spine before the dorsal, which is not noticed by its describers, and the scales which partially cover the dorsal are omitted in the figure they have given. The species differs from the other members of the genus named above, in the papillæ of the under-lip being sufficiently elongated to produce a beard, and it therefore stands in the same relation to them that *Pogonias* does to *Micropogon.*

Hab. Japanese sea.

ANOPLUS BANJOS, Temm. et Schl. F. J. p. 17. pl. 8. *Banjos*, Voy. de Krusenst. pl. 54. f. 1. *Rad.* D. 10|12; A. 3|7; C. $17\frac{4}{3}$; V. 1|5. (Bürger's Spec.)

The conjectures of the authors of this genus, that the *Coius polota* of Buchanan and Hamilton is a second species, have been found to be correct by Edward Blyth, Esq., who has ascertained that the Indian fish wants the recumbent dorsal spine of *Hapalogenys.* The *Coius binotatus*, Gray, Hardw. Illustr., is said by Mr. Blyth to be merely a variety of *polota.* A Japanese species of *Anoplus* collected by Bürger exists in the British Museum.

Hab. Sea of Japan.

SCOLOPSIDES RUPELII, C. et V. v. p. 332. *Sc. kurite*, Rüppell, Atl. p. 3. taf. 2. fig. 3; *Icon.* Reeves, 47; Hardw. Acanth. 48. Chinese name, *Hung hae tsĭh*, "Red sea-rule" (Reeves, Birch). *Rad.* D. 10|9; A. 3|7; P. 17, &c. (Spec. Br. Mus.)

The differences between this fish and *Scolopsides kate* (C. et V. v. p. 329; Bl. 325. f. 2) appear to be extremely slight, or at least they are not very clearly exposed in the 'Histoire des Poissons.' Bloch says that his specimen came from the sea of Japan, and it is highly probable that he had the *rupelii* before him even if the Malabar *kate* be a distinct species. The British Museum possesses a Chinese specimen of *rupelii*, presented by Mr. Reeves. Villiform teeth, long and slender. Two suborbitar teeth pointing backwards, one under the other and more slender; none pointing forwards. A small angle of bone on the edge of the operculum, not spinous.

Hab. Red sea and seas of China and Japan.

SCOLOPSIDES INERMIS, Temm. et Schl. F. J. Sieb. p. 63. pl. 28; *Icon.* Reeves, 262; Hardw. Acanth. 57. *Rad.* D. 10|9; A. 3|7; C. 17; P. 18; V. 1|5. (Spec. Br. Mus.)

The British Museum has Mr. Reeves's specimen of this fish. The drawing differs from the figure in the 'Fauna Japonica,' just as a recent specimen from one that has become flaccid in spirits and lost its plumpness and height. The vertical bands are also fainter in the drawing, and the fins have a deep saffron-yellow or Dutch-orange colour instead of the pale primrose tint shown in the 'Fauna Japonica.' Teeth villiform with an outer row of stouter ones. Lower jaw teeth shorter. A very minute bony point on the edge of the gill-cover. A flat, acute, suborbitar tooth, with a point beneath its base. Edge of the suborbitar under the posterior third of the orbit strongly serrated. We have seen a drawing of a *Scolopsides*, executed at the islands of Houtman's Abrolhos, on the west coast of Australia, by Lieut. Emery, of the Royal Navy, which strongly resembles this fish; but the fins have only a yellow border and are otherwise colourless.

Hab. Seas of China and Japan.

Scolopsides pomotis, Richardson. *Icon.* Reeves, *β.* 15; Hardw. Acanth. Chinese names, *Shih kei*, "Stone robber" (Reeves); *Shih tsei* (Birch).

Though this drawing does not exhibit the peculiar suborbitar tooth of the genus, I am induced, in the absence of specimens, from its near resemblance to the preceding two species, to refer it to *Scolopsides*; and if this reference be correct, it possesses specific marks in the jet black tip of the gill-cover, and in a black speck on the base of the upper pectoral ray. It has the yellow fins and bright carmine spot on the gill-cover of the preceding species; but its back is browner and its profile undulated. Length of the drawing 6 inches.

Hab. Chinese sea. Canton.

Lobotes incurvus, Richardson. *Icon.* Reeves, 168; Hardw. Acanth. 76. *Rad.* D. 12|15; A. 3|11; P. 17, &c. (Spec. Br. Mus.)

This fish has the blackish hue of *Lobotes farkarii*, but not the orange-coloured fins, and it has a more deeply incurved profile and higher fins than any species described in the 'Histoire des Poissons.'

Head scaly to orbit and forward on the cheek to the angle of the mouth, also the disc of the preoperculum. Edge of this bone spinosely dentate all round. Gill-cover, with a rounded projecting bony point and no sinus above it, scaly to the edge. Supra axillary plates of coracoid bone with fourteen teeth. Soft dorsal, anal caudal and base of pectoral scaly. Spines strongly striated. Outer row of teeth subulato-conical, inclined backwards, rather taller on the sides of the lower jaw. Within the upper jaw a narrow band of granular teeth. On the lower jaw the interior teeth are in a single row and very minute. In the drawing the sides and head are densely clouded with blackish purple mixed on the base of the fins, and towards the lower parts with siskin-green. The soft dorsal, anal and caudal are blacker, and the latter is edged obscurely above and below with yellow or pale green. The pectoral is clay-coloured; the ventrals and spinous dorsal clouded with neutral tint. Length 12 inches.

Hab. China seas. Canton.

Lobotes citrinus, Richardson. *Icon.* Reeves, 191; Hardw. Acanth. 168.

This species has the pale bar on the extremity of the caudal fin and some other colours ascribed to *Lobotes erate* in the 'Histoire des Poissons,' particularly to the specimens which M. Dussumier brought from the coast of Malabar (v. p. 323); but the height of the body is greater, being equal to half the length of the fish, caudal fin excluded, and I have therefore thought it expedient to give it a provisional specific name. The Chinese collection at Hyde Park contains specimens which I have very cursorily examined. The ground colour in Mr. Reeves's drawing is dull lemon-yellow, with obscure purplish clouding, a purplish black shading round the eye, on the tip of the gill-cover, the nape and bases of the vertical fins and pectorals. The pectorals are pale and transparent, the rest of the fins are blackish, more or less clouded, and the soft dorsal and anal are bordered with buff-orange.

Hab. China seas. Canton.

Priacanthus benmebari, Temm. et Schl. F. J. Sieb. p. 19. pl. 7. f. 1. Krusenst. 53. f. 2. *Rad.* D. 10|13; A. 3|14; C. $16\frac{3}{3}$; P. 19; V. 1|5.

The British Museum possesses two of Bürger's Japanese specimens. In them the end of the caudal is concave, not convex, as in the figure in the 'Fauna Japonica;' and the scales are not so rough as in most other species.

Hab. Sea of Japan.

Priacanthus tayenus, Richardson. *Icon.* Reeves, *β.* 14; Hardw. Acanth.

36. Chinese name, *Ta yen lap*, "Large-eyed lap" (Reeves); *Tai gans lap* (Bridgem. Chrest. 129). *Rad.* D. 9 vel 10|12; A. 3|12 vel 13; C. 16$\frac{4}{4}$; P. 19.

There is some difficulty in discovering ready characters by which the *Priacanthi* may be distinguished from one another. In the published descriptions much stress has been laid on the form and size of the angular projection of the preoperculum, but this varies greatly on different sides of the same individual, and in the 'Fauna Japonica' it is stated that there is a variation in this part as well as in the relative size of the fins, depending on the age of the individual. The fish at present under consideration may perhaps eventually prove to belong to the preceding species, should the elongation of the tips of the caudal and peak of the dorsal be discovered to be merely a sexual peculiarity or the more perfect state of the fish. One specimen exists in the museum of the Cambridge Philosophical Society, to which it was presented by the Rev. George Vachell, and another in the British Museum, received from John Reeves, Esq., both obtained at Canton.

Eye fully as large as in *boops*, interfering a little with the profile, and not much above half a diameter from the end of the snout. Height of body equal to one-fourth of the total length; suborbitar chain presenting small knobs round the margin of the orbit, crenated on the lower edge; preorbitar narrow and toothed. In both specimens the preopercular spine is long, tapering, and acute on one side and comparatively short on the other, and its serratures are not uniform; the operculum has a very small spinous point, which is the tip of a short ridge; the fourth soft ray of the dorsal is lengthened into a short filiform tip, the posterior corner of the fin being rounded; the anal is much rounded and about half the height of the body; caudal forked, with the tips acute and lengthened, particularly the upper one in Mr. Reeves's specimen; but in Mr. Vachell's, the upper tip only is a little larger than the rest of the fin, and is nearly straight on the edge; pectoral considerably smaller than in *benmebari*, and rounded; ventrals large; the scales silvery and bright. In the figure a bright carmine colour runs along the base of the dorsal, and gradually fades away as it descends the sides, which are silvery; the same is the case on the head; a faint roseate tint spreads over the dorsal, the edge being deeper; the anal and ventrals are pale blue, the latter being rose-coloured towards the edges, and marked by about eight rows of brown spots, with two larger round ones in the membrane which connects the last ray with the belly as far as the anus; the pectorals and caudal are siskin-green and rose-coloured. One specimen 4$\frac{3}{4}$ inches, the other 9$\frac{1}{4}$ inches.

The *Priacanthus speculum* of the Seychelle islands is stated in the 'Histoire des Poissons' (vii. p. 471) to be readily distinguished from other species by its forked caudal. We are prevented from considering it as identical with the Chinese fish, by the eye being a full diameter of the orbit from the edge of the snout, the extreme smallness of the preopercular point, and the absence of the round spots on the pectoral. In the latter character *tayenus* agrees more nearly though not perfectly with *benmebari*. In the angular or pointed dorsal it resembles *japonicus*.

Hab. Chinese sea. Canton.

PRIACANTHUS DUBIUS, Temm. et Schl. F. J. Sieb. p. 19.

Hab. Sea of Japan.

PRIACANTHUS JAPONICUS, C. et V. iii. p. 106. pl. 50; Temm. et Schl. F. J. Sieb. p. 20.

Hab. Japanese sea.

PRIACANTHUS NIPHONIUS, C. et V. iii. p. 107; Temm. et Schl. F. J. Sieb. p. 21. *Rad.* D. 10|12; A. 3|10; &c. (Bürger's spec.)

One of Bürger's specimens is in the British Museum. Scales much rougher than those of *benmebari*. In the roughness and general character of the scales *Priacanthus* approaches to the *Myripristidæ*.

THERAPON THERAPS, C. et V. iii. p. 129. et vii. p. 475. pl. 53; Richardson, Ann. Nat. Hist. ix. p. 126. *Pterapon trivittatus*, Gray, Hardw. Ill.; *Icon.* Reeves, *a.* 43; Hardw. Acanth. 49. Chinese name, *Ketseĕ tsze* (Birch); *Kin sih* (Reeves); Aborigines of Port Essington, *At a goorn* (Gilbert).

Hab. Seychelles, Indian ocean, Torres Straits, Javan and Chinese seas.

THERAPON SERVUS, Bloch (*Holocentrus*), 238; C. et V. iii. p. 125; Richard. Ann. Nat. Hist. ix. p. 126. *Grammistes servus*, Bl. Schn. p. 185. *Sciæna* *jarbua*, Shaw, Gen. Zool. iv. p. 541; *Icon.* Reeves, β. 44; Hardw. Acanth. Chinese name, *Ting kun yu*, "Nail-fish" (Reeves); *Ting kung u* (Bridgem. Chrest. 130).

Some of the Chinese specimens of this fish in the British Museum possess all the characters ascribed to *servus*, others seem to be intermediate between this species, *theraps* and *oxyrhynchus*; so that it is difficult to decide on the species to which they ought to be referred.

Hab. Red sea, Indian ocean, north-west coast of Australia, Javan sea, Torres Straits, the Moluccas and Chinese sea.

Therapon oxyrhynchus, Temm. et Schleg. F. J. Sieb. p. 16. pl. 6. f. 3; *Icon.* Reeves, 193; Hardw. Acanth. 70. Chinese name, *Shih keŏ tseĕ*, "Stony-horned tseĕ" (Birch); *Shih koh tsih*, "Strong-horned *tsih*" (Reeves, Bridgem. Chrest. 131).

The brown lines in Mr. Reeves's figure resemble those of *Th. ghebul*, Ehrenberg. Several examples exist in the Chinese collection at Hyde Park, and there is one in the museum at Haslar, which was obtained near Canton by Captain Dawkins of the Royal Navy.

Hab. Coasts of China and Japan.

Therapon quadrilineatus, Bloch (*Holocentrus*), 239. f. 2.; C. et V. iii. p. 134; *Icon.* Reeves, β. 34; Hardw. Acanth. Chinese name, *Chang ko po* (Reeves); *Cheung ko po* (Bridgem. Chrest. 136).

Hab. Chinese sea.

Latilus argentatus, Cuv. et Val. v. p. 369. et ix. p. 495; Temm. et Schl. F. J. Sieb. p. 63. pl. 28. f. 2. *Coryphene chinoise*, Lacép. iii. p. 176 et 209. *Coryphæna sima*, Bl. Schn. p. 296; *Icon.* Reeves, 192; Hardw. Acanth. Chinese name, *Fang tow hwŏ*, "Square-headed hwo" (Birch); *Fang tow wuh*, "Square-head wuh" (Reeves); *Fang tow wah* (Bridgem. Chrest. 215).

Mr. Reeves's drawing has a pale purplish-red hue, but he has informed me that the recent tints of the fish had faded before it was submitted to the painter. It represents the form of a specimen of Bürger's in the British Museum better than the figure in the 'Fauna Japonica,' the caudal in the latter being more rounded.

Hab. Indian ocean and seas of China and Japan.

Fam. Cirrhitidæ (Gray).

Cirrhites aureus, Temm. et Schl. p. 15. pl. 7. f. 2; *Icon.* Reeves, α. 16; Hardw. Acanth. 47. Chinese name, *Hwang gaou*, "Yellow gaou" (Reeves).

Mr. Reeves's drawing shows a fatty protuberance on the nape, overhanging the orbit, and a blackish patch on the gill-cover, which do not appear in the plate of the 'Fauna Japonica.' An example of the fish exists in the British Museum which agrees with Mr. Reeves's painting.

Hab. Chinese and Japanese seas.

Cheilodactylus zonatus, C. et V. v. p. 365. pl. 129; Temm. et Schl. F. J. Sieb. p. 64. pl. 29. *Labre du Japon*, Krusenst. Voy. pl. 63. f. 1; *Icon.* Reeves, β. 43; Hardw. Acanth. Chinese name, *Ke kung yu*, "Cock fish" (Reeves, Birch); *Kai kung u* (Bridgem. Chrest. 124).

The British Museum possesses two of Bürger's specimens of this fish, and there are Chinese ones in the collection at Hyde Park, the form of which is better represented by Mr. Reeves's drawing than by the figure in the 'Fauna Japonica.'

Hab. Seas of China and Japan.

Fam. Mænidæ.

Gerres equula, Temm. et Schl. F. J. Sieb. p. 76. pl. 9. f. 1; *Icon.* Reeves, 215; Hardw. Acanth. 148. Chinese name, *Tswan tsuy*, "Boring mouth" (Reeves); "Boring lips" (Birch). *Rad.* D. 9|10; A. 3|7; C. $17\frac{8}{9}$; P. 16; V. 1|5. (Spec. Camb. Ph. Inst.)

The Rev. George Vachell has deposited a Canton specimen in the museum of the Cambridge Philosophical Society.

Hab. Seas of China and Japan.

GERRES PUNCTATUS, C. et V. vi. p. 480. *Woodan*, Russell, 68? *Icon.* Reeves, 260; Hardw. Acanth. 149. Chinese name, *Hae tsih* (Birch, Reeves); "Sea tsih" (Reeves).

Mr. Reeves's figure, probably from an oversight of the artist, shows four anal spines.

Hab. Indian ocean and China seas.

GERRES ——? *Icon.* Reeves, β. 39; Hardw. Acanth.

This drawing evidently represents another species of *Gerres*, having less elongation of the anterior dorsal spines, and wanting the vertical faint purple bands; but the drawing is less precise in its details than in most others of this admirable collection, and in the absence of specimens we cannot ascertain whether it be a described species or not. Its Chinese appellation is the same with that of the *punctatus*.

Hab. China seas.

DITREMA, Temm. et Schl. F. J. Sieb. p. 77. pl. 40. f. 2. "*Rad.* B. 6; D. 10|22; A. 3|27; P. 19; C. 16; V. 1|5." (Fauna Jap.)

Hab. Sea of Japan.

CHÆTOPTERUS, Temm. et Schl. F. J. Sieb. p. 7. pl. 37. f. 2. "*Rad.* B. 4; D. 10|10; A. 3|8; C. 18; P. 17; V. 1|5." (Fauna Jap.)

Hab. Sea of Japan.

Fam. SPARIDÆ.

CHRYSOPHRYS ARIES, Temm. et Schl. F. J. Sieb. p. 67. pl. 31.

A Chinese specimen exists in the collection at Hyde Park. Incisors between chisel-shaped and conical.

Hab. Japanese and Chinese seas.

CHRYSOPHRYS TUMIFRONS, Temm. et Schl. F. J. Sieb. p. 70. pl. 34.

A specimen of Bürger's in the British Museum has the hind head less high, and the preorbitar one-third lower than the figure in the 'Fauna Japonica.'

Hab. Sea of Japan.

CHRYSOPHRYS MAJOR, Temm. et Schl. F. J. Sieb. p. 71. pl. 35.

Hab. Sea of Japan.

CHRYSOPHRYS BERDA, Forskal (*Sparus*), p. 32; C. et V. vi. p. 113; Rüppell, Neue Wirlb. p. 120. taf. 27. f. 4. *Sparus hasta*, Bl. Schn. p. 275; *Icon.* Reeves, 223; Hardw. Acanth. 75. *Rad.* D. 11|11; A. 3|8, &c. (Spec. Chin. coll.)

Specimens of this fish exist in the Chinese collection at Hyde Park and in the British Museum, the latter brought from Canton by John Reeves, Esq. In Mr. Reeves's drawing the large pectoral is ochraceous, the rest of the fish gray, with a yellowish gloss on the belly, and the base of each scale blackish-gray. The lips are thick, and the fish has a sciænoid aspect. It is compared by Mr. Reeves with *Diagramma cinctum*.

Hab. Red sea, Indian ocean, and China.

CHRYSOPHRYS LONGISPINIS, C. et V. p. 116; Temm. et Schl. F. J. Sieb. p. 68. pl. 32.

One of Bürger's specimens in the British Museum has the preoperculum streaked on the disc and pectinately toothed on its vertical edge, the teeth bluntish, and concealed by membrane in the recent fish. A narrow, flat, blunt, bony point terminates the operculum behind the tip of the gill-flap. First anal spine very short, third one slender, second stouter and longer.

Hab. Sea of Japan.

CHRYSOPHRYS CARDINALIS, Lacép. (*Sparus*), iv. p. 141; C. et V. vi. p. 130; Temm. et Schl. F. J. Sieb. p. 69. pl. 33; *Icon.* Reeves, 199; Hardw. Acanth. 46. Chinese name, *Kin sze lă**, "Gold-skein lă fish" (Birch); *Kum sze lap* (Reeves); *Kum su lap* (Bridgem. Chrest. 212). *Rad.* D. 12|10; A. 3|9; C. 17; P. 14; V. 1|5. (Spec. Brit. Mus.)

Mr. Reeves has deposited a Canton specimen 7 inches long in the British Museum, and there are several in the Chinese collection at Hyde Park. A small, slightly pungent opercular point. Nuchal scales scarcely to be distinguished from the others. Three pits on each limb of the lower jaw. Preorbitar equal in height and breadth.

Hab. Chinese and Japanese seas.

CHRYSOPHRYS ——? *Icon.* Reeves, 95; Hardw. Acanth. 59. Chinese name, *Kam tze na*, "Gold-threaded robe" (Reeves); *Kam sze nap* (Bridgem. Chrest. 100). *Rad.* D. 12|11; A. 3|8; P. 13, &c. (Reeves's figure.)

This figure looks very much like a second representation of *cardinalis*, the only differences I can perceive being its rather larger head, the third anal spine rather shorter than the second one, and the serratures of the supra-scapular more strongly marked; it has moreover yellow not roseate pectorals, pale angular marks on the spinous dorsal, and wants the superciliary green streak represented in the drawing of *cardinalis.*

Hab. China. Canton.

CHRYSOPHRYS AURIPES, Richardson. *Icon.* Reeves, 128; Hardw. Acanth. 58. Chinese name *Kin tze lă*, "Gold thread lă fish" (Birch, Reeves). *Rad.* D. 11|11; A. 3|8; C. $17\frac{5}{5}$; P. 15; V. 1|5. (Spec. Br. Mus.)

A Canton specimen of this fish, presented to the British Museum by Mr. Reeves, has three longish, subulate, somewhat incurved teeth on each intermaxillary, and five rows of small upper molars, the interior rows being short, and the last three teeth of the third row bigger than the rest, but not exceeding swan-shot; there is the usual crowd of small teeth behind the incisors, and four rows of the lower molars. Preorbitar twice as long as it is high. Preopercular disc faintly striated. Operculum ending in a small flat truncated point, with the bone sloped away above and below, where the edge is more concave than above. A row of crenated and striated, but not very conspicuous nuchal scales. The dorsal spines swell out on alternate sides, and the second anal spine is longer and stronger than the third one, which equals the soft rays. The height of the body is contained two times and a half in the total length, and the profile rises with little convexity and no undulation from the upper lip to the dorsal. The falcate pectoral, which is rather too short in the figure, reaches to the anal. The colour is brightly silvery, with ash-gray shadings on the base of the scales. The dorsal and upper half of the caudal are also gray with darker shadings on their borders. The lower half of the caudal and the other fins are saffron-yellow. Length of figure $7\frac{1}{4}$ inches.

Hab. Chinese seas. Canton.

CHRYSOPHRYS XANTHOPODA, Richardson. *Icon.* Reeves, 85; Hardw. Acanth. 61. Chinese name, *Hwang yĭh* (Birch); *Hwang yih*, "Yellow fin" (Reeves); *Wong yi* (Bridgem. Chrest. 221). *Rad.* D. 11|11; A. 3|9; P. 15, &c. (Spec. Br. Mus.)

Mr. Reeves has deposited a specimen of this fish also in the British Museum. In form it is very similar to the last, except that the profile bulges a little at the orbit. The colours also are nearly the same, the back showing merely a deeper tint of yellowish-gray with some green on the nape and parts of the head; the yellow of the lower fins also is more vivid. The specimen has only two short conical canines on each intermaxillary and five rows of molars, the largest, which are those of the middle row, not exceeding partridge-shot. The canines are very short in the lower jaw, and there are only three rows of molars to be clearly made out. Preorbitar as in *auripes*, and with a thin papyraceous edge. Preoperculum striated on the disc, and minutely but regularly serrated along the upper limb. Flat point of the operculum rather more prominent than in *auripes*, and much like the corresponding point in a *Scolopsides.* Middle anal spine long and strong as in *auripes*, and the pectoral long. Length of the figure $8\frac{1}{2}$ inches.

Both the preceding species have the colours of the *Chitchillee* of Russell, plate 91

* This character, as written on the drawing here and in the following places, is pronounced *cha* (Morrison, Dict. i. part 2, No. 32), but Bridgem. Chrest. substitutes *lă.*

(*Chrysophrys chrysargyra*, C. et V.); but in that figure the third anal spine is larger than the second, the soft rays of the fin are more numerous, and the profile is more arched.

Hab. China seas. Canton.

Pagrus unicolor, Quoy et Gaim. (*Chrysophrys*), Voy. de l'Uranie, p. 299; C. et V. vi. p. 162; *Icon.* Reeves, 160; Hardw. Acanth. 41. Chinese name, *Hung lă*, "Red la" (Reeves); *Hung lap* (Bridgem. Chrest. 213). *Rad.* 12|10; A. 3|8; C. $15\frac{6}{6}$; V. 1|5. (Spec. Br. Mus.)

Specimens brought from Canton by John Reeves, Esq. and the Rev. George Vachell, exist in the British Museum and Cambridge Philosophical Institution. Surgeon R. A. Bankier, R. N., sent one to the Haslar Museum from Hong Kong. Third anal spine longer than second one.

Hab. China seas (Canton). Western Australia (King George's Sound).

Dentex setigerus, C. et V. vi. p. 253. *Spare chinois*, Lacép. iv. p. 46; Temm. et Schl. F. J. Sieb. p. 73. pl. 37. f. 1; *Icon.* Reeves, β. 58; Hardw. Acanth. 60. Chinese name, *Kin sze yu*, "Gold silk fish" (Jap. Fish, ii. p. 20); *Hung shan*, "Variegated red silk" (Birch); *Hung sam*, "Red jacket" (Reeves); *Hong sham* (Bridgem. Chrest. 66).

The British Museum possesses one of Bürger's specimens, and also one brought from Canton by John Reeves, Esq.

Hab. Coasts of China and Japan.

Dentex griseus, Temm. et Schl. F. J. Sieb. p. 72. pl. 36.

A specimen of Bürger's exists in the British Museum.

Hab. Japanese sea.

Lethrinus hæmatopterus, Temm. et Schl. F. J. Sieb. p. 72. pl. 36; Richardson, Zool. of Sulph. p. 144. pl. 64. f. 1–3; *Icon.* Reeves, 232; Hardw. Acanth. 63. Chinese name, *Tsëen tsuy lă*, "Dog-lipped lă" (Birch); *Tseen tsuy tso* (Reeves).

We have seen a specimen in the British Museum, brought from Canton by John Reeves, Esq., and one sent from Hong Kong by Surgeon R. A. Bankier, R.N.

Hab. Seas of Japan and China. Canton. Hong Kong.

Lethrinus anatarius, Richardson, Zool. of Sulph. Voy. p. 145. *Icon.* Reeves, 245; Hardw. Acanth. 55. Chinese name, *Go lă*, "Goose lă fish" (Birch); *Go tso*, "Goose tso" (Reeves).

Hab. Sea of China. Canton.

Crenidens punctatus, Gray (*Girella*), Ill. Ind. Zool. Hardw. pl. 98. f. 3, 4. *Icon.* Reeves, 79; Hardw. Acanth. 74. Chinese name, *Kwa tze lă*, "Melon lă fish" (Birch); *Kwa tze tso* (Reeves). *Rad.* B. 5? D. 14|13 vel 15|14; A. 3|11 ad 13; C. $15\frac{5}{5}$; P. 20; V. 1|5. (Spec. Br. Mus.)

Mr. Reeves deposited two specimens of this fish in the British Museum. Teeth curved, flat and expanding towards their ends, which are tricuspid, standing out in three rows on the margin of the jaw; and a little way behind them a brush-like band of much smaller teeth, which are also tricuspid, and like the others except in size. Preoperculum minutely serrated on the edge and radiately ridged on the disc. Lower part of gill-cover and suboperculum smooth and scaleless. Operculum ending in two thin, flat, widely separated corners. Scales strongly ptenoid, pale, with dark borders, and resembling melon-seed. The prevailing colour of Mr. Reeves's figure is umber-brown, deeper above the lateral line and on the dorsal fin. The other fins are blackish-gray, the pectoral having a yellow edge. The iris bright blue. Caudal even.

Hab. China. Canton.

Crenidens leoninus, Richardson. *Icon.* Reeves, 263; Hardw. Acanth. 73. *Shih tze tso*, "Stone lion tso" (Birch). *Rad.* D. 14|16; A. 3|12 vel 13, &c. (Reeves's fig.)

The general colour of the head and upper parts of this fish is apple-green, the belly gradually becoming faint tile-red. The green colour spreads over the scaly bases of the fins, their membranes are purple with a greenish gloss.

Hab. Canton.

CRENIDENS MELANICHTHYS, Temm. et Schl. F. J. Sieb. p. 75. pl. 39. *Icon.* Reeves, 247; Hardw. Acanth. 72. Chinese name, *Lŭh yen ke*, "Green-eyed fowl" (Birch, Reeves). *Rad.* D. 14|14; A. 3|12; C. 17; P. 17; V. 1|5. (Fauna Jap. and Reeves's fig.)

The authors of the 'Fauna Japonica' have named this species as the type of a peculiar genus, but have not assigned any strong reason for separating it from *Crenidens*. They who agree with them in thinking that the group ought to be subdivided, should observe that Mr. Gray's generic name *Girella* is prior to the *Melanichthys* of the 'Fauna Japonica.' In Mr. Reeves's drawing the general colour is black and blackish-purple, with purer purple tints on the face. The caudal is glossed with purplish-brown, the soft dorsals, anal and pectorals, with deep blackish green, and the ventrals, spinous dorsal and spines of the anal, with auricula-purple. The eyes are green. These various shades of dark colours give a general blackish aspect to the fish. In the illumination of the figure in the 'Fauna Japonica' the colour is black, the greenish and purple tints being omitted, as they are in a drawing made by Deputy-Assistant Commissary General Neill, of *Crenidens tephræops*, a Western-Australian fish, which agrees nearly in outline with the Japanese fish. (Ichth. Ereb. and Terror, pl. 41. f. 1, 2.) The Australian names are *Kowelany* and *Memon*.

Another Western-Australian fish, similar in profile, has the body thinning off like a wedge towards the belly, and is known to the settlers by the name of "Zebra-fish," on account of nine black vertical bars on the sides. Its local names are *Kgummul* and *Karraway*, "The striped."

A third Australian fish having the same local name of *Memon*, and another also of *Muddier*, has more of a *Scaroid* aspect than the preceding, but yet appears to be of the same genus. A scale which accompanies Mr. Neill's drawing has the same form and ptenoid structure with those of the preceding two Australian fish. The caudal is truncated, with the side-points projecting to the length of one-third of the fin, and the intermaxillaries and maxillaries? are set by a close row of large trenchant teeth. The colour is black, marbled with sky-blue and a brownish-red tint on the breast. The ventrals blackish-gray and blue; the other fins black. The figure is twenty-one inches long. Mr. Neill's drawings of these and many other Australian fish are contained in a volume which he presented to the British Museum. The 'Ichthyology of the Voyage of the Erebus and Terror' (p. 36, pl. 25. f. 2) contains a description and figure of *Crenidens triglyphus*, a Port Jackson fish which has the physiognomy of *Crenidens forskalii*, while the group of *Melanichthys* approaches more to the *Pomacentridæ* in general aspect.

Hab. Seas of Japan and China.

Fam. ACANTHURIDÆ.

AMPHACANTHUS MARGARITIFERUS, C. et V. x. p. 145. "*Chætodon canaliculatus*, Park Lin. Tr. iii. p. 33. *Amph. canaliculatus*, Bl. Schn. p. 209" (Hist. des Pois. x. p. 146). *Amph. albo-punctatus*, Temm. et Schl. F. J. Sieb. p. 128. *Icon.* Reeves, 259; Hardw. Acanth. *Rad.* D. 13|10; A. 7|9; C. $17\frac{1\,1}{1\,1}$; P. 15; V. 2|3. (Spec. Camb. Ph. Inst.)

A specimen of this fish from Canton was presented to the Cambridge Philosophical Society by the Rev. George Vachell. The profile of the snout is somewhat gibbous before the eye. The teeth are deeply notched, the cusps unequal and crenated. The preoperculum is marked at its angle by three or four diverging furrows, and a few small scales are sunk in the integument of the cheek close to its bend. The lateral line is composed of a series of short simple tubes not very close. Eye rather large. The drawing is grass-green on the upper parts and on the dorsal and caudal fins, the colour fading to mountain-green and bluish-gray as it descends the sides. Many oval silvery spots are scattered over the sides. The spinous dorsal is narrowly edged with blackish-gray; there are dots of that colour on the rays, and the anal and ventrals are spotted or barred with the same. The pectorals are pale green at the base, passing into a clay colour on the disc of the fins. The belly and sides of the head have much silvery lustre. Length 7 inches. The green changes to brown in spirits.

Hab. Seas of China and Japan. Indian ocean.

AMPHACANTHUS FUSCESCENS, "Houttuyn, Mem. de Haerl. xx. p. 333;" C. et V. x. p. 156; Temm. et Schl. F. J. Sieb. p. 127. pl. 68. f. 1; *Icon.* Reeves, 115; Hardw. Acanth. 229. Chinese name, *Le mong* (Reeves); *Lai mang* (Bridgem. Chrest. 37). *Rad.* D. 13|10; A. 7|9; V. 2|3, &c.

A mounted and varnished specimen exists in the British Museum, which was brought from Canton by John Reeves, Esq.; and there is another example in the Chinese collection at Hyde

Park. The post-frontal is ridged in a radiated way and slightly cancellated, and no scales could be discovered through the varnish on the cheeks or temples. The teeth are strongly tricuspid, the larger middle lobe rounded and crenated, the lateral ones acute. In the drawing an accessory or binate anal spine is shown, and the same thing is noticed by Park in his description of *Amph. margaritiferus.* The body is clouded with umber-brown and silvery blotches, occupying nearly equal space, but a dark tint prevailing on the back. On the flanks and tail there are besides many small silvery dots. The throat is umber-brown, and the sides of the head are umber-brown and olive-green, shading into each other. The caudal, soft dorsal, posterior half of the spinous part and soft anal are chestnut-brown. A cream-yellow stripe runs along the base of the anal. The ventrals, fore-part of the dorsal, and spinous portion of the anal are bluish-gray, and the pectorals straw-yellow with an umber-brown blotch on the base. Length 10 inches.

Hab. Seas of China and Japan. Canton.

AMPHACANTHUS AURANTIACUS, Temm. et Schleg. F. J. Sieb. p. 128. pl. 68. f. 2.

Hab. Sea of Japan; rare.

ACANTHURUS ORBICULARIS, Quoy et Gaim.; C. et V. x. p. 237.

The scales or cuticular ridges on the edge of the thorax, from the gill-openings to the ventrals, are serrated by fine, acute teeth pointing backwards. A specimen exists in Haslar Museum.

Hab. Chinese Sea (Sir Edward Belcher). Guam (Hist. des Pois.).

NASEUS FRONTICORNIS, "Commerson;" C. et V. x. p. 259; Temm. et Schl. F. J. Sieb. p. 129. pl. 69. *Harpurus monoceros*, J. R. Forst. Descr. An. ed. Licht. p. 219; *Icon.* G. Forster, Bib. Banks, 194. *Monocerus biaculeatus*, Bl. Schn. p. 180. *Naseus longicornis*, Guer.; *Icon.* Règ. An. pl. 35. f. 31. "Name at Waigiou, *Een-raw*; at Otaheiti, *E-ooma*," Forster.

Hab. Chinese and Japanese seas. Sandwich islands (Webber). Polynesia. Guam.

In Sir Edward Belcher's collection there are several species of *Acanthuridæ*, among which is an adult *Naseus brevirostris*, and also specimens of *Naseus lituratus*, some of which may have been collected in China; but as this officer visited New Guinea, which has been recorded previously as the native place of these fish, and he put fish from various localities into the same jars, we are unable to affirm that any of these specimens are Chinese.

PRIONURUS SCALPRUM, C. et V. x. p. 298; Temm. et Schl. F. J. Sieb. p. 129. pl. 70; *Icon.* Reeves, 183; Hardw. Acanth. Chinese name, *Hĭh tseang keun*, "Black general" (Birch); *Hak tseang keun tsang*, "Black *tseang keun* (a military officer)" Reeves. (Spec. Br. Mus.)

General colour blackish-purple, paler towards the belly, the fins blacker, and a narrow reddish streak from the angle of the mouth to the preoperculum.

Hab. Chinese and Japanese seas.

Fam. CHÆTODONTIDÆ.

PIMELEPTERUS INDICUS, Kuhl et Van Hasselt, in C. et V. vii. p. 270; Temm. et Schl. F. J. Sieb. p. 86. "*Rad.* D. 11|12; A. 3|11," &c. (F. J.)

Hab. Indian ocean. Sea of Japan.

PEMPHERIS MOLUCA, C. et V. vii. p. 306; Temm. et Schl. F. J. Sieb. p. 85. pl. 44. f. 3.

Hab. The seas of Japan and the Moluccas.

HYPSINOTUS, Temm. et Schl. F. J. Sieb. p. 84. pl. 42. f. 2.

I possess a drawing of a fish caught in the Bight of Benin by Dr. Thompson of the Royal Navy, which has the exact profile, the position of the ventrals and general appearance of M. Bürger's figure published in the 'Fauna Japonica,' except that the ventrals have the red colour of the rest of the fish.

Hab. Sea of Japan.

DREPANE PUNCTATA, Lin. (*Chætodon*), C. et V. vii. p. 132. *Chætodon* *punctatus*, Solander; *Icon.* 21. Parkinson, Bib. Banks. *Lattè*, Russell, 79; *Icon.* Reeves, 51; Hardw. 162. Chinese name, *Ke lung tsang*, "Coop tsang fish" (Birch); "Fowl-basket" (Reeves).

Hab. Round the entire coasts of Australia and New Guinea, and in the Javan and China seas, and the Indian ocean.

Drepane longimana, Bl. Schn. (*Chætodon*), p. 231; C. et V. vii. p. 133. *Terla*, Russell, 80–81; *Icon.* Reeves, 241; Hardw. Acanth. 159. Chinese name, *Lew tsang*, "Willow sang" (Birch); "Willow dory" (Reeves). *Rad.* D. 9|21; A. 3|19; C. $17\frac{6}{6}$; P. 17; V. 1|5. (Spec. Camb. Ph. Inst.)

The vertical bars which are described in the 'Histoire des Poissons,' from faded specimens, have a lively auricula-purple colour, and are eight in number. The Rev. George Vachell has deposited a Canton specimen in the Cambridge Philosophical Institution.

Hab. Indian ocean, Javan and China seas.

Scatophagus argus, Lin. (*Chætodon*); C. et V. vii. p. 136. *Pool chitsilloo*, Russell, 78. *Icon.* Reeves, 272? Hardw. Acanth. 171? *Rad.* D. 11|17; A. 4|14, &c. (Spec. Camb. Ph. Inst.)

Two specimens of this fish exist in the Cambridge Philosophical Institution, which were brought from Canton by the Rev. George Vachell, and there are several in the Chinese collection at Hyde Park, all of which vary from one another in the size of the spots, which in some are bigger than the orbit, in others less. Mr. Reeves's drawing shows much larger spots, and a more concave and sloping profile than Russell's figure. The colour is also more purpurascent, sombre and dingy than it is described to be in the 'Histoire des Poissons,' so that it may possibly represent a distinct species.

Hab. India. China. Moluccas.

Scatophagus ornatus, C. et V. vii. p. 143. *Icon.* Reeves, β. 35; Hardw. Acanth. 169. Chinese name, *Kin koo*, "Metal drum" (Birch); *Kin koo*, "Golden drum" (Reeves).

Length of figure $2\frac{1}{2}$ inches.

Hab. China. Amboyna.

Scatophagus bougainvillii, C. et V. vii. p. 142? *Icon.* Reeves, 83; Hardw. Acanth. 172. Chinese name, *Lang peen yu*, "Good flat fish" (Reeves, Birch).

This drawing has exactly the profile of Russell's figure of *argus*, but the dorsal spines are rather lower, and the second anal spine considerably larger than the others. The colour is lemon-yellow with a bright golden lustre, becoming silvery towards the belly, much of the head and parts of the fins being shaded by deep liver-brown. There are also some fainter large brown marks on the upper half of the body. In form this figure agrees with the description of *Bougainvillii*, of which the true colours and markings are not known, the specimen described in the 'Histoire des Poissons' having been badly preserved.

Hab. China.

Ephippus orbis, Bloch (*Chætodon*), 202, f. 2; C. et V. vii. p. 127; Lacépède, iv. p. 458 et 491; *Icon.* Reeves, 210; Hardw. Acanth. 157. Chinese name, *Yin kung* (Birch); *Ying kung* (Reeves); *Ngan kung* (Bridgem. Chrest. 30).

Hab. Indian ocean and China sea.

Platax ehrenbergii, C. et V. vii. p. 221. *Platax vespertilio*, Whitch. Bennett, Ceylon, pl. 5; *Icon.* Reeves, 103; Hardw. Acanth. 179. Chinese name, *Fei yih*, "Flying wings" (Birch); *Fe yih*, "Flying fins" (Reeves); *Fi yik* (Bridgem. Chrest. 26).

Mr. Reeves's drawing has the yellow caudal fin with the dark brown bar on its base, and the precise dimensions of body and vertical fins which Bennett's figure possesses. It shows moreover the broad vertical bars, of which there is only a trace in the Ceylon plate, viz. an ocular band, a pectoral one, a broad one taking in the soft dorsal and anal, and the brown bar on the base of the caudal, which makes a fourth. The yellow tints are not so general as they are shown by Mr. Bennett, being more confined to the breast.

Hab. Mauritius. Red sea. Indian ocean and China sea.

PLATAX VESPERTILIO, Bloch, 199; Temm. et Schl. F. J. Sieb. p. 83. pl. 43. *Platax blochii*, C. et V. vii. p. 222.

The figure in the 'Fauna Japonica' wants an undulation in the arched part of the lateral line and the yellow caudal, with its *ſ*-shaped edge, which are shown in Mr. Reeves's figure of the preceding. The authors of the 'Fauna Japonica' consider their fish to be the true *vespertilio*, though there are some peculiarities of colour.

Hab. Mauritius. Indian ocean. New Guinea and China.

HÆNIOCHUS MACROLEPIDOTUS, Bloch, 200. f. 1 (*Chætodon*). C. et V. vii. p. 93; Temm. et Schl. p. 82. pl. 44. f. 1.

Hab. Sea of Japan. Moluccas. Celebes. New Guinea. Indian ocean, Mauritius and Mozambique.

HOLACANTHUS SEPTENTRIONALIS, Temm. et Schl. F. J. Sieb. p. 82. pl. 44; *Icon.* Reeves, 178; Hardw. Acanth. 175.

Mr. Reeves's drawing is illuminated with a rich orange-brown ground colour and pure china-blue stripes, which are broader than in the figure of the fish in the 'Fauna Japonica.' One stripe is bent into a ring on the operculum and another on the base of the pectoral. The soft dorsal and anal are blackish, the other fins reddish-orange.

Hab. Sea of China and Japan.

CHÆTODON AUREUS, Temm. et Schl. F. J. Sieb. p. 81. pl. 42. f. 1; *Icon.* Reeves, *a*. 23; Hardw. Acanth. 151. Chinese name, *Ho paou kin*, "Purse gold" (Birch); "Golden purse" (Reeves); *Ho pau kam* (Bridgem. Chrest. 25).

The *Chætodon collare* of Bloch (pl. 216. f. 1), which he says he had from Japan, appears to be this species. The profile, bands and numbers of the rays agree tolerably well.

Hab. Seas of China and Japan.

CHÆTODON SETIFER, Bloch, pl. 425. f. 1; C. et V. vii. p. 76.

Sir Edward Belcher obtained specimens of this fish in the outer China sea.

Hab. China sea. Moluccas, Polynesia, the Indian ocean, and Mozambique channel.

CHÆTODON MODESTUS, Temm. et Schl. F. J. Sieb. p. 80. pl. 41. f. 2; *Icon.* Reeves, *β*. 41; Hardw. Acanth. Chinese name, *Tsèèn tsuy lă* (Birch); *Tseen tsui lap*, "Sharp-nose lap" (Reeves); *Tsim tsuy lap* (Bridgem. Chrest. 23).

Mr. Reeves kept a specimen of this fish alive for some weeks in a glass globe filled with sea water. There is a Japanese example in the British Museum.

Hab. Seas of China and Japan.

CHÆTODON STRIGATUS, Langsdorff. C. et V. vii. p. 25. pl. 170; Temm. et Schl. F. J. Sieb. p. 80. pl. 40. f. 1; *Icon.* Reeves, *β*. 4; Hardw. Acanth. 166. Chinese name, *Chae yu*, "Fuel-fish" (Birch); "Faggot-fish," from the resemblance of its stripes to a bundle of fire-wood (Reeves).

Mr. Reeves deposited a Canton specimen in the British Museum.

Hab. Seas of China and Japan.

PSETTUS ARGENTEUS, Lin. (*Chætodon*), Chin. Lagœrstr. in Amœn. Ac. 1754. iv. p. 249. No. 26; Richardson, Ichth. of Voy. of Ereb. and Terror, pl. 35. f. 1–3. *Icon.* Reeves, 240; Hardw. Acanth. 226. Chinese name, *Yin leen tsang*, "Silver-scaled *tsang*" (Reeves, Birch). *Rad.* B. 6; D. 8|29; A. 3|29; C. $17\frac{3}{3}$; P. 17; V. 1|5.

Dr. J. O. M'Williams, the intrepid and scientific surgeon of the Niger expedition, presented two specimens of this fish to the Haslar Museum. He obtained them at Norfolk island.

Hab. Polynesia. East coast of Australia and sea of China. Canton (Reeves). Norfolk island (M'Williams). Vanicolo (Quoy et Gaimard).

Hoplegnathus fasciatus, Temm. et Schl. (*Scarodon*), F. J. Sieb. p. 89. pl. 46. f. 1 and 2. Genus *Hoplegnathus*, Zool. Trans. vol. iii. p. 114; "*Poisson perroquet noir*, Krusenst. Voy. Atl. pl. 52. f. 2." "*Rad.* B. 7; D. 12|16; A. 3|13; C. 17; P. 18; V. 1|5." (Fauna Jap.)

I read an account of the genus *Hoplegnathus* before the Zoological Society, on the 9th of March, 1841, which was noticed shortly afterwards in the Zoological Proceedings, and subsequently published at length, with a figure, in the Zoological Transactions. A fasciculus of the 'Fauna Japonica,' which was published towards the end of the year 1844, gives an account of the same genus under the name of *Scarodon*, and mentions the earliest representation of a species in the Atlas of 'Krusenstern's Voyage.' The specimen described in the Zoological Transactions was supposed to be Australian, and differs from all the Chinese species in its more oblong form. I counted only five branchiostegous rays in the only example (a dried skin) which I had an opportunity of examining. The rays were as follows:—Br. 5? D. 12|12; A. 3|12; C. 15$\frac{4}{4}$; P. 18; V. 1|5. The colour was gone.

Hab. Sea of Japan.

Hoplegnathus punctatus, Temm. et Schl. (*Scarodon*), F. J. Sieb. p. 91; *Icon.* Reeves, *a.* 12; Hardw. Acanth. 308. Chinese name, *Hih shih la*, "Black stone lă" (Birch); *Hih shih tsoo* (Reeves).

Specimens of this fish exist in the Chinese collection at Hyde Park. I have also seen very cursorily, in the museum at Fort Pitt, a spotted *Hoplegnathus* from Norfolk Island, which seemed to be more oblong and of a lighter colour than this species.

Hab. Seas of Japan and China.

Hoplegnathus maculosus, *Icon.* Reeves, 270; Hardw. 173. (Spec. Chinese collection at Hyde Park.)

Not having examined the specimens in the Chinese collection and compared them with one another, this is propounded only provisionally as a separate species. In Mr. Reeves's drawings the spots are of two sizes, many smaller ones being scattered among others of the same dimensions with those of *punctatus*. More rays are shown in the soft dorsal and anal than in the figure of that species. The profile is less gibbous at the eyes, and the ventrals are smaller; but on the whole the two drawings are very much alike and may be both representations of one species.

Hab. Sea of China. Canton.

Fam. Fistularidæ.

Aulostoma chinensis, Bloch, 338 (*Fistularia*). *Fistularia sinensis*, Lacépède, v. p. 357.

Sir Edward Belcher has deposited a Chinese specimen of this fish in the museum at Haslar.

Hab. China seas. Polynesia.

Fistularia immaculata, Commerson. Cuv. Règn. An. ii. p. 167. *Fistularia tabaccaria*, White's Voy. to Botany Bay, p. 2962. f. 2. *Icon.* Reeves, 185; Hardw. 315. Chinese name, *Ma peen yu*, "Horse-whip fish" (Reeves); *Ma pin* (Bridgem. Chrest. 52).

Three Chinese specimens of this fish exist in the British Museum.

Hab. China seas. Malay archipelago. Coasts of Australia.

Amphisile scutata, Lin. (Centriscus). Bl. 123. f. 2. "Klein Mant. Ichth." Rüppell Neue Wirlb. 142.

Chinese specimens exist in the British Museum, Sir Edward Belcher's collection and in the Canton insect-boxes.

Hab. Chinese sea, Malay archipelago, Indian ocean and Red sea.

Tribus Periodopharyngei.

Fam. Mugilidæ.

Mugil japonicus, Temm. et Schl. F. J. Sieb. p. 134. pl. 72. f. 1. *M. ce-*

phalotus, Cantor, Ann. and Mag. of Nat. Hist. xi. p. 29. *Rad.* D. 4|–1|8; A. 3|9; C. $14\frac{6}{6}$; P. 16; V. 1|5. (Cantor's Spec. Brit. Mus.)

Hab. Seas of Japan and China. Estuaries and canals (Cantor).

Mugil (vel Cestræus?) xanthurus, Richardson. *Icon.* Reeves, 127; Hardw. Acanth. 260. Chinese name, *Hwang wei tze*, "Yellow-tailed parer" (Birch); *Hwang ne tsae*, "Yellow-tailed" (Reeves); *Wong ne tsai* (Bridgem. Chrest. 117).

This Mullet has a close resemblance in form to *japonicus*, but as it is a little more slender and its colours differ, we have given it a distinct name. The snout is represented as projecting beyond the lower jaw, which shuts close up beneath it. The back is coloured pale leek-green, the sides and belly being silvery and pearly, with a short dark streak in the middle of each scale, making six or seven rows, none being perceptible below the middle of the fish. There are some hyacinth-red tints on the face and edges of the gill-pieces, and a pale-blue shading in the middle of the operculum. The pectoral is honey-yellow, very dark at the base and pale at the end. The membrane of the first dorsal is very pale-red lilac; the second dorsal is wood-brown; the ventrals and anal buff-orange, the latter having an opake white bar at its base. The caudal is gamboge-yellow with a crimson border in the notch.

Hab. Sea of China. Canton.

Mugil melancranus, *Icon.* Reeves, 73; Hardw. Acanth. 259. Chinese name, *Woo tow* (Birch); *Ootow*, "Black head" (Reeves); *Utau* (Bridgem. Chrest. 119).

In Sir Edward Belcher's collection, which was formed chiefly in the China seas, though specimens from other parts of the ocean were mixed with the fish there taken, I find a *Mugil* having a close resemblance to Mr. Reeves's drawing above quoted, except that the belly is rather more prominent. The upper lip is more fleshy and the orifice of the mouth considerably larger than in *M. strongylocephalus*, exceeding the size of the orbit in both directions. The under lip is horizontal with a slightly notched keel, and the teeth, which penetrate it, are sufficiently visible to the naked eye. The slender maxillary is visible nearly for its whole length when the mouth is closed, but it scarcely projects beyond the preorbitar, which has a straight front edge finely toothed, and ends in a point formed by a tooth larger than the rest. It is the tapering narrow form of this bone, and not a notch, which prevents it from concealing the maxillary. The length of the head and height of the body are equal, and rather exceed a fifth of the length of the fish. The pectorals are contained six times and three-quarters in the same length, and the lobes of the caudal four times and a third. The thickness at the gill-plates is equal to two-thirds of the height of the body, but under the first dorsal the thickness is less than half the height. There are thirty-seven scales in a row, besides some small ones on the caudal, and eleven rows under the first dorsal. Each scale has eight or ten fan-like furrows diverging from a small tube before the middle of the disc, and the free border of the scale is tessellated by worn teeth, which, though minute, show on the edge. There are none of the branching lines seen in the scale of *strongylocephalus*, in which also the only appearance of ptenoid structure is obscure and confined to the middle of the disc. The second dorsal and anal are scaly, and the latter commences a little sooner and ends a little further from the caudal. The caudal is also minutely scaly almost to the tips of its lobes. The top of the head is flat from the preoperculum forwards, but is much narrower than that of *macrolepidotus*; the nape is flatly rounded. There are the usual long scales at the first dorsal, above the pectoral and ventrals, and between the latter, but none of them are very conspicuous. The remains of a blue mark on the front base of the pectorals and a purple tint in the axilla are still visible in the specimen, which differs from *cæruleo-maculatus* and *axillaris* in the pectorals not being long or pointed.

In Mr. Reeves's drawing, the top of the head, a circle round the eye, and the borders of the gill-pieces are dark oil-green; the top of the back is greenish-gray, and the sides silvery, with a yellowish-gray line through the middle of each row of scales. The pectorals are orpiment-orange with a blue mark on the scaly base, and the other fins are greenish-gray. Length of specimen 7·7 inches; from snout to gill-opening, 1·65 inch; to anus, 4 inches; to end of scales on base of caudal, 6·15. Height under the first dorsal, 7·55. Thickness at gill-plates, 0·95. Between the orbits, 0·65. Thickness of back under the first dorsal, 0·70 inch.

It is probable that this species is the Mullet referred to by Dr. Cantor as inhabiting the Peiho, and supposed by him to be the *Mugil parsia* of Buchanan Hamilton (Ganges, pl. 17. f. 21), Ann. Nat. Hist. ix. p. 15.

Hab. China seas? (Belcher). Canton (Reeves).

Mugil hæmatocheilus, Temm. et Schl. F. J. Sieb. p. 135. pl. 62. f. 2. *Icon.* Reeves, β. 49; Hardw. Acanth. 262. Chinese name, *Keuen yu*, "Dog's fish" (Reeves, Birch).

Hab. Seas of China and Japan.

Mugil macrolepidotus, Rüppell, Atlas, p. 140, tafel. f. 2. *a. b.*; C. et V. xi. p. 136.

A specimen of this fish exists in Sir E. Belcher's collection.

Hab. Red sea (Rüppell). Polynesia and Indian ocean (C. et V.). China seas? (Belcher.)

Mugil strongylocephalus, Richardson.

The Haslar Museum possesses an example of this fish, procured at Hong Kong by Surgeon R. A. Bankier, R.N. The orifice of the extended mouth is small and triangular, the lips are thin with acute edges, the lower one being horizontal with a central notched keel. The teeth are invisible to the naked eye, but with a lens their points may be seen protruding through the edges of the lips like fine hairs. The jaws have considerable protractility, and when thrust out, the maxillaries are wholly seen; but when the mouth is retracted they are completely hidden. The preorbitar is very narrow, with a rounded and finely toothed tip, behind which a smooth shallow groove turns round the edge of the bone, giving it a twisted appearance; but there is no distinct notch and no teeth on the fore-edge of the bone. In profile the fish has considerable resemblance to the *macrolepidotus* of Rüppell (Atlas, 35. f. 2), but when seen from above, its snout, though rounded, is much narrower, being little more than half as wide as the head is at the gill-covers. It differs from *cæruleo-maculatus* (C. et V. xi. p. 128) and its allies in not having a thick upper lip. The height of the body is to the whole length of the fish as 1 to 5¼; the thickness, which is greatest at the gill-plates, as 1 to 7·8; and the length of the head as 1 to 46. In profile the fish closely resembles *M. parsia* of Buchanan Hamilton (pl. 17. f. 21), and the curve is regular from the dorsal to the nostrils. When viewed from above, however, there appears a greater narrowness of the snout, which, though obtuse, has not more than half the width at the nostrils that it has at the gill-plates. The head is also much and evenly rounded off laterally, being in nowise flattened. It differs further from *parsia* in the maxillary being entirely concealed. The cleft of the shut mouth is bent *en chevron*, the angle being at the symphysis. An adipose substance, such as exists at certain seasons in the Mackerel, invests the temples and front of the eye, partially covering the preorbitar and leaving a vertically elliptical part of the eye visible. Thirty-one scales form a row between the gill-opening and caudal, and there are ten rows in the height of the body. Each scale has from seven to twelve basal furrows with a corresponding number of crenatures, a small central tube with a fine line running back from it and branching off to the various furrows, and on the posterior or free border there are thirty or forty fine lines commencing near the tube and becoming fissures on the extreme edge, producing so many flat and extremely thin teeth set like those of a fine comb. The central tubes, when the scales are *in situ*, produce, in conjunction with the basal furrows which shine through, the appearance of as many lateral lines as there are rows of scales, causing the marks on each scale to appear compound, though they are really simple. On the head there are several scales which have each two or three contiguous deeply impressed furrows on their discs; these produce one row on each temple, and another on each side more interiorly, which are connected by a transverse row on the nape, and also by a cross row at the orbits. The anal commences a little before the dorsal, and also ends sooner, though it is a little larger. The difference of origin is not so great as in *M. parsia*. Neither of the fins are large, and they are both scaly. The first anal spine is so minute that it can be detected only by dissection. The fourth spine of the first dorsal is short and slender. There are pointed scaly processes over the pectorals and ventrals, and one between the latter fins. No peculiar markings remain on the specimen, which, except that the tips of the pectorals are broken, is in excellent condition. The scales are bright, and the whole fore-part back to the anus is dark bronze-coloured, more as if the fish had been stained by others in the same jar than like an original marking. There is no spot on the base of the pectoral. Length 7 inches; from snout to anus, 3·8 inches; to dorsal, 2·85 inches; to termination of scales on the tail, 5·75 inches. Length of head, 1·35 inch. Height of body, 1·5 inch. Thickness at gill-plates, 0·90 inch.

Hab. Sea of China. Hong Kong.

Mugil ventricosus, Richardson. *Icon.* Reeves, β. 31; Hardw. Acanth. 261. Chinese name, *Pah tze*, "White mullet" (Reeves); *Pĭh tse*, "White parer" (Birch); *Patz tsai* (Bridgem. Chrest. 118).

This Mullet, which is known to us only by the figure, is remarkable for its slender-pointed head, the prominent curve of its belly, and the thickness of the trunk of its tail. The under-lip is shown as shutting in under the snout, and the form of the preorbitar is not so distinctly defined as to enable us to place the species in its proper group. The height of the body is contained three times and a half in the total length, caudal included. The back is little elevated but is angular in profile, which rises in a gentle and slightly concave slope from the point of the snout to the first dorsal. From thence to the second dorsal the line is horizontal; and the rest of the upper profile to the base of the caudal is slightly concave. The under curve is boldly convex to the anus, from whence to the caudal the ascent is considerable and the curve concave. The second dorsal commences one-third of the length behind the beginning of the anal, and extends as far beyond it. The space between the anal and caudal exceeds the length of the anal. The caudal is acutely but not deeply notched.

On the back and upper part of the sides the discs of the scales are pale grass-green, their margins silvery, and the whole lower parts are pearly and silvery. The tubes of the scales are strongly marked down to the middle of the sides, producing rows. The mouth is hyacinth-red, the fore part of the gill-cover is buff-orange, and there is a patch of bright Berlin-blue at the upper angle of the gill-opening. The pectoral is dark brownish olive-green; the first dorsal red lilac-purple; the second dorsal and caudal mountain-green, the notch of the latter being edged with plum-purple; the membrane of the anal is pale mountain-green, its rays and a streak at its base being white. The rays of the ventrals are also opake, white, with some carmine streaks on their tips, and the membrane is pale blue.

Hab. Chinese sea. Canton.

Fam. ANABANTIDÆ.

ANABAS SCANDENS, Daldorf (*Perca*), Lin. Tr. iii. p. 62; C. et V. vii. p. 325; Cantor, Ann. Nat. Hist. ix. p. 28. *Anthias testudineus*, Bl. 322. *Amphiprion testudineus* et *scansor*, Bl. Schn. p. 204. *Cephalopholis*, id. p. 570. *Lutjan tortue*, Lacép. iv. p. 192 et 235. *L. grimpeur*, ibid. p. 195 et 239. *Coius cobojius*, Buch. Ham. pl. 13. f. 33.

Hab. Chusan. Streamlets and canals (Dr. Cantor). Malacca. Celebes. Java. Indian peninsula.

POLYACANTHUS CHINENSIS, Bloch, 218, f. 1 (*Chætodon*); C. et V. vii. p. 357. *Chétodon chinois*, Lacép. iv. p. 461 et 496.

Hab. China.

POLYACANTHUS? PALUDOSUS, Descript. of Animals, Banks, Lib. MSS. No. 84, p. 167. fig. 101 (*Labrus*). *Rad.* B. 5; D. 7|8; A. 17|6; P. 10; V. 1|6. (Lib. citat.)

The anonymous author of the book quoted above has given a pen-and-ink sketch of a small fish taken by him in the ditches and stagnant pools of Danes Island in the river at Canton, and named by him *Labrus paludosus*. Broussonnet has referred it to the *L. opercularis* of Linnæus, but we think erroneously, as the numbers of the rays do not agree, the spines of the dorsal in particular differing widely. It seems to be either a *Polyacanthus* or *Macropodus*, and it differs from the described species of the latter in its cuneate tail and in the tips of the other two vertical fins being less elongated. Its form is oblong-linear; the height being contained five or six times in the total length; the head obtuse in profile, and the mouth at mid-height and terminal. The body tapers slightly to the semi-oval end of the tail, which is embraced by the pointed caudal. Body compressed and scaly, the back narrow. The second ray of the ventrals is stated to be very long by the author, but his figure represents it as not reaching beyond the anterior third of the anal. The colour is olive-green with ten transverse yellow bars, and there is a dark mark on the upper part of the gill-cover near its edge.

Hab. Canton.

POLYACANTHUS? OPERCULARIS, Lin. (*Labrus*), Ammœn. Acad. iv. p. 428. "*Rad.* D. 12|8; A. 15|13; C. 16; V. 1|5." (Linn.)

This fish is described as having its body extended nearly in form of a parallelogram with the soft rays of the dorsal and anal longer than the spines, and the ventrals with a thread-like point. The body is shining with more than ten cross brown bars, the head spotted above, and the tip of the gill-cover marked by a dark brown spot.

Hab. China.

The *Labrus linearis* of Lin., Am. Acad. i. p. 597, is considered by Cuvier as belonging to this family. Its rays are B. 6; D. 20|1; A. 15; C. 12; P. 12; V. 2|4, the single soft dorsal ray being considered as anomalous among the *Acanthopterygii*.

MACROPODUS VIRIDI-AURATUS, Lacép. iii. p. 417. pl. 16. f. 1; C. et V. vii. p. 373.

Hab. China, Cochin-china.

MACROPODUS VENUSTUS, C. et V. vii. p. 375. *M. ocellatus*, Cantor, Ann. Nat. ix. p. 28? "*Rad.* B. 4; D. 17|8; A. 20|12; C. 12; P. 11; V. 1|5." (Cantor.)

Hab. Canton (Dussumier). Chusan (Cantor).

OSPHRONEMUS OLFAX, Commerson; C. et V. vii. p. 377. *Osphronème gourami*, Lacép. iii. p. 117. pl. 3. f. 2. *Trichopus goramy*, Shaw, iv. p. 388.

Hab. China. Java. Naturalised in the Isle of France and Cayenne.

OPHICEPHALUS MACULATUS, Lacépède (*Bostrychus*), iii. p. 140 et 143; C. et V. vii. p. 437; *Icon.* Reeves, 148 et *β*. 19; Hardw. 251. Chinese name, *Săng yu*, "Living fish" (Reeves, Birch, Bridgem. Chrest. 121). *Rad.* D. 42; A. 1|27; C. 22; P. 16; V. 1|5. (Spec. Camb. Phil. Inst.)

Height of body one-sixth of total length, and rather more than half the length of the head. Teeth short and densely villiform, or rather finely card-like, with a cluster of longer ones at the symphysis, as in the *Serrani*. A portion of the dental surface projects forward at the apex of the lower jaw, and the teeth of the exterior row there and at the sides of the jaw are stronger than the rest. The palatine bones are armed with stronger curved teeth, having smaller ones at their bases. Vomerine teeth small. Pharyngeal apparatus an oval cell capable of being closed by various lobes which spring from its borders. Scales ciliated, and strongly marked by curved streaks nearly parallel to their posterior edges. Lateral line interrupted over the anus, and commencing again on the second row of scales beneath, whence it runs straight to the end of the tail. Ground colour yellowish-brown, fading to broccoli-brown and bluish-gray on the belly. Large irregular blackish-brown spots in two or three rows on the sides, and ten or eleven round spots along the base of the dorsal, which becomes dark towards the edge, and in the figure shows obscurely three other rows of dark spots; these are effaced in the specimens. The anal also is dark on its outer half, and shows faintly a series of oblique bars. One blackish-brown stripe passes backwards from the eye along the temporal groove, and dilates on the side of the head and upper edge of the gill-cover; another crosses the cheek lower down, and passing over the lower border of the operculum, is continued to the base of the pectoral; the space between these is nearly filled by a paler umber-brown bar, which is bordered by the yellowish-brown ground colour. There are also blackish-brown spots and bars scattered over the nose, top of the head and jaws; and three imperfect bars on the pectorals. The caudal in fig. 148 is uniformly dark, with two transverse bars on its scaly base. In figure *β*. 19 the basal half of the caudal is straw-yellow, with four dark transverse bars, and the other vertical fins are also lighter with more definite bars. Length of specimen 5½ inches; length from snout to anus, 2·45 inches; length of head, 1·6 inch; height of body, 0·9 inch.

There is a difference in the numbers of the fin-rays in Mr. Reeves's two figures.

The above description is drawn up of two specimens in the museum of the Cambridge Philosophical Institution, which were brought from Canton by the Rev. George Vachell. In the same institution are two rather larger specimens from the same quarter which do not differ in any essential point of structure, but present a series of bright silvery rhomboidal marks between the two principal rows of dark lateral spots, having, with them, a quincuncial arrangement. These bright places are not shown in either of Mr. Reeves's figures. There are series of pores in the temporal fossæ down the limb of the preoperculum and along the limbs of the lower jaw. The lateral line is interrupted over the anus, but there are as many rows of lines as there are scales, so that the proper continuation of the line is difficult to make out. Length of specimens 6½ and 8½ inches; rays of dorsal, 44; of anal, 1|28.

These Ophicephali are carried about the streets of Canton in tubs and are cut in pieces alive for sale.

Hab. Canton.

OPHICEPHALUS IRIS, C. et V. vii. p. 439.

Described from a Chinese painting brought from Canton by M. Dussumier. An azure-blue spot on the end of the tail.

Hab. Canton.

OPHICEPHALUS MILIARIS, C. et V. vii. p. 439.

Also described from a Chinese painting.

Hab. Canton.

OPHICEPHALUS ARGUS, Cantor, Ann. Nat. History, ix. p. 29. "*Rad.* B. 5; D. 49; A. 33; C. 14; P. 16; V. 1|5" (Cantor).

"Brownish-green back and sides, reddish-white abdomen; numerous black ocellated spots edged with white above the lateral line; fins yellow, spotted with black."—Cantor.

Hab. Chusan. Streamlets and estuaries.

OPHICEPHALUS GRANDINOSUS, C. et V. vii. p. 434.

Described from a painting executed at Canton.

Hab. Canton.

OPHICEPHALUS OCULATUS, Lacépède (*Bostrychoïdes*), iii. p. 144 et 145. *Ophicephalus ocellatus*, C. et V. vii. p. 454.

This species is very imperfectly known, and only from a Chinese painting.

Hab. China.

OPHICEPHALUS PUTICOLA, *Icon.* Reeves, 142; Hardw. 248. Chinese name, *Tsing kung yu*, "Well kung yu" (Reeves); *Ching kung u* (Bridgem. Chrest. 245).

As most of the Chinese *Ophicephali* have been described from drawings only, and the colours appear to vary with age and season, it is probable that there has been an undue multiplication of species; and the drawing now quoted may eventually prove to be referrible to the same species with Lacépède's *oculatus*, but his figure differs in form, and it is impossible to reconcile the two in the present state of our knowledge of the ichthyology of Canton.

Mr. Reeves's drawing of *puticola* presents a light oil-green colour along the back, gradually passing on the sides and belly into peach-blossom red; a pale apple-green bar deeper towards its edges covers the temples and operculum; and there are about eleven blackish-green bars on the sides, bent backwards *en chevron* in the middle, and fading away towards the belly. On the scaly base of the tail, above its middle, there is a round spot of the same blackish-green hue. The head behind the eyes, the whole of the sides, the lower half of the dorsal, and the basal half of the caudal, are thickly spotted with points and small lines of sienna-yellow. All the fins are broadly bordered with blackish-gray, the basal halves of the anal and dorsal being ochraceous, and of the pectorals and caudal approaching to hyacinth-red. The tubular margins of the anterior nasal openings are represented as unusually long: the caudal as much rounded, and the length as equal to six times and one-half the height of the body. D. 43; A. 34, &c. Length of figure $9\frac{3}{4}$ inches.

Hab. Canton.

OPHICEPHALUS JOVIS, *Icon.* Reeves, 143; Hardw. 249. Chinese name, *Luy kung yu*, "Thunder king's fish" (Birch, Reeves); *Lui kung u* (Bridgem. Chrest. 246).

As the young of *Oph. marulius* differs very greatly from the adult in its colours, so it is not impossible but this may be the young of the preceding. Its different Chinese designation, however, and very different tints of colour, induce us to name it as distinct.

The body is marked by ten or eleven blackish-green waved and forked bands, alternating with as many arterial blood-red ones; the two colours being about equal in quantity, either may be considered as the ground one. The top of the head is dark green; a dark green stripe which runs backwards from the eye and spreads over the gill-cover, is traversed part of the way by two red bars; and there is a red spot near the tip of the gill-flap. Some yellow points are scattered on the side of the head and along the flanks, but not nearly so copiously as in *puticola*. The caudal, dorsal and pectorals are broccoli-brown, without bars or spots. The anal is yellowish-brown at the base, marked along its middle by a narrow white riband, which is shaded above by blackish-gray passing into white, and finally, the edge of the fin is bluish-gray. The anterior nostrils are tubular, but the tubes are scarcely so long as those of *puticola*. The form of the fish otherwise is much the same as in that species. Length of figure nearly 6 inches.

Hab. Canton.

Tribus ——?

Fam. Pomacentridæ.

Glyphisodon cælestinus, Solander (*Chætodon*), MSS. Bib. Banks; C. et V. v. p. 464; *Icon.* Parkins. Bib. Banks., 31; Reeves, 256; Hardw. 143. *Rad.* D. 13|12 ad 14; A. 2|11 vel 12, &c. (Spec. var.)

Specimens from China have been presented to the British Museum by John Reeves, Esq., and to Haslar Museum by Sir Edward Belcher and Capt. Dawkins, R.N.

The teeth are entire, chisel-shaped and trenchant in a single row.

Hab. Mozambique. Seychelles. Mauritius. Indian ocean. Polynesia and Chinese sea.

Glyphisodon tyrwhitti, Benn. Ceylon (*Chætodon*), pl. 25; *Icon.* Reeves, *a.* 31; Hardw. 144. *Rad.* D. 13|12; A. 2|11, &c. (Spec. Br. Mus.)

A specimen of this fish in the British Museum, brought from China by Mr. Reeves, can be distinguished from the preceding only by the teeth, which are those of a *Dascyllus*, and are villiform, with the front row stronger. It has not the aspect of a *Dascyllus*, nor the serrated preoperculum. It is not easy to say which of Mr. Reeves's drawings, *a.* 31 or 256, represents this fish best, but on the whole we have thought proper to refer to the former, which indicates the blue borders of the caudal more distinctly. The two figures are illuminated much alike, viz. with fine vertical blue or black bands, and intermediate spaces on the back of bright gamboge yellow. In *a.* 31 the yellow colour spreads over the dorsal to near its edge, while in 256 the fin is uniformly dark blue, the scaly sheath at its base being yellow; *a.* 31 has also a crimson-red head and a streak of carmine round the base of the pectoral. Length of figure 6 inches.

Hab. Canton. Ceylon.

Glyphisodon rahti, Russell (*Rahti-pota*), 86? C. et V. v. p. 456 et ix. p. 507? *Icon.* Reeves, *a.* 33; Hardw. 142.

The prevailing colour in Mr. Reeves's drawing is pale mountain-green, without any of the yellow of the preceding two species. The cheeks and gill-covers are crimson. The fins are greenish, but darken greatly towards their borders. The species has been determined solely from the drawing, and is doubtful. In the 'Histoire des Poissons,' Bennet's figure of *Chætodon tyrwhitti* is referred to *rahti*, but as it is illuminated in accordance with Reeves's figure *a.* 31, I have considered it to be a representation of the specimen described in the preceding article.

Hab. Red sea. Indian ocean. Malay archipelago and Chinese sea.

Glyphisodon sordidus, Forskal (*Chætodon*), p. 62; C. et V. v. p. 468; Rüppell, Atl. p. 34. taf. 8. f. 1. *Calamoia pota*, Russell, 85. *Pomacanthe sale*, Lacép. iv. p. 519.

Examples of this species, procured in the China seas by Capt. Dawkins, R.N., were presented by him to the museum at Haslar.

Hab. Red sea. Indian ocean. China seas.

We have not seen a specimen to which we could refer Mr. Reeves's drawing 274 (Hardw. 145), and are unable to determine the genus to which it belongs. It has the aspect of *Glyphisodon*, a large eye, narrow preorbitar, oblong-oval form, the height of the body being equal to half the distance between the snout and the base of the caudal fin. The rays are D. 13|11 or 12; A. 2|10, &c.; the second anal spine is stouter than usual, the caudal much forked with pointed lobes, and there is a filiform tip to the ventrals. The general tint is dark greenish-blue without bars, the head glossed with crimson, the fins blackish-brown, and a black mark on the base of the pectoral. The drawing, like the rest, was executed at Canton. It measures 5 inches.

Glyphisodon bankieri, Richardson. *Rad.* D. 13|11; A. 2|11; C. 15; P. 17; V. 1|5. (Spec.)

The only example we have seen of this species was sent to Haslar Museum from Hong Kong, by Surgeon R. A. Bankier, R.N. It has the oblong form of a *Pomacentrus*, the height of the body being contained thrice and a half in the total length, caudal included. The teeth stand in a single row and are chisel-shaped, with truncated entire tips. The eye is large; the preorbitar and suborbitar chain very narrow and not toothed; the vertical limb of the preoperculum uneven, but not regularly toothed; and the operculum terminating in a flat acute pungent point, with a shallow sinus above it ending in a sharp corner: a longitudinal row of scales between the gill-opening and caudal contains twenty-six. The lateral line terminates at the base of the last dorsal ray, and is continued lower down by a little pore in the disc of each scale. The vertical fins are scaly as usual. The middle soft rays of the dorsal end in a short filiform tip, and there is a corresponding acumination of the anal, but not so well marked. The caudal is slightly forked with acute tips. The species differs from the members of the group headed in the 'Histoire des Poissons' by *azureus*, in the pointed lobes of the caudal. It has lost much of its colour, and shows no traces of the dark eye-like spots which characterize the majority of the group. The caudal, end of the tail and hinder parts of the dorsal and anal retain a tinge of yellow; the rest of the two latter fins appears to have been fringed with black, and the fore-part generally of the fish looks dark. Length 2¾ inches.

Hab. Chinese seas. Hong Kong.

Heliases notatus, Temm. et Schl. F. J. Sieb. p. 66. "*Rad.* D. 13|12 vel 13; A. 2|13, &c.; B. 5." (F. J.)

This species has a spot behind the dorsal like *Glyphisodon sordidus*.

Hab. Japan.

Heliases reticulatus, Richardson. *Rad.* D. 12|15; A. 2|13; C. 15¼; P. 17; V. 1|5. (Spec.)

The profile of this species, leaving out part of the tail, is nearly orbicular, and the body is greatly compressed. Teeth in one row short, subulate, acute, with very minute ones behind, scarcely perceptible even through a lens. Narrow preorbitar scaly, and when examined by a lens, seen to be minutely toothed; as is also the vertical limb of the preoperculum, a few teeth at the corner of this bone being larger. A slight sinus in the operculum. Twenty-five scales in a row between gill-cover and anus, and ten or eleven in a vertical row, the lateral line being traced on the second row from the base of the dorsal. It is at first marked by a single pore on the disc of each scale, and further on by a series of short tubes which terminate at the end of the dorsal. Most of the posterior scales have a little pit on their discs, producing the semblance of several lateral lines. We have seen only two examples of this species, which were brought from China by Sir Edward Belcher. The tips of the soft rays of their vertical fins are a little shortened, but the caudal is sufficiently perfect to show that it was slightly notched at the end. After long maceration in spirits, the ground colour is milk-white, with a well-defined pale yellowish-brown border to each scale, producing a net-work with acutely elliptical meshes. The spinous dorsal and the ventrals are clouded with umber-brown. The other fins retain no colour. Length 2¼ inches.

Hab. China seas (Sir E. Belcher).

Pomacentrus nigricans, Lacépède (*Holocentrus*), iv. p. 332 et 367; C. et V. v. p. 425; *Icon.* Reeves, *a.* 32; Hardw. 146. Chinese name, *Hih yu*, "Black fish" (Reeves, Birch).

Hab. Sandwich islands and coasts of China.

Amphiprion chrysargyrus, *Icon.* Reeves, *a.* 26; Hardw. 141. Chinese name, *Hae kin yu*, "Silver gold fish" (Birch); "Sea gold fish" (Reeves).

It has been remarked in the 'Histoire des Poissons,' that the differently coloured Amphiprions may be in many instances mere varieties of one species. As these have however been described and named, it seems necessary that this one, whether species or variety, should also be noted.

The general colour appears nearly uniform, but is composed of black with orange-brown and crimson, the latter colour replacing the others before the nose. The breast, pectorals and ventrals are bright saffron- or king's-yellow; a white band descends from the nape over the fore part of gill-cover and edge of preoperculum, another from the posterior dorsal spines to the anal region, and a third occupies the trunk of the tail between the vertical fins. These three bands have a faint flesh-coloured or roseate tinge, and the first two are edged with verdigris-green. The caudal is cream-yellow without shadings or spots. The lobes of the caudal are obtuse. Length 4¼ inches.

Amphiprion japonicus, Temm. et Schl. F. J. Sieb. p. 66. *Rad.* B. 5; D. 10|15; A. 2|14; C. 24; P. 19; V. 1|5. (Spec. Haslar Mus.)

The Haslar Museum possesses specimens of this fish, presented to it by Capt. Dawkins, R.N., who brought them from China. In one individual the ventrals are wholly orange-coloured, in another they are edged like the anal with black, as described by the authors of the 'Fauna Japonica.' It is probable that both this fish and the one preceding it will eventually prove to be mere varieties of *chrysopterus*. In *japonicus* the stomach is nearly globular with three conical pyloric cæca, and the eggs are oblong-oval, and not round.

Hab. Seas of China and Japan.

AMPHIPRION CHRYSOPTERUS, C. et V. v. p. 401.

Hab. Japanese sea.

Tribus PHARYNGOGNATHI.

Fam. LABRIDÆ.

LABRUS EÖTHINUS, Richardson. *Icon.* Reeves, 197 ; Hardw. . Chinese name, *Tze ko*, "Purple parrot" (Birch); *Soo ko* (Reeves); *Su ko* (Bridgem. 219). *Rad.* D. 9|11 ; A. 3|10; C. 12$\frac{3}{3}$; P. 12 ; V. 1|5.

This fish agrees with *L. pœcilopleura* and *gayi* in the number of the rays and in many other characters, but differs from both as much as they do from one another.

Teeth labroid, curved, acute and conical, diminishing as they recede from the symphysis; but a large curved canine tooth stands forwards from the angle of the mouth. A row of small interior teeth runs as far back as the middle of the upper jaw, but in the lower jaw it is confined to the front part. Five rows of small tiled scales cover the cheek up to the suborbitar chain. None exist on the disc of the preoperculum, nor on the dilated interoperculum which spreads under the throat. Large irregular scales cover the operculum. Lateral line traced on twenty-six or twenty-seven scales by bushy muciferous canals. Each cluster is formed of obtuse bifurcations thrice repeated, but the forks are less numerous near the bend of the line at the end of the dorsal, and almost disappear in the short space behind it. The very even dorsal and anal fins move in furrows formed by scaly fillets, and there is a filament behind the tip of each dorsal spine. The drawing is coloured aurora-red, passing into hyacinth-red on the back, with a darker meniscoid patch on the edge of each scale, and ten green lines radiating from the eye forwards, across the top of the head and backwards over the nape, but not on the cheek. There is also a yellowish tinge on the snout. The vertical fins are coloured like the body, but the dorsal and base of the caudal are glossed with yellow and green, and the dorsal is marked by three rows of small olive-green spots. The ventrals are peach-blossom red, and the pectorals transparent, with a blue edge to their scaly base. Length of the specimen 9$\frac{3}{4}$ inches; of the drawing, 7 inches.

Hab. China seas. Canton.

LABRUS RUBIGINOSUS, Temm. et Schl. F. J. *Rad.* D. 9|11 ; A. 3|10; C. 13$\frac{6}{6}$; P. 11 ; V. 1|5. (Spec. Br. Mus. inches long.)

Our knowledge of this species is derived from one of Bürger's Japanese specimens belonging to the British Museum. It has the general form of *L. eöthinus*, but is rather more slender, and is further distinguished from that species by a purple spot at the base of the fifth dorsal spine, some white spots on the back and four brown longitudinal lines. There are twenty-five scales on the lateral line, and the muciferous canals on each are twice forked on the anterior part of the body, and more simple posteriorly, being no where bushy. The number of the 'Fauna Japonica' which is to contain the descriptions of the *Labridæ* is not yet published (March 1, 1846), and we do not therefore know whether the authors of the work in their selection of the specific epithet had reference to the *Sparus rubiginosus* of Solander, which is either a *Labrus* or *Iulis*. This however has a lunate caudal with acute angles, while the Japanese fish has a rounded or nearly square caudal (vide *Iulis? rubiginosus*, Richardson, 'Ann. and Mag. of Nat. Hist.' for June 1843).

Hab. Sea of Japan.

LABRUS RETICULATUS, Temm. et Schl. F. J. pl. 83, 83 A, 84.

Hab. Sea of Japan.

LABRUS JAPONICUS, C. et V. xiii. p. 99 ; Temm. et Schl. pl. 85.

Hab. Sea of Japan.

COSSYPHUS RETICULATUS, C. et V. xiii. p. 139. *Labrus reticulatus*, Temm. et Schl. F. J. Sieb. pl. 83 (*Jun.*), pl. 83 A. (*Med. ætat.*); pl. 84 (*Adult.*).

The text appertaining to this Plate is not yet published (Sept. 1845).
Hab. Sea of Japan.

COSSYPHUS MICROLEPIDOTUS, Bl. 292 (*Labrus*); C. et V. xiii. p. 140.
Hab. Sea of Japan.

COSSYPHUS BILUNULATUS, Lacépède (*Labrus*), iii. p. 454 et 528; C. et V. xiii. p. 122; *Icon.* Reeves, 243; Hardw. 302. Chinese name, *Hung ying yu*, "Red parrot-fish" (Birch); "Red eagle-fish" (Reeves).

Hyacinth-red glossed with yellow inferiorly, each scale finely dotted on the margin with brownish-red, the head above deep crimson, with arterial blood-red stripes. Cheeks and gill-pieces silvery with purplish tints, a few red specks and a brownish-red stripe from the corner of the mouth over the lower part of the cheek and suboperculum to the gill-opening. Soft parts of vertical fins and caudal yellow with red shadings. Spinous dorsal, pectorals and ventrals lake-red. Black marks on the hinder part of back and top of tail, and first three dorsal spines blackish-blue. Length of figure $9\frac{3}{4}$ inches.

Hab. Mauritius. China seas. Canton.

COSSYPHUS CYANOSTOLUS, Richardson. *Icon.* Reeves, 251; Hardw. 292. Chinese name, *Tsing e*, "Blue clothes" (Birch); *Ching e*, "Blue coat" (Reeves); *Tsing i* (Bridgem. Chrest. 123). *Rad.* D. 13|7; A. 3|10; C. $12\frac{3}{3}$; P. 18; V. 1|5. (Dried spec. Br. Mus.)

A dried specimen of this fish, brought from Canton by John Reeves, Esq., exists in the British Museum, measuring fourteen inches in length. The drawing is eleven inches long. In the number of the rays and many other characters it agrees with *C. schœnleinii*, but it has not the vertical profile of that species. In the rays, and also in the form and distribution of the markings, it is much like the *Labrus japonicus* as figured in the 'Fauna Japonica,' pl. 85, but has a much less convex and more sloping profile as well as a different ground colour. The latter difference would weigh little as a specific distinction, since the reds, greens and blues of the *Labridæ* are interchangeable at various seasons and after the death of the fish; but there is also a discrepancy in the ramifications of the mucous canals which form the lateral line. They are less branched anteriorly in *L. japonicus*, but in *C. cyanostolus*, as in *schœnleinii*, they become more simple posteriorly.

Height of body contained twice and two-thirds in the whole length. Profile between the upper lip and dorsal a small arc of a circle, slightly gibbous at the eye. A long scaly trunk of the tail, the scales covering much of the caudal fin, which consequently looks short and spreads little. A stout subulato-conical tooth next the symphysis is followed by a shorter one. The jaw behind them swells out into a thickish roll, in which a short conical tooth is implanted immediately behind the front canine; further along the jaw there are some scarcely perceptible granular teeth. In the lower jaw the second tooth is slightly recurved, and there is no toothlet in the bony roll behind the front canine, but some very minute granular teeth exist on the edge of the jaw, and at the angle of the mouth four contiguous teeth rise above the rest; but even these are small and might be easily overlooked in a recent specimen. Lips large. Top of the head, large preorbitar, margin of the orbit, lower jaw, most of the inter-opercular plate, and the disc of the preoperculum minutely porous. Five rows of small, round, distant scales imbedded in the cheek, thinning off to one row on the temples. Upper limb of preoperculum finely serrated by teeth which point upwards, the corner slightly rounded, and the lower limb half as long as the upper one. Interoperculum spreading out into a large sub-membranaceous flap which comes over the throat. In the specimen there are only four or five scales remaining on this bone, and they are closely tiled at the angle of the preoperculum. Four or five rows of larger scales exist on the operculum. The gill-flap ends in a rounded membranous lobe which projects over the base of the pectoral. Lateral line composed of thirty scales, and marked on each scale by a bush-like cluster of mucous canals, which are equally full of branches from the beginning to the end of the line. Each cluster is bifurcated, spreading equally above and below the line, and each fork consists of about four undulating branches with short lateral branchlets. The basal striæ show faintly through the scale which overlaps them. A patch of scales covers the supra-scapular, as in a sparoid.

The ground colour of the drawing is oil-green, darker on the head and back, and each scale on the body and hinder part of the gill-cover is marked by an oval indigo-blue spot placed vertically, and shaded off for the most part by greenish-blue. There are no spots beneath and before the pectoral, and on the tail behind the anal and dorsal the spots are placed lengthwise, so as to form longitudinal rows, which end in nearly continuous streaks on the caudal. They are broken again into spots on the extremity of the caudal, and some of the streaks are glossed with green. Three blue and green stripes radiate from the eye over the nose, and as many backwards over the temples. A blue stripe edged with hyacinth-red borders the lips and passes from the angle of the mouth over the lower limb of the preoperculum and suboperculum. The membrane of the dorsal is hyacinth-red, the rays blue; a series of blue and green blotches mark the membrane between the spines at the points of the large scales, which form a furrow for the fin, and there is a series of small blue points along the base of this scaly furrow. The anal is lemon-yellow with an indigo-blue border, and streaks of the same, which meander over the fin and anastomose. The pectorals are purplish with an aurora-red scaly base bordered with blue. The rays of the ventrals are indigo-blue, and the membrane of the caudal crimson and brown.

The description of form is wholly from the dried specimen. Two smaller examples in spirits from China are also deposited in the British Museum. In these there are two acute teeth in the bony swelling behind the front canine, but no visible granular ones. There is however a small canine at the angle of the mouth. In the lower jaw the interior bony roll is flattish near the symphysis, and the posterior two-thirds of its length is occupied by short, conical and rather acute teeth. Two rows of scales cover two-thirds of the interoperculum; there are three or four rows of large opercular scales, and the scaly fillets at the base of the anal and dorsal are very distinct. The specimens are $11\frac{1}{4}$ inches long.

Hab. China seas. Canton.

Cossyphus ommopterus, Richardson. *Icon.* Reeves, 98; Hardw. 295. Chinese name, *Hwa ying ko*, "Blue parrot" (Birch); "Variegated parrot-fish" (Reeves); *Ta aing ko* (Bridgem. Chrest. 65). *Rad.* B. 5; D. 13|7; A. 3|10; P. 17 vel 18; V. 1|5. (Mounted spec. Br. Mus.)

The British Museum possesses a mounted specimen of this fish, which was brought from Canton by John Reeves, Esq. It is nearly allied by form and colour to *C. cyanostolus*, *schœnleinii* and *Labrus japonicus*, all of which agree closely in the numbers of the fin-rays, but it is readily distinguished by an eyed spot in the soft dorsal. Profile much like that of *C. cyanostolus*, with a more gibbous nape, and the eye closer to the frontal line. The small scales on the top of the head terminate between the orbits by a deeply concave line. The snout, nasal region, jaws, throat, fore part of cheek and disc of preoperculum are naked. Five rows of small scales occupy a space in the curve of the preoperculum, equal in breadth to that of the porous skin betwixt them and the eye. Upper limb of the preoperculum finely and equally serrated; under edge roughish, but not distinctly crenated; its corner slightly rounded. Five or six horizontal rows of scales on the gill-cover, which ends in a roundish flap, that is narrowed, as in the preceding species, by a curve cutting into the suboperculum. A strong conical tooth next the symphysis of the upper jaw inclines to the mesial line and rests against its fellow in the other intermaxillary; a small tooth immediately follows it, and in the middle of the gape there is another, but none at the corner of the mouth, and no other teeth, although some faint crenatures may be detected on the edge of the jaw. In the lower jaw the front tooth on each limb is almost horizontal; a smaller one succeeds, as in the upper jaw, but the tooth in the middle of the limb is wanting; there is a single row of minute rounded teeth on the rather acute edge of the jaw, two or three of them next the corner of the mouth, rising above the others. A small bony roll or ridge swells up behind the front teeth of the lower jaw, but the limbs of the jaw are rather thin. About twenty-eight scales enter into a row between the gill-opening and caudal, and the radiating lines appear more distinctly than in *cyanostolus*. The lateral line is formed by a short stem on each scale with short curved branchlets directed upwards and downwards, the branchlets becoming inconspicuous under the last five dorsal rays, and more posteriorly. This answers to the description of the lateral line in *C. schœnleinii*, but the specimen has not the low dorsal of that species, nor the vertical forehead. The tips of the membrane overtop the spines of the dorsal.

The ground colour of the drawing is apple-green deepening to blackish-green on the back, and passing into oil-green and wax-yellow towards the belly. The pectorals and most of the caudal have the middle tint of the sides, and the head is mostly oil-green with much lustre. Each scale down to the lower edge of the pectoral has an oval mark on its disc, which anteriorly is ultramarine-blue, and posteriorly verdigris-green. The bases of the caudal rays are also green, and the upper corner of the fin is orpiment-orange, edged with blue, while the lower corner is wholly purple. The anal has a blue stripe at its base, two rows of blue spots on its disc, and a purple edge. The dorsal is yellowish-brown with the tips of membrane behind the spines, and a row of patches along the middle of the fin blue. The edge of the soft part of the fin is orange, and there is a blackish-blue spot, surrounded by a paler ring, on the bases of the first two jointed rays. The rays of the ventrals are blue, and the scaly base of the pectorals is Dutch-orange, finely dotted with brown and edged with blue. The lips are blue; a blue stripe runs back from the angle of the mouth to the preoperculum; and a blue streak surrounds the gill-cover some way from its border. The eye is encircled by a blue ring; a streak of the same hue runs downwards to the upper lip, and two pass backwards over the temples and upper part of the gill-flap. Length of the specimen 6¼ inches. The drawing is an inch and a half longer.

Hab. Sea of China. Canton.

CTENOLABRUS AURIGARIUS, Richardson, Ichth. of Voy. of Sulphur, p. 90. pl. 45. f. 1, 2. *Icon.* Reeves, β. 24; Hardw. 303. Chinese name, *Kin shaou* (Birch); *Kum shaou*, "Golden ration" (Reeves); *Kam shau*, (Bridgem. Chrest. 67). *Rad.* D. 9|11; A. 3|9; C. 12$\frac{3}{3}$; P. 12; V. 1|5. (Spec. Br. Mus.)

The British Museum possesses an example of this species preserved in spirits, which was brought from Canton by John Reeves, Esq.; and there is another in the Chinese collection at Hyde Park.

Hab. China seas. Canton.

CTENOLABRUS RUBELLIO, Richardson, Ichth. Voy. of Sulphur, p. 93. pl. 45. *Icon.* Reeves, 90; Hardw. 54. Chinese name, *Hung ying ko le*, "Red parrot carp" (Birch); "Red Parrot carp" (Reeves). *Rad.* D. 9|10; A. 3|8; C. 12$\frac{3}{3}$; P. 13; V. 1|5.

A mounted specimen of this fish from Canton was presented to the British Museum by John Reeves, Esq. In the structure of the gill-pieces, the numbers of the fin-rays and other characters, this and the preceding species, and also *Ctenolabrus flagellifer*, have much resemblance to *Labrus japonicus* and *Cossyphus schoenleinii*, *cyanostolus* and *ommopterus*. Their distribution into different genera seems to be artificial.

Hab. China seas. Canton.

CHEILIO INERMIS, Forskal (*Labrus*), Descr. An. p. 34. *Labrus fusiformis*, Rüppell, Neue Wirlb. p. 7. taf. 1. f. 4. *Cheilio forskalii*, C. et V. xiii. p. 349; *Icon.* Reeves, 100; Hardw. 304. Chinese name, *Hae lung*, "Sea dragon" (Reeves, Birch); *Hoi lung* (Bridgem. Chrest. 103).

The colours and markings of the Chinese fish agree in the main with individuals taken in the Red sea, but as there is some difference, it may be proper to describe Mr. Reeves's drawing. The ground colour is dark duck-green, deepening to blackish-green on the summit of the back, and fading away on the ventral line. The rays of all the fins have the same green colour. Each scale is marked by a clear round white spot, shaded with sky-blue. In the descriptions of the Red sea fish these spots are said to be confined to the lower parts of the sides. A pale red-lilac streak runs from the corner of the mouth to the preoperculum. The suboperculum is edged by a line of the same colour, and several traverse its disc and anastomose with one another. A small China-blue bar, bent *en chevron*, is placed on the tip of the gill-cover. Eye reddish-orange. The membranes of the dorsal and caudal are hyacinth-red, and the lower half of the former is marked by three rows of white spots. The basal half of the anal is white with oblique bars of hyacinth-red, its outer border is reddish-lilac. The pectorals are olive-green and the ventrals blue.

Hab. Sea of China (Canton). Red sea.

JULIS EXORNATUS, Richardson. *Icon.* Reeves, β. 10; Hardw. *Rad.* D. 9|12; A. 3|12; C. 12$\frac{1}{4}$; vel 1|–14; vel 2|13; P. 14; V. 1|5.

Specimens of this fish were sent from Hong Kong by Surgeon R. A. Bankier, R.N.; several exist in the British Museum and Cambridge Philosophical Institution, which were brought from Canton by John Reeves, Esq. and the Rev. George Vachell; and there are also three in the Chinese collection at Hyde Park. Height of body and length of head equal to one another, and to one-fourth of the total length: the thickness contained twice and one-half in the height. Caudal rounded. About twenty-six scales in the lateral line, which is bent suddenly down near the end of the dorsal by a short oblique elbow. Each scale of the line is marked obscurely by three short tubes, diverging from the point of a very short stem. Scales truncated at the base, elliptical at the posterior or free end, with about twenty to twenty-six fine furrows on each end diverging in a fan-like manner from near the centre, a triangular space on each side showing only the parallel lines of structure. Teeth rather bluntish; a sharp curved canine standing forwards from each side of upper jaw near the angle of the mouth. Jaws with considerable protractility.

In Mr. Reeves's drawing the ground colour of the body is pistachio-green, the breast and belly being paler. About eight or nine irregular bars, formed by the dark borders of the scales, descend from the back past the middle. The vertical fins are vermilion-red, with four rows of round and oval straw-yellow spots occupying more space than the red, which however forms a border to the dorsal and anal. In the specimens only two rows of these yellow spots remain on the dorsal, the outer half of the fins being red with a very slight mottling; but there is a dark spot on the dorsal, between the fifth and seventh spines, which is not shown in the figure. The corners of the caudal, both in the figure and specimens, are yellow, and in the figure there are various orange-coloured spots and bars on the head shaded with blue. The form of these can be traced on the specimens though the colour is gone. The dorsal spines have filamentous tips, and are shorter than the soft rays. Length of specimens and figure $5\frac{1}{2}$ and 6 inches. The anal spines vary from one to three, there being one or two additional jointed rays when the spines are deficient.

Hab. China seas. Canton. Hong Kong.

Julis exornatus, *var. a.*? *Icon.* Reeves, 258; Hardw. —. Chinese name, *Ying ko yu* (Reeves); "Parrot fish" (Birch); *Ang ko u* (Bridgem. Chrest. 63).

Notwithstanding that this drawing and the following differ somewhat in form and in the numbers of the spinous rays from the preceding one as well as in colours, I have a strong suspicion that they are all three representations of the same species in different conditions. The yellow corners of the caudal are common to them all. The marks on the head and on the dorsal are also on the same plan, and on comparing the numerous specimens of *exornatus* which we have seen, most of them appear intermediate in their markings between Mr. Reeves's drawings *β*. 10 and 258.

In 258 the green colour of the body is varied by an elliptical orange-brown spot, placed vertically on each scale. There are three indistinct golden spots under the spinous rays and fore-half of the soft dorsal, and four yellow patches on the middle height of the tail posterior to the anus, which shade off into the green. The bars on the head are orange-brown, instead of orpiment-orange. The two basal rows of spots on the dorsal and anal are dull, and of a wax-yellow or olive-green colour, and the ground colour of these with their outer halves and the middle part of the caudal are cochineal-red or dark crimson. The corners of the caudal are bright yellow. The base of the pectoral is red, and there is a bluish shade on the supra-axillary plate of the coracoid bone. Some blue marks exist also on the upper half of the spinous dorsal, most crowded between the fifth and seventh spines, where the dark mark of *exornatus* is placed. Length of figure nearly 7 inches.

Hab. Sea of China.

Julis exornatus, *var. β. Icon.* Reeves, 86; Hardw. 297. Chinese name, *Ying ko le* (Reeves, Birch); "Parrot carp" (Birch); "Parrot carp" (Reeves); *Ang ko li* (Bridgem. Chrest. 63).

In this figure the head is marked and coloured like the preceding one, but the sides are chequered by square golden spots which alternate with similar spaces of the ground colour. This is green, like the preceding varieties, on the head, along the back, and in the middle over the anus; but in the humeral region and on the tail it passes into indigo-blue. The belly is white, the white passing along above the base of the anal; while in the preceding figures, the ground colour, though paler, goes to the base of the fin. The dorsal is coloured not much unlike that of the preceding, but the orange-brown ground colour fades to hair-brown on the outer half, and the spots at the base of the fin are orange, shaded with pale yellow. The anal is pale green on the basal half, and purple exteriorly, with a darker green stripe where the colours meet. The corners of the caudal are bright yellow, the middle part dark grayish-blue, with indigo-blue spots on the base. The scaly base of the pectoral red, as in the preceding. In some respects this figure resembles the *Julis decussatus* (Benn. Ceylon, pl. 14).

Hab. Sea of China.

Julis dorsalis, Quoy et Gaim., Astrol. pl. 15. f. 5; C. et V. xiii. p. 448. *Labrus pulcherrimus,* Solander, *Icon.* Park. Bib. Banks, 49. *Sparus hardwickii*, Benn. Ceyl. 12.

Several specimens exist in Sir Edward Belcher's collection.

Hab. Sea of China? Polynesia, Malay archipelago, Indian ocean, and sea of Mauritius.

Julis trimaculatus, Quoy et Gaim., Astrol. pl. 20. f. 2; C. et V. xiii. p. 452.

Several examples of this species exist in Sir Edward Belcher's collection, which agree well with the figure in the 'Voyage of the Astrolabe,' though it is objected to in the 'Histoire des Poissons' as not being sufficiently gibbous at the nape. The markings on the head are exactly as in the figure, and also the first and last of the three black dorsal spots, but the intermediate one has disappeared in all the specimens. The borders of all the scales are brightly silvery.

Hab. Sea of China? Vanikoro.

Julis pœcilopterus, F. J. 86. bis, f. 1. *Icon.* Reeves, 233; Hardw. 299. *Rad.* D. 9|13 vel 14; A. 2|14; C. 11$\frac{3}{3}$; P. 12; V. 1|5. (Spec. Mus. Brit.)

A dried specimen of this fish exists in the British Museum, which was brought from Canton by John Reeves, Esq. The height of the body is somewhat less than the length of the head, and equals one-fourth of the whole length of the fish. The upper jaw has five conico-subulate teeth of the usual form, with small rounded interior ones, and these come forward to the edge of the jaw behind the last subulate tooth in two or three rows, like the minute molars of a sparoid. On the lower jaw there are thirteen exterior teeth on each limb, and the interior granular teeth do not run so far back. Gill-flap tapering, but rounded at the tip. Lateral line composed of twenty-nine scales, slightly arched at its commencement, then continuing horizontal as far as the ninth soft ray of the dorsal, when it is bent down over three scales and continued straight again to the caudal. It is marked on each scale by a gently waved and slightly rising tube, which before the bend of the line is simple and more posteriorly emits one or two branchlets. The ground colour is pistachio-green, darker on the bases of the scales, and fading to asparagus-green on the lower parts of the sides. The nape is brownish-red, and two stripes of that colour traverse the fish, the narrower one keeping along the summit of the back and the broader one along the middle of the side. On this stripe above the pectoral there is a dark blackish-blue spot. There are many rows of small, round reddish-orange spots, nearly as numerous as the scales, and becoming dark orange-brown in the stripes. These spots extend to the caudal, which is deep sulphur-yellow. The head is marked by golden stripes bordered by blue. The dorsal and anal are pale crimson with a greenish tint on the soft rays, and are thickly sprinkled with carmine spots. The pectorals and ventrals are almost colourless, but the scaly base of the former is yellow and purple bounded by a red streak. The lateral stripe is almost black in the dried specimen. Length of specimen 8$\frac{3}{4}$ inches, of head 2 inches.

Hab. China seas. Canton.

Julis thersites, Richardson. *Icon.* Reeves, 208; Hardw. i. 298, &c.

This species wants the brown longitudinal stripes of the preceding, but has otherwise considerable similarity in its tints of colour and markings. If the humped-back be not an accidental individual deformity, the fish is at once distinguished by it from other species. The ground colour of the head is duck-green, dark on the back, paler on the sides, and mixed with oil-green and yellow; the under surface is pale blue. There is a darker meniscoid spot on each scale, which on the shoulder and pectoral region is orange-red. A large dark blue mark over the pectoral has the spots on the scales almost black. The lines and spots on the head are vermilion with blue edges. The fins are pale Berlin-blue and are covered with tile-red spots, which form transverse bars on the caudal, and the dorsal and anal have a submarginal red stripe. The base of the pectoral is blue with a red streak; its membrane and that of the ventrals are spotless. The back of this fish rises into a bold hump under the spinous dorsal, the lateral line partaking of the curvature. Length of the figure 7 inches.

Hab. China seas. Canton.

Julis lunaris, Lin. (*Labrus*); C. et V. xiii. p. 409. *Labrus lutescens et L. lorius*, Solander, MSS. *Icon.* Parkins. Bib. Banks, 47. *L. gallus*, Forskal. *L. zeylonicus*, Penn. Ind. Zool. p. 56. pl. 16. *Julis hardwickii*, Gray, Illust. Ind. Zool. pl. 9. *Icon.* Reeves, a. 30; Hardw. 300. *Rad.* D. 8|13; A. 2|11; C. 11$\frac{3}{7}$; P. 14; V. 1|5. (Spec. Mus. Brit.)

Several specimens from Canton exist in the Chinese collection at Hyde Park and in the British Museum, the latter being the donation of John Reeves, Esq.

Hab. China seas. Canton. Java. Polynesia. Siam. Ceylon. Red sea.

Julis meniscus, C. et V. xiii. p. 415.

Hab. Seas of China (Canton). Seychelles (Dussumier).

Julis viridis, Bl. 282 (*Labrus*); C. et V. xiii. p. 420.

Hab. Sea of Japan? Mauritius.

GOMPHOSUS CEPEDIANUS, Quoy et Gaim. Freycinet, pl. 55. fig. 2; C. et V. xiv. p. 18. pl. 390.

A specimen, seven inches long, exists in Sir Edward Belcher's collection.

Hab. Sea of China? the Sandwich Isles, Carolines, and Otaheiti.

NOVACULA PENTADACTYLA, "Ankarkrona Mem. de Stockh. An. 1740 (*Blennius*), i. p. 451. pl. 3. f. 2;" C. et V. xiv. p. 67. *Coryphæna pentadactyla*, Bl. 173.

Hab. China seas. Celebes.

XYRICHTHYS PUNICEUS, Richardson. *Icon.* Reeves, 184; Hardw. i. 306.

This drawing represents a fish having a profile more vertical than that of the European *cultratus* and much like that of Rüppell's *bimaculata*, but with a proportionally higher body, a taller first dorsal ray, larger filiform tip to the ventrals, apparently no scales on the cheek, a much less rounded caudal, larger front teeth, and a lateral spot placed nearly, like that of *pavo*, on the seventh or eighth scale of the lateral line and rising above it. As near as one can judge from description alone, its form seems to be like that of *X. cyanifrons* of the 'Histoire des Poissons,' but its colours do not correspond and its black lateral mark distinguishes it.

The colours of the upper and lower part of the sides and the disc of the caudal fin are bright carmine, the middle of the flanks from the pectoral to the hinder part of the anal being pale buff orange, as are also the membranes of the dorsal and anal. The top of the head and back above the lateral line which terminates at the base of the last dorsal ray are lavender-purple; the trunk of the tail, which is bisected by the short second portion of the lateral line, being wholly carmine. Each scale throughout the body has a deeper coloured meniscoid segment on its edge, but of the same tint with its much paler disc. The cheeks are carmine with red-lilac-purple gill-pieces, throat and breast. The profile of the head, from the nape to the dorsal, is edged with a blue and green stripe, and there are six or seven wavy crimson streaks on the temples, and a few faint longitudinal ones on the operculum. Two rows of blue dots run along the summit of the back, and three rows along the belly, beginning at the ventrals and thinning off at the end of the anal. An oval black mark without a pale border is placed on the lateral line at the seventh scale, most of the spots being above the line. The anterior dorsal ray, which is nearly equal in height to the nape and twice as tall as the other rays, is blue, and three blue lines, more or less interrupted, run along the fin, which is shaded on the edge with lake-red. The anal has a blue line along its base, and its rays are blue with red tips. The upper and under edges of the caudal are buff orange, and its posterior rounded edge pale or whitish. Ventrals lemon-yellow with purple rays, and the pectorals purple at the base, shaded at the top into blackish-gray. Length of drawing 7¾ inches.

Hab. China seas. Canton.

In the Chinese collection at Hyde Park there are drawings of another species or variety of *Xyrichthys*.

XYRICHTHYS DEA, Temm. et Schl. F. J. Sieb. pl. 87.

Hab. Sea of Japan.

CHEILINUS NEBULOSUS, Richardson. *Rad.* D. 9|10; A. 3|8; C. 16½; P. 12; V. 1|5.

This species seems to be nearly allied in form and in being banded vertically to the *Ch. quinquecinctus* of Rüppell, but the caudal is much less notched between the points of the rays, the anal is rounded at the top and not so long, the profile of the forehead more even and sloping, the snout more slender, and the pale and vertical bands differently placed. It agrees with *quinquecinctus* in having two rows of scales on the cheek, and in the bases of the vertical fins being sheathed by large scales like a *Cossyphus*. It differs from *Ch. fasciatus*, Bl. 257, in having a truncated and slightly rounded caudal, as well as in the profile and disposition of the dark bands.

The muzzle is slender, the profile of the face straight and sloping, nearly touching the eye, and the nape very slightly arched. The height of the body is contained three times and a half in the total length, caudal included. Of this length the head forms rather less than one-third. The dorsal is rather less rounded at the tip than the anal, and they are nearly of equal length, neither of them passing the base of the caudal. The rays of the caudal are forked at the tips, and scarcely project beyond the membrane. The ventrals are attached under the axilla of the pectorals, being somewhat further back than in *Ch. quinquecinctus*, as represented by Rüppell. The two anterior teeth of each jaw are so much larger than the others as to appear like canines, and behind the upper ones are three or four bluntish teeth. On the limbs of both jaws the teeth are in a single series, diminishing slightly as they approach the angle of the mouth. The jaw is not swelled as in *Cossyphus*, but except in that respect and the interrupted lateral line, this fish agrees closely with that genus. The scales are large, there being only about twenty in a longitudinal row behind the gill-opening. The upper part of the lateral line is traced on thirteen scales and the lower one on eight, the parts overlapping each other a little. The tubes of the scales are sparingly furnished with lateral branches which are mostly short and basal. On some scales near the tail they are quite simple.

The prevailing tint of the specimens, which have been for two years in spirits, is a rich purplish brown, with lighter parts forming indistinctly about six bars, the first of which descends from the suboperculum over the breast, the second is behind the pectoral, and the last on the base of the caudal. The dark parts are clouded and spotted, and run over the dorsal and anal. They anastomose irregularly with one another, and are also varied by a narrow pale vertical streak on each scale, the tip of the scale being dark. Similar streaks, inclined various ways, exist on the scales of the operculum and temples, and on the cheek and interoperculum they are contracted into a roundish spot in the centre of each scale. Three pale lines cross each preorbitar, and one follows the curve of the orbit on the suborbitar, having underneath it a row of pale pores with open mouths. The caudal is pale towards the base, dark and mottled on the posterior, with the extreme tip paler again. The pectoral is pale without markings, and there are dark blotches on the ventrals.

Two specimens, about five inches long, exist in Sir Edward Belcher's collection, in which they were associated with some Chinese fish, but the place of their capture was not noted.

Hab. Sea of China.

Epibulus insidiator, Pallas (*Sparus*), Spicil. p. 41. t. 5. fig. 1; C. et V. xiv. p. 110. pl. 398. *Sparus insidiator*, Bl. Schn. 278.

A specimen exists in Sir Edward Belcher's collection, most probably but not certainly obtained on the coast of China.

Hab. Sea of China? Moluccas, Java, Sumatra and the Mauritius.

Scarus limbatus, C. et V. xiv. p. 271. *Icon.* Reeves, *a.* 13; Hardw. 312. Chinese name, *Ching e*, "Blue clothes" (Reeves); *Tsing i* (Bridgem. Chrest. 123). *Scarus ovifrons*, Temm. et Schl. F. J. Sieb. pl. 88? *Rad.* D. 9|10; A. 3|9; C. $11\frac{4}{4}$; P. 14; V. 1|5. (Spec. Brit. Mus.)

John Reeves, Esq. presented an example of this specimen from Canton to the British Museum. It differs slightly, in the numbers of its rays, from the specimen of *limbatus* described in the 'Histoire des Poissons,' also from Canton, yet the distribution of the colours is so similar, that I have little hesitation in considering it to be of the same species. I am also of opinion that it is identical with *Sc. ovifrons* of the 'Fauna Japonica.' It has a gibbous snout, though not to the same degree as is exhibited in the figure of the species just named, but such gibbosities vary in many fish with age, and not unfrequently with the degree of fatness of the individual. There is some discrepancy as to colour, and on that account I have quoted the synonym with doubt, which may perhaps be cleared away when the letter-press of this portion of the 'Fauna Japonica' appears, and we learn whether the figure was illuminated from the recent fish or from one whose colours had partially changed. The Chinese name of the fish is the same as that of the *Cossyphus cyanostolus*. The jaws are greenish with a smooth surface, in which the form of the teeth is obscurely seen. The edges of the jaws are crenated, particularly posteriorly, where the edges are also undulated, but there is no canine tooth there. The scales have finely granulated discs, and the lateral line is formed of a series of tubes, each with a bushy tip, which is so obscure as scarcely to be distinguished from the granulations. Twenty-five scales compose the line, the last three lying on the caudal fin. Length of specimen $16\frac{1}{2}$ inches, of drawing 14 inches. In the drawing the general colour is blackish-green, slightly glossed with brown on the belly, the edges of the scales being dark chocolate. The dark green surrounds the eye, and glosses the lower part of the cheek and the interoperculum; the rest of the sides of the head, the breast and discs of all the fins are dark hyacinth-red, which in the anal is glossed with auricula-purple. The outer edges of all the fins, the corner of the mouth and the lower lip are indigo-blue. The edges of the lips are carmine.

Hab. Seas of China, Japan, Java, and the Mauritius.

Scarus pyrrostethus, Richardson. *Icon.* Reeves, 76; Hardw. 309. Chinese name, *Suy nga*, "Grinding teeth" (Reeves); *Tsui nga* (Bridgem. 125). *Rad.* D. 9|10; A. 3|9; C. $11\frac{4}{3}$; P. 14; V. 1|5. (Spec. Brit. Mus.)

A specimen in the British Museum is identified by Mr. Reeves as belonging to the species which his drawing represents. The specimen measures $13\frac{1}{2}$ inches, the drawing an inch more. In form and distribution of colours the species closely resembles *Scarus frenatus*, Lacép., *Sc. psittacus* and *Sc. harid*, Rüpp., *Sc. harid*, C. et V. (which is different from that of Rüppell), and *Sc. dussumieri*, and several others described in the 'Histoire des Poissons.' It cannot however be perfectly reconciled with the descriptions of any of them; and unless several characters, which have been relied upon by ichthyologists for distinguishing species, should prove to be mere individual variations, it is a proper species; but I expect when further comparisons have been instituted, that a number of nominal species, and this probably among the number, will be absorbed in the more ancient designations. In the 'Histoire des Poissons,' the name of Rüppell's *Scarus* is changed from *harid* to *ruppelii*, another species or variety being described as the *harid* of Forskal; but the dentition, as described by the latter author, agrees much better with Rüppell's fish than with the *harid* of M. Valenciennes, which wants the canines at the angle of the mouth. *Sc. pyrrostethus* is much like *Sc. pepo* (Benn. Ceyl. 28. Maj. Neild's drawing in Hardw. Coll. Br. Mus. No. 313) in distribution of colours, but that fish has an uniformly arched profile.

Scarus pyrrostethus has the profile of the face moderately concave before the eye, and the acute points of the caudal projecting very little beyond the even or slightly rounded end of the intermediate membrane. The white jaws are moderately convex and bulge less than those of *limbatus*. About ten teeth may be counted on each side of the symphysis of each jaw, and there is no canine at the angle of the mouth. The scales of the cheek approach close to the orbit and permit less of the veined suborbitars to be seen than in *limbatus*. The lateral line is traced on twenty-five scales by a tube on each, which emits a few simple branches upwards and downwards, and has no bushy end. [The *harid* of the 'Histoire des Poissons' is described as having a lateral line formed of a series of unbranched tubes.] The discs of the scales are more finely granulated than in *limbatus*. The first anal spine is very short, and the last soft ray is divided only at the tip, while the last ray of the dorsal is divided to the base.

Each scale on the body and tail, down to the level of the lower edge of the pectoral fin, has an indigo-blue disc with a broad golden-coloured border edged with chestnut-brown. The borders are wider on the back and the blue discs smaller, and the scaly sheath of the base of the dorsal presents alternate, short, golden and blue vertical bars, the blue running into a stripe of the same colour that runs along the bottom of the membrane. The rays of the fin and its outer border are also blue, the membrane being reddish-orange. The anal has a reddish-orange disc without the blue rays, but its outer edge and a line skirting its base are blue. The same blue colour exists on the upper and under edge of the caudal and the first rays of the pectoral and ventrals, but not on any other part of these fins. A part of the pectoral next the blue ray, three soft rays of the ventrals, and the under part of the fish below the level of the pectorals, are reddish-orange. The disc of the caudal and upper parts of the head are yellowish-brown. The eye and lips are orpiment orange, and there is a blue bar behind each lip; another curves up from the angle of the mouth to the orbit to terminate there, and a blue streak passes from the temples over the eye and across the forehead, to meet its fellow on the other side.

Hab. Chinese sea. Canton.

SCARUS CÆRULEO-PUNCTATUS, Rüppell, Neue Wirlb. p. 24. pl. 7. f. 3. (*Calliodon*); C. et V. xiv. p. 262. *Icon.* Reeves, 248; Hardw. i. 311. Chinese name, *Ma e*, "Flax clothes" (Birch); "*Ma* clothed;" *Ma* is a Canton word (Reeves).

Mr. Reeves's drawing shows numerous blue dots on the head, and also four rows of them on the rays of the ventrals and anal, which are not mentioned in the 'Histoire des Poissons,' but which are indicated in Rüppell's figure.

Hab. Sea of China and the Red sea.

CALLIODON CHLOROLEPIS, Richardson, Ichth. of Voy. of Sulph. p. 137. pl. 64. f. 4–7; *Icon.* Reeves, 77; Hardw. i. 310. Chinese name, *Tsuy leen chuy*, "Green-scaled tsuy-fish" (Birch); *Tsuy lin chuey*, "Scaly king-fisher;" *Tsuy* is the name of the king-fisher (Reeves); *Tsui lun chui* (Bridgem. Chrest. 122).

Surgeon R. A. Bankier, of the Royal Navy, presented a specimen of this fish, which he obtained at Hong Kong, to Haslar Museum.

Hab. China seas. Canton (J. Reeves, Esq.). Hong Kong (Surgeon R. A. Bankier, R.N.).

CALLIODON JAPONICUS, Temm. et Schl. F. J. Sieb. pl. 89. (Letter-press not published.)

Hab. Sea of Japan.

Fam. Scomberesocidæ.

Belone caudimacula, Cuv. Règn. An. ii. p. 285. *Kuddera A.*, Russell, 176. *Icon.* Reeves, *β.* 33; Hardw. Malac. 135. Chinese name, ***Ho tsin***, "Stork's bill" (Reeves, Birch); ***Hok tsam*** (Bridgem. Chrest. 57).

Hab. China. Canton (Reeves). Penang, and a salt-water lake near Calcutta (Hardwicke). River Brunai in Borneo. Port Essington, North Australia.

Belone ciconia, Richardson. *Icon.* Reeves, 186; Hardw. Malac. 134.

This drawing does not correspond with Russell's figure of the *Wohla kuddera* 175, nor with the two *Belones* described by Rüppell in the 'Neue Wirlbethiere,' nor with figures of any other species that we have met with. The two jaws are equal, or very nearly so, and when measured to the front of the orbit, their length is contained four times and three-quarters in the whole length of the fish. The anal is long, the dorsal moderately so, and commencing over the second quarter of the anal, it seems to approach a little nearer to the caudal than that fin. The caudal is slightly lunate at the end with the lower lobe rather the most prominent. The back is green, the sides silvery with a purplish tint. Scales are distinctly represented in the green upper part of the body, which is separated from the nacry sides by a lateral line, but no inferior lateral line or keel is shown in the figure.

Hab. Chinese seas. Canton.

Hemiramphus intermedius, Cantor, Ann. Nat. Hist. ix. p. 30. *Icon.* Reeves, 167; Hardw. Malac. 129, 133. Chinese name, *Cheung tün tsam* (Bridgem. Chrest. 80); "Long-headed borer" (Reeves). *Rad.* B. 9; D. 1|14; A. 1|17; C. $15\frac{5}{5}$; P. 11; V. 1|5. (Chin. Spec.)

This species differs at first sight from *H. longirostris* (Cuv. et Russell, 178), and from *H. brevirostris* (Idem et Russ. 177), in the relative size of the lower jaw, being less than that of the one and longer than that of the other. From *H. gamberur* (Rüpp. Neue Wirlb. 74; Lacép. v. pl. 7. f. 2), it is distinguished by some differences in the numbers of the rays as well as by the comparative length of the lower jaw. We have received specimens of *intermedius* both from Chusan and Canton, but all of them have lost many of their scales, and also in some degree their proper shape, by maceration in spirits. A section of the body has the form of a thin wedge, broadest near the back, which is rounded by the swelling muscles of the sides, and attenuated towards the acute belly. There is no appearance of there ever having been much projection at the inferior lateral line, so as to render the section quadrangular. This line runs near the edge of the belly from the lower part of the operculum nearly to the caudal fin. It is formed by a simple or in some places a forked tube on each scale. The preorbitar is sub-elliptical, with an undulated disc and a minute central umbo. Its anterior edge describes the quadrant of a circle; its posterior one is much less curved. The dorsal and anal are opposite to each other at their commencement, and the former reaches a little nearer to the caudal, though it has fewer rays than the anal. The lower lobe of the caudal is the longest, as usual. The back is greenish, the sides silvery, and there is a broad lateral stripe more brilliantly silvery than the rest, which dilates between the dorsal and anal. The following measurements furnish the comparative lengths of the several parts. Length from the point of the upper jaw to end of caudal, 5·25 inches. From ditto to gill-opening, 0·91 inch. From ditto to anus, 3·38 inches. Length of upper jaw, 0·2 inch. Length from point of lower jaw to end of caudal, 6·35 inches. From ditto to angle of mouth, 1·38 inch. From ditto to fore-edge of orbit, 1·6 inch. From ditto to gill-opening, 2·18 inches.

Hab. Chinese seas. Canton. Chusan.

Exocœtus volans, Solander, MSS. Bib. Banks. *Icon.* Parkinson, 110. Bib. Banks. *Rad.* D. 12; A. 13; C. $15\frac{3}{5}$; P. 15; V. 6. All jointed. Length of specimen $5\frac{1}{2}$ inches.

A specimen of this fish was brought from China by Sir Edward Belcher. It is probably the same species with the *evolans* of Bloch (398); but in his figure the ventrals are as near to the end of the snout as to the beginning of the anal, while in the Chinese specimen the distance from the snout to the ventrals, when carried backwards, reaches past the middle of the anal; in other respects there appears to be little difference. The same officer brought several specimens of young flying fish from the Chinese seas, evidently of the same species, but none of them exceeding $2\frac{1}{2}$ inches in length. All these have the profile of the face more curved, with a variable degree of gibbosity of the nape. They have also two brown spots on the top of the occiput, formed by a congeries of small specks. All the specimens are so much injured that I think it better to avoid attempting a minute description, especially as I have not an Atlantic example of *evolans* at hand for comparison.

Hab. Seas of China and Polynesia.

EXOCÆTUS FASCIATUS, Lesueur, Jour. Ac. Nat. Sc. Philad. ii. pl. 4. f. 2. Length of specimen $2\frac{3}{4}$ inch.

Sir Edward Belcher brought an *Exocætus* from the sea of China which seems to belong to this species, but the specimen having been preserved in salt, the colours have perished and the fins are mutilated in their length. It agrees however with *fasciatus* in the approximation of the large eye to the end of the snout, in which it differs from *Ex. exiliens* of Bloch (397). It has also a similar degree of concavity between the eyes with that exhibited in M. Lesueur's figure (fig. 2. 6); and there is a correspondence also in other parts. The fins look dark.

Hab. Sea of China.

EXOCÆTUS MONOCIRRHUS, Richardson. *Rad.* D. 13; A. 13; C. $15\frac{2}{4}$; P. 15; V. 6. Length of spec. $2\frac{1}{4}$ inches.

Several *Exocœti* having barbels have been figured, viz. *Ex. nuthalii* (Lesueur), *furcatus* of Mitchell, and *appendiculatus* of Wood, which have a plurality of these appendages, and *comatus* of Mitchell, which is described as having only a single one, but which agrees with the others that have been named in the backward position of the ventrals resembling *exiliens*.

A species with two very short barbels, inhabiting the seas of Polynesia, has the ventrals placed as in *Ex. mesogaster* of Bloch (399), but in it the pectoral reaches only to the fore part of the anal, and it is distinguished from all other *Exocœti* by the size and height of its dorsal, which is black on the upper half. This fish was taken by Banks and Solander at Otaheite, and is named in the manuscripts of the latter *Ex. brachypterus*. Parkinson's figure of it is numbered 108.

In a small *Exocætus*, which was obtained by Sir Edward Belcher on the coast of China and which we have named *monocirrhus*, the distance from the end of the snout to the ventrals, when carried backwards, does not reach to the middle of the anal; and the pectoral extends a little beyond the base of the caudal. The eye is rather larger than that of *volans*, and is situated at a similar distance from the end of the snout. The barbel, which is black and wrinkled, springs from the end of the chin, and is flat or furrowed on the surface that applies to the membrane between the jaws. It does not equal the head in length, but it may perhaps have lost a small part of its tip. There is no trace of a minute lateral barbel such as is shown in Mr. Wood's figure of *appendiculatus* (Journ. Ac. Sc. Phil. iv. p. 283. pl. 17. f. 2).

Hab. Sea of China.

Fam. BLENNIIDÆ.

BLENNIUS ? AURO-SPLENDIDUS, Richardson. *Icon.* Reeves, 0 (non Hardw.).

It is possible that this species may be a *Pholis*, *Petroscirtes* or *Salarias*, but in the absence of information respecting its dentition and gill-openings, we cannot say to which of the genera established in the 'Histoire des Poissons' it properly belongs. It has much of the aspect of a Blenny, and has a vertical face and crested head like the males of *Blennius pavo*, and of some other species. The body is longer than of the fish just named, and the first seven dorsal rays are elongated, the remainder of the fin being even. The body is wax-yellow, with a brownish bar faintly indicated on the posterior part of the lateral line, and five rows of bright golden specks intermingled with much smaller and more numerous black dots in seven or eight rows. The head and all the fins, except the anal, are bright king's yellow. The crest is dotted with black, and a bar of that hue descends from it through the eye to the corner of the mouth. There is also a round black mark on the middle of the fore-part of the dorsal, comprising the first four rays. The anal is reddish-orange or buff, passing into yellow at its base. Length of the figure nearly 4 inches.

Hab. Macao.

BLENNIUS ? FASCIOLATOCEPS, Richardson. *Icon.* Reeves (nullo numero nec Hardw.).

This figure represents a fish having more nearly the proportions of *Blennius pavo* than the preceding. Its head is also crested, and the dorsal perfectly even without elongated rays. General colour wax-yellow, obscurely mottled, the head marked by five vertical black bands on a brighter yellow ground. The second band passes through the eye, and the fifth descends from the shoulder over the gill-opening. The fins are dull honey-yellow. Neither this figure nor that of the preceding species show any barbels or cirrhi. Length of figure 2¾ inches.

Hab. Macao.

SALARIAS FASCIATUS, Bl. pl. 162. f. 1 (*Blennius*). C. et V. xi. p. 324.

The native place of this fish is unknown, there being some uncertainty as to whether it came from India or Japan. Few particulars respecting its structure are recorded.

PETROSCIRTES BANKIERI, Richardson, Ichth. of Voy. of Sulph. p. 136. pl. 64. f. 8–10. Genus, *Petroscirtes*, Rüppell; *Blennechis*, C. et V.

Surgeon R. A. Bankier presented a specimen which he obtained at Hong Kong to Haslar Hospital.

Hab. Hong Kong.

STICHÆUS HEXAGRAMMUS, Temm. et Schl. F. J. Sieb. p. 136. pl. 73. f. 1. "*Rad.* B. 6; D. 40|; A. 29 *simplices*; C. 12; P. 14; V. 3." (Fauna Jap.) Genus *Stichæus*, Remhardt, Oversigt over det Kongelige, &c. 1835–6. p. 9.

Hab. Japan. Bay of Simabara.

GUNNELLUS NEBULOSUS, Temm. et Schl. F. J. Sieb. pl. 73. f. 2. (Letter-press not yet published.) *Rad.* D. 80|; A. 39; C. 21; P. 15; V. 1|1. (Spec. 9¼ inch. long in Br. Mus.)

Hab. Japan. Bay of Mogi.

GUNNELLUS CRASSISPINA, Temm. et Schl. F. J. Sieb. p. 139. "*Rad.* D. 78; A. 2|10; V. 1|1." (Faun. Jap. *l. c.*)

Hab. Japan.

DICTYSOMA, Temm. et Schl. F. J. Sieb. p. 139. pl. 73. f. 3. Spec. 4½ inch. long in Br. Mus. "*Rad.* B. 6; D. 58|9; A. 2|43; C. 10; P. 10." (Fauna Jap.)

Hab. Japan. Bay of Simabara.

Tribus SCOMBRISINA.

Fam. ZEIDÆ.

ZEUS JAPONICUS, Tilesius, Voy. Krusenst. pl. 61 (*Dorée ou Poisson à miroir du Japon*). C. et V. x. p. 24; Temm. et Schl. F. J. Sieb. p. 123. *Icon. piscium* a Pictore Sinense pict. Bib. Banks. Japan Fishes, Bib. Banks. *Zeus australis*, Richardson, Ichth. of Voy. of Erebus and Terror, p. 36. pl. 25. f. 1.

In the work last quoted I gave a figure of a Dory obtained by Sir James C. Ross at Port Jackson, drawn from a specimen that was in very bad condition. The account of the Japanese Dory, contained in the 'Fauna Japonica,' mentions no character that I do not find in the Australian one.

Hab. Seas of Japan, China, and Australia.

ZEUS NEBULOSUS, Temm. et Schl. F. J. Sieb. p. 11. pl. 66.

Hab. Sea of Japan.

SPHYRÆNIDÆ.

SPHYRÆNA OBTUSATA, C. et V. ii. p. 350; Temm. et Schl. F. J. p. 33. pl. 13. f. 2.

Hab. Southern coasts of Australia, Javan sea, sea of Japan, Indian ocean, and the Mauritius.

SPHYRÆNA CHINENSIS, Lacépède, v. p. 334. pl. 10. f. 2; *Icon.* Reeves, 62; Hardw. 86. Chinese name, *Chuh tsëen*, "Bamboo stick"; *Choh tsin* (Bridgem. Chrest. 224). *Rad.* B. 7; D. 5|–1|8; A. 2|8; P. 20; V. 1|5.

A specimen in the museum of the Cambridge Philosophical Society, brought from China by the Rev. George Vachell, enables us to give a short account of this species. It differs from *obtusata* in having two points to the gill-cover, and from all the species that have been hitherto figured, in its higher shoulder and more concave profile. The specimen does not exhibit this peculiarity of form so strongly as the figure, but it is flaccid and may have lost its exact shape.

Canine teeth acute, subulate and slightly flexuose, like the italic *s*. Two on each side, widely set on the upper jaw, with small lateral teeth pointing backwards, not arranged by threes but with intervals, as if one had fallen out here and there. A few tall, compressed, lancet-shaped teeth arm the palate-bones, and smaller teeth of the same form stand in a single row on the limbs of the lower jaw, their size augmenting gradually as they near the corner of the mouth; two canines standing contiguously on the tip of the jaw. No teeth on the small chevron of the vomer. The gill-cover shows two small, slender, flat points, the upper one being rather the longest. Lateral line almost straight; torulose.

Hab. Canton.

SPHYRÆNA NIGRIPINNIS, Temm. et Schl. F. J. Sieb. p. 34. pl. 13. f. 1.

Hab. Japanese sea.

SPHYRÆNA (VULGARIS) JAPONICA, C. et V. ii. p. 354; Temm. et Schl. F. J. Sieb. p. 33.

This fish was merely indicated in the 'Histoire des Poissons' from a Japanese drawing, but the authors of the 'Fauna Japonica' possess a single dried specimen, which they state to be in no respect different from the European one. It is distinguished from the Indian *Sphyrænæ* by the ventrals being further back than the tips of the pectorals.

Hab. Japanese sea. (Mediterranean?)

Fam. SCOMBRISIDÆ.

SCOMBER SCOMBRUS, Lin. Bl. Auct. C. et V. viii. p. 6; Temm. et Schl. F. J. Sieb. p. 92; *Icon.* Reeves, 163. Chinese name, *Ta che*, "Variegated *che*" (Reeves); *Fa chi* (Bridgem. Chrest. 105).

Hab. Chinese and Japanese seas. Cape of Good Hope. Atlantic. Mediterranean. Black sea (not in the sea of Azof). English channel. North sea and Baltic.

SCOMBER PNEUMATOPHORUS, "Laroche," C. et V. viii. p. 36; Temm. et Schl. F. J. Sieb. p. 93. pl. 47. f. 1 et 2.

Hab. Chinese, Japanese, and Australian seas. Mediterranean and Atlantic coasts of North Africa.

SCOMBER DELPHINALIS, "Commerson," C. et V. viii. p. 53. *Icon.* Reeves, β. 23; Hardw. i. 183. Chinese name, *Hwa tsze* (Birch); *Ta tze*, "Flowered *tze*" (Reeves); *Fa chi* (Bridgem. Chrest. 106).

Hab. China seas and coasts of Madagascar.

THYNNUS ORIENTALIS, Temm. et Schl. F. J. Sieb. p. 94.

Hab. Sea of Japan.

THYNNUS THUNNINA, C. et V. viii. p. 104. t. 202; Temm. et Schl. F. J. Sieb. p. 95. pl. 48. *Maquereau à quatre points*, Geoffr. Egypt. pl. 24. f. 3. Japan Fishes, Bib. Banks, fig. 35.

Hab. Japanese sea. Mediterranean.

THYNNUS PELAMYS, Lin. (*Scomber*). C. et V. viii. p. 113. Japan Fishes, Bib. Banks, fig. 49. *Icon.* G. Forsteri, 230. in Bib. Banks (Atlantic); Temm. et Schl. F. J. Sieb. p. 96. pl. 49.

Hab. Sea of Japan. Malay Archipelago. Straits of Sunda. Polynesia. South American coasts. Canaries. African coasts.

THYNNUS SIBI, Temm. et Schl. F. J. Sieb. p. 97. pl. 50 (*sibu*).

Hab. Sea of Japan.

Thynnus macropterus, Temm. et Schl. F. J. Sieb. p. 98. pl. 51.
Hab. Sea of Japan.

Pelamis orientalis, Temm. et Schl. F. J. Sieb. p. 39. pl. 52.
Hab. Sea of Japan.

Cybium commersonii, Lacép. ii. p. 600. pl. 20. f. 1? (*Scomber*). C. et V. viii. p. 165?; Rüppell, Atl. p. 94. taf. 25. *Icon.* Reeves, 228; Hardw. i. 184. Chinese name, *Lan teen keaou*, "Green-spotted *keaou*" (Birch); *Lam teem kow*, "Blue-spotted *kow*" (Reeves).

The spinous dorsal is higher than in Lacépède and Russell's figure, and more resembles Rüppell's, supposing that the membrane connecting the filamentous tips were more fully developed than it is shown to be in his figure. The central half of the fin is pure white.

Hab. China seas. Indian ocean. Red sea and the Mauritius.

? Cybium mertensii, C. et V. viii. p. 179? *Icon.* Règn. An. ed. nova. *Icon.* Reeves, 216; Hardw. 182. Chinese name, *Shen keaou*, "Fleshy *keaou*" (Reeves); "Edible *keaou*" (Birch). (Figure 15 inches long.)
Hab. China seas.

Cybium chinense, Lacépède iii. p. 23 (*Scomber*). C. et V. viii. p. 180; Temm. et Schl. F. J. Sieb. p. 100. pl. 53. f. 1. *Icon.* Reeves, *a.* 52; Hardw. i. 186? Chinese name, *New pe keaou*, "Cow-skin *keaou*" (Birch); *New pe kaou* (Reeves).

Approaches closely to the preceding, but it has more dorsal spines, and wants the spots on the tail.

Hab. Seas of China and Japan.

Cybium niphonium, C. et V. viii. p. 180; Temm. et Schl. F. J. Sieb. p. 101. pl. 53. f. 2.
Hab. Sea of Japan.

Cybium guttatum, Bl. Schn. (*Scomber*), p. 23. t. 5; C. et V. viii. p. 173; *Wingeram*, Russell, 134; *Icon.* Reeves, *β.* 46; Hardw. i. 181. Chinese name, *Keaou yu* (Birch); *Kaou yu* (Reeves); *Kau u* (Bridgem. Chrest. 243).
Hab. China seas. Malaccas and the Indian ocean.

Trichiurus armatus, Gray, Zool. Misc. p. 9. *T. savala*, C. et V. viii. p. 251; *Icon.* Reeves, *β.* 56; Hardw. 189. Chinese name, *Pih tae*, "White girdle" (Birch); "White tape" (Reeves); *Pak tai* (Bridgem. Chrest. 241).

A Chinese specimen of this fish exists in the British Museum.

Hab. China sea. Indian ocean.

Trichiurus lepturus, japonicus, Temm. et Schl. F. J. Sieb. p. 102. pl. 54. *Tr. muticus*, Gray, Zool. Misc. p. 10?
Hab. Sea of Japan. (Atlantic?)

Trichiurus intermedius, Gray, Zool. Misc. p. 10. *Rad.* D. 128 vel 130; P. 12. (Spec. Haslar Mus.)

I have had an opportunity of examining several specimens of this fish, viz. two brought from the neighbourhood of Canton by Captain Dawkins and Sir Edward Belcher, and one from the mouth of the Yan tze kiang by Sir Everard Home, besides some injured ones, all of this species. They agree in the height of the body, which is greatest some way behind the anus or nearly in the middle, being equal to one-fourteenth of the whole length; the head*

* Measured between the tip of the snout and end of gill-flap. As the lower jaw projects the relative height of the head would be greater if the measurement were made from thence.

being equal to one-ninth, and the finless tip of the tail to a tenth. The lateral line runs about two-fifths of the height from the edge of the belly, and three from the summit of the back. The distance between the tip of the snout and fore-edge of the orbit is one-third of the length of the head. There are upwards of fifteen very faint streaks on the preorbitar. The margin of the upper jaw is curved at the junction of the intermaxillary and maxillary, and the former bone carries ten small teeth, exclusive of the canine one, while the latter is armed by only seven, which are somewhat larger. The maxillary can retire wholly under the preorbitar, and scarcely reaches the orbit. The canine teeth have a thin posterior edge at the tip, which ends abruptly, producing a barb which is too minute to be seen by the naked eye, and not to be compared with the acute arrow-headed tooth of *Tr. lepturus*, as represented in Bl. Schn. t. 100. The small teeth are enlarged by similar edges at the base, the tips being narrower and roundish. Top of the head flattish without an acute ridge. The spines on the under edge of the tail are so minute that they cannot be reckoned even by aid of a lens in a plump perfect specimen. In one a little decayed, they are seen to be the clear pungent tips of the interspinous bones, with which they agree in number, amounting to about 110 or more. There are two spinous points on the hinder edge of the very small anus. Length, 14·15 inches. From snout to anus, 4·09. Length of head 1·55, of point of tail beyond the dorsal fin 1·40. Height of body 1 inch.

Hab. Sea of China.

NAUCRATES INDICUS, C. et V. viii. p. 326.

Specimens of this fish were brought from the China seas by Captain Dawkins, and presented by him to the Haslar Museum.

Hab. China seas. Amboyna. Indian ocean.

ELECATE BIVITTATA, C. et V. viii. p. 338; Temm. et Schl. F. J. Sieb. p. 104. pl. 56; *Icon.* Reeves, 172; Hardw. 192.

Mr. Reeves's figure shows the bands as described in the 'Histoire des Poissons,' but not the white corners of the caudal. Neither the one nor the other are expressed in the plate of the 'Fauna Japonica.'

Hab. Seas of China and Japan, and the Moluccas.

CHORINEMUS ORIENTALIS, Temm. et Schl. F. J. Sieb. p. 106. pl. 57. f. 1.

Hab. Sea of Japan.

CHORINEMUS LEUCOPHTHALMUS, Richardson. *Icon.* Reeves, 219; Hardw. 195. Chinese name, *Yin pĭb kèaou*, "Silver-white *keaou*" (Birch); *Yen pak keaou*, "White-eyed mackerel" (Reeves).

I have been unable to refer this figure to any described species. It has nearly the proportions and general form of *Ch. commersonianus*, but it wants the spots, and has a more obtuse snout and larger ventrals. The profile is incurved over the eye which renders the snout gibbous. The eye is large. The lateral line makes a small arch at its commencement and is then waved twice slightly up and down under the spinous dorsal, the remainder being quite straight from the third or fourth soft ray to the caudal. The scales appear to be very minute, deeply imbedded in the satiny skin and not close to each other. Most of the fish is brightly silvery, but the back is deep lavender-purple, which fades away before it reaches the lateral line. The snout and temples are shaded with the same, and there is a large blackish-purple patch on the upper and posterior parts of the operculum. The supra-scapular region is brightly silvery, as is also the iris, which has a yellow ring round it. The pectorals are cream-yellow, shaded at the base with brown. The teeth are shown small, setaceous, and thickly set on both jaws. Length of figure 16 inches.

Hab. Sea of China. Canton.

CHORINEMUS DELICATULUS, Richardson. *Icon.* Reeves, i. 92; Hardw. 220. Chinese name, *Wang seang*, "Royal omen" (Birch).

This figure has much the general form of Bloch's *aculeatus*, but differs in the mouth being cleft beyond the middle of the head, and consequently passing the eye considerably. Its snout is also more gibbous at the nostrils. It may possibly be the young of some of the spotted species. In the size of its mouth it appears to coincide with *exoletus*, but the lateral line wants the undulations which are noticed in the description which is given of that fish in the 'Histoire des Poissons.' The cleft of its mouth is larger than that of *leucophthalmus*. The lateral line makes an angle over the pectoral and afterwards continues straight without any undulation whatever. In the figure the back is illuminated by a clouded mixture of delicate sienna-yellow, having metallic lustre and pale siskin-green, the parts below the lateral line being brightly silvery. A stripe of umber-brown runs along the side of the head over the eye, the temporal groove is shaded by the same, and there are a few diverging brown streaks on the upper edge of the operculum and humeral bones. The pectoral and caudal are ochraceous, the dorsal and anal faint mountain-green, and the ventrals pink. Length of the figure 6 inches.

Hab. Chinese sea.

Trachinotus auratus, Richardson. *Icon.* Reeves, 104; Hardw. 196. Chinese name, *Hwang lă tsang,* "Yellow *wax tsang*" (Birch); *Wong la tsong,* "Yellow wax" (Reeves); *Wong lap tsong* (Bridgem. Chrest. 150). *Rad.* D. 6|–1|20; A. 2|–1|17; C. $17\frac{4}{6}$. (Spec. Br. Mus.)

This species makes the nearest approach to *Tr. mokalee*, but its snout is not so high, and its colour differs. The British Museum possesses a specimen from Macao which measures 9 inches in length; but it attains a greater size, as Mr. Reeves's figure measures 14 inches. The height is equal to twice the length, including the central caudal rays. The snout is not vertical as in *mokalee*, but is very convex, the profile running nearly straight, or scarcely arched, from the nostrils to the dorsal with a slope of about forty degrees. The points of the dorsal and anal are a little less acute and falcate than in *mokalee*. The caudal is deeply forked, the length of its lobes being equal to half the height of the body. First jointed rays of dorsal and anal compressed but strong, lateral line undulated. The colour is a bright saffron-yellow, with much lustre, which gives place on the breast and along the belly and base of the anal to a pure silvery colour. The head is also yellow, with silvery lower jaw and edges of the gill-pieces: a blue tint spreads round the nostrils. The dorsal and pectorals are dark hair-brown, the former with a pale edge. The ventrals are bluish white, and are smaller than the pectorals; the anal is tinged with orange, and the caudal, mostly coloured like the dorsal, is edged in the depth of the fork with yellow.

Hab. China seas. Canton.

In the Chinese collection at Hyde Park, there are two specimens of a *Trachinotus* of another species, but having the same number of dorsal spines with the preceding. I examined them only in a very cursory manner.

Trachinotus anomalus, Temm. et Schl. F. J. Sieb. p. 107. pl. 57. f. 2. "*Rad.* D. 4|–2|30; A. 2|–1|29; C. 20; P. 20; V. 1|5." (F. Jap. from figure.)

Hab. Sea of Japan.

Trachinotus melo, Richardson. *Icon.* Reeves, 97; Hardw. 218. Chinese name, *Kwa tsze tsang,* "Melon tsang" (Birch); "Melon seed *tsong*" (Reeves); *Kwa tsz tsong* (Bridgem. Chrest. 152). *Rad.* D. 7|19; A. 3|17; C. $16\frac{10}{10}$; P. 18; V. 1|5. (Spec. Camb. Ph. Inst.)

The *Tr. anomalus* of the 'Fauna Japonica' is described solely from the figure which was executed in Japan. It may therefore prove, when better known, to be the same species with the Chinese one represented in Mr. Reeves's drawing. Of this an example exists in the Museum of the Cambridge Philosophical Institution, which was brought from Canton by the Rev. George Vachell. It has the same elliptical profile with *anomalus*, but its snout is more obtuse and sufficiently gibbous at the nostrils to project a little beyond the mouth. Mouth small. Nostrils two round contiguous openings before the eye. Eye large. Anus between the tips of the ventrals immediately before the anal fin, no free spines intervening. Head nacry, without scales. Scales of the body very minute and tender, but not deciduous. Lateral line nearly straight, without any semblance of a keel or armature posteriorly. There are no scales on the vertical fins. The spines of the dorsal have been omitted by the artist, and they may be very readily overlooked when recumbent: they are seven in number, exclusive of the recumbent ones. The first is very short, and the sixth is shorter than the fifth, so that the spinous part has a very slightly arched shape, and is almost as distinct from the soft part as in some *Sciænidæ*, which are described as having two dorsals. The sixth spine equals the fifth one in length, and belongs more properly to the soft fin, which is not in any way pointed or falcate. The second anal spine is as long as the third one, and is stronger and somewhat curved. Pectorals moderate size. Ventral spines short: these ventrals, from the thinness of the belly, are contiguous. The fish generally is brilliantly nacry or silvery, with a bluish-gray tint along the back and at the bases of the opercular pieces. There is a wood-brown tint on the nape, and a gloss of the same on the sides. The fins are transparent, and the dorsal is traversed by a faint stripe below its middle; and another faint brownish stripe a little arched runs from the temples to the trunk of the tail. The muscles shine through the integuments of the sides, producing stripes bent *en chevron*, first at the brown stripe and then in the opposite direction at the lateral line. Length of the specimen, 2·15 inches. Height of its body, 0·85 inch. Length of figure, 6 inches.

Hab. China seas. Macao.

Another *Trachinotus*, resembling the preceding, but apparently not the same, exists in the Chinese collection at Hyde Park. Its numbers are—*Rays*, D. 8|16; A. 3|16; V. 1|5, &c. The first dorsal spine is very small, the second one is the highest, and is large and greatly compressed. The first anal spine also is very short, the second one strong, and the third one as tall as the second, but slender, delicate, and looking like a soft ray. The examination of this specimen was too hurried to enable me to record other particulars.

Hab. China seas. Macao.

Blepharis fasciatus, Rüppell, Atl. p. 129. pl. 32. f. 2; *Icon.* Reeves, 269; Hardw. 214. Chinese name, *Pih seu kung* "White-haired sir" (Birch); *Pak seu kung* (Reeves); *Pak su kung* (Bridgem. Chrest. 36). Same name as the *Scyris indica*. *Rad.* D. 8|23; A. 2|–1|19; C. $16\frac{10}{10}$; P. 1|16; V. 1|5. (Spec. Camb. Ph. Inst.)

A specimen brought from Canton by the Rev. George Vachell exists in the Museum of the Cambridge Philosophical Institution. Its rays differ a little from the numbers given by Rüppell, but the profile so closely corresponds that I have little hesitation in considering it to be his species. The dorsal spines are arched, the third one being tallest, and the first, seventh and eighth very short. Scales small and deeply imbedded. Lateral line completing its curve under the fourteenth or fifteenth soft dorsal rays, keeled in the tail and armed with minute closely-incumbent shields, which gradually pass into a torulose line as they approach the curve.

Hab. China and Red seas.

Blepharis indicus, C. et V. ix. p. 154; Temm. et Schl. p. 113. pl. 60. f. 2.

This is a shorter and higher fish than the preceding, and has not so convex a cranium. In the text of the 'Fauna Japonica' six dorsal spines are mentioned, but the figure shows eight, and one at the base of the soft ray.

Hab. Sea of Japan. The Moluccas.

Gallichthys major, C. et V. ix. p. 168. pl. 254; Russell, 57; *Icon.* Reeves, 189; Hardw. 211. Chinese name, *Chang e mong*, "Long-finned mong" (Reeves); *Cheung yik mong* (Bridgem. Chrest. 35). *Rad.* D. 6|–1|19; A. 1|16; P. 18; V. 1|5. (Spec. Camb. Ph. Inst.)

A specimen obtained by the Rev. George Vachell at Macao was presented by him to the Cambridge Philosophical Institution. It agrees with the plate in the 'Histoire des Poissons,' except in the profile, from the nostrils to the mouth being rather more oblique, as represented in Bloch's plate, 192. f. 1. The teeth are minute in several rows below, in one or two above. The scales of the body are invisible to the naked eye, but may be detected by a common eye-glass. The lateral line is composed of tubes, giving it a torulose appearance; and on the slender part of the tail the little eminences become wider, making approach to obtuse shields. The usual recumbent spine exists before the dorsal, and it is preceded by three interspinous bones whose thin nail-like heads show through the integument. There are also two interspinous bones protruding before the anal. The anterior filamentous branches of the first four dorsal and anal rays are black, and the anal also is black. Mr. Reeves's drawing is very silvery, with a faint diffused blush of red-lilac-purple, and four vertical bands of that colour a little darker, but still very pale. There are crimson blotches on the base of the pectorals, the inner edge of the ventrals, and under part of the anal and dorsal. Length of figure 6 inches.

Hab. China seas. Moluccas and Indian ocean.

Seriola purpurascens, Temm. et Schl. F. J. Sieb. p. 113. pl. 61. "*Rad.* D. 7|–1|30; A. 2|–1|20; C. 25; P. 20; V. 1|5." (F. J.)

Hab. Sea of Japan.

Seriola auro-vittata, Temm. et Schl. F. J. Sieb. p. 115 (pl. 62. f. 1. not yet published); *Icon.* Reeves, 230; Hardw. 210. Chinese name, *Kin peen che*, "Gold-edged pool" (Birch); *Kum peen che*, "Golden-bordered" (Reeves). *Rad.* D. 7|–1|32; A. 2|–1|20; C. $17\frac{6}{6}$; P. 18; V. 1|5. (Chinese spec. Br. Mus.)

Besides the principal yellow band, Mr. Reeves's figure shows another, which runs from the eye over the supra-scapulars. The ventrals are blotched with purple and green, and there are differences in the tints of less moment. It is a shorter fish than *purpurascens*.

Hab. Seas of China and Japan. Canton.

SERIOLA QUINQUERADIATA, Temm. et Schl. F. J. Sieb. p. 115. pl. 62. f. 2. "*Rad.* D. 5|-1|32; A. 2|-1|19; C. 22; P. 22; V. 1|5." (F. J.)
6|-1|31; 2|-1|20; P. 20, &c. (Spec. Br. Mus.)

It is probable that this is a mere variety of *auro-vittata*. In a specimen in the British Museum which was brought from China by Mr. Reeves, we found six spines in the first dorsal. This individual presented no other difference in form from *auro-vittata*, except that the teeth were a little shorter and more closely villiform. It measured ten inches, and the specimen of *auro-vittata*, with which it was carefully compared, exceeded it by only one inch.

Hab. Seas of China and Japan.

SERIOLA INTERMEDIA, Temm. et Schl. F. J. Sieb. p. 116. "*Rad.* D. 7|-1|32; A. 1|-1|15; C. $16\frac{4}{4}$; P. 21; V. 1|5." (F. J.)

Hab. Sea of Japan.

LACTARIUS DELICATULUS, Bl. Schn. p. 31 (*Scomber lactarius*). C. et V. ix. p. 238; Chundawah, Russell, 108; *Icon.* Reeves, 170; Hardw. Acanth. 38; (Scales very deciduous) Reeves.

Hab. China sea and Indian ocean.

NOMEUS MAURITII, Cuv. Règn. An. 1re ed. ii. p. 315; C. et V. ix. p. 243. pl. 262 (*Seriola argyromelas*).

In Sir Edward Belcher's collection several specimens of this fish were marked as having been taken in the China seas. They have not the marks of *N. peronii*, but correspond well with the figure of *mauritii* in the 'Histoire des Poissons.'

Hab. Brazils. Coast of Guinea and sea of China.

EMMELICHTHYS SCHLEGELII, Richardson. *Erythrichthys*, Temm. et Schl. F. J. Sieb. p. 117. "pl. 63. f. 1."

Hab. Sea of Japan.

The ninth decade of the Ichthyological part of the 'Fauna Japonica' has just reached me as this sheet is passing through the press, and I perceive by the figure of *Erythrichthys* in the 63rd plate, that the genus is identical with the Australian one which I published in the 'Ichthyology of the Voyage of the Erebus and Terror,' on the 1st of March 1845. I do not know the date of the letter-press of the 'Fauna Japonica' describing *Erythrichthys*. The Australian species differs in the form of its preorbitar and in the dorsal spines. The genus seems to me to be more allied to the Sparoid or Mænoid families than to the Scomberoid, from which it differs in its ptenoid scales.

SCOMBROPS, Temm. et Schl. F. J. Sieb. p. 118. "pl. 63. f. 2."

Hab. Sea of Japan.

CORYPHÆNA JAPONICA, Temm. et Schl. F. J. Sieb. p. 120. pl. 64.

Hab. Sea of Japan.

STROMATEUS ARGENTEUS, Bloch, 421; C. et V. ix. p. 393; *Icon.* Reeves, β. 32; Hardw. 227. Chinese name, *Tsang yu* (Reeves, Birch); *Tsong u* (Bridgem. Chrest. 148). This is one of the most common fish brought to table during its season in China (Reeves). *Rad.* D. ?|44; A. 46; C. $15\frac{5}{7}$; P. 24. (Dried spec. Br. Mus.)

Mr. Reeves presented a specimen to the British Museum. No spines protrude through the skin in front of the dorsal, but six or seven interspinous bones show through the thick integument. Two or three rays of the anal also are deeply concealed in the front of the fin. This specimen, compared with Russell's figure of *candidus* (pl. 42), was found to differ in the position of the anus relative to the anal fin, and to want the streaks in the supra-scapular region, there being only a few on the nape. The operculum itself is marked by striæ diverging from its upper anterior corner. The profile is a little gibbous behind the eye, and as evenly curved as in *candidus*. The specimen measured $11\frac{1}{2}$ inches in length, and the figure $14\frac{1}{2}$; the body being $7\frac{1}{2}$ high in the latter.

Hab. China seas. Canton. Indian ocean.

STROMATEUS NIGER, Bloch, 160 (*Str. paru*). C. et V. ix. p. 385. *Nalla sanda-*

wah, Russell, 43; *Icon.* Reeves, 194; Hardw. 225. Chinese name, *Hih tsang* (Birch); *Hak tsong*, "Black tsang" (Reeves, Bridgem., Chrest. 149). *Rad.* D. 4|42; A. 1|36; P. 21. &c. (Spec. Br. Mus.)

The British Museum possesses a Chinese specimen. One spine can be observed incumbent on the front of the dorsal, but the other three are concealed. The specimen measures 14½ inches, the figure nearly 11. There is a greater distance between the anus and anal fin in this species than in the preceding one. The lateral line is decidedly keeled, and the fins are less pointed than they are represented to be in Bloch's fig. 160, and much less than in his plate 422. The colour is yellowish-gray with lilac and purple tints by no means dark, so that the name of *niger* is not appropriate.

Hab. China sea and Indian ocean.

STROMATEUS SECURIFER, C. et V. ix. p. 344. pl. 373; Cantor, Ann. Nat. Hist. ix. p. 45.

Hab. China sea and Indian ocean. Chusan (Cantor).

STROMATEUS PUNCTATISSIMUS, Temm. et Schl. F. J. Sieb. p. 121. pl. 65.

More pointed and longer anal than *argenteus* has.

Hab. Sea of Japan.

STROMATEUS ATOUS, Russell, 42, (*Atoo koia*). C. et V. ix. p. 389. "*Stromateus sinensis*, Euphrasen in N. Schwed. Abh. ix. p. 49. t. 9;" Bl. Schn. 492.

Hab. Sea of China.

STROMATEUS ACULEATUS, Bl. Schn. p. 492; C. et V. ix. p. 394. "*S. argenteus*, Euphrasen N. Schwed. Abh. ix. p. 49. t. 9." (Mem. de Stockh.)

Hab. China seas.

SESERINUS VACHELLII, Richardson. *Rad.* D. 5|42; A. 3|37; C. 17$\frac{10}{10}$; P. 21; V. 1|5. (Spec. Camb. Ph. Inst.)

This fish has the same close resemblance to *Stromateus niger* that *Seserinus microchirus* has to *Stromateus fiatola*. The Prince of Canino has replaced the Mediterranean *Seserinus* in the genus *Stromateus*, but the discovery of the Chinese species with larger ventrals and a keeled lateral line justifies Cuvier's separation of the two forms. The Rev. George Vachell brought two specimens from Canton of the *Seserinus* which we have named in honour of him. It is a greatly compressed fish, which is thickest at the orbits, the height of its body being only a quarter less than the length, caudal excluded. The acute nuchal ridge vanishes in the interorbital space, which is however not flat. A recumbent spine is placed in front of the dorsal, and five erect ones are so buried in front of the fin that they can be detected only by dissection. The fifth spine has a long, flexible, but not jointed tip, which is also concealed; the others are pungent. The first anal spine is short, the third one a quarter of the length of the soft rays, and the second one of intermediate length. Both the dorsal and anal are falcate. The pectorals are long and falcate, their tips reaching over two-thirds of the anal. Ventrals small, falcate or pointed, attached beneath the corner of the preoperculum, and having the anus between their tips. Tail slender, caudal deeply forked. Scales small, the lateral line torulose or keeled on the tail by soft triangular plates, which have an acute point that catches the finger when drawn back. These plates are small, and when examined with a lens appear to be formed of two divergent tubes, with the acute point rising from the disc they enclose.

Eye distant from the profile. Preoperculum and operculum striated. Lower jaw when depressed longer than the upper one. Teeth as fine as hairs, slightly curved in one close row on both jaws. Colour gone.

Length 3·75 inches. Height of body between dorsal and anal, 2 inches. Length of head, 1 inch.

Hab. China seas. Canton.

CARANX TRACHURUS, Lin. Bl. (*Scomber*). C. et V. ix. p. 11; Temm. et Schl. F. J. Sieb. p. 109. pl. 59. f. 1. With 70 to 75 shields on lateral line.

Hab. Chinese and Japanese seas. Amboyna. New Zealand. Australian seas. Cape of Good Hope. English Channel.

CARANX ROTLERI, Bloch, t. 346 (*Scomber*). C. et V. ix. p. 29; *Icon.* Reeves, 206; Hardw. 203. Chinese name, *Peen kea* (Birch); *Peen kap che*, "Flat-scaled mackerel" (Reeves); *Pin kap chi* (Bridgem. Chrest. 109).

Hab. China sea. Malaccas and Red sea.

Obs. Only one species of *Caranx*, with several separate finlets succeeding to the dorsal and anal, is distinguished in the 'Histoire des Poissons.' The *woragoo* of Russell (143), which is therein referred to that species, has a more flatly curved lateral line; and there is a second figure 75 in Mr. Reeves's portfolio with another Chinese name which presents some differences, though slight, from *rotleri*. There are fewer detached finlets, the pectoral fin is shorter, does not quite reach to the anal, and is contained above four times in the total length of the fish; and the black spot on the gill-plate, instead of being high up on the operculum, is on the middle of its edge, as in the *woragoo*. The numbers of shields on the lateral line and of the rays of the fins are nearly the same as in *rottleri*, but the curved commencement of the line has been omitted by the artist. Teeth close shorn, villiform, with a taller outer row. *Rad.* D. 7|–1|12 et vii.; A. 2|–1|10 et vi.; P. 25; &c. *Squamæ carinatæ*, 53. This is not so strongly marked a variety as some that we observe among the *Trachuri*. Its Chinese name is *Chih kea tze*, "Red-mailed tender fish" (Birch).

Hab. Sea of China and the Indian ocean.

Caranx muroadsi, Temm. et Schl. F. J. Sieb. p. 108. pl. 58. f. 1; *Icon.* Reeves, *β* 36. Chinese name, *Tsze yu*, "Affectionate fish" (Reeves, Birch); *Chi u* (Bridgem. Chrest. 111).

The first dorsal and the anal spines are omitted in Mr. Reeves's figure, probably because they were depressed in the specimen placed before the artist. The bronze stripe, which is represented narrow and defined in the 'Fauna Japonica,' is diffused over much of the side in the Chinese figure.

Hab. Coasts of China and Japan.

Caranx maruadsi, Temm. et Schl. F. J. Sieb. p. 109. pl. 58. f. 2.

Hab. Sea of Japan.

Caranx cancroides, Richardson. *Icon.* Reeves, *β*. 30. Chinese name, *Hwa tsze*, "The crab mackerel" (Reeves); *Hea che* (Birch); *Ha chi* (Bridgem. Chrest. 108). *Rad.* D. 7|–1|22; A. 1|19, &c. *Squamæ carinatæ*, 40. (Spec. C. Ph. Inst.)

A specimen of this Caranx was brought from Canton by the Rev. George Vachell, and presented by him to the Cambridge Philosophical Institution. It belongs to the group of *luna* (Histoire des Poissons, ix. p. 80), which have the teeth in a single row. They are scarcely perceptible, except through the aid of a lens. The species differs from *C. platessa* and *georgianus* and others of the group in the numbers of its rays and extent of armature of the lateral line. The form is elliptical, the height of body being to the length, caudal included, as one to three. The profile from the mouth to the dorsal is sloping with a moderate convexity, and corresponds in its obliquity and curvature with the under profile from ventrals to tip of lower jaw. Pectorals as long as the head, and equal to one-fourth of the length of the fish. Lateral line straight and cuirassed forward to the beginning of the anal, the shields embracing nearly the whole height of the tail behind that fin. No spots are shown on the operculum or elsewhere. The back is coloured olive-green, and the sides and belly brightly silvery, with a tinge of lake on the breast. The fins are transparent, without any darkening on their edges, and have an uniform pale greenish hue. Length of the drawing 4½ inches.

Hab. China seas. Canton.

Caranx cestus, Richardson. *Icon.* Reeves, *α*. 39; Hardw. 206. Chinese name, *Tae yu*, "Girdle-fish" (Birch); *Te yu* (Reeves).

This drawing is remarkable among the other representations of the Chinese Scomberoids in Mr. Reeves's portfolio for the size and definite form of the scales. The shields on the keel are strong and pointed, and run forward to beneath the beginning of the second dorsal. The lateral line appears to be but slightly arched over the pectoral. In form the fish is regularly elliptical, the ventral and dorsal curves equal, and not more convex in the anterior than in the posterior half of the ellipse. Height one-third of the length, including the central caudal rays. Head forming a fourth of the same length. Snout rather acute. Eye somewhat large. Teeth apparently in a single row, small and slender. Pectorals falcate, reaching over the anterior quarter of the anal. This fin and the dorsal are acute and higher anteriorly, but not so much so as to be falcate. The spinous dorsal one quarter lower than the fore-part of the second fin. Three anal spines are shown as incumbent on the first soft ray of the anal, but no free spines, though from the large space which intervenes between the anus and anal it is probable that such exist. Colour of the back olive-green, with a diffused yellow tinge over the lateral line and temples. There is a very slight tint of lake along the under side of the lateral line, and the under parts are pearly and silvery. Pectorals and ventrals pure sulphur-yellow, the former having a carmine streak across the base, edged with bluish-gray. There is also a reddish stripe along the bases of the dorsal and anal, and the tips are red. A small black spot exists on the edge of the gill-cover, and the membrane connecting the last ten dorsal rays is tipped with black.

Hab. China sea. Canton.

Carangi.

CARANX FORSTERI, C. et V. ix. p. 107. *Yarradanree para*, Russell, 147? *Scomber hippos*, Forster, Hist. Anim. p. 199; *Icon.* G. Forster in Bib. Banks, No. 221; Reeves, 214; Hardw. 207; Chinese name, *Fang che*, "Square mackerel" (Reeves); *Fong chi* (Bridgem. Chrest. 107).

Hab. Mauritius, Indian ocean, China seas, Malay archipelago, New Zealand and Australian seas.

CARANX MALABARICUS, Bl. Schn. p. 31 (*Scomber*). C. et V. ix. p. 121. *Tallam parah*, Russell, 150; *Icon.* Reeves, β. 21; Hardw. 208. *Hwa tsang* (Birch); *Fa tsong*, "Flowered or variegated mackerel" (Reeves); *Fa tsong* (Bridgem. Chrest. 151). *Rad.* D. 8|–1|22; A. 1|18 vel 19, &c. (2 Spec. C. Ph. Inst. from China.)

Hab. China seas, Indian ocean and Red sea. Canton (Vachell).

CARANX EQUULA, Temm. et Schl. F. J. Sieb. p. 111. pl. 60. f. 1. "*Rad.* D. 8|–1|24; A. 2|–1|23," &c. (F. Jap.)

The figure in the 'Fauna Japonica' has a near resemblance to Mr. Reeves's drawing β. 21, which is quoted above as representing *C. malabaricus*, but its profile is more sloping.

Hab. Sea of Japan.

CARANX NIGRIPES, C. et V. ix. p. 122 et p. 141 (*Olistes atropus*). *Mais parah*, Russell, 152; *Icon.* Reeves, 181; Hardw. 224.

The *Brama atropus*, Bl. Sch. p. 98. t. 23, seems to be also this fish, and Schneider indeed mentions the first dorsal and the spines before the anal, as he observed them in the dried specimen recumbent in their respective grooves. He also points out its Scomberoid characters. *Atropus* is therefore the prior specific name, but being compounded of Greek and Latin it is objectionable, and may be allowed to give place to the appellation of the same import proposed in the 'Histoire des Poissons.' M. Valenciennes states that a specimen preserved in Bloch's museum is labelled *Brama melampus* and *Scomber ciliaris*. Examples of the species from China exist in the British Museum and the Chinese collection at Hyde Park.

Hab. China sea and Indian ocean.

CARANX FLAVO-CÆRULEUS, Temm. et Schl. F. J. Sieb. p. 110. pl. 59. f. 2; *Icon.* Reeves, 213; Hardw. 204. Chinese name, *Hwang joo*, "Yellow milk" (Birch); *Wang joo*, "Yellow breast" (Reeves); *Wong u* (Bridgem. Chrest. 112).

A specimen of this fish exists in the Chinese collection at Hyde Park.

Hab. Seas of China and Japan.

CARANX CHRYSOPHRYS, var. *hyemalis*, C. et V ix. p. 77? *Icon.* Reeves, 239; Hardw. 209. Chinese name, *Tung kwa tsang* (Birch); *Tong kwa tsong*, "Winter gourd" (Reeves). *Rad.* 8|–1|21; A. 2|–1|19, &c. (Reeves's drawing.)

This figure closely resembles that of *chrysophrys* in the 'Histoire des Poissons,' except that the snout is rather blunter; there is a small incurvature of the profile at the nostrils, the points of the dorsal and anal are scarcely so long, and the cheek, as well as the belly nearly to the anal spines, are represented scaleless. The golden tint of the eyebrow is very obscure. Length of figure 14 inches.

Hab. China sea. Seychelles?

CARANX MARGARITA, Richardson. *Icon.* Reeves, r, nullo numero; Hardw Acanth. 205. Chinese name, *Hwang chang*, "Yellow bowels" (Birch).

This Caranx much resembles *C. flavo-cæruleus* or *cancroides* in its profile, its height being one-third of the total length, and the space between the snout and first dorsal flatly arched, not steep, as in the *Carangi*. The breast is scaly, but no scales are shown on the cheek, nor any teeth in the jaws. The arch of the lateral line terminates over the beginning of the anal and under the ninth ray of the second dorsal, the straight part being pretty strongly armed by about eighteen or twenty bucklers. The spines of the first dorsal are rather tall and stout, and the fin ends at the foot of the second. The fish has a pearly hue throughout, with some faint yellow tints on the upper half of the body and forehead. The caudal and anal are saffron-yellow, the first dorsal and ventrals French-gray, and the second dorsal greenish-gray with yellowish front rays. Length of figure 4·32 inches, height of body 1·50 inch.

Hab. Sea of China. Canton.

Citulæ.

CARANX CILIARIS, C. et V. ix. p. 129; Temm. et Schl. F. J. Sieb. p. 112. *Tchawil parah*, Russell, 151. *Rad.* D. 8|–1|21; A. 2|–1|18; P. 15. (Spec. C. Ph. Inst.)

Hab. Seas of China and Japan, Malay archipelago and Indian ocean.

SCYRIS INDICA, C. et V. ix. p. 145. pl. 252; Rüpp. Atl. taf. 33. f. 1; *Icon.* Reeves, *a.* 17; Hardw. 213. Chinese name, *Pih seu kung*, "White-bearded gentleman"; *Pih seu kung*, "White-bearded king" (Reeves); *Pak su kung* (Bridgem. Chrest. 36). *Rad.* D. 7|19; A. 1|16; C. $17\frac{4}{5}$; P. 17; V. 1|5. (Spec. Br. Mus.)

A dried specimen of this fish brought from Canton by Mr. Reeves was presented by him to the British Museum. It measures 12·25 inches in length; the height of the body is 5·65 inches, and the length of the head 3 inches. Three interspinous bones present their blunt edges before the recumbent spine, which precedes the seven dorsal spines.

Hab. China seas. Malay archipelago and Indian ocean.

EQUULA NUCHALIS, Temm. et Schl. F. J. Sieb. p. 126. "pl. 67. f. 1" (not yet publ.); *Icon.* Reeves, *g.* 90. et *b.* 85 set of small figures; Hardw. 221 et 223. Chinese name, *Kow yaou*, "Dog's waist" (Birch).

Two specimens were brought from Canton by the Rev. George Vachell.

Hab. China and Japan.

EQUULA RIVULATA, Temm. et Schl. F. J. Sieb. p. 126. "pl. 67. f. 2" (not yet published); *Icon.* Reeves, *c.* 86; Hardw. 219. Chinese name, *Hwa shin lĭh* or *kin tsze*, "Flowery bodied ——" (Birch).

The authors of the 'Fauna Japonica' mention that the specimens they examined were in bad condition, otherwise I should have hesitated in referring Mr. Reeves's most beautiful and elaborately finished drawing to the species established by them, on account of a difference in their relative heights. Mr. Reeves's figure shows the height of the body to be half the length to the base of the caudal; but the description in the 'Fauna Japonica' gives to it a more elongated form, and we have not seen the plate. The fish, as represented in Mr. Reeves's drawing, is brightly silvery, with pale, wood-brown, short undulating bars pretty closely ranged in two or three rows above the lateral line. They are continued down the sides by silvery streaks. The fins are pale, slightly ochraceous, with a brighter yellow tint at the beginning of the dorsal and anal.

Hab. Seas of China and Japan.

MENE MACULATA, Bl. Schn. p. 95. pl. 22 (*Zeus*). C. et V. x. p. 104. pl. 285; Temm. et Schl. F. J. Sieb. p. 127. "pl. 67. f. 3" (not published). *Menè Anne-Caroline*, Lacép. v. pl. 14. f. 2.

Hab. Seas of China and Japan and Indian ocean.

XYPHIIDÆ, Agassiz.

HISTIOPHORUS ORIENTALIS, Temm. et Schl. F. J. Sieb. p. 103. pl. 35.

Hab. Sea of Japan. Malay archipelago.

CEPOLIDÆ.

CEPOLA LIMBATA, C. et V. x. p. 402; Voy. de Krusenst. pl. 60. f. 1.

Hab. Sea of Japan.

CEPOLA MARGINATA, C. et V. x. p. 402; Krusenst. pl. 60. f. 1.

Hab. Sea of Japan.

CEPOLA KRUSENSTERNII, Temm. et Schl. F. J. Sieb. pl. 71. f. 1.

The authors of the 'Fauna Japonica' are inclined to include the two preceding species in this one. The British Museum possesses one of Bürger's specimens.

Hab. Sea of Japan.

CEPOLA HUNGTA, *Icon.* Reeves, β. 2; Hardw. 228. Chinese name, *Hung tae*, "Red girdle" (Birch); "Red tape" (Reeves); *Hung tai* (Bridgem. Chrest. 5).

We cannot refer this figure to any of the foregoing *Cepolæ*, nor, on account of the numbers of the rays, to *abbreviatus*, of which we have seen neither figure nor detailed description. Height at the pectorals equal to the length of the head, or to one-tenth of the whole length of the fish. The upper and under profiles incline evenly and gradually to each other, and meet in an acute point at the tail. The fins are highest anteriorly and diminish in height like the body, also meeting in an acute point, the caudal not being distinguished by longer rays from the adjoining parts of the other two vertical fins. The anal is higher than the dorsal. Ventrals exactly under the pectorals. The whole surface of the body is divided into almost square rhombs by yellow lines, and there is a nacry spot in the centre of each. There are only ninety-four of these rhombs in a line between the gill-opening and point of the tail, so that they are greatly larger than the scales of the other *Cepolæ*. The general tint is pale ochre-yellow passing into reddish-orange on the back, and there are eighteen equidistant gamboge-yellow spots on the middle of the sides, the yellow tint confined to the lines dividing the scales from one another. These spots are much larger than those of *krusensternii* and not in pairs. The orbits and top of the head are shaded with carmine, and there is a carmine stripe along the middle of the dorsal, the edge of the fin being saffron-yellow and the base pearl-gray. The anal is lake at the base, white along the middle, and saffron-yellow edged interiorly with lake on the border. Pectorals yellow. Ventrals lake. Length of the drawing 12 inches. Height of body at ventrals 1·15 inch. Height of dorsal anteriorly 0·48; of anal anteriorly 0·70 inch.

Hab. China seas. Canton.

LOPHOTES CAPELLEI, Temm. et Schl. F. J. Sieb. p. 132. pl. 71 et 72.

Hab. Sea of Japan.

Tribus HETEROSOMATA.

Fam. PLATESSOIDEÆ.

PLATESSA CHINENSIS, Lacépède, iv. p. 595 et 638. pl. 14. f. 1? (*Pleuronectes*), Gray, Ind. Zool. pl. 94. f. 1; *Icon.* Reeves, 107, *a* et *b*; Hardw. Malac. 261, 262. Chinese name, *Hwa tsăng pe*, "Variegated boiler nose" (Birch); *Hwa tsang pe* (Reeves). *Icon.* piscium 24 a pictore Sinensi, &c.

Mr. Reeves figures two examples of this species, one with the eyes on the right side, the other on the left; and the figure given by Mr. Gray in Hardwicke's 'Illustrations of Indian Zoology,' was drawn from one of Mr. Reeves's Canton specimens deposited in the British Museum. The general colour of the upper side is dull umber, clouded faintly with liver-brown, with scattered small black spots, each surrounded by a pale ring. The fins are also brown, and the vertical ones are marked by rather large, well-defined, roundish, dark liver-brown spots, most crowded on the caudal, which is rhomboidal. Length 6 and 10 inches.

Hab. Coasts of China. Canton.

PLATESSA CHINENSIS, var.? *cæruleo-oculea*. *Icon.* Reeves, 204; Hardw. Malac. 263.

This seems to be from the drawing, for we have seen no specimen, to be a pale variety of *chinensis*. The ground colour is bluish-gray, clouded with blackish-gray, and the spots are dark blue with sky-blue borders; the vertical fins are tile-red on their basal halves, and bluish- or blackish-gray towards their borders. The spots as in *chinensis*, with the addition of a few on the ventrals.

Hab. Chinese coasts. Canton.

PLATESSA VELAFRACTA, *Icon.* Reeves, 105; Hardw. Malac. 264. Chinese name, *Hwa po pung*, "Variegated sail-fish" (Birch); *Fa po pang*, "Variegated broken mat" (Reeves); *Fa po pung* (Bridgem. Chrest. 145).

This drawing differs little in appearance from 107, *Platessa chinensis.* The ground tint and shadings are nearly the same, the black spots want the pale borders, and the blotches on the fins run into each other and form a border of grayish-black. The caudal is less rhomboidal and more rounded at the end.

Hab. Coasts of China. Canton.

PLATESSA BALTEATA, *Icon.* Reeves, 205; Hardw. Malac. 259. Chinese name, *Po pŭng*, "Broken sail" (Birch); *Po pung*, "Broken mat flounder" (Reeves, Bridgem. Chrest. 54).

This has the same Chinese appellation with *chrysoptera* which follows, the same regularly oval form and the brownish-red ground tint, interspersed with a few small darker points and crossed by several dark brown bands, one on the nape, another broad one behind the pectorals, a forked one further back, and a narrow one on the tail. The vertical fins are speckled with dark brown. Caudal rhomboidal. Length of drawing 7¾ inches.

Hab. Coasts of China. Canton.

PLATESSA CHRYSOPTERA, Bloch, Schn. (*Pleuronectes*), p. 151? *Icon.* Reeves, 104; Hardw. Malac. 260. Chinese name, *Po pung*, "Broken sail" (Birch); *Po pang*, "Broken mat" (Reeves); *Po pung* (Bridgem. Chrest. 54).

Mr. Reeves's drawing 104 answers better than any other one in his portfolio to the short characters of *chrysoptera* contained in Schneider's edition of Bloch, and this is our only reason for considering it to be the same species.

The ground tint of the drawing is brownish-red or orange-coloured brown, with numerous minute specks of umber and irregular rings of the same equally dispersed over the body with paler dull areas. The fins are wax-yellow, with reddish rays spotted with brown. Caudal fin subrhomboidal. Length of specimen 10 inches.

A specimen in the Chinese collection at Hyde Park has conical teeth on the lower jaw and near the symphysis of the upper one, with smaller ones laterally, and a prominent smooth acute interorbital ridge.

Hab. Chinese coasts. Canton.

PLATESSA ASPERRIMA, Temm. et Schl. F. J. Sieb. pl. 91. (Letter-press not yet published.)

Hab. Sea of Japan.

HIPPOGLOSSUS DENTEX, Richardson, Ichth. of Sulph. p. 102. pl. 47. *Icon.* Reeves, 195; Hardw. Malac. 267. Chinese name, *Tso kow*, "Mouth on the left" (Birch); *Tso kau*, "Left mouth" (Reeves); *Tso hau* (Bridgem. Chrest. 147). *Rad.* B. 7; D. 47; A. 33; C. 18; P. 17; V. 1|5.

Hab. Coasts of China. Canton.

HIPPOGLOSSUS ORTHORHYNCHUS, *Icon.* Reeves, 106; Hardw. Malac. 266. Chinese name, *Ching pe*, "Straight nosed" (Birch); "True nose" (Reeves); *Ching pi* (Bridgem. Chrest. 146).

We have seen no specimen of this. The figure represents the dorsal as commencing much further back than in the preceding; the ground colour as broccoli-brown, with a darker clove-brown bar running between the middles of the dorsal and anal, and blending with bars or shadings of the same tint which cover shoulder and arch over the pectoral. The vertical fins are also broccoli-brown, with a few obscure darker blotches. Pectorals yellowish-brown with fine dark speckling.

Hab. Coasts of China. Canton.

Hippoglossus goniographicus, *Icon.* Reeves, 254; Hardw. Malac. 265.

The ground colour of this drawing is yellowish-brown, marked like a map with large angular blotches of dark umber- or liver-brown, which extend to the caudal, and one or two of them also run out on the dorsal and anal. The membranes of the fin are between yellowish-brown and rust-coloured, and their rays are obscurely speckled. Five or six umber-brown bars cross the pectoral. Length of drawing 8½ inches.

Hab. Coasts of China. Canton.

Rhombus cinnamomeus, Temm. et Schl. F. J. Sieb. pl. xciii. (Letter-press not yet published.)

Hab. Sea of Japan.

Samaris cristatus, Gray, Zool. Misc. p. 8; *Icon.* Reeves, 171; Hardw. Malac. 268. "*Rad.* D. 61; A. 51; C. 16; P. 4; V. 5." (Gray, *l.c.*)

Hab. Coasts of China. Canton.

Solea ommatura, Richardson. *Icon.* Reeves, β. 13; Hardw. Malac. 273, 275. Chinese name, *Hwa tat sha*, "Flowered or variegated sole" (Reeves); *Hwa ta sha**, "Striped or flowery sole," also *Woo teën yĕ*, "Black guava leaf" (Birch); *Fa tat sha* (Bridgem. Chrest. 204). *Rad.* D. 70; A. 60; P. 11–11; V. 3 vel 4. (Spec. Camb. Phil. Inst.)

Two of the Rev. George Vachell's specimens of this fish exist in the Cambridge Philosophical Institution, and small ones are very common in the China insect-boxes. It belongs to the subdivision of the genus which is characterized by the blending together of the three vertical fins, and is very much like the Indian *Solea zebra*, but it is not so much elongated, and has a peculiar eye-like mark on the caudal fin, formed by several yellow spots, inclosed by a bright yellow parallelogram, of which one side is deficient. The body is crossed by about twenty-three vertical whitish bars, alternately broader and narrower, and bent backwards, where they run out on the fins. The intermediate spaces are wood-brown on the body and blackish on the fins; short bars radiate forward from the eyes on the snout.

The eyes are on the right side, and are small and nearly contiguous. The teeth, if any exist, are invisible to the naked eye. The left lips and gill-membranes are fringed, and the latter are united to the pectorals, the union of the left gill-membrane being more conspicuous. The scales on both sides of the fish are strongly ciliated and run up on the fin-rays. The lateral line is straight. Length of the figure 8¾ inches. The specimens are smaller.

In form this species is intermediate between the *Jerree potoo*, B, Russell, 81, and *Jerree potoo*, C, 82; and in the geminate distribution of its vertical stripes it agrees with neither.

Hab. Coasts of China. Canton. Sea of Borneo.

Solea ovalis, Richardson. *Icon.* Reeves, 179; Hardw. Malac. 179. Chinese name, *Teaou pan yu* (Birch).

This greatly resembles *Pleuronectes pan*, Buch. Hamilton, pl. 24. f. 42; but the hinder end is less acute, the form being a perfect oval, equally blunt both ways. The mouth also is cleft beyond the eyes, which appear to be more approximated, and the dark liver-brown spots are more numerous. The ground colour is reddish-brown.

Hab. Coasts of China.

Solea foliacea, Richardson. *Icon.* Reeves, β. 5; Hardw. Malac. 271. Chinese name, *Neen ye tze*, "Guava-leafed sole" (Birch); *Neem yeep tze* (Reeves); *Nim ip tsai* (Bridgem. Chrest. 203; *Icon.* Reeves, *h.* 91; Hardw. Malac. 269).

This differs little from the preceding, but the mouth is not so much cleft, the eyes smaller and further apart, like those of *Pleuronectes pan*, and the spots are composed of a congeries of smaller ones. The ground colour of drawing β. 5 is pale reddish-brown, but in the smaller one, *h.* 91, it is olive-green.

Hab. Coasts of China. Canton.

Solea ovata, Richardson. *Rad.* D. 65; A. 47; C. 21; P. 9, &c. (Spec. Camb. Phil. Inst.)

In this species the rounded caudal is well distinguished from the other two vertical fins,

* The term *tă shă*, applied to the sole, means "to beat the sand."

though they are united to its base by membranes. The dorsal commences over the anterior edge, and there is no membranous edge from thence to the mouth, which is a little way behind the very obtuse snout. Form ovate and very regular. Teeth nearly imperceptible and existing on the reverse side of mouth only. A band of cuticular filaments commences on the under lip and extends backwards to the lower edge of the gill-cover, fringing the gill-opening on the pale side only. The lower eye touches the upper lip, and the eyelids of both eyes are minutely scaly. Scales on both sides very strongly ciliated, but rather more rough on the coloured or right side; equally large on the head as elsewhere, and covering the fins in broad belts above and below. Lateral line straight. Upper side of the four specimens, which are preserved in spirits, grayish-brown, with a minute mottling a little deeper than the general tint, and some scattered black specks, which are not round. Under side of fish lead-gray, unspotted. Pectorals blackish behind, and on the outer half on the anterior surface. Caudal spotted. Length 3½ inches. Height 1½.

Hab. China seas. Canton (Rev. George Vachell).

Plagiusa auro-limbata, Richardson. *Icon.* Reeves, 151; Hardw. Malac. 283. Chinese name, *Kin peen tae shae*, "Golden-winged sole" (Reeves); *Kin peen ta sha* (Birch); *Hak tim tar sha* (Bridgem. Chrest. 210).

This fish, judging solely from the drawing, is elliptic anteriorly and tapers gradually to the end of the moderately acute tail, the height of the body, excluding the fins, being contained three times and a quarter in the length. The snout appears to be edged with membrane, and the dorsal commences above the level of the eye and rather before the mouth. Eyes less than a diameter of the orbit apart and placed over the middle of the mouth. Head one-fifth of the total length. Scales of moderate size. Lateral line quite straight. No ventrals shown in the figure. Colour uniform chestnut-brown, without spots, the fins being merely a little lighter and the fore part of the anal alone varying, being bluish-gray. Length of figure 10½ inches.

Hab. Coasts of China. Canton.

Plagiusa puncticeps, Richardson. *Icon.* Reeves, *m.* 95; Hardw. Malac. 282. Chinese name, *Nae pǐh* (Birch).

This figure corresponds with the preceding in outline, but the dorsal does not appear to reach before the eyes. Lateral line straight. Scales moderate. Colour yellowish-brown, with irregular blotches of a much deeper tint of the same scattered over the body, and many dark specks on the head. Length of figure 4¼ inches.

Plagiusa nigro-labeculata, Richardson. *Icon.* Reeves, 152; non Hardw. Chinese name, *Hih teen ta sha*, "Black-spotted sole" (Birch, Reeves); *Hak tim tar sha* (Bridgem. Chrest. 210).

This fish has not the symmetry of *auro-limbata*, but its height has the same relative proportion to its length, and its colour is the same with the addition of about a dozen roundish black marks on the fore-part of the body and humeral region. Dorsal fin commencing posterior to the eyes. If the artist has been inaccurate in indicating the origin of the dorsal in this and the two preceding figures, they may be all varieties of one species.

Hab. Coasts of China. Canton.

Plagiusa grammica, Richardson.

Two specimens of a *Plagiusa*, closely resembling the preceding two in form, exist in the museum of the Cambridge Philosophical Institution, to which they were presented by the Rev. George Vachell. The height of the body is contained three times and three-quarters in the total length, and the length of the head five times and two-thirds. Snout edged by a skinny membrane without rays, the dorsal commencing above the eyes and before the tip of the lower jaw. Eyes small and almost contiguous. Scales smaller than those shown in the figure of *auro-limbata*, strongly serrated on both sides of the fish. Lateral line straight. Ventrals situated in the same plane with the anal, one composed of four rays being distinct, and the other joined to the anal, and as it were forming its first four rays. Both are pointed. The anus is on one side of the second ventral and opposite to its last ray. Fins not scaly. Colour dark chestnut-brown, slightly streaked or shaded with umber, and marked by three irregular rows of dark vertical lines like Chinese characters. Length of specimen 3¾ inches.

Hab. Coasts of China. Canton.

Plagiusa abbreviata, Gray, Hardw. Ill. ii. pl. 94. f. 3. drawn from Mr. Reeves's China specimen; *Icon.* Reeves, *β.* 17; Hardw. Malac. 284.

Chinese name, *Tze leen ta shă*, "Minute-scaled sole" (Reeves); *Sai lin tat sha* (Bridgem. Chrest. 205).

Besides the straight central lateral line, another runs along the back at a little distance from the fin, and is continued round the snout to the mouth; and a third runs in like manner near the edge of the belly forward to the gill-opening. A transverse line crosses the nape, connecting the upper and middle lines, and another cross line, originating from the true lateral line a little further forwards, descends on the temples, and there divides; one branch encircling the gill-cover; and another, descending the preoperculum and running forwards to the point of the lower lip. Eyes over the posterior corner of the mouth. Colour umber-brown, the fins yellowish-brown without spots, but the gill-cover and middle of the body are darker and shading off. The defined black patch which includes the gill-cover in Mr. Gray's figure is merely a darker brown shading off in Mr. Reeves's drawing.

Hab. Coasts of China. Canton.

Plagiusa melampetala, Richardson. *Icon.* Reeves, 150; Hardw. Malac. 285. Chinese name, *Hih lëen ta sha*, "Black-scaled sole" (Birch); *Hih lin tat sha* (Reeves); *Hak lun tar sha* (Bridgem. Chrest. 207).

This is a large scaled species with two lines, as in *bilineata* (Bloch, 188, the *Jerree potoo*, E, Russell, 74, and *Pl. potous*, Cuv., *Jerree potoo*, D, Russell, 73), but with the dorsal not shown further forwards than the gill-opening. The general colour is dark chestnut-brown, with an obscure clouding of umber-brown, a large grayish blotch behind the gill-openings, and another near the hinder part of the anal. The fins are bluish- or blackish-gray. Eyes over the mouth. Height of body equal to the length of the head, or to one-fourth of the length of the body, excluding the fins. Length of figure 13½ inches.

Hab. Coasts of China. Canton.

Plagiusa favosquamis, *Icon.* Reeves, *β*. 50; Hardw. Malac. 281. Chinese name, *Meih lëen ta*, "Small-scaled sole" (Birch); *Meih lin tat sha*, "Close-scaled sole" (Reeves); *Mat lin tat sha* (Bridgem. Chrest. 206).

This species has proportionally larger scales than the preceding one. The dorsal commences over the middle of the mouth and before the eyes. The mouth has a smooth flesh-coloured edge, and the form of the body is elongated, its height equalling the length of the head, and being contained four times in the total length. Colour chestnut-brown, darker along the middle of the back, and each scale marked near the margin by a streak of umber-brown. Length about 9½ inches.

Hab. Coasts of China. Canton.

Tribus ——?

Fam. Siluridæ.

Silurus xanthosteus, Richardson, Ichth. of Voy. of Sulph. p. 133. pl. 56. f. 12–14. *Icon.* Reeves, 102; Hardw. Malac. 142, 143 (duplicates). Chinese name, *Hwang kŭh*, "Yellow bone" (Birch); *Hwang hwă* (Reeves); *Wong kwat u* (Bridgem. Chrest. 190).

The British Museum possesses Chinese examples of this fish presented by Mr. Reeves, and two specimens from Chusan, which were collected there by Dr. Cantor, and came from him through the India House, labelled *S. punctatus* and *nanus*. The labels have evidently been accidentally transposed, and could not have been attached by Dr. Cantor to these specimens, as they want the black lateral spots and black edges to the pectorals, which he mentions in his description of *punctatus*, and no account of a species named *nanus* is contained in his paper on the *Fauna* of Chusan.

Hab. Canton (Reeves). Chusan (Cantor).

Silurus sinensis, Lacép. v. pp. 58 et 82. pl. 2. f. 1 (*Le silure chinois*). M'Clelland, Calc. Journ. iv. p. 402. *Icon.* Reeves, 131; Hardw. Malac. 141. Chinese name, *Lëen yu*, "Sickle fish" (Birch); *Lin yu* (Reeves); *Lim u* (Bridgem. Chrest. 191).

This and the preceding species belong to the group of *Siluri*, which have short faces and projecting lower jaws, embracing the upper lip when the mouth is shut, and giving them, together with an accompanying elevation of the shoulder, more or less the aspect of a *Schilbe*. *S. xanthosteus* is distinguished at once from the present species by the union of the anal and caudal, as in *S. glanis* or *asotus*. Lacépède's figure of *S. sinensis* is too rude to be of much use, and we are quite of M. Valenciennes' opinion when he says that it is by no means precise enough to serve for the establishment of a species. Mr. M'Clelland has however had an opportunity of examining a *Silurus* from Chusan, which he has referred to Lacépède's species; and Mr. Reeves's drawing above-quoted answers better to the description of the colours and markings of *sinensis* than to any species introduced into the 'Histoire des Poissons.' His drawing represents a fish with the nape but sparingly elevated, and having a caudal slightly notched in the middle with rounded equal lobes, the lower one distinct from the anal. The maxillary barbel reaches nearly to the end of the pectoral; the barbels of the lower jaw are not quite half as long. The lateral line runs straight, a little above the mid-height, and is marked by a series of yellowish white points, which are met at right angles by about fourteen short rows of the same kind of dots descending at regular intervals from the back. The ground colour of the body is oil-green passing into yellowish-gray, and is reticulated by irregular meshes of neutral tint of a deeper colour. The meshes disappear in the darker hue of the summit of the back which approaches to blackish-green, and do not spread over the belly, which is white; but they descend lower at the anus, and include the posterior two-thirds of the anal. The ground colour is mostly silvery below the lateral line, but a buff-coloured band runs along the base of the anal, reticulated like the rest of the body. The dorsal, caudal and border of the anal are oil-green; the basal part of the anal being lilac-purple, with the darker reticulations posteriorly. The pectorals are lilac at the base, dull green on the disc, and have a yellow border. The ventrals are pale greenish-yellow with a lilac tint. The upper parts of the head are yellowish-brown with a purplish blush and without spots. Length of the figure 14½ inches.

Hab. Canton. Chusan.

"SILURUS MYSORICUS, C. et V. xiv. p. 364. *Silurus duda*, Buch. Hamilt. p. 152; M'Clelland, Calcutta Journ. iv. p. 402."

These references are given entirely on the authority of Mr. M'Clelland. Having the Indian fish under his eye, his opportunity for comparing it with his Chusan specimen is good; and it is important that a scrupulous comparison should be made, as this is one of the very few instances in which the same species of freshwater fish has been detected in India and China. The pointed caudal lobes distinguish this species from the foregoing ones.

Hab. Chusan (M'Clelland).

"SILURUS BIMACULATUS, Bl. 364; C. et V. xiv. p. 360; M'Clelland, Calc. Journ. iv. p. 401."

Hab. Chusan (M'Clelland).

"SILURUS PUNCTATUS, Cantor, Ann. Nat. Hist. ix. p. 30."

"*S. supernè nitidè olivaceo-viridescens sive brunnescens, seriebus duabus punctorum nigrorum infra lineam lateralem; abdomine albo-flavescenti; alis dorsalibus, caudalibus analibusque nigris; ventralibus albo-flavescentibus; pectoralibus latè nigro marginatis. Cirrhi* $\frac{2}{2}$; ***Radii***: D. 5; A. 80; C. 15; P. 1|5; V. 14; Br. 5."

"*Hab.* Fresh and brackish water in the island of Chusan." (Cantor, *l. c.*) No specimen.

SILURUS JAPONICUS, Temm. et Schl. Faun. Jap. Sieb. ***Rad.*** D. 5; A. 72; C. 17; P. 1|11; V. 12. (Spec. Br. Mus., 11 inches long.)

The part of the 'Fauna Japonica' relating to this species is not yet published, but we have compared the specimen with *S. xanthosteus*. The ventrals are farther behind the dorsal than in that species, and the maxillary barbel not longer than the head. Short branchlets descend at intervals from the lateral line.

Hab. Sea of Japan.

? BAGRUS CRINALIS, Richardson. *Icon.* Reeves, 217; Hardw. Malac. 179 (et 180 dupl.). Chinese name, *Sang maou* (Birch); "Growing hair" (Reeves). Length of fig. 10 inches.

This drawing closely resembles *Bagrus sagor*, Buch. (*Icon.* Hardw. Malac. 169 et 176; C. et V. xiv. p. 446), and also *B. bilineatus*, C. et V. 454; Russ. 169; but we are prevented from referring it to either of these species by its rather smaller anal and considerably larger ventrals. Its profile is sufficiently like that of *bilineatus* or *deddi-jellah* (Russ.) to need no further description, except that the ascent from the snout to the dorsal is a continuous straight line without any rounding before the dorsal. The maxillary barbels reach to the gill-opening, the exterior submandibular pair are half as long, and the interior pair a quarter as long. The operculum is finely veined, and the roughness of the nuchal plate is shown in the drawing by fine gold points. The lateral line is flatly arched over the pectoral, and takes a straight course from the tip of that fin to the caudal rather above mid-height. The points of the ribs form an oblique line from the shoulder to the anal. The dorsal and pectoral spines are slender and serrated in front: their posterior teeth, if they possess any, are not shown in the drawing. The top of the head, nape and back is sap-green, with fine parallel streaks of a deeper tint, bent *en chevron* near the dorsal line, and disappearing at the lateral line; the sides and belly are silvery with a purplish reflexion. There are some crimson tints round the mouth, and purplish ones at the union of the gill-pieces and on the breast; also a greenish-yellow border round the end of the tail embraced by the caudal. The dorsal is celandine-green, with darker rays tinged with crimson at the base. The adipose fin is yellow, with a black spot on the edge. The pectorals and ventrals have crimson-coloured rays and buff membranes. The anal is sulphur-yellow and the caudal a dingy wax-yellow. This drawing agrees in several particulars with the description of *Arius ocellatus* noticed below.

Hab. Canton.

BAGRUS LIMBATUS, Richardson.

None of Mr. Reeves's drawings represent this fish, which was brought from Canton by the Rev. G. Vachell; the only one that it resembles in having eight barbels being the *Pimelodus* ? *fulvi-draco* noticed below. From this it is distinguished by all the fins being edged with black, and the specimen shows no traces of the peculiar markings of *fulvi-draco*. I examined it cursorily, and noted down only a few of its characters. There is a short viliform dental plate on the vomer, set more densely and with shorter teeth than the jaws, and continued without a break over the mesial line. The casque terminates over the base of the pectorals, but sends out a narrow styloid process which touches the small chevron of the second interspinous bone. The adipose fin rises imperceptibly from the dorsal line, and the ventrals are smaller than those of *B.* ? *crinalis*, and do not reach to the anus. The ventrals have six rays, the last of which is divided to the base. A supra-axillary plate is half the length of the pectorals, and the nasal cirrhus is short.

Hab. Canton. Specimen in the Cambridge Philosophical Institution.

? BAGRUS (*an* PIMELODUS ?) BOUDERIUS, Richardson. *Icon.* Reeves, 203; Hardw. 183. Chinese name, *New yu*, "Buffalo fish" (Birch); *Nou yu*, "Cow fish" (Reeves); *Ngau u* (Bridgem. Chrest. 194).

A specimen of this fish exists in the Chinese collection at Hyde Park, but we have not examined the palate so as to ascertain from its dentition whether it is properly placed in this genus or not. If it be a *Bagrus* it belongs to the group which have eight barbels, a long anal and a comparatively short adipose fin. It comes nearest to *B. vacha* (Buch. Ham.) of any member of the group described in the 'Histoire des Poissons,' but may be at once distinguished by its much smaller mouth and fleshy lips. The head, viewed in profile, is depressed, tapering and rather pointed, with the eye rather nearer to the gill-opening than to the end of the snout. The lower jaw is shorter than the snout, and the mouth is not cleft so far back as the posterior nostrils, which are about midway between the eye and end of the snout. The nape rises suddenly in an arch from the hind head, and then runs backwards with little ascent to the first dorsal. The height of the body there is equal to the length of the head, or to one-fifth of the total length of the fish. The maxillary barbels are rather longer than the head: the exterior submandibular ones are a third shorter, while the nasal barbels and the interior submandibular ones are a little longer than the quarter of the length of the head. The lateral line is arched at the commencement, and then runs nearly straight from before the first dorsal to the caudal, a little above the middle height of the body. [In *B. buchanani*, Val., the lateral line is straight from end to end.] The pectoral spine is strong, and is strongly serrated towards its tip interiorly. A triangular plate proceeding from the humeral chain is shown very boldly in the figure above the fin. The dorsal spine is drawn without serratures, taller than the soft rays, pretty stout and rather spindle-shaped, with a tapering acute point. Six soft rays are shown. The ventrals are pretty large, but smaller than the pectorals; the anal long, containing above thirty rays; the adipose fin of a moderate size, and the caudal deeply forked, but with the lobes rather obtuse and equal. The colour on the dorsal aspect is dark mountain-green or greenish-gray, passing high on the sides into sienna-yellow, which continues down to the pale lilac edge of the belly. There are no spots. The fins have all more or less of lake or crimson-red with greenish rays. The two colours are most distinctly separated on the anal, the base being rose-red or carmine, and the outer half grass-green.

The base of the caudal is oil-green, the middle parts crimson, and the hinder edge blackish-green. The lips are orpiment-orange. Length of the figure $16\frac{1}{4}$ inches.

Hab. Canton (Reeves). No specimen.

In the 'Description of Animals,' &c., which we have repeatedly quoted, there is a sketch (fig. 162) of a Siluroid with a short adipose fin and long anal, which I should have referred to *B. bouderius*, but for the shortness and number of the barbels, which are stated in the text to be only four; and only two are shown in the drawing, the maxillary one, which is the longest, being shorter than the head, and the submandibular one still smaller. The nostrils are shown without cirrhi, and the belly is more prominent than that of Reeves's *bouderius.* In the text (p. 191) the head is said to be "naked and somewhat depressed, the body compressed, smooth and gray. Breast prominent. Ventral in middle of the abdomen. The rays B. 14; D. 8; A. 30; C. 28; P. 13; V. 6. Length 20 inches."

Hab. Canton river.

? Bagrus vachellii, Richardson. *Rad.* D. 1|7; A. 23; C. $17\frac{+}{+}$; P. 1|8; V. 6; *Cirrhi* 8.

A specimen of this fish exists in the collection of the Cambridge Philosophical Institution, to which it was presented by the Rev. G. Vachell. In the form of the adipose fin and general outline it resembles Mr. Reeves's drawing 203, which is described above under the appellation of *Bagrus? bouderius*, but the anal fin is not so extensive. In the hasty record I made of its characters, I unfortunately omitted to note the exact nature of the dental plates on the roof of the mouth, having merely written that the teeth are disposed in broad, close shorn villiform plates; so there remains an uncertainty as to the genus which cannot be cleared up without a re-examination of the specimen. The mouth is small, and the under jaw is shorter than the snout, which is round. The maxillary barbels are as long as the head and larger than the others; the interior submandibular pair equal the nasal ones, and are shorter than the exterior submandibular ones. They are all slender. The dorsal spine is smooth in front, but is armed with recurved teeth behind. The pectoral spine is also smooth in front, but it is strongly toothed behind. Many short rays are incumbent on the base of the caudal, above and below. Three front rays of the anal are short and graduated, and the last dorsal ray is divided to the base. The specimen is five inches long. In the number of the anal rays this specimen nearly agrees with *Arius ocellatus* introduced below.

Hab. Canton.

Arius falcarius, Richardson, Ichth. of Voy. of Sulph. p. 134. pl. 62. f. 7–9. *Icon.* Reeves, 101; Hardw. Malac. 184. Chinese name, *Lëen yu*, "Sickle fish" (Reeves, Birch); *Lim u* (Bridgem. Chrest. 193). Length of drawing $10\frac{1}{2}$ inches.

Hab. Canton. Spec. Brit. Mus.

Arius sinensis, C. et V. xv. p. 72.

Hab. "Touraine" (Hist. des Poiss.).

Arius ocellatus, Bl. Schn. (*Silurus*), 378; C. et V. xv. p. 104. *Silurus maculatus*, Thunb. Act. Stockh. 1792. pl. 1. f. 1 et 2.

The only one of Mr. Reeves's drawings which has anything like an eyed spot on the adipose fin is the one described above as the *Bagrus? crinalis*; but this is scarcely a distinguishing mark, as many of the *Siluridæ* have the adipose more or less broadly edged with black.

Hab. Japan.

? Galeichthys stanneus, Richardson. *Icon.* Reeves, 238; Hardw. Malac. 177. Chinese name, *Seih yu*, "Tin fish" (Birch); *Seih yu*, "Tin fish" (Reeves). *Seih* means also the gingling ornaments of a horse.

I have referred this figure to *Galeichthys* on account of its resemblance to *G. feliceps*, C. et V. pl. 424, but it may nevertheless be a *Pimelodus.* The head seems to be quite smooth above, with less appearance of a casque than in the figure of *feliceps* above-quoted. The granulations of a narrow interparietal process and a small crutch at the base of the dorsal spine are however shown. The head is wide and depressed, with a rounded snout, and forms about one-fourth of the total length of the fish. The height of the body is equal to rather more than a fifth of the length. The nasal orifices are round without either valves or barbels. The maxillary barbels are shorter than the head, but are longer than the exterior submandibular

dibular pair, and more than twice as long as the interior pair. There is a large triangular plate of the humeral chain above the pectoral which is covered with smooth skin. The dorsal and pectoral spines are long and rather slender, the former being equal to two-thirds of the height of the fish and serrated both before and behind. The latter is also serrated on both sides, but only at the tip. The adipose fin rises abruptly from the back, and is small; the anal is of moderate size; behind these fins the tail becomes narrower than usual in a siluroid, but again expands where it is embraced by the base of the caudal. The caudal is deeply forked with acute lobes. The lateral line is arched at the shoulder, and descends to the middle height of the body over the ventrals, its course to the caudal fin being straight from thence. The general colour is violet-purple passing into Scotch-blue, and gradually changing to a bright silvery tint on the lower part of the sides and under surface of the head. A series of chevrons are shown between the ventrals and pectorals evidently corresponding to the ribs. The under fins are bluish, the dorsal and caudal purplish brown. Length of the drawing, 15¼ inches. The Chinese name probably refers to the colour of the body.

Hab. Canton.

PIMELODUS GUTTATUS, Lacépède, v. pp. 96 et 113. pl. 5. f. 1; C. et V. xv. p. 143. *Icon.* Reeves, 129 et 130; Hardw. Malac. 161. Chinese name, *Hwa han*, "Flowery or spotted chiton" (Birch); *Ta kan*, "Variegated kan" (Reeves); *Fa kom* (Bridgem. Chrest. 196). *Rad.* D. 1|6; A. 1|8; C. 15; P. 1|8; V. 8. (Fig. Reev.) Length of fig. 129, 13½ inches; of 130, 16¼ inches.

This species was known to Lacépède only by a Chinese drawing; and though Mr. Reeves's drawings present both a top and side view whereby we can perceive that the fish has no casque, yet from our ignorance of the dentition we cannot say positively that it belongs to the genus *Pimelodus* as constituted in the 'Histoire des Poissons.' It has considerable resemblance to *Bagrus cavasius*, possessing the eight barbels, long adipose and short anal which characterise the group to which that species belongs, and which is equivalent to the genus *Porcus* of M. Geoffroy St. Hilaire. On the other hand, it has also the external characters of the Pimelodes, with a round head destitute of a casque and with eight barbels. In profile the head appears conical and rather slender, with an acute snout which projects beyond the lower jaw, the face and nape rising in a straight gentle acclivity to the dorsal. Viewed from above, the snout is broadly rounded; there is no appearance of a casque, and the distance between the eyes is equal to a third of the length of the head. The head forms one-fourth of the length of the fish, caudal excluded; and the height of the body at the commencement of the dorsal is nearly equal to a sixth of the length, caudal included. The maxillary barbels reach to the tip of the pectoral. The outer pair of submandibular barbels are less than half that length, and the other two and the nasal pair are still shorter. The pectoral spine is stout and very strongly toothed behind, but no teeth are shown on the dorsal one in either figure. The dorsal terminates over the first ventral ray, and the adipose fin commencing over the axilla of the ventrals extends far past the anal and almost to the caudal, being nearly equal in length to a third of the fish. The caudal is deeply notched with thick, rounded equal lobes. The lateral line has a very slight decurvature as far as the ventrals, but is otherwise nearly straight and rather nearer to the belly than to the back. The supra-axillary plate of the humeral chain is drawn narrow and rather long. The colour of the back, top of the head and breast is brownish purple-red; the sides and belly white, with a faint wax-yellow or siskin-green reflexion. Many transverse bars are shown, that meet *en chevron* near the back, and again less sharply at the lateral line, which is green. The body, adipose fin, and caudal and the rays of the dorsal and ventrals are marked with many scattered black spots of irregular shapes and sizes. The dorsal, adipose and caudal are yellowish-brown at the base, the rays of the pectoral are greenish, and those of the ventrals and anal carmine. The membranes of most of the fins appear to be thin and transparent.

Icon. Reeves, 132; Hardw. Malac. 162. Chinese name, *Han yu*, "Chiton fish" (Birch); *Kan yu*, "*Han* tiled-fish" (Reeves); *Kom u* (Bridgem. Chrest. 192). Figure 13 inches long.

This is seemingly another representation of the same species, with the outline a little distorted from the example placed before the artist having been in a more limber state. Hence the profile, instead of rising from the snout in a straight acclivity, is undulated by the comparative depression of the head and swelling out of the nape. Some serratures are shown at the tip of the dorsal spine, and the silvery supra-axillary plate of the humeral chain is notched, as in the figure of *B. cavasius* (Jacquemont, Voy. de l'Inde, pl. 16. f. 2): there are no other perceptible differences of structure. The spots on the base of the caudal are more numerous, but they are fewer and more scattered on the body than in the other figures, and there are none on the lower fins. The purplish-brown tints are confined to the shoulder, the general colour posteriorly being shining yellowish-brown, with oil-green transverse bars.

Hab. Canton.

PIMELODUS CANTONENSIS, C. et V. xv. p. 142 (8 barbels).

Hab. Fresh waters at Canton.

PIMELODUS ASPER, M'Clelland, Calc. Journ. iv. p. 404. pl. 24. f. 2.

Hab. Chusan.

PIMELODUS TACHISURUS, Lacépède (*Tachisurus chinensis*), v. p. 151. pl. 5. fig. 2; C. et V. xv. p. 163.

Lacépède describes this fish from a Chinese drawing. His figure is not without considerable resemblance in general form to the drawing which we have named *Galeichthys stanneus*, but Mr. Reeves's figure is entirely without blotches such as are represented by Lacépède.

Hab. China.

PIMELODUS MONG, Richardson. *Icon.* Reeves, β. 20; Hardw. Malac. 173. Chinese name, *Măng tze*, "Grain or barley-awn fish" (Reeves, Birch); *Mong tsai* (Bridgem. Chrest. 195).

In outline and the relative size and shape of the fins, this drawing has some resemblance to the *Arius pumilus* of Jacquemont (Voy. dans l'Inde, pl. 18. f. 1), but it wants the casque and the crutch-like interspinous process of that fish, there being merely a few black dots on the nape, probably intended to represent some roughness of that part. There are no nasal barbels. The maxillary ones reach beyond the head, and the submandibular ones are shorter. The upper half of the dorsal spine is serrated in front and behind; and the pectoral one only behind. The anal is small and rectangular. The adipose fin also rectangular, and of medium size. The caudal acutely forked. The fish is drawn curved, and the lateral line, which is marked by a silvery stripe, has a corresponding curvature, but is evidently quite straight when the fish is in a true position. The back of the fish is bluish or greenish-gray, the other parts being more or less brightly silvery. The fins have a similar tint to the back, and there is a small black mark on the edge of the adipose fin. Length of the drawing 5½ inches.

Hab. Canton.

PIMELODUS? FULVI-DRACO, Richardson. *Icon.* Reeves, 155; Hardw. Malac. 174 (et 175 dupl.). Chinese name, *Hwang lung*, "Yellow-dragon" (Birch, Reeves); *Wong lung* (Bridgem. Chrest. 199). Length of the figure 5¼ inches.

The profile of this fish, the form of the head and operculum, and the unusual distribution of the dark patches of colour, remind one of the *Pimelodus bagarius* of Buchanan Hamilton, but it wants the prolongations of the dorsal, pectorals and caudal, which characterise that species, and also the enlargement of the maxillary barbels. It has likewise much resemblance to the *P. viridescens* of the same author, of which fig. 157, Hardw. Malac. is a coloured representation. In pl. 11. f. 56 (Fishes of the Ganges), the engraving has been less accurately executed than in the rest of Buchanan Hamilton's plates, and the three green bars which cross the back are not distinctly shown. In *fulvi-draco* the maxillary barbels are a little longer than the head, while the nasal one is only half that length, being about equal to the four submandibular ones. The dorsal and pectoral spines are both stout, the latter being serrated on both sides, the former only behind. The caudal is forked with thickish lobes. There are two colours in the body, viz. olive-green and sienna-yellow, each forming three vertical bands with a connecting longitudinal stripe low on the sides. Of these the olive-green occupies the greatest space. A dark dingy green stripe runs through each caudal lobe, the rest of the fin being yellowish-brown. The dorsal is also yellowish-brown and the anal a rather lighter yellow, but with a broad green bar in its middle, descending from the horizontal ventral stripe of that colour. The pectorals and ventrals are dark with pale rays. The prevailing tints on the head are yellowish-brown and sienna-yellow, passing into a darker brown above.

Hab. Canton.

PLOTOSUS LINEATUS, C. et V. xv. p. 412. *Plotose Anguille*, Lacépède, v. p. 129, 130. pl. 3. f. 2. *Ingelee*, Russell, 166. *Plotose ikapor*, Lesson, Voy. des Duperrey, pl. 31. f. 3; Krusenstern, pl. 60. f. 12 et 13. *Plotosus anguillaris*, Rüpp. Neue Wirlb. p. 76. *Icon.* Reeves, β. 11; Hardw. Malac.

199. Chinese name, *Yen ting* (Birch); *Gan ting*, "Cottage nail" (Reeves); *Om ting* (Bridgem. Chrest. 197). *Icon.* piscium 24 a pict. Sin. &c.

Hab. Seas of Japan and China. Macao. Philippines. Amboyna. Celebes.. Western Australia. Friendly Isles. Indian Ocean. Mauritius. Seychelles and Red sea. Chinese specimens exist in the museum of the Cambridge Philosophical Institution, the British Museum, the Chinese collection at Hyde Park, Haslar Museum, and very commonly in the Chinese insect-boxes.

Clarias pulicaris, Richardson, Ichth. of Voy. of Sulph. p. 135. pl. 62. f. 5. 6. *Icon.* Reeves, *β*. 16; Hardw. Malac. 198. Chinese name, *Tĭh sa*, "Pond louse" (Birch); *Tang sih*, "Bird-flea" (Reeves); *Tong sat* (Bridgem. Chrest. 198).

Hab. Canton. Spec. Br. Mus. (Reeves).

The *Macropterote brun* of Lacép. v. pl. 2. f. 2. is probably the above species, and not the *Clarias fuscus* of Sumatra (C. et V. xv. p. 383).

Clarias hexacicinnus, Lacép. (*Macropteronotus*), v. pp. 84, 88. pl. 2. f. 3. Established on a Chinese painting.

Hab. China.

Clarias abbreviatus, C. et V. xv. p. 386.

This species resembles Lacépède's *C. hexacicinnus* in the shortness of its body.
Hab. Canton.

The *Cossyphus ater* of M'Clelland, Calcutta Journ. (iv. p. 405. pl. 24. f. 3), is apparently an injured example of a fish of this genus. The specimen came from China.

Tribus ——?

Fam. Cyprinidæ.

As we know the bulk of the Chinese species of this difficult family chiefly from Mr. Reeves's drawings, the Cuvierian generic groups seem to be better adapted for their description than the minuter subdivisions of more recent ichthyologists, depending as many of them do on anatomical characters. I have compared these drawings carefully with General Hardwicke's numerous figures of Indian *Cyprinidæ**, and also with the plates of M'Clelland's paper in the 19th volume of the Asiatic Researches for 1839, and am satisfied that the Chinese species are almost wholly different from those of the peninsula of India. Mrs. Bowdich (now Lee) copied for Baron Cuvier many drawings of Chinese fish, some of which are referred to by M. Valenciennes in the sixteenth and seventeenth volumes of the 'Histoire des Poissons' which treat of the *Cyprinidæ*. Mr. Brown kindly pointed out to me the drawings she traced from in the Banksian Library. They are kept loose in a portfolio, and are entitled in the Catalogue 'Icones piscium 24 a pictore Sinensi Cantoni eleganter pictæ, fol.' Aided by the dimensions of the tracings noted by M. Valenciennes, and his descriptions of the colours, I have been able to identify most of these drawings with the species named by him; but as he quotes more of Mrs. Bowdich's tracings of *Cyprinidæ* than there are originals in this small collection, it is evident that she made copies also of the figures in some other Chinese book or collection of drawings; and M. Valenciennes also mentions several figures of *Cyprinidæ* which he saw in the Banksian Library, but which I have not been able to find.

(*Cyprini veri vel cirrhati.*)

Cyprinus atro-virens, Richardson. *Icon.* Reeves, 116; Hardw. Malac. 7. Chinese name, *Hĭh le*, "Black carp" (Reeves, Birch); *Hak li* (Bridgem. Chrest. 15). Length of drawing $11\frac{1}{2}$ inches.

The height of the body is a little more than a third of the length, and the back is elevated in

* There are in all 128 drawings of *Cyprinidæ* in the Hardwickian volumes, of which 65 appear from the references on many of them, and the sameness of the style of others, to have been executed by the artists that were employed by Buchanan Hamilton.

form of a long flat ellipsoidal arch, rounding off and descending considerably at the shoulder, to meet the depressed and scarcely convex profile of the face. The chief spine of the dorsal and also of the anal is strongly serrated posteriorly almost to the base. The barbels at the angle of the mouth are about equal to the rictus in length, and those which spring from the middle of the maxillary are not much shorter, in which respect the drawing differs from that of *nigro-auratus* of Lacépède. Seventeen soft rays are shown in the dorsal and six in the anal, the last one in both being divided to the base*. The discs of the scales have a shining bronze colour, their bases a deep blackish-green. The head is mostly dark blackish-green with some golden reflexions, and the operculum is marked with curved streaks descending from its upper anterior corner. The pectoral and caudal are blackish-green, the dorsal dark hair-brown, and the three under fins have ochraceous rays. The lateral line is slightly deflexed, equidistant from back and belly, and is composed of about twenty-eight scales.

Hab. Canton.

CYPRINUS RUBRO-FUSCUS, Lacépède, v. p. 331. pl. 16. f. 1; C. et V. xvi. p. 74. *Icon.* Reeves, 117; Hardw. Malac. 4. Chinese name, *Tang le*, "Pond carp" (Reeves, Birch); *Tong li* (Bridgem. Chrest. 14). Length of figure 11·1 inch.

It is with the doubt which pervades all such approximations that we refer Mr. Reeves's drawing, above-quoted, to the species noticed by Lacépède. In general form it approaches that of Reeves, 116 (*atro-virens*), but the outline of the back is rather less flat, and slopes moderately each way to an apex at the beginning of the dorsal. The height is contained thrice and one-sixth in the total length, of which the head makes a fourth. The rays shown by the artist are D. 2|20 ; A. 2|5 ; the strong spines being deeply serrated, and the last soft rays divided to the base. The dorsal commences over the tip of the pectorals and front of the ventrals, and terminates a little farther from the caudal than the anal does. The lateral line is straight, and is composed of twenty-eight or thirty scales. The scales generally are brightly silvery with olive-green bases, which deepen on the back to blackish-green, and fade lower on the sides to apple-green and oil-green. There is a slight reddish blush on the shoulder, and an ochraceous tint on the breast and lower parts of the head. The operculum is streaked on its upper anterior half. The dorsal is pale ash-gray, with a row in the middle of darker pearl-gray blotches between the rays. The ventrals and anal are also pale with bright red tips, and the caudal is bordered at the end with red, the body of the fin being dark yellowish-gray. The pectoral is blackish-gray.

Hab. Canton.

CYPRINUS FLAMMANS, Richardson. *Icon.* Reeves, 118 ; Hardw. Malac. 6. Chinese name, *Ho le*, "Fire carp" (Reeves, Birch); *Fo li* (Bridgem. Chrest. 18). Length of drawing $10\frac{1}{4}$ inches.

This drawing represents a fish with the same profile as the preceding one (Reeves, 117), the only differences being a trifling increase in the length of the head, and the dorsal commencing a very little farther back. The barbels are the same, and both this and the two preceding species have a conspicuous, elevated, scoop-shaped border to the posterior nasal orifice. The rays shown in the figure are D. 2|18 or 19 ; A. 2|5. It is possible that this may be merely the *rubro-fuscus* in its spawning dress. The lateral line is very slightly decurved, and is traced on thirty-one scales. The operculum is striated almost to the edge. The bases of the scales down to a row or two below the lateral line are duck-green, so defined as to produce rows of rectangular spots. The discs of the upper scales and the upper parts of the head have bronze reflexions; the lateral ones are silvery with a reddish blush, and the whole under parts of the head and body are bright orpiment-orange, the colours being most intense on the circumference of the scales. The ventrals and anal are also orange; the pectorals and caudal lake-red, and the dorsal pale chestnut-brown.

Hab. Canton.

CYPRINUS VIRIDI-VIOLACEUS, Lacépède, v. p. 548. pl. 16. f. 3. *Icon.* Reeves, 157; Hardw. Malac. 5. Chinese name, *Lŭh le*, "Green carp" (Reeves, Birch); *Luk li* (Bridgem. Chrest. 13). *Rad.* B. 3 ; D. 2|19 ; A. 2|5 ; C. $18\frac{5}{6}$; P. 14 ; V. 9. (Reev. Spec.)

Mr. Reeves has deposited two specimens in the British Museum, which we refer to his figure, and also, though with less confidence, to Lacépède's *viridi-violaceus*. In profile it differs a little from the preceding species, in the curve of the back passing insensibly into the tail, and

* In most of the drawings the very short anterior spines of the dorsal and anal are omitted. We enumerate only those which are shown by the artist.

in the facial line not being so suddenly depressed at its union with the nape, which is nevertheless gibbous. The height of the body is equal to a third of the total length, of which the head forms one-fourth; excluding the caudal, the head is equal to a third of the length; the thickness amounts to nearly half the height. The barbel which issues from near the middle of the maxillary is very small; that which springs from near its tip is moderately large. The straight or very slightly decurved lateral line is traced on thirty-three scales, and there are ten rows of scales in the height of the body. Their discs are obscurely radiated and roughish. No streaks appear on the gill-cover. The dorsal commences some way before the ventrals and over the posterior third of the pectorals; its third soft ray stands above the front of the ventrals. Its large spine and that of the anal are strongly serrated, and the last soft ray of the two fins is divided to the base.

The general hue of this fish is fully darker than any other one of Mr. Reeves's drawings of the genus, the bases and edges of the scales being blackish-green passing into greenish-black, with bronze discs above the lateral line, the light and dark parts being arranged so as to produce lines corresponding in number with the rows of the scales. The dark bases are continued over the belly, but restricted in size; and the discs of the scales below the lateral line are pale olive-green with very slightly deeper coloured edges. Some crimson and lake tints exist on the belly and under surface of the tail. The top of the head is blackish-green, the cheeks and opercula are rich, dark auricula-purple, bordered by brilliant bronze. Under parts of the head and throat buff-orange. Dorsal ash-gray with a yellowish-gray base. The ventrals and anal are pale with rosaceous tips; the pectorals show faint yellow, purple and red tints, and the dark clove-brown caudal has the ends of the lobes hyacinth-red. Lengths of the specimens 6 and $8\frac{1}{2}$ inches: of the figure $10\frac{3}{4}$ inches.

Hab. Canton.

Cyprinus hybiscoides, Richardson. *Icon.* Reeves, 156; Hardw. Malac. 3. Chinese name, *Foo yung le* (Birch); *Foo yang le*, "Hibiscus-flower carp" (Reeves); *Fu yung li* (Bridgem. Chrest. 12). Length of figure 12·2 inches.

This has much the form of *viridi-violaceus*, but is more elegantly shaped at the nape, which is not so gibbous. The barbels are longer and the fins are all very tall, seemingly the effect of monstrous growth. A small specimen apparently of this species, but with a triple caudal, was brought from China by Captain Dawkins. Only one spine, the tall serrated one, is represented by the artist in the dorsal and anal, whose rays are D1|19; A. 1|6 or 7. The colour of the back down to the straight lateral line is the same as in *viridi-violaceus*, but the purple tints are replaced on the side of the head by a shining bronze colour. The sides and belly are silvery, with a greenish-gray shade at the bases of the scales. Dorsal and caudal brownish-red, fading to purplish-red towards the edges; anal and pectorals blood-red, the spine of the former and rays of the latter being light purplish-gray. Anterior half of the ventrals blackish-purple, the posterior half peach-blossom red.

Hab. Canton.

Cyprinus acuminatus, Richardson. *Icon.* Reeves, 125; Hardw. Malac. 2. Chinese name, *Shang hae lă*, "Shang hae lă fish," or the "*Shang hai* wax-fish" (Birch); "Superior sea-carp" (Reeves); *Sheung hoi lap* (Bridgem. Chrest. 17). Length of drawing $9\frac{3}{4}$ inches.

This species has an elevated back, shaped in profile like the roof of a house, with the summit at the commencement of the dorsal, which is over the posterior third of the small pectoral and some way before the ventrals. The posterior slope of the back is the more gradual one, and is entirely occupied by the dorsal. The belly is horizontal, with a short upward slope to the tail which is occupied by the anal. Head small, forming one-fifth of the length of the fish, while the height of the body equals a third of the same length. The nostrils want the valve or erect lip shown in the drawings of the preceding species, and there is a deep groove across the snout a short way before them, and on a line with the front of the preorbitar. The tip of the snout is tumid, though not large. The barbels are small, particularly the upper pair. The rays shown in the drawing are D. 2|19; A. 2|5. The spines are strong and coarsely serrated, particularly the anal one.

Top of the head and bases of the scales of the back oil-green. More and more of the discs of the scales become silvery as they approach the lateral line; and they are wholly so lower down, except that a very pale wax-yellow colour marks their bases on the belly. The cheek is bluish-gray; the fins are all more or less tinged with aurora-red, with pale borders. The red is deepest on the caudal, but that fin also has a broad colourless border at the end. The lips are reddish, and the eye, which is large, has a red iris.

Hab. Canton.

Cyprinus nigro-auratus, Lacépède, v. p. 547. pl. 16. f. 2; C. et V. xvi. p. 73. *Icon.* Reeves, 119; Hardw. Malac. 1. Chinese name, *Hae le,* "Sea-carp" (Reeves, Birch); *Hoi li* (Bridgem. Chrest. 16). Length of the drawing 15½ inches.

If one may judge from the size of the figure, this is the largest true carp that came under Mr. Reeves's observation. Its profile rises very considerably in a bold arch to the dorsal, with a shallow transverse groove before the nostrils and a slight undulation at the nape. The belly is flattish. The height of the body is contained thrice in the total length, and the length of the head four times and a half. The mouth is rather oblique, and the upper jaw goes beyond and somewhat overhangs the lower one. The upper barbels are short *. The lateral line, which is traced on thirty-one scales, is slightly decurved, and descends a little below the middle height, taking a straight course through the middle of the tail after passing the ventrals. No streaks are shown on the gill-covers. The long, low dorsal commences behind the tip of the pectorals and before the ventrals, and reaches past the middle of the anal. The pectorals and ventrals are small and rounded. The rays shown in the figure are D. 1|21; A. 2|5. The dorsal spine is serrated; but the anal one, which is longer and stronger, is represented as smooth. The colours are not dark, the scales having much silvery lustre: they are shaded at the base with olive-green on the back, and with pale honey-yellow on the lower parts.

M. Valenciennes mentions that he saw two paintings of this species in the library of Sir Joseph Banks, but I have been able to discover only one of these, and it is the only true *Cyprinus* with barbels contained in the collection named 'Icones Piscium 24, &c.' The figure is 10 inches long and 3½ inches high, and its pectoral fin has been omitted. The name of *nigro-auratus* is not characteristic either of this drawing or of Mr. Reeves's, which show much more lively colours than M. Lacépède describes, as M. Valenciennes has remarked. But for the observation of the latter naturalist, who has examined the Chinese drawings on which M. Lacépède's species are founded, I should have been inclined to quote Mr. Reeves's darkest drawing, our *atro-virens,* as corresponding best with the epithet *nigro-auratus.*

Hab. Canton.

Cyprinus sculponeatus, Richardson. *Icon.* Reeves, 120; Hardw. Malac. 8. Chinese name, *Keih le* (Birch); "Clog or Wooden-shoe carp" (Reeves); *Kik li* (Bridgem. Chrest. 21). Length of figure 8¾ inches.

This species differs from the preceding ones in form, the dorsal being more flatly arched and the belly more prominent, with a considerable upward slope behind to join the trunk of the tail. The height of the body is contained thrice and one-half, and the length of the head four times and a quarter in the whole length. The lateral line, which is considerably decurved, but does not descend beyond the middle height, is traced on twenty-nine scales. The barbels are rather short. The dorsal commences over the first ventral ray, and the greater part of the anal is posterior to its termination. The rays shown in the figure are D. 2|17 or 18; A. 2|5. The spines are serrated and shorter than the soft rays. A valve is shown between the nostrils.

The scales have much silvery lustre, and are almost wholly nacry below the lateral line; but the back is tinted with leek-green, which deepens into blackish-green at the base of the scales and forms spots. The edges of the upper scales are also darker leek-green, and the top of the head is of the same colour. There are carmine tints on the lips and tips of the anal and caudal. The pectoral, dorsal and caudal, are leek-green, the ventrals and anal very pale ochre.

Hab. Canton.

Obs. The seven species noticed above seem all to be true *Cyprini,* allied to the common carp of Europe; and their existence in the Chinese waters shows a marked difference between the ichthyology of that country and of India, which does not appear to possess any member of this group. The *Cyprinus semiplotus* of M'Clelland is indeed introduced among the true carps with barbels in the 'Histoire des Poissons'; but this would appear to be from inadvertence, as the figure in the 'Asiatic Researches' (19. pl. 37. f. 2), and

* On first looking at the figure only the barbels which hang from the corners of the mouth are seen; but on examining more narrowly, we may perceive that the painter has drawn the upper barbels lying close to the maxillary.

Mr. M'Clelland's character of his genus *Cyprinus* both indicate that it does not possess these appendages; and no serratures are shown on the dorsal or anal spines.

CYPRINUS? FOSSICOLA, Gray (*Mursa*), Cat. Br. Mus. *Icon.* Reeves, *a.* 40; Hardw. Malac. 11. Chinese name, *Hang le*, "Ditch carp" (Birch); *Kang he*, "Ditch carp" (Reeves). Length of figure 8 inches.

This fish has two moderate-sized barbels issuing from behind the middle of the lip and none from the corner of the mouth, and on that account I should have placed it in the genus *Rohita* of M. Valenciennes, which had previously received the appellation of *Nandina* from Mr. Gray, both authors deriving their generic name from one of Buchanan Hamilton's species. Mr. Reeves's drawing, however, does not indicate that development of the upper lip, nor the fringes that characterise *Rohita*; and it is probably on this account that Mr. Gray, in the analysis that he had commenced of these drawings, bestowed on this one another generic epithet as above quoted. In the uncertainty which exists respecting the true characters of this species, I have preferred noticing it under the general appellation of *Cyprinus*. In the extent of the dorsal it resembles the *Cyprinus nandina* of Buchanan Hamilton, or the *Cirrhinus macronotus* of M'Clelland, but it differs much from that fish in its profile. The back forms a very flat elliptical curve, and there is a considerable gibbous descent at the shoulder to meet the facial line, which would be a straight slope, were it not that a slight rising of the thin snout gives it a small degree of concavity. The mouth is terminal, and the lower jaw is very little shorter than the upper one. The head is exactly a fourth of the length of the fish, and the height of the body somewhat exceeds a third of the length. The eye is rather small, and is equidistant from the mouth and gill-opening. The nostrils are not drawn with an elevated border. The lateral line is considerably decurved, descending over the ventrals below the middle height, but running through the middle of the tail. It is traced on only twenty-five scales. A few short streaks radiate from the anterior superior corner of the operculum. The dorsal, which is highest anteriorly and has a straight edge, begins before the ventrals, over the last fifth of the pectorals, and approaches almost as near to the caudal as the anal does. Its first two rays are drawn as stout and spinous, standing up stiffly from the others: they are not denticulated. The anterior anal rays are nearly similar. The numbers shown by the artist are D. 2|20; A. 2|5, &c. The scales are mostly silvery, with a pale mountain-green tint towards the base of each. This tint covers more of the disc towards the back, and most of the upper scales are also edged with the same. There is a crimson tint on the top of the head, and a faint blush of the same runs along the side above the lateral line. The lips are carmine, and the pectorals, anal and caudal, are carmine at the base, mixed with buff towards their borders, the extreme edge of the caudal being mountain-green. The dorsal is celandine-green with carmine rays, and the ventrals bluish-gray, also with carmine rays.

Hab. Canton.

(*Cyprini non cirrhati*:—*Cyprinopsis*, Fitzinger; *Carassius*, Nilsson.)

CYPRINUS LINEATUS, C. et V. xvi. p. 96.
Hab. Macao.

CYPRINUS CARASSIOIDES, Gray, Cat. Br. Mus. *Icon.* Reeves, 126; Hardw. Malac. 12. Chinese name, *Keih yu*, "Shoe fish" (Reeves, Birch); *Kik u* (Bridgem. Chrest. 21). Length of figure $9\frac{1}{4}$ inches.

This drawing represents a fish having nearly the same profile with *C. acuminatus*, being merely a little higher and wanting the transverse furrow on the snout as well as the barbels. The dorsal, which is high in front with an even edge, begins over the middle of the ventrals and terminates opposite to the middle of the anal. The anal spine is thick and as long as the soft rays; the dorsal one is shorter; both are serrated. The numbers shown are D. 2|18; A. 2|5, &c. Lateral line straight and traced on twenty-eight scales. No streaks on the operculum. The scales are brightly silvery, shaded gradually from their bases with greenish-gray above the lateral line, and with faint sulphur-yellow lower on the sides and belly. The edges of the opercular pieces and of the humeral chain are also sulphur-yellow. The fins have ash-gray edges, and are tinged with aurora-red towards their bases. The dorsal has a soiled hyacinth-red bar along its base, and another more distinct along its middle. The eye-brow is flax-flower blue.

Hab. Canton.

Cyprinus (carassius) burgeri, Temm. et Schl. F. J. Sieb. *Rad.* D. 3|15; A. 3|5; C. 19$\frac{6}{5}$; P. 17; V. 9. (Spec. Br. Mus.)

The specimen in the British Museum is four inches long, and is named by the authors of the 'Fauna Japonica.' It may possibly be the same with the preceding, which it resembles in outline, but it has fewer dorsal rays. There are thirty-one scales bearing tubes on the lateral line, and twelve rows in the height of the fish. It seems to have been a paler fish than the following species.

Hab. Japan.

Cyprinus gibelioides, Cantor, Ann. Nat. Hist. ix. p. 29. *Icon.* Reeves, 123; Hardw. Malac. 10. Chinese name, *Tsih* * *yu* (Birch); *Tsih u*, "Pattern carp" (Reeves). *Rad.* B. 3; D. 4|17; A. 3|6; C. 18$\frac{7}{7}$; P. 18; V. 9.

As M. Valenciennes compares *C. langsdorfii* to *gibelio*, it is possible that Dr. Cantor's fish may be the same. Several of Dr. Cantor's specimens have reached the British Museum through the India House, one of them labelled *C. nigrescens*, which was probably merely a provisional name, and changed when Dr. Cantor drew up his paper. In form the fish is regular and rather elegant. Its face is convex, and the shoulder ascends in a gentle arch to the dorsal. The head makes rather less than a fourth part of the length of the whole fish; the height of the body is contained three times and a quarter in the length, and the thickness rather more than seven times, or twice and one-third in the height. The mouth is small, not being cleft as far as the nostrils. The symphysis of the lower jaw rises in the form of a minute obtuse point. The lateral line is straight or very slightly decurved, and is traced on twenty-seven scales. There are thirteen rows of scales in the height: each scale is marked on the disc by streaks radiating from the centre. The dorsal commences over the ventrals and extends back to the middle of the short anal. It has four spines, of which the two anterior ones are very minute: the fourth one is strongly toothed behind, and its flexible tip is also toothed. The same is the case with the third anal spine †. The posterior pair of soft rays in both fins are approximated at the base. The colour on the back is greenish-gray, deepening at the base of the scales to blackish-gray, becoming lighter inferiorly and changing to an ochraceous tint on the breast. The fins are greenish or blackish-gray, of different degrees of intensity, and their edges when folded are blackish. The pectoral and anal fins are red on their fore-edges. The figure is 7$\frac{1}{2}$ inches long; the smallest specimen only 2$\frac{1}{2}$ inches.

Hab. Canton. Chusan.

Cyprinus (carassius) cuvieri, Temm. et Schl. F. J. Sieb. *Rad.* D. 3|18; A. 3|5; C. 19$\frac{6}{5}$; P. 17; A. 9. (Jap. Spec. Br. Mus. length 4 inches.)

This is much like *gibelioides*, and may prove to be the same, in which case Dr. Cantor's name has the priority. It seems rather more slender, and has a shorter and more delicate pectoral.

Hab. Japan.

Cyprinus langsdorfii, C. et V. xvi. p. 99.

The 'Icones Piscium 24 a pictore Sinensi,' &c., include three figures which may belong to this species, if they are not referable to the *gibelioides* of Cantor. They have the lobes of the caudal and the sinus between them much more obtuse than those of *gibelioides*, or of Reeves's figure 123, and apparently the large suborbitar of *langsdorfii*. Their lengths are 6 inches, 5$\frac{3}{4}$ and 3 inches respectively.

Hab. Japan.

Cyprinus thoracatus, C. et V. xvi. p. 97.

M. Valenciennes refers to this species a Japanese painting of a fish whose Chinese name is *tsi*, but this is a generic appellation apparently equivalent to *Carassius*.

Hab. Mauritius (and Japan ?).

Cyprinus abbreviatus, Richardson. *Icon.* Reeves, 124; Hardw. Malac. 13. Chinese name, *Sŭh kŭh tsĕih* ‡ (Birch); *Suh kwut sih*, "Contracted bone carp" (Reeves); *Shuk kwat tsik* (Bridgem. Chrest. 20). Length of drawing 7$\frac{3}{4}$ inches.

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* *Tsih* is one of the names of the cuttle fish.

† The teeth of the spines are omitted in the figure.

‡ "The fish which has the power of raising and depressing, or rather puckering its bone."

This species has a short, high body, with a peculiarly short trunk of the tail. The length of the head is contained four times and a sixth in the total length, and the height of the body twice and a half. The profile of the back is very slightly arched, so that it is almost parallel to the straight belly, and the descent to the mouth is mostly from the nape and is pretty steep. There is also a considerable ascent from the breast to the mouth, which is terminal, but with the lower jaw a little longer than the upper one. A small conical eminence is represented on the snout immediately before the nostrils. The eye is rather small and is about twice as far from the gill-opening as from the tip of the snout. The cheek appears from the drawing to be covered by the preorbitar, like that of *thoracatus*, and the whole surface of the operculum is streaked. The lateral line is perfectly straight and is traced on twenty-three scales only. The dorsal commences over the front of the ventrals and approaches as near to the caudal as the anal does. The latter fin has the same direction with the caudal, being attached to a vertical inflection of the under profile. The spines of the dorsal and anal are shorter than the soft rays. The figure shows D. 2|18; A. 2|5, &c.

The scales are silvery with bluish- or blackish-gray bases, deeper towards the back, but very pale towards the belly. The top of the head is dark greenish-gray, and the shoulders brownish. The edges of the gill-pieces and the throat are straw-yellow. The fins are greenish-gray with a slightly brownish tinge on the lower part of the dorsal.

Hab. Canton.

CYPRINUS AURATUS, Lin. Bl. 93 et 410; C. et V. xvi. *Icon.* Reeves, 121 and a sheet representing 7 varieties; Hardw. Malac. 9; Descript. of Animals, p. 203. f. 213. Chinese name, *Kin tsih* (Birch); *Kan tseih*, "Golden carp" (Reeves); *Kam tsik* (Bridgem. Chrest. 22).

Figure 121 Reeves appears to be the fish in its natural or uncultivated state. Its colours are pure hyacinth-red, with silvery borders to the scales and saffron-yellow edges to the gill-pieces. The pectoral, dorsal and caudal are hyacinth-red with a pale bluish-gray border to the latter. The scaly base of the pectoral is purple and lilac, the rays of the anal are yellow and those of the ventral red. The most brilliant of the cultivated varieties represented in Mr. Reeves's drawings are vermilion and arterial blood-red, picked off with bright gold-yellow. Others have the scales shaded with Berlin- and flax-flower-blue, and are marked with large vermilion patches. One is wholly bronze-coloured, the colour being deepest along the back. All the cultivated varieties have an elevated edge or valve between the nostrils, which is not shown in figure 121, and also the triple caudal: one of them has a double anal; three of them have dorsals but of different sizes, and four of them want the dorsals entirely. One of them has very large eyes, and two or three of them eyes sustained on a telescopic pedestal.

Hab. "The Province of Tche kiang from latitude 27° 12′ N. to 31° 10′ N." (Hist. des Poiss. p. 105.)

Among the 'Icones Piscium 24 a pictore Sinensi,' &c., one figure measuring $8\frac{1}{4}$ inches in length and nearly 2 inches in height, and belonging to the group of *Carassius*, has no representative in Mr. Reeves's portfolio. The dorsal and anal are acute, and the caudal very much so; the lateral line straight and a little below the mid-height, and traced on thirty-four scales. Colour mountain-green, with metallic lustre on the back, replaced below the middle of the sides by a silvery tint. Upper fins coloured like the back, lower ones pale. M. Valenciennes, at p. 101 of the 16th volume of the 'Histoire des Poissons,' mentions two drawings in the Banksian library, one of which may be the figure here noticed, and the other perhaps one of the three paintings which we have alluded to above under the head of *Cyprinus langsdorfii.*

CAPOËTA RHOMBEA, Temm. et Schl. F. J. Sieb. *Rad.* D. 14; A. 12; C. $19\frac{6}{7}$; P. 17; V. 8. (Spec. Brit. Mus. $3\frac{1}{4}$ inches long.)

Lateral line straight a little below the middle, traced on thirty-nine scales: ten rows of scales on the height of the body. First two rays of dorsal and anal jointed, but incumbent on the base of the third one.

Hab. Japan.

CAPOËTA LIMBATA, Temm. et Schl. F. J. Sieb. *Rad.* D. 10; A. 12; C. $19\frac{7}{8}$; P. 13; V. 8. (Spec. Brit. Mus.)

Lateral line decurved in the middle to the lower third of the height and traced on thirty-three or thirty-four scales. The part of the 'Fauna Japonica' relating to this fish and the preceding one is not yet published.

Hab. Japan.

Barbus deauratus, C. et V. xvi. p. 188; *Icon.* Reeves, 154; Hardw. Malac. 96. Chinese name, *Kea yu* (Birch); "Excellent *yu*" (Reeves); *Ka u* (Bridgem. Chrest. 6). Length of the drawing 10½ inches.

Colour of the body a rich golden-yellow, faintly reticulated and changing to silver on the belly. Back marked by six or seven large blotches of umber-brown, which are partly confluent behind the dorsal. Head purplish-red and crimson on the upper half, rest whitish. Tip of the gill-flap sap-green. The basal half of the caudal is pale gall-stone yellow: the other fins have yellowish rays, and their membranes more or less deeply shaded by blackish-gray. Front rays of the anal and pectoral and also the axilla of the latter crimson.

Hab. Canton. Cochin China.

Abramis bramula, C. et V. xvi. p. 357, fide figuræ inter Icon. Piscium 24 a pictore Sinensi Cantoni pictas, Bib. Banks; *Icon.* Reeves, 108; Hardw. Malac. 16. Chinese name, *Peen yu*, "Side fish" (Birch); *Peen yu*, "Flat fish" (Reeves); *Pin u* (Bridgem. Chrest. 9). Length of drawing 19 inches. Height 6 inches. Length of head 3½ inches. Genus *Rhodeus*? Agassiz.

This species is partly rhomboidal in form, the very strong, round and slightly curved dorsal spine crowning the superior angle. The slope is straight from thence to near the base of the caudal, but anteriorly it is moderately convex to the nape, where the depression or horizontality of the facial line gives a considerable concavity to the profile. The posterior underside of the rhomb is shorter than the upper one and is wholly occupied by the anal. The under angle of the rhomb is wanting, the belly being straight from the anus to the pectoral, where the outline again ascends. The height to the apex of the rhomb is equal to nearly a third of the whole length of the fish. The very obtuse lower jaw is a little shorter than the thickish upper one, yet the mouth is terminal. Eye large, a little above mid-height and much nearer to the end of the snout than to the gill-opening. The triangular dorsal commences behind the ventrals and ends opposite to the anus. Its height is equal to half that of the body and much exceeds that of its base. The rays shown in the drawing are D. 2|6, the strong second spine being a little shorter than the adjoining branched ray, and the last ray divided to the base. A. 1|29: the spine strong. Caudal deeply forked. Lateral line traced on forty-one scales, decidedly below the middle height and very slightly decurved. Scales large, very silvery, and on the back faintly oil-green with a well-defined rectangular or crescentic olive or blackish-green spot on the base of each. From the lateral line downwards these spots are replaced by light pearl-gray shadings. The temples and edges of the gill-plates are buff and saffron-yellow; the top of the head hair-brown; and the end of the nose and centre of the operculum bluish- or greenish-gray. Upper half of the operculum reddish-brown; lower half pale yellow. Dorsal clove-brown with a broad bluish-gray border. Anal greenish-gray at the base and bluish-gray on the border. Caudal blackish-gray with a crimson base. Ventrals pale with bluish-gray rays.

Hab. Canton.

Abramis terminalis, Richardson; *Icon.* Reeves, 80; Hardw. Malac. 15. Chinese name, *Peen yu*, "Border fish" (Reeves); *Pin u* (Bridgem. Chrest. 10). Length of drawing 9 inches. Height of body 3. Length of head 1·63 inch. Genus *Rhodeus*?, Agass.

This fish has the rhomboidal form of the preceding species; but the profile of the very small head, instead of being almost horizontal, forms part of the anterior face of the rhomb. The dorsal spine is strong and tall, being equal to two-thirds of the height; but the anal spine is represented as slender. D. 2|7; A. 1|20. Dorsal placed as in the preceding species, its base little exceeding half its height. Caudal deeply forked with very acute lobes. Eye large; snout acute; mouth small. Lips thin, but drawn as if both upper and under one were double. The scales appear to be very delicate and nacry; about fifty-eight are represented as forming the lateral line, which is conspicuously decurved from the middle of the pectoral to the middle of the anal. The scales are shaded with greenish-gray on the back and are pearly on the sides without spots, the resulting general tint being pale. Opercular pieces and eye bordered with oil-green, and there are some reddish tints on the snout and round the gill-opening. The fins yellowish-gray and greenish-gray.

Hab. Canton.

Abramis rhomboidalis, C. et V. xvii. p. 78 (*Leuciscus*).

M. Valenciennes describes this species from a Chinese painting, and it appears from his account of it to have much resemblance to one of the preceding two, but it differs from them both in having a gibbous forehead, in the lateral line traversing the body at mid-height and in the greater number of its anal rays.

Hab. China.

LEUCISCUS CHEVANELLA, C. et V. xvii. p. 358.

Hab. China.

LEUCISCUS MOLITRIX, C. et V. xvii. p. 360; *L. hypophthalmus*, Gray, Cat. Br. Mus.; Richardson, Ichth. of Voy. of Sulph. p. 139. pl. 63. f. 1; *Icon.* Reeves, *a*. 54; Hardw. Malac. 34. Chinese name, *Peen yu*, "Broad fish" (Reeves, Birch). Genus *Aspius*?, Agassiz.

A specimen was presented by Mr. Reeves to the British Museum. Having omitted to describe the colouring in the 'Ichthyology of the Sulphur,' I may here state that in Mr. Reeves's drawing the top of the head is represented of a deep olive-green colour, and that a fainter tint of the same extends along the back, but is glossed with much brassy lustre. Immediately above the lateral line there is a dilute tinge of crimson, and all the under parts are pearl-gray and brightly silvery. The cheeks are silvery. The under lip deep rose-red, and the gill-cover and membrane are washed with the same. The rays of all the fins are more or less brightly crimson, and the membranes, which vary from dark greenish-gray to blackish-gray, are glossed with crimson on the under fins. This tint is richest on the pectorals, and there are also orange colours between the rays of these fins.

Since this fish was figured and described in the 'Ichthyology of the Voyage of the Sulphur' under the specific name given to it by Mr. Gray, I have ascertained by consulting the 'Icones Piscium 24 a pictore Sinensi Cantoni eleganter pictæ,' that it is the *L. molitrix* of M. Valenciennes. The drawing in the work just quoted measures 11 inches.

Hab. Canton.

LEUCISCUS NOBILIS, Gray, Cat. Br. Mus.; Richardson, Ichth. of Voy. of Sulphur, p. 140. pl. 63. f. 3; *Icon.* Reeves, 134; Hardw. Malac. 33. Chinese name, *Tsing yu*, "Eminent fish" (Reeves). Genus *Aspius*, Agassiz.

Mr. Reeves has deposited a specimen of this fish also in the British Museum. The brassy hue of the scales of this and the preceding species draws attention to the names *cupreus* and *æneus* given by M. Valenciennes to two Chinese *Leucisci*, but the few particulars of form which he has recorded do not correspond, and had the drawings he comments upon represented either *hypophthalmus* or *nobilis*, he could not have failed to remark the unusual depression of the eyes into the curve of the preoperculum. In fact both extremities of the suborbitar chain rise above the level of the eye, as they do also, though in a less degree, in *L. jesella* and some other species.

Hab. Canton.

LEUCISCUS ROSETTA, C. et V. xvi. p. 356. Length of figure 10½ inches, the head one-third of the length.

L. nobilis is the only *Leuciscus* represented by Mr. Reeves's drawings which has so large a head as *rosetta*; and in *nobilis* the head equals the third of the length only when the caudal is excluded. There is no drawing of this species among the 'Icones Piscium 24 a pictore Sinensi,' &c.

Hab. China.

LEUCISCUS RECURVICEPS, Richardson. *Icon.* Reeves, 149; Hardw. Malac. 14. Chinese name, *Yaou king*, "Stiff necked" (Birch); *Keu too*, "Hooked head" (Reeves). Length of figure from mouth 15 inches. Height of body 3·3. Length of head 3. Genus *Aspius*, Agassiz.

This fish is remarkable for the face being inclined upwards by a sudden curvature over the temples like the profile of a pug-dog. The nape rises in a short arc, but the dorsal line is only slightly convex, while the belly is considerably more curved, and the tail behind the anal is slender. The head, excluding the lower jaw, is one-fifth of the length of the fish; and the height of the body is a little more. The drawing represents a convex keel between the ventrals and anus. The cleft of the mouth is vertical, with a curve towards its angle; and the lower jaw, which forms the anterior end of the head, is dilated and apparently naked, like that of *Aspius mento* and *maxillaris*. The large eye is equal in diameter to a fourth part of the length of the head, and is situated one diameter behind the mouth. The lateral line is decurved at its commencement, and makes a sudden short bend downwards under the dorsal, after which it ascends very gently in a straight line till it has passed some way beyond the anal, and then runs straight for the short remaining space to the caudal. Scales small, there being about sixty-eight rows represented between the gill-opening and caudal. Dorsal having a height in front of twice the length of its base, acute and placed over the middle space between the ventrals and anal. Its second ray is represented as strong, round and curved like that of a *Rhodius*, and the first one as slender, but only a third part shorter. Anus behind the middle, ventrals well forward, and the pectorals triangular and acute. D. 2|6; last divided to base; A. 31. Caudal forked. The scales have silvery discs, and are shaded at the base with greenish-gray on the back; on the upper part of the sides with very pale buff or ochre-yellow; and below the lateral line with pearl-gray, the whole being very bright, except on the summit of the back, where the gray spreads over the entire discs of the scales. Dorsal the colour of the back, with a brownish tint on the rays. Pectoral, ventrals and anal colourless on the outer halves, and yellowish-brown at the base. In the anal the brown is confined to the fore part of the fin. The caudal is tinged with darker yellowish-brown at the base, and is bluish-gray on the posterior half.

Hab. Canton.

LEUCISCUS MOLITORELLA, C. et V. xvii. p. 359; *Icon.* Reeves, 110; Hardw. Malac. 22. Chinese name, *Too ling**, "Land carp" (Birch); "Ground carp" (Reeves); *To ling* (Bridgem. Chrest. 33). Length of drawing 13½ inches. Height of body 3·1 inches. Length of head 2·15. Genus *Aspius*?, Agassiz.

This drawing has all the characters recorded by M. Valenciennes of *molitorella*, except that the caudal has longer and more pointed lobes than other *Leucisci* represented in Mr. Reeves's drawings, while this fin is said in the *molitorella* to have the lobes rounded and little lengthened. I have not however thought it advisable to keep it distinct merely because of this discrepancy. In the drawing the snout projects beyond the mouth, which is small, with the lower jaw shutting close up. Its dorsal is large, triangular, and as high in front as the body, with a base nearly as long as its height. The ventrals are attached beneath its middle. The anal is nearer to the caudal than to the ventrals. The rays are D. 12 or 13; A. 7.

The summit of the back is olive-green, with a quadrangular spot at the base of each scale of dark duck-green approaching to blackish-green. These spots disappear above the lateral line, which is nearly straight, and give place to a pale shading of bluish-green, which is replaced on the belly by cream-yellow, the discs of the scales being mostly silvery. About twelve of the scales immediately above the pectoral fin are bordered with china-blue, their discs remaining silvery, and thus producing a reticulated rhomboidal spot. The dorsal, ventrals and anal are very pale mountain-green and transparent; the first being oil-green at the base, and the two latter tipped with peach-blossom red. The caudal has greenish rays and roseate tints with a bluish-gray edge; and the rays of the pectoral are also greenish with a faintly roseate membrane. The sides of the head are silvery, shaded with green and glossed by some rose-coloured and lilac tints.

Hab. Canton.

LEUCISCUS FINTELLA, C. et V. xvii. p. 356.

Hab. China.

LEUCISCUS HEMISTICTUS, Richardson. *Icon.* Reeves, 133; Hardw. Malac. 26. Chinese name, *Tsing yu* (Reeves, Birch). Length of figure 14½ inches.

L. fintella is represented as being thrice as long as it is high; but in the figure of *hemistictus* the height is contained four times and a half in the length, and the head five times. It has a general resemblance to the *Barilius goha* of Buchanan Hamilton, p. 385 (Hardw. Malac. 36 and 53; *Opsarius gracilis*, M'Clelland, 47. f. 1), but it wants the spots on the head, and the dots on the body are blacker and more regular. The profile of *hemistictus* is symmetrically fusiform. The head is a slender cone with a bluntish apex; and the lower jaw, which is shorter than the upper one, is represented as shutting as it were partly within it. The dorsal commences a little before the ventrals, which are attached in the middle of the length, caudal excluded, and the vent terminates the third quarter of the same distance. No streaks on the gill-cover. Scales large, smooth and nacry, thirty-eight in a longitudinal row and eight or nine in height. The lateral line is evenly decurved and runs beneath mid-height till it passes the anal, after which it runs straight in the middle of the tail. Back olive-green with a narrow border of paler oil-green to the posterior edge of each scale, and a well-defined round spot of blackish-green or greenish-black on the base, making six rows in the middle of the

* Ling is "a kind of carp," "a fish resembling a carp."

body, all of them above the lateral line, but only four on the trunk of the tail; one of them below the lateral line. The discs of the scales are more silvery on the sides, and beneath the lateral line they are faintly shaded at the base with pearl-gray, and have neither spots nor coloured borders. Head greenish above, glossed with crimson on the snout, temples and operculum, and silvery with yellow shadings beneath. Dorsal yellowish-gray. Pectorals greenish at the base and cream-yellow elsewhere. Anal and ventrals pale cream-yellow with ochraceous rays. Caudal dark blackish-gray. Iris silvery with a patch of orpiment-orange.

Hab. Canton.

Leuciscus machærioides, Richardson. *Icon.* Reeves, 111. Hardw. Malac. Chinese name, *Lan taou*, "Rope-knife" (Birch); *Lan tow* (Reeves). Length of figure 7⅓ inches. Height 1¼ inch. Genus *Chela* ?, Buch. Ham. *Pelecus* ?, Agassiz.

The shading of the drawing seems to indicate that the belly of this fish is acute from the middle of the pectorals to the anus. Its back is very flatly arched, the nearly horizontal face forming part of the curve, which is much inferior in convexity to the belly. The height of the body is about equal to the seventh of the length, of which the head forms less than an eighth part. The scales seem to be small and delicate, and the lateral line descends at its commencement in a short arc to the lower quarter of the height, and then runs horizontally from the last quarter of the anus, where it rises parallel to the curve of the attachment of the anal fin, and again resumes its horizontal direction when it has reached the middle of the tail. The dorsal commences a little behind the front of the ventrals or in the middle of the length, caudal excluded. It is taller than the anal, and equals it in the length of its base. The caudal is forked.

The very silvery scales are shaded at the bases with leek-green on the back and light pearl-gray on the belly. The fins are pale mountain-green, transparent and without spots, except the pectoral, which is asparagus-green with a blackish spot on its inferior angle, near the base. There are some greenish-yellow shadings on the head.

Hab. Canton.

Leuciscus acutus, Broussonnet MSS. in Descript. of Anim. p. 205. fig. 194 (*Cyprinus*). *Leuc. acutirostris*, Gray, Cat. Br. Mus. *Icon.* Reeves, *a.* 42; Hardw. Malac. 29. Chinese name, *Leen taou* (Birch); *Leen tou*, "Sickle or reaping-knife" (Reeves). Length of figure 7·35 inches. Height of body 1·85 inch. Length of head 1·35 inch.

This figure has considerable resemblance to *L. machærioides*, and the curvature of the lateral line is the same, but it has a straighter back, a more convex belly, higher body, and a longer and lower anal. The head is equally slender, the snout and lower jaw more acute, and the eye larger. The triangular and acute dorsal commences opposite to the axilla of the ventrals. The pectorals are very acute and the anal reaches near to the caudal. The rays shown in Mr. Reeves's figure are D. 8; A. 15. In the 'Descr. of Animals' they are noted as D. 8; A. 14; C. 18; P. 15; V. 8. About thirty-four scales exist in a longitudinal row, and there are ten or eleven rows in the height.

Colour of the back pale and pure wood-brown with seven pale crimson, longitudinal streaks in the whole height, corresponding with the rows of scales. Below the middle height the scales are shaded with pearl-gray. The caudal is pistachio-green, the dorsal, anal and pectorals ash-gray, with a blotch of rich carmine on the base and first ray of the dorsal, and a slight blush of the same on the base of the ventrals, the first anal ray, and all the pectoral rays.

Hab. Canton.

Leuciscus idella, C. et V. xvii. p. 362. *Icon.* Reeves, 122; Hardw. Malac. 23. Chinese name, *Hwan yu*, "Hwan fish" (Birch); *Hwan u*, "Strong carp" (Reeves). Length of figure 17½ inches. *Icon.* Piscium a pictore Sinensi 24, &c., drawing 14½ inches long. *Rad.* D. 9; A. 9; C. $19\frac{6}{6}$; P. 19; V. 8, *omnes articulati.* (Spec. Br. Mus.) Genus *Aspius* ?, Agassiz. An *Idus* ?, Heckel.

A specimen deposited in the British Museum by John Reeves, Esq. measures fourteen inches in length. It is fusiform, with a thickish tail and rather acute snout, perfectly well represented by Mr. Reeves's drawing. The stoutish upper jaw projects beyond the lower one, and curves slightly over it, but the rictus of the mouth is not large and does not reach backwards to the nostrils. Operculum finely streaked. The eye is rather above the middle height of the head, and the furrowed preorbitar and temporal extremity of the suborbitar tubes rise above its level. The maxillary touches the corner of the mouth, but scarcely forms part of the upper lip. It is semi-lanceolate with a straight fore-edge. The lateral line descends a little at its commencement, and when opposite to the acute tip of the pectoral, takes a straight course along the middle of the height to the tail. It is traced on thirty-six scales, and there are nine rows of scales in the height of the body, of which five are above the lateral line. The dorsal commences a little before the middle of the length, caudal excluded, and its height, which is equal to two-thirds of the height of the body, measures almost twice the length of its base. The last ray being comparatively longer and the corners of the fin rounded, it has not the triangular form of the dorsal of many of the other *Leucisci*. The front of the ventrals is under the middle of the dorsal, and the anal is midway between them and the caudal.

The large discs of the scales, down to a row beneath the lateral line, have an uniform oil-green tint with much lustre, and are surrounded by a defined border of deep duck-green, producing hexagonal reticulations. Lower down, the discs of the scales are silvery, and the meshes that enclose them pass into ochre- and cream-yellows. The base of the pectoral and scales before that fin have a red-lilac tint, and the head corresponds in colour with the body, being green above and ochraceous or cream-coloured below. There is a little blue around the eye and on the upper corner of the operculum. The pectorals are green, with a brownish gloss; the ventrals buff-coloured, and the other fins dark greenish-gray, the rays of the caudal being dark green. In the figure belonging to the collection in the Banksian library quoted by M. Valenciennes, the bases of the scales are darker than the borders, but the drawings are otherwise so much alike as to occasion little doubt of their being representatives of the same species.

Hab. Canton.

Leuciscus piceus, Richardson. *Icon.* Reeves, 153; Hardw. Malac. 24. Chinese name, *Hĭh hwan*, "Black hwan fish" (Birch); *Hih wan*, "Black ——" (Reeves); *Hak wan* (Bridgem. Chrest. 233). Length of the figure $15\frac{1}{2}$ inches. Height of body 3 inches. Length of head $3\frac{1}{2}$ inches.

This fish is elongated like *idella*, but is rather less symmetrical, has even a thicker tail, more obtusely-forked caudal, and more unevenness in the profile of the head and shoulders. The mouth is similarly formed, the eye in the same position, and the fins similar in place and form. The scales are smaller but appear to be equally strong, and the lateral line as distinctly marked by an elevated straight tube on each scale. It runs very nearly straight, or with a slight general decurvature along the middle of the fish. The fins are taller than those of *jesella*, the dorsal being equal in height to the body, and the anal not very much lower. All the fins are obtuse. The operculum and supra-scapulars are furrowed.

General colour pitchy or blackish-brown, deepest on the back, and gradually changing on the belly to bluish-gray. The scales are not enclosed in a dark mesh-work like those of *jesella*, but are darkest on the fore-edge, and grow gradually paler towards their bases. Head blackish-gray above, beneath white. There is a greenish tint on the breast and a tinge of crimson along the edge of the belly. All the fins are blackish-gray, deepening to black towards the edges, and their rays are whitish at the base. There are forty-three scales on the lateral line, and ten or eleven rows in height. The rays shown are D. 9; A. 10, &c.

Hab. Canton.

Leuciscus coreensis, C. et V. xvii. p. 355.

Hab. Japan. Corea.

Leuciscus jesella, C. et V. xvii. p. 360.

Hab. Canton.

Leuciscus xanthurus, Richardson. *Icon.* Reeves, 112; Hardw. Malac. 25. Chinese name, *Hwang we ling*, "Yellow-tailed carp" (Birch); *Hwang ne ling* (Reeves); *Wong mi ling* (Bridgem. Chrest. 30). Length of figure 11 inches. Height of body nearly 3 inches. Length of head 1·8 inch. Genus *Aspius* ?, Agassiz.

This figure represents a fish with an elevated back rising to a point at the beginning of the dorsal. The anterior slope is varied by a moderate gibbosity of the nape, but the posterior one runs in a perfectly straight, obliquely-descending line to the caudal fin. Belly most prominent under the middle of the pectorals, sloping suddenly up to the throat and very gradually to the caudal. Head small. Eye large and low in the cheek. Snout full and apparently fleshy, projecting beyond the lower jaw, which shuts up beneath it. Pectorals small, acute. The dorsal commences in the middle of the distance between the top of the snout and base of the caudal, and its second ray is represented as stout, round, and acute, like that of a *Rhodeus*, the third one being also simple, but more slender and shorter. D. 3|6, last divided to base;

A. 11, &c. The front of the ventrals is rather before the dorsal: the anal is small, the caudal deeply forked with thickish lobes. The lateral line is a little decurved over the pectoral, and then takes a straight course below the middle of the height to the caudal. It is traced on about forty-eight scales, which are consequently rather small, fourteen or fifteen rows are represented in the height.

The colour of the back is pure oil-green, the silvery borders of the scales increasing in breadth on the flanks, the green is confined to a slight tinge on the base of each, and on the belly it is replaced by pearl-gray. Caudal saffron-yellow with a bluish-gray border. The top of the head is coloured like the back, the snout and under jaw are crimson, the temples mountain-green, and the operculum purple. The dorsal is pale buff with the third ray crimson, and there are crimson tints on the bases of the inferior fins; the front of the anal being yellowish-green. All the inferior fins appear to be transparent.

Hab. Canton.

Leuciscus bambusa, Richardson, Ichth. of Voy. of Sulphur, p. 141. pl. 63. f. 2. *Icon.* Reeves, 286; Hardw. Malac. 32. Chinese name, *Chŭh nuy yu*, "Bamboo spoilt fish" (Birch). (An *Chela*, Ham. Buch.? *Pelecus*, Agassiz?)

A specimen was presented to the British Museum by John Reeves, Esq. which measures seventeen inches in length. Not having seen Mr. Reeves's drawing of this species until after the publication of the 'Ichthyology of the Voyage of the Sulphur,' the colours of the recent fish were not therein described. They are pale chestnut-brown on the back with silvery discs to the scales, and a gradual passage into greenish-gray on the belly. The jaws, pectorals, lower fins, and under lobe of the caudal are ochre-yellow; the upper lobe of the caudal the same, with a greenish tinge, and the dorsal greenish-blue. There are also some blushes of carmine at the bases of the ventrals and caudal. This *Leuciscus* is remarkable for the size and solidity of the intermaxillaries, and for the conical process which rises from the symphysis of the lower jaw, as well as for its slender form.

Hab. Canton.

Leuciscus curriculus, Richardson. *Icon.* Reeves, 141; Hardw. Malac. 28. Chinese name, *Hĭh shĭh wan*, "Stone-black barrow (Birch); "Black-stone carriage" (Reeves); *Hak shik wan* (Bridgem. Chrest. 236). *Rad. omnes articulati*; D. 8; A. 9; C. $19\frac{3}{4}$; P. 19; V. 9. (Spec. Br. Mus. J. R. Reeves, Esq.) Length $8\frac{1}{4}$ inches. Height of body $1\frac{1}{2}$ inch. Thickness 0·95. Length of head 1·48 inch.

Shape fusiform, with a conical head and narrow snout slightly longer than the lower jaw. The lateral line runs in the middle of the height, and has a gentle decurvature from end to end. It is traced on forty scales, and there are ten or eleven rows in the height. The height slightly surpasses the length of the head, and is contained five times and a half in the total length of the fish. The dorsal, narrow and less in height than the body, commences opposite to the front of the ventrals, which are in the middle of the length, caudal excluded. The pectorals are obtuse and do not reach the ventrals. The anal is short and similar to the dorsal. Caudal forked. Operculum striated.

Colour of the back liver-brown, with greenish glosses and longitudinal streaks of darker brown. Beneath the lateral line the scales have much nacry lustre and a very pale roseate tint. There are some grass-green tints round the eye and on the operculum. The fins are dark olive or blackish-green, with crimson tints on the bases of all except the dorsal.

Hab. Canton.

Leuciscus vandella, C. et V. xvii. p. 363. Icones Piscium 24 a pictore Sinensi, &c. (two figures on separate sheets).

Judging from the drawings, this approaches closely to *curriculus*, but its caudal is more forked and the lateral line more bent down and in a different curve.

Hab. Canton.

Leuciscus plenus, Broussonnet MSS. in Descript. of Anim. p. 204. fig. 197 (*Cyprinus*).

This sketch most resembles *L. curriculus* (141 Reeves), but does not quite agree with it. "The head is oblong, somewhat depressed. Body oblong and roundish. Dorsal nearly in the middle. Tail bifid. Ventrals opposite to the posterior ray of the dorsal. Pectorals pointed. Lateral line convex downwards." "D. 8; A. 11; C. 20; P. 14; V. 10." A foot long.

Hab. "Canton river."

Leuciscus cupreus, C. et V. xvii. p. 361.

Hab. China.

Leuciscus homospilotus, Richardson. *Icon.* Reeves, *a.* 20; Hardw. Malac. 27. Chinese name, *Hung yen seun*, "Red-eyed sprout" (Birch); *Hung lang seun*, "Red-eyed? *seun*" (Reeves); *Hung ngen sun* (Bridgem. Chrest. 236). Length of figure 10 inches. Height of body 2·2 inches. Length of head 1·9 inch. Genus *Aspius*?, Agassiz. *Alburnus*?, Heckel.

This fish has an elegant, symmetrical fusiform shape, the back rather less arched than the belly, the face nearly straight, and a very slight gibbosity at the nape. The head is slenderly conical with an obtuse snout, projecting a little beyond the lower jaw. The eye is nearly in the centre, between the tip of the snout and the gill-opening, and the nostrils are considerably before it. Dorsal rounded, commencing opposite the front of the ventrals. Anal short, moderately high. Caudal forked. Lateral line equally decurved to near the caudal, descending a little below the middle opposite to the ventrals, and traced on about thirty-five scales. There are nine rows in the height. D. 9; A. 9 or 10, &c.

Colour of the back pure wood-brown, with four or five streaks of the same through the rows of scales. The scales are shaded with pearl or ash-gray below the lateral line. Caudal leek-green. Dorsal, anal and ventrals mountain-green, with crimson tints on the rays. Pectorals crimson and asparagus-green. Upper quarter of the iris orpiment-orange, the rest silvery. There are a few black specks on the commencement of the lateral line, and three short rows of similar ones above it; the middle row being under the dorsal and the two others on the shoulder.

Hab. Canton.

Leuciscus æneus, C. et V. xvii. p. 361.

Hab. China.

Leuciscus temminckii, Temm. et Schl. F. J. Sieb. (unpubl.) *Rad.* D. 9; A. 13; C. $19\frac{7}{9}$; P. 13; V. 9. (Spec. Brit. Mus. 2·4 inches long.)

Lateral line decurved, principally in the pectoral region, to the lower quarter of the height. Forty-two scales in a row. A dark longitudinal stripe on the middle of the side. Lateral line lower than that of *L. homospilotus*, which this fish resembles in profile.

Hab. Japan.

Leuciscus platypus, Temm. et Schl. F. J. Sieb. (unpubl.) *Rad.* D. 9; A. 12; C. $19\frac{7}{9}$; P. 17; V. 9. (Spec. Brit. Mus. 5 inches long.)

Lateral line decurved to lower third of height. Forty-three scales in a row. Rays of the anal curiously compressed.

Hab. Japan.

Leuciscus minor, Temm. et Schl. F. J. Sieb. (unpubl.) *Rad.* D. 9; A. 11; C. $19\frac{6}{7}$; P. 15; V. 9. (Spec. Brit. Mus. $3\frac{3}{4}$ inches long.)

Lateral line decurved to the lower quarter of the height. Thirty-nine scales in a row.

Hab. Japan.

Cobitis anguillicaudatus, Cantor, Ann. Nat. Hist. ix. p. 30. An. 1842; Richardson, Ichth. of Voy. of the Sulph. p. 143. pl. 55. f. 9, 10. *C. pectoralis*, M'Clelland, Calc. Journ. Nat. Hist. iv. p. 400. pl. 23. f. 3. An. 1844. *C. erythropterus*, Temm. et Schl. F. J. Sieb. *Icon.* Reeves, 278; Hardw. Malac. 118 et 119. dupl.

The British Museum and the India House are in possession of several of Dr. Cantor's specimens, and of a Japanese one named by the authors of the 'Fauna Japonica; five or six were presented by Sir Everard Home, Bart. to the College of Surgeons.

Hab. Canton. Chusan. Yang tze kiang kew.

Cobitis psammismus, Richardson. *Icon.* Reeves, 145; Hardw. Malac. 120. Chinese name, *Sha chuy*, "Sand club" (Birch); *Sha Chiuy*, "Sand-needle" (Reeves); *Sha chui* (Bridgem. Chrest. 104). Length of drawing $7\frac{1}{2}$ inches.

In this drawing only four barbels are shown, and the ventrals are a little farther forward than in *anguillicaudatus*. The general colour of the body is umber-brown, pretty dark on the back, but paler and with silvery lustre on the sides. The fins are also brown. A considerable number of oblong or roundish black spots are pretty equally scattered over the whole body, and there are more crowded round ones on all the fins except the ventrals.

Hab. Canton.

Cobitis hæmatopterus, Temm. et Schl. F. J. Sieb. *Rad.* D. 7; A. 5; C. $16\frac{10}{10}$; P. 11; V. 7. (Spec. Br. Mus. $5\frac{1}{4}$ inches long.)

Hab. Japan.

Fam. Scopelinidæ (Müller).

Saurus nehereus, Buchanan Hamilton (*Osmerus*), Fish of Ganges, p. 209; *Wana motta*, Russell, 171. *Salmo microps* et *Harpodon*, Lesueur, Journ. Ac. Sc. of Phil. v. pl. 3. f. 1, 1 a. *Saurus ophiodon*, Cuv. Règn. Anim. ii. p. 314; Descript. of Anim. p. 192. fig. 160; *Icon.* Reeves, α. 18; Hardw. Malac. 207 (et 208, 209, dr. of *Osmerus nehereus* of India). Chinese name, *Kow too*, "A dog vomiting" (Birch); *Kou tza*, "Dogs' guts" (Reeves); *Kau to u* (Bridgem. Chrest. 164). *Rad.* D. 12; A. 15 (vel 13–14); C. $17\frac{7}{7}$; P. 9; V. 9. (Spec. Coll. Surg.)

The British Museum possesses a Canton specimen of this fish, presented by Mr. Reeves, and there are many in the museum of the College of Surgeons, which were sent from Woosung by Capt. Sir Everard Home, Bart., R.N. Mr. Reeves mentions that this is the species which is exported from Bombay in a dried state, and sold in London under the name of "Bombay ducks." In Mr. Reeves's drawing, a long spinous-looking prolongation of the suboperculum is shown, which seems to have originated in some mistake of the artist, as there is no trace of it in the specimen. The skin is naked, except the lateral line, which is protected by moderately-sized tiled scales, which are more crowded posteriorly and run out on the caudal, forming a middle point or lobe which is shorter than the side. The largest specimen we have examined is eleven inches long.

Hab. Sea of China. Indian ocean. Chusan. Woosung. Canton.

Saurus lemniscatus, Lacépède (*L'Osmere galonné*), v. p. 230. 238. pl. 6. f. 1. *Saurus elegans*, Gray, Cat. Brit. Mus. *Icon.* Reeves, 188; Hardw. Malac. 206. Length of drawing 9 inches.

This drawing resembles *Salmo fœtens*, Bl. 384. f. 2, more than any other *Saurus* of which we have seen a figure. It has the same very short obtuse snout, short pectorals, forward ventrals and long anal, but *S. fœtens* has an unspotted body and is an inhabitant of the Atlantic. Lacépède's figure of *lemniscatus* is rude, but his description of the patterns of the markings answers exactly to Mr. Reeves's drawing, though the colours are not the same. His plate and his description are both founded upon a drawing on vellum by Plumier, and it is very probable that in the lapse of time the colours may have undergone considerable change, assuming that they were perfectly correct in the first instance.

In Mr. Reeves's drawing, the ground-colour on the top of the back is lemon-yellow, which is thickly speckled with irregular spots of brownish-red and umber-brown; on the sides the yellow forms about four longitudinal stripes, alternating with purplish-red ones, the latter becoming broader and changing to crimson on the belly. The head is mostly of the purplish-red tint, and there is a black spot on the supra-scapular. The dorsal, ventrals and anal are transparent and faintly crimson, with one yellow bar on the ventrals and two or three on the dorsal. The dorsal is yellowish at the base and blackish-gray on its posterior border. The cheeks and body are scaly, but no scales are shown on the gill-cover.

Hab. Sea of China.

Saurus variegatus, Commerson in Lacépède (*Salmone varié*), v. p. 157–224. pl. 3. f. 1. *Icon.* Reeves, 187; Hardw. Malac. 205. Chinese name, *Hwa kow kwăn*, "Flowery dog stick" (Birch); *Fa kow kwan*, "Painted dog stick" (Reeves). *Rad.* B. 12; D. 13; A. 7, last one divided to the base; P. 15; V. 8. (Spec. Brit. Mus.)

A Chinese specimen was presented to the British Museum by Mr. Reeves. The teeth of the upper jaw are small, unequal in height, and disposed in two rows; the lower jaw ones are longer, hastate, and in three or four rows. The teeth which arm the palatine bones are cardiform; those on the tongue are very strong. The ground colour of the back is a mottled mixture of greenish-gray and yellow, varied by fifteen or sixteen transverse bars composed of small spots of umber-brown. These bars are irregular on the top of the back, but they descend below the lateral line, and are there more distinct, from the intervening spaces being gamboge-yellow. The belly is brightly silvery. The head is varied by many spots of umber-brown, the jaws being also much spotted. The caudal is pale orange-brown, with about nine transverse bars thickly spotted with umber. The other fins are more or less deeply yellowish-brown with five or six rows of darker spots on the rays, except the pectorals, which do not appear to be spotted.

The *Dentex nebulosus* (Banks and Solander, Parkinson, Icon. 113. Bib. Banks), which frequents the seas of Otaheite, has considerable resemblance to this species.

Hab. Seas of China and the Mauritius.

Saurus argyrophanes, Richardson. *Icon.* Reeves, β. 15; Hardw. Malac. Chinese name, *Kin lin chuy*, "Silk-scaled chuy" (Birch); *Kin lin cheuy*, "Silver-scaled *cheuy*" (Reeves); *Kam lun chui* (Bridgem. Chrest. 165). *Rad.* D. 9*; A. 11*; V. 9 (*ex figurâ*). Length of figure 10 inches.

This, judging from the drawing, is a more elongated species than the preceding ones, the height of the body scarcely exceeding a seventh of the total length. The eye is moderately large, and is situated over the middle of the cleft of the mouth. The pectorals, which are not large, reach just to the front of the ventrals, and the dorsal commences over the axilla of the latter fins. The caudal is forked as in the preceding two species, without any middle lobe. The lateral line is strongly marked, and one of the most distinctive characters of the fish appears to be the strong contrast between the colours above and below the line, the upper parts being a decided yellowish-brown, darker on the edges of the scales, producing reticulations, and the lower parts bright silvery, the two tints being exactly defined by the lateral line, which is darker than the other parts. The head is mostly coloured like the back. There are no spots either on the body or fins, but the ends of the pectorals and the posterior edge of the caudal are blackish.

Sir Edward Belcher's collection contains a *Saurus* which I should be inclined to refer to the species represented by Mr. Reeves's drawing, but for the greater acuteness of the snout of the specimen. They correspond in colours and position of the fins. In this specimen the height of the body is inferior to its width, and is contained about eight times in the total length. The back is rounded and depressed, and the thickness diminishes gradually from the dorsal fin to the tip of the acute snout, and also in the other direction to the slender tail, which is round near the base of the caudal fin. The jaws are equal. The cleft of the mouth exceeds half the distance from the tip of the snout to the edge of the gill-cover. The centre of the eye is rather behind the middle of the cleft, and the length of the head exceeds a fifth part of the whole length, or more exactly forms a fourth part of the length, caudal excluded. The eyes encroach on the profile and are about a diameter apart, the edges of the orbits being deficient or notched above. The interorbital space is concave. The occiput ends in a serrated edge, which is slightly concave posteriorly, and the supra-scapulars also show a projecting rough edge. The fronts of the ventrals are attached exactly midway between the tip of the snout and the vent. The tips of the pectoral reach just to their first ray, and the commencement of the dorsal is a little behind the axilla of the ventrals. The rays are B. 12–13; D. 10; A. 12; C. $17\frac{4}{6}$; P. 13; V. 8. The lateral line is straight and is formed by a series of pores; there are also a number of lines parallel to it, produced by the transparency of the scales, permitting the meeting of the edges of two rows to shine through the discs of the intervening incumbent row. The teeth are slender with lanceolate tips, but none of them appear to be distinctly barbed. In the upper jaw, the tall ones are inclined forwards and are ranged in a widely-set series, with some shorter ones at the base. In the lower jaw there are several graduated rows inclined inwards, the interior row being the tallest. The palatine teeth form card-like plates which approach each other anteriorly in an acute angle, leaving a narrow smooth space on the mesial line. The surface of the tongue is also armed by rows of teeth, but smaller than any of the others we have mentioned. The edges of the branchial arches are rough, with much more minute teeth, very dissimilar to the slender, curved and barbed teeth of the gills of *Harpodon*.

Hab. Most probably the China seas.

Myctophum boops, Richardson, Ichth. of Voy. of Erebus and Terror, p. 39. pl. 27. f. 6–12.

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* The incumbent front ray of these fins is omitted in the figure, and the formula ought to be D. 10; A. 12, &c.

Sir Edward Belcher and Sir James Ross brought home examples of this species, which have been deposited in the British Museum.

Hab. Seas of China (Belcher). New Zealand and Australia (Ross).

ASTRONESTHES NIGRA, Richardson, Ichth. of Voy. of Sulphur, p. 97. pl. 50. f. 1–3.

Sir Edward Belcher obtained two specimens.

Hab. China seas. ?

LEUCOSOMA CHINENSIS, Osbeck (*Albula*), Voy. i. p. 385. *Leucosoma reevesii*, Gray, Zool. Misc. p. 4; *Icon.* Reeves, 144; Hardw. Malac. 212. Chinese name, *Pih fan yu*, "White rice fish" (Birch); *Pih fan yu*, "White *fan yu*" (Reeves); *Pak fan u* (Bridgem. Chrest. 244); *Pack fanny* (Osbeck). *Rad.* "B. 3;" D. 11; A. 25; C. $19\frac{1}{14}$; P. 10; V. 6 vel 7. (Spec. Reev.)

Examples of this fish exist in the British Museum, where they were deposited by Mr. Reeves and General Hardwicke, in the Chinese collection at Hyde Park, and in the Cambridge Philosophical Institution, to which they were presented by the Rev. George Vachell. As Osbeck's generic appellation was in his day generally applied to the *Coregoni*, it is probable that he did not consider this fish as presenting peculiar generic characters, and had no intention of restricting the name of *Albula* to this species; Mr. Gray's expressive one of *Leucosoma* is therefore the proper generic appellation for this very peculiar form: besides, Bloch after Osbeck gave the name of *Albula* to the genus *Butirinus*, and its re-introduction would lead to confusion. It is the "white bait" of the foreign residents at Macao.

Body elongated, roundish anteriorly; compressed and higher at the dorsal, which is far back, the compression increasing in the tail, which is again more slender. A furrow runs along the top of the back to the front of the dorsal and reappears behind that fin. There is likewise a furrow from the ventrals to the anus, and the very low posterior part of the anal stands also in a furrow. The body is scaleless and transparent, so that the muscles, intestines and spinal column can be seen without dissection. Head and jaws very much depressed, presenting a mere edge in profile, but when viewed from above, showing a lanceolate outline much like the bill of a *Tyrannula*. The head appears to be composed chiefly of thin, flexible and diaphanous bone. A fine short mesial ridge exists at the end of the snout, and farther back there is a rhomboidal membranous space, which is perforated by three holes, through each of which a tooth of the lower jaw protrudes when the mouth is closed. The velum of the upper jaw is posterior to this membranous space. The eyes are lateral and encroach both on the upper and under profiles of the head. Two minute nasal orifices are situated a short way before each eye. The jaws are equal and the short cleft of the mouth is nearly horizontal, but with a slight arching in the middle. The maxillary curves over the angle of the mouth, and sending a fine slip in front of the end of the intermaxillary, forms a considerable part of the margin of the upper jaw. About four widely separated, subulate, recurved teeth arm the limb of each intermaxillary; and between the foremost of these canines and the tip of the jaw there are several much smaller ones in a single series. A close pectinated row of short teeth edges the maxillary; and the lateral teeth of the lower jaw are also smaller and more numerous than the upper ones: but in front, a little within the narrow, unarmed tip of the jaw, three strong teeth stand in a triangle and pass through the holes above mentioned. The palatine bones are finely toothed on the edge, but there are no teeth on the vomer, which is not at all prominent. A row of strong recurved teeth runs along the middle of the pointed tongue. The gill-cover is convex and curves in so as to touch its fellow on the under surface of the head; the opening is large and is partly seen on the upper surface of the head. The gill-membrane unites with the isthmus about one-third nearer to the eye than to the tip of the gill-cover. The ventrals are attached rather before the middle of the fish, the first dorsal considerably farther back, and the adipose fin over the hinder part of the anal, which is wholly behind the dorsal. The first stout ventral ray is jointed, but I can perceive no joints in the short anterior ray of the dorsal and anal. The first two rays of the dorsal are graduated and incumbent on the base of the third one, which is the tallest; the three anterior rays of the anal are also imbedded in the base of the fin*. The pectoral is obliquely truncated, and the caudal is acutely notched at the end. On the base of the fin above and below there is a seam-like edge which is supported by fourteen short rays. The gut appears to be a straight tube without convolutions, but I did not ascertain the absence of pyloric cæca. Length $7\frac{1}{4}$ inches.

Hab. Canton.

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* There is probably some variety in the numbers of the rays as in notes of the specimen belonging to the Cambridge Philosophical Society I find them recorded as D. 14; A. 30. The numbers given above correspond better with the enumeration of Osbeck and Gray.

Fam. SALMONIDÆ.

PTEROGLOSSUS ALTIVELIS, Temm. et Schl. F. J. Sieb.

Two specimens exist in the British Museum labelled as above. They measure 7 inches and $4\frac{3}{4}$ inches respectively.

Hab. Japan.

Fam. CLUPEIDEÆ.

CLUPEA ISINGLEENA, Richardson. *Icon.* Reeves, 60; Hardw. Malac. 219. Chinese name, *Tsing lin*, "Blue scale" (Birch); *Tsing lein*, "Blue scale" (Reeves); *Tsing lun* (Bridgem. Chrest. 82). *Rad.* B. 5, upper ones broad; D. 15; A. 21, slender; P. ; V. 8. (Spec. Br. Mus.) Length $5\frac{1}{2}$ inches.

John Russell Reeves, Esq. presented a specimen of this fish to the British Museum. It is a short high fish with a rounded back and a very acute belly, which is serrated by sixteen teeth before the ventrals and ten behind them. The height is contained thrice in the length to the base of the caudal, or thrice and three-quarters when that fin is included. The curve of the back is slight, that of the belly very considerable, and attaining its apex under the beginning of the dorsal. The length of the head is one-fifth less than the height of the body. The mouth is small and terminal, and the maxillary, which is oval and obtuse at the lower end, reaches to beneath the middle of the eye; near its articulating head, a portion of the oval is deficient on the upper side only. There are no teeth on the jaws, but the lining of the mouth and the oval disc of the tongue are studded with minute papillæ. There are ten rows of scales in the height of the body and forty in a row. The ventrals are under the fore-third of the rather large dorsal, and all the fins are scaly. The scales of the back are bright grass-green with silvery edges; lower down they are more silvery with pale ultramarine blue shadings. The fins are pale asparagus-green, with a yellow tint on the pectorals, and the head is mostly silvery with green shadings, orange iris and gamboge edges to the gill-pieces. There is a dark honey-yellow spot on the humeral bone.

This fish has more resemblance to the *Kowal* or *Kowarloo* of Russell (186) than to any other figure in his book, but he enumerates the dorsal rays as 18. They may however, on a comparison of specimens, prove to be the same. It is not unlike Bloch's figure (pl. 405) of *Clupea sinensis*, but there are no indications of the black bars on the dorsal and caudal in Mr. Reeves's figure.

Hab. Chinese seas.

CLUPEA NYMPHÆA, Richardson. *Icon.* Reeves, β. 25; Hardw. Malac. 222. Chinese name, *Chang yaou lin*, "Long-waisted scale" (Birch); *Chang yaou lin*, "Long fine waist" (Reeves); *Cheung iu lun* (Bridgem. Chrest. 83). *Rad.* B. 6 (*vel* 7?); D. 17; A. 15 (*vel* 16); C. $15\frac{6}{6}$; P. 18; V. 9. (Specimen in the Br. Mus. brought from Canton by Mr. Reeves.)

The head forms a fourth of the length of the fish, caudal excluded, or rather more than a fifth part including that fin. Both back and belly are acute, and the thickness of the body equals half its height. The back rises in a very gentle curve from the snout to the dorsal, and descends still more gently to the caudal. The curve of the belly is more convex from the tip of the lower jaw to the front of the pectorals, but posteriorly it corresponds with that of the back. The end of the under jaw forms the extremity of the head. Eye near the profile. The disc of the maxillary is an oval approaching nearly to a circle, with a short, slender articulating process: its lower end comes under the middle of the eye. The intermaxillary forms the border of the upper jaw, the maxillary merely touching the corner of the small orifice with its rounded shoulder. The centre of the dorsal is a little anterior to the middle of the length, caudal excluded, and the ventrals are attached under the middle of the dorsal. There are forty or forty-one scales in a longitudinal row. The belly is strongly serrated behind the ventrals, but before these fins the points of the keeled scales are more depressed. The pointed scaly process over the pectoral equals the fin in length.

Colour of the back light duck-green with silvery borders to the scales. The sides silvery shaded by faint bluish-green. Head silvery with green shadings and some rich umber tints on the hind-head and humeral bones. Fins asparagus-green with darkish edges to the caudal. The pectorals are wood-brown.

This fish agrees generally with the figure of *Clupanodon sinensis* of Lacépède (v. pl. 11. f. 2. pp. 468, 471), but does not correspond in the numbers of the fin-rays. It may nevertheless be the same; but as the names of *chinensis* and *sinensis* have been too liberally applied to Chinese fish, and to more than one species in this genus, confusion will be avoided by dropping it in this instance, even were the identity of Mr. Reeves's specimen and Lacépède's more clearly made out than we have been able to do. It is very unlike the *Clupea sinensis* of Bloch, 405.

Hab. Chinese seas.

Clupea cæruleo-vittata, Richardson. *Icon.* Reeves, 59; Hardw. Mal. 223. Chinese name, *Hwang tsih*, "Yellow glossy" (Birch); *Hwang tseih*, "Yellow ——" (Reeves); *Wong chak* (Bridgem. Chrest. 84). Length of figure $8\frac{3}{4}$ inches.

This drawing greatly resembles the preceding species in form, and it has even a better title to the epithet of long-waisted. The dorsal curve is similar to that of *nymphæa*, but the ventral one is more gradual anteriorly, its summit being thrown back to the middle of the dorsal. The anal is longer and lower, and the pectoral reaches only one-third of the distance to the ventrals. The rays shown by the artist are D. 17; A. 18 or 19. The scales are as large as those of *nymphæa*, about forty-two being represented in a longitudinal row. No serratures are shown on the belly.

The upper parts are grass-green with a brownish gloss along the top of the back. The sides are more completely silvery, but a little above the middle the scales are bordered by China-blue producing a stripe, and the silvery parts lower down have a purplish reflexion and some pale blue shadings on the bases of the scales. Some crimson tints occur on the sides of the head. Caudal and ventrals asparagus-green. The other fins yellowish- or greenish-gray.

Hab. Chinese seas. Canton.

Clupea flosmaris, Richardson. *Icon.* Reeves, 64; Hardw. Malac. . Chinese name, *Hae ho*, "Sea lily" (Birch); *Hae ho*, "Sea river" (Reeves); *Hoi ho* (Bridgem. Chrest. 85). Length of figure 6 inches.

This drawing represents a rather slender fish with the dorsal curve exceeding that of the belly, and having a culminating point at the commencement of the dorsal. Ventrals far back under the posterior part of the dorsal. Anal short, more than the length of its base distant from the caudal, which is much forked with acute lobes. The skin is represented as nacry without distinct scales, but with the fasciculi of the muscles, which meet in chevrons in the middle height shining through. The rays shown by the artist are D. 11; A. 9.

The back is shaded with leek-green; the sides pearly with blue and crimson reflexions. Head silvery with pale green shadings. Pectorals faintly crimsoned: other fins asparagus-green and transparent. An umber-brown streak runs from the upper angle of the gill-opening over the shoulder and disappears gradually under the commencement of the dorsal.

Hab. Chinese seas. Canton.

In the 'Description of Animals,' p. 201, fig. 149, we have a sketch and short notice of a slender Clupeoid fish having a resemblance to *C. flosmaris* in general form. Its length is stated to be four inches, and the numbers of the rays to be as follows: D. 13; A. 19; C. 14; P. 10; V. 9. "The body long, narrow and somewhat compressed. Dorsal fin in the middle of the back. Tail with two acute lobes. Mouth small, curving upwards. Maxillary flat, narrow, pointed and entire." The belly is represented as serrated, and the pointed maxillary as reaching a little past the eye.

Hab. Canton river.

Clupea gracilis, Temm. et Schl. F. J. Sieb.

A specimen so labelled exists in the British Museum, but it is in bad condition, and I have not been able to identify it with any of the preceding species.

Hab. Japan.

Alosa reevesii, Richardson. *Icon.* Reeves, *a.* 8; Hardw. Malac. 220. Chinese name, *San le* (Reeves, Birch); *Sam lai* (Bridgem. Chrest. 92). *Rad.* D. 17; A. 17; C. $17\frac{6}{6}$; P. 15; V. 8. (Spec. Br. Mus.) Length of fig. 17 inches. Length of spec. 15 inches.

Mr. Reeves deposited a specimen in the British Museum which still retains the original label numbered in reference to his drawing. It has considerable resemblance to the *palasah* of Russell (198), or *Icon.* Hardw. Malac. 214, *fig. indica*, but the pectoral fin is shorter, the coarseness of the scales on the caudal and the numbers of the fin-rays differ, and we therefore keep them distinct. Russell states the rays of *Alosa palasah* to be D. 18; A. 20; V. 9, &c.

In *A. reevesii* the eye is placed considerably below the temporal groove, and the maxillary, which is slender at its head, swells out in the middle into a regular obtuse oval, and reaches back to the hinder edge of the orbit. Some branching veins exist on the shoulder, but none are visible on the gill-cover. No teeth on the jaws or maxillary. The lateral line cannot be made out. The scales are faintly streaked. Thirty of them compose a longitudinal row, and there are thirteen rows over the ventrals. Thirteen depressed teeth exist on the rim of the belly before the ventrals, and there are fourteen more prominent ones behind these fins. The front of the dorsal is midway between the end of the nose and the base of the caudal.

The colour of the back is dark greenish- and blackish-gray, forming lines corresponding in number with the rows of scales. Sides and belly very silvery with pearl-gray lines. Snout and top of the head gray and dull crimson, with a greenish shade over the eye; rest of the head silvery with lilac reflexions. Pectorals cream-yellow, glossed in the upper border with purplish-gray. The other fins clove-brown.

Hab. Chinese seas.

ALOSA PALASAH, Russell, 198.? *Icon.* Reeves, β. 51; Hardw. Malac. 221. Chinese name, *Sam le* (Reeves, Birch); *Sam lai* (Bridgem. Chrest. 183). *Rad.* B. 6; D. 16; A. 18; P. 15; V. 9. (Spec. Br. Mus.) Length of spec. 7 inches. The figure measures 12 inches.

This species has, like *A. reevesii*, much resemblance to Russell's figure 198, and as the fin-rays approach pretty nearly to those of the Indian fish in numbers, we have considered them to be the same, but not without doubt, because there is a difference in the size and form of the pectoral, besides other discrepancies. Mr. Reeves's Chinese specimen differs from *A. reevesii* in having a larger head with its profile running more evenly into that of the back, which is moreover acuminated at the beginning of the dorsal. The head forms a fourth part of the whole length of the fish; the height of the body is contained thrice and two-thirds in that length, and the thickness is equal to a third of the height. The back is acute, and the belly much more so, and strongly serrated between the ventrals and anus. The mesial ridge of the cranium commences between the nostrils, and after dilating a little, tapers off again and disappears without reaching the nape. The sides of the cranium slope a little downwards from the mesial ridge. The shoulder is feebly veined, but the gill-covers are smooth.

The maxillary having an oblong-oval form reaches back to the hinder edge of the orbit. The tongue is widely oval with a small keel on its tip, and the symphysis of the lower jaw also rises in a small point. No teeth on the jaws. Forty scales form a longitudinal row, and there are fifteen rows in height. The pectorals are rather larger than those of *A. reevesii*, and reach nearly to the ventrals, which are attached before the middle of the dorsal. The caudal is much forked.

The scales are shaded by pale leek-green on the back, and by pearl-gray on the sides and belly. The snout and shoulder-plates are glossed with red. The pectorals, ventrals and upper half of the dorsal are cream-yellow, the rays of the pectorals being buff-coloured. The lower parts of the dorsal, anal and caudal are ash-gray, the latter fin being tinted with carmine at its base.

Mr. Reeves mentions that this fish is very plentiful in its season, but is very bony; and Russell makes a similar remark respecting the Indian fish, which is known at the tables of the English residents by the name of "sable-fish."

Hab. Seas of China and India.

ILISHA ABNORMIS, Gray, Cat. Br. Mus. *Icon.* Reeves, 81; Hardw. Malac. 240. Chinese name, *Tsaou pih*, "Dead white" (Birch); *Tso pih*, "White *tso*" (Reeves); *Tso pak* (Bridgem. Chrest. 81). *Rad.* D. 19; A. 48; C. 19$\frac{5}{5}$; P. 16. (Spec. Br. Mus.) Length of spec. 14$\frac{1}{4}$ inches. Length of fig. 15$\frac{3}{4}$ inches.

In the 'Règne Animal' (ii. p. 319) Cuvier mentions that the *jangarloo* of Russell, 191, and his *ditchoee*, 192*, may be separated from the herrings on account of the position of the dorsal behind the ventrals and the length of the anal. Mr. Gray has given this group a name evidently taken from the specific appellation of one of Buchanan-Hamilton's *Clupeæ*.

Mr. Reeves deposited a dried and varnished specimen of *Ilisha abnormis*, numbered in reference to his drawing, in the British Museum. It is a more elongated fish than the *jangarloo*, and consequently much more so than the *ditchoee*. Its profile slopes gently from the nostrils to the shoulder, which is a little gibbous, and then runs horizontally to the dorsal, whence it declines slightly to the caudal. The face has however a marked degree of concavity caused by the intermaxillaries being inclined upwards, which is common to all the known members of the group. The under profile is a long uniform curve, extending from the under

* The *Clupea affinis* (Gray, Hard. Ill. Ind. Zool.) is also a member of this group.

jaw to the end of the anal. The short trunk of the tail behind this fin is slender, and the caudal is forked like the tail of a swallow with long tapering lobes, the lower one being considerably the longest. The dorsal terminates just over the anus, and the belly is most prominent opposite to it. The intermaxillaries are short, lie transversely at the end of the snout, and are armed with a single row of very short subulate teeth. The maxillary has a broad disc, whose width exceeds half its length, and whose end reaches to the articulation of the lower jaw. It is shaped like the valve of a wide *Pinna*, and its fore shoulder only enters into the composition of the orifice of the mouth. Its under edge, which lies on the limb of the lower jaw, is toothed. The point of the lower jaw projects beyond the intermaxillaries. Eye large, near the profile. About fifty scales enter into a row extending from the gill-opening to the caudal, and there are fourteen rows in the height. The belly is strongly serrated by fourteen teeth before the ventrals and thirteen behind them. The anal is long and low.

The scales are very silvery and are tinged on the back by brownish purple-red, and lower down by a very pale cream colour. The jaws are siskin-green; there is a purple blotch on the under part of the preorbitar and a greenish-gray one over the eye. Fins cream-yellow, the vertical ones having also blackish-gray borders. Seven branchial rays are shown in the figure. Their number cannot be made out in the specimen*.

Hab. Chinese sea.

Icon. Reeves, 67; Hardw. Malac. 240, is a smaller drawing than the figure of *abnormis*, but exhibits no other difference in form than a slightly shorter and less pointed pectoral. The back is shaded with pale leek-green instead of brown, and the purplish tints of the head are more extended, but the prevalence of the silvery lustre is so great that there is no striking difference in the colours of the drawings. Length of the figure 14 inches. Number 241 in Hardwicke's 'Malacopterygii' is a drawing of a species captured at Penang, which has a higher shoulder and smaller ventrals than *abnormis*, but otherwise much resembles it.

CHATOESSUS AQUOSUS, Richardson. *Icon.* Reeves, 63; Hardw. Malac. 230. Chinese name, *Shwuy hwa*, "Slipping in the water" (Birch); *Shwuy hwă*, "Watery bone" (Reeves); *Shui wat* (Bridgem. Chrest. 89). *Rad.* D. 18; A. 23; C. $19\frac{4}{5}$; P. 15; V. 8. (Spec. Br. Mus.) Length $7\frac{3}{4}$ inches.

Mr. Reeves has deposited in the British Museum a dried specimen of this fish numbered in accordance with his figure. Its form is symmetrical, the curve of the back corresponding with that of the belly. The height of the body is greatest in front of the dorsal and ventrals, which are opposite to each other, and is contained thrice and three-quarters in the total length. The upper jaw projects beyond the lower one, and the intermaxillaries form two-thirds of the upper lip. The maxillaries are oblong, but taper towards their articulating ends. They reach backwards as far as the anterior third of the eye: the articulation of the lower jaw is under the posterior third. The eye has an elliptical iris, placed vertically like that of a feline animal. There are forty-six scales in a longitudinal row, exclusive of three or four smaller ones on the base of the caudal, and thirteen or fourteen rows in the height of the body. The keeled belly is armed by thirteen spinous teeth behind the ventrals, and by about fifteen before them; but the latter are nearly obsolete. The ventrals are rather before the middle of the length, caudal excluded. The upper parts are leek-green with silvery edges to the scales, and the lower parts silvery and pearl-gray, with a crimson blush. Caudal and anal oil-green. Dorsal and ventrals pale oil-green, the former tipped with carmine. Pectorals yellow. There are some blue and carmine tints on the head.

This fish approaches the *Cl. nasus*, Bl. 429, f. 1, in form, but does not agree exactly either with that figure or the *Kome* of Russell, 196, and there is a difference in the numbers of the fin-rays.

Hab. Chinese sea.

CHATOESSUS TRIZA, Linn. Amœn. Acad. Chinens. Lagerstr. No. 30, An. 1754 (*Clupea*). *Icon.* Reeves, 224; Hardw. Malac. 232. Chinese name, *Yen yaou lin*, "Silver-waisted scale" (Birch); *Yen yaou lin*, "Silver-scaled waist" (Reeves). Length of the figure $9\frac{1}{2}$ inches.

Mr. Reeves observes that the nose of this fish, when recent, was as transparent as glass, and that he suspects some mistake in the characters of the Chinese name. It is not easy to identify one among several species closely resembling each other with the short account given of *triza* in the 'Amœn. Acad.,' but this figure corresponds most nearly with the characters enumerated by Linnæus. The *C. thrissa* of Osbeck has more rays in the dorsal. In form *triza* approaches the *Cl. thrissa* of Bloch, 404, but the back is more arched and the anal

* Russell enumerates six in his species.

fin lower and considerably longer. The snout is obtuse and shorter than the lower jaw, the profile of the head arched. The ventrals, which are under the middle of the dorsal, are equidistant from the end of the snout and base of the caudal. The point of the acute pectorals passes beyond them and falls but a little short of the anus. None of the other *Chatoessi* represented in Mr. Reeves's portfolio have pectorals of equal length. The truncated end of the maxillary reaches as far as the anterior third of the orbit. The eye is rather large and is some distance from the profile.

The scales are silvery and show towards their bases a mixture of blackish-green, oil-green and honey-yellow, the dark green predominating on the ridge of the back. Below the lateral line blue tints are intermixed with the general silvery lustre, and the honey-yellow forms faint longitudinal streaks corresponding with the rows of scales. There are some bluish and purple tints round the eye, and a rich orange-coloured brown on the occiput and supra-scapular region, which gradually disappears on the shoulder. The caudal is lemon-yellow, with a flesh-coloured tint at the base and blackish-gray posterior edges. The other fins are pale bluish-lilac.

Hab. China sea.

CHATOESSUS CHRYSOPTERUS, Richardson. Descript. of Animals, p. 200. fig. 148. *Icon.* Reeves, 61; Hardw. Malac. 231. Chinese name, *Hwang yu*, "Yellow fish" (Reeves, Birch); *Wong u hoi* (Bridgem. Chrest. 91). Length of figure $9\frac{1}{4}$ inches.

This drawing represents a fish with a higher body than *C. triza*, a more arched back and a shorter anal. The height is equal to exactly a third of the length, including the extreme tips of the acutely-forked caudal. The back is regularly and considerably arched; the belly is still more convex. The ventrals are a little before the middle, caudal excluded, and are attached beneath the fore part of the dorsal. The top of the triangular pectoral falls considerably short of the ventrals. The jaws are equal, the mouth small, and the maxillary reaches only to the front of the eye, which is smaller and higher in the head than that of *Ch. triza.*

The scales are brightly silvery, and are shaded towards the base on the back with dark leek-green. Below the middle they are sparingly shaded with pale bluish-lilac. The top of the head and edges of the gill-pieces are green; there is a prussian blue patch at the temporal groove and some carmine tints on the snout and suboperculum. The fins are gamboge- and lemon-yellow, this colour being most faint on the dorsal and ventrals. The front of the dorsal and bases of the pectorals and ventrals are tinged with carmine.

Hab. Chinese sea.

CHATOESSUS MACULATUS, Gray, Cat. Br. Mus. *Icon.* Reeves, 109; Hardw. Malac. 233. Chinese name, *Hwang yu*, "Yellow fish" (Birch, Reeves); *Wong u* (Bridgem. Chrest. 87). *Rad.* D. 16; A. 28. (Spec. Camb. Ph. Inst.) Length of figure $8\frac{1}{4}$ inches.

The Rev. George Vachell obtained a specimen of this fish at Canton and presented it to the Cambridge Philosophical Institution. It is symmetrical in its form, the ventral and dorsal curves being nearly alike, and the height at the front of the dorsal very nearly equal to one-third of the length, caudal included. The ventrals are attached before the middle, caudal excluded, and under the fore-third of the dorsal. The posterior dorsal ray reaches, as in the other species, to the base of the caudal. The belly is strongly serrated by seven teeth before the ventrals and nineteen behind them. A notch in the upper jaw receives the pointed extremity of the lower one, which is scarcely shorter than the snout. The maxillary is rounded at the end and reaches the middle of the eye.

The colour of the back is pale leek-green, which soon passes into pale honey-yellow. Below the middle the yellow gives place to pale lilac. These colours are confined to the base of the scales, which are very silvery, occupying however more and more of the disc as they approach the top of the back. A round black spot exists on the shoulder and is followed on the flanks by five others, which diminish successively in size. The head is varied by yellowish, brownish and crimson tints on a silvery ground. The rays of the pectoral are buff or orpiment-orange, the caudal dull yellow with blackish-gray posterior edges, and the other fins show a very pale bluish-gray tint. The Chinese name is the same as that of *Ch. chrysopterus*, which this species certainly closely resembles in form. The black spots may perhaps disappear in some seasons.

Hab. Chinese seas.

ENGRAULIS COMMERSONIANUS, Lacépède (*Stolephore commersonien*), v.

p. 382. pl. 12. f. 1. Cuv. Règn. An. ii. p. 323. *Clupea vittargentea*, Lacép. v. p. 424, 458, 461, *exclus. syn.* *Clupea nattoo vel nettooli*, Russ. 187. *Atherina australis*, White, Voy. New S. Wales, 196. f. 1. *Rad.* B. 10; D. 16; A. 23; C. 19$\frac{4}{8}$; P. 13; V. 7. Length of spec. 3$\frac{3}{4}$ inches.

John Russell Reeves, Esq. presented several examples of this fish to the British Museum. The species is ranged by Cuvier among the Anchovies, whose bellies are not toothed; but the specimens show six teeth before the ventrals as fine as hairs. None exist behind these fins. An adipose substance fills an angle before and behind the eye as in the Mackerels.

Hab. Seas of China, Australia and India.

The *Stolephore japonois* of Lacépède, or the *Atherina japonica* of Houttuyn, Act. Haarl. xx. p. 340, is probably the above species, with the rays of the dorsal imperfectly counted; and it is possible that the fish of which a notice from the 'Description of Animals' follows after *Cl. flosmaris*, p. 303, may also be an Anchovy, though it is not represented as having a projecting nose.

Notopterus kapirat, Lacép. ii. p. 189, 190. *Gymnotus notopterus*, Pall. Spic. vi. pl. 6. f. 2. *Clupea synura*, Bl. Schn. p. 426. *Mystus karipat*, Gray, Hardw. Ill. Ind. Zool. pl. 91. f. 2. *Icon.* Hard. Malac. Ined. 246.

Schneider states that he examined two dried examples of this fish, one from India, the other from China. He particularly notices the smallness of the ventrals, so that it could not be the *pengay* of Renard, f. 90, which he saw, as that has long ventrals, nor, as he is silent about spots on the tail, is it so likely to have been the *Mystus chitot* of Pennant, 'View of Hindostan,' t. xi. (*Mystus chitala*, Ham. Buch. p. 236, 382; Gray, Hardw. Ill. Ind. Zool. pl. 91. f. 1).

Hab. Seas of China and India.

Coilia grayii, Richardson, Ichth. of Voy. of Sulphur, p. 99. pl. 54. f. 1 & 2. *Clupea mystus*, Osbeck, Voy. ii. p. 25. Engl. tr.; Linn. Amœn. Ac. iv. t. 3. f. 12. *Mystus clupeoides*, Lacép. v. p. 466, 467. *Icon.* Reeves, α. 14; Hardw. Malac. 252. Chinese name, *Fung we*, "Phœnix tail" (Birch); *Fung ne* (Reeves); *Fung mi* (Bridgem. Chrest. 3). *Rad.* B. 10; D. 12; A. 86; C. 20; P. vii. et 10; V. 7. (Spec. Hasl. Mus.) Genus, *Adara*, Temm. et Schl.

A specimen was brought from the Chinese seas by Captain Dawkins, R.N., and presented to the museum at Haslar.

Hab. Chinese seas. Canton.

Coilia playfairii, M'Clelland (*Chætomus*), Calc. Journ. iv. plate . *Polynemus*, Descript. of Anim. p. 198. fig. 150; *Adara*, Temm. et Schl. *Icon.* Reeves, β. 26; Hardw. Malac. Chinese name, *Matse* (Birch); *Machai* (Reeves). *Rad.* B. 9; D. 12; A. 70 *ad* 80; C. 20; P. vi. et 11; V. 7. (Spec. Br. Mus.)

Specimens exist in all the collections of Chinese fishes that we have seen. The scales are used in the manufacture of artificial pearls, and the fish is eaten, when pickled, by the Chinese. A Japanese specimen exists in the British Museum and is labelled "Adara" by the authors of the 'Fauna Japonica.' It agrees with *Coilia grayii* in the number of its anal rays, but has the form of *C. playfairii* and the same number of free pectoral rays. Its numbers are D. 12; A. 86; C. 21; P. vi. et 14; V. 7.

Hab. Chinese seas. Chusan. Yang tze kiang. Canton river. Hong Kong. Japan.

Thryssa mystax, Bl. Schn. p. 426. t. lxxxiii. (*Clupea*). Cuv. Règn. An. p. 323. *Clupea malabaricus*, Bl. 432; Bl. Schn. p. 425. *Poorawah*, Russell, 189; *Icon.* Reeves, 138; Hardw. Malac. 236. Chinese name, *Tsing kwa* (Reeves). *Rad.* B. 12; D. 13; A. 39; C. 19$\frac{6}{6}$; P. 13; V. 7. (Spec. Br. Mus.) Length of specimens 7$\frac{1}{2}$ and 9 inches. Length of figure 9$\frac{3}{4}$.

Mr. Reeves has deposited a specimen in spirits and also a varnished one in the British Museum. We have not had an opportunity of comparing them with Indian examples, but we have little doubt but the synonyms we have cited above are correct, as the figures show the characteristic black mark with white veins on the shoulder, and the indistinct stripe along the middle of the anal. Mr. Reeves's drawing however, which agrees with his specimens, shows a slight gibbosity on the hind head, which is not represented in the figures of Bloch and Russell.

The head is acutely ridged from the nape to the end of the snout, the sides sloping down to the lateral ridges. The intermaxillaries are small and lie in the same line with the long, slender acute maxillaries, which are composed of three pieces. These and the lower jaw are set with fine teeth. There is no tongue, and the gills coming forward to the tip of the lower jaw are connected by a narrow ridge-like isthmus, which is rough with minutely villiform teeth. The head is contained nearly six times in the total length; the height of the body somewhat exceeds a fifth of the length, and the thickness is contained twice and a half times in the height. The belly is serrated by thirteen teeth before the ventrals and nine behind them. There are eleven rows of scales in the height of the body, and thirty-eight in a row between the gill-opening and base of the caudal.

The dorsal surface is coloured by dark grass-green, which is mixed with brown on the top of the head; the lower parts are brightly silvery. The black humeral patch is finely veined with white. The dorsal and ventrals are pistachio-green, the former being blackish on the edges and tinged with yellow in front. The anal is yellow in front, the rest of the fin being green, darkening along the middle so as to form a stripe. The caudal is greenish at the base; bright saffron-yellow on the disc, and blackish-green on the edges. The pectoral is also saffron-yellow, and is sparingly mottled with blackish-green.

Hab. Seas of China and India.

Megalops setipinnis, J. R. Forster, *in figurâ* Georgio Forster *pict.* 242. Bib. Banks; Richardson, Ann. Nat. Hist. x. p. 493. *Clupea thrissoides*, Schn. 424. *cum Cl. cyprinoide*, Bl. 403. *confusâ*; *Clupea cyprinoides*, Broussonnet, Ichth. (non Blochii); *Kundinga*, Russell, 203? *Icon.* Reeves, 96; Hardw. Malac. 234. Chinese name, *Hang tsaou pih*, "Ditch dead white" (Birch); *Hang tso pak* (Reeves, Bridgem. Chrest. 88). *Rad.* Br. 21–22; D. 18 vel 19; A. 25; C. $20\frac{4}{4}$; P. 15; V. 10. (Spec. Br. Mus.)

We have not seen an Indian or Chinese example of this species, but specimens exist in the British Museum from Port Essington, and have been described at length in the 'Annals and Magazine of Natural History' as above quoted. One anomaly occurs in Mr. Reeves's drawing, the existence of a pointed canine tooth in the upper jaw, whereas in the specimens the edges of the jaws are rough with very narrow bands of minute teeth. The colours in the Chinese painting are also different from those described by Forster, but Broussonnet's figure, as well as George Forster's, correspond exactly in profile and size of fins, shape of head, &c., with Mr. Reeves's drawing. Russell's seems distorted, probably from the flaccidity of the specimen.

The discs of the scales are like frosted silver, and they have a well-defined border of a polished silvery appearance. The scales of the lateral line are forty in number, and they are marked by six or seven radiating, forked furrows. In Mr. Reeves's drawing the bases of the scales on the back are shaded with bluish-lilac, which gradually changes on the sides and belly to celandine-green. The sides of the head are oil- and siskin-green, the occiput being tinged with hyacinth-red. The pectorals are yellow, which is mixed with brown on the upper border; the last ray of the dorsal is sulphur-yellow; the rest of the fins are hair-brown, the fronts of the dorsal and anal being wood-brown. Iris grass-green.

Hab. Seas of China, India, Australia and Polynesia. Brackish lagoons, Port Essington.

Megalops curtifilis, Richardson. *Icon.* Reeves, 136; Hardw. Malac. Chinese name, *Ke yu* (Birch); *Ko yu* (Reeves); *Ki u* (Bridgem. Chrest. 86). Length of figure 8 inches.

This drawing represents a rather more slender fish than *M. setipinnis*, with a smaller eye, narrower maxillary, fewer scales both longitudinally and vertically, the dorsal commencing farther back over the axilla of the ventrals, and having with the anal fewer rays. The last ray of the dorsal is shorter, and the last anal one more decidedly lengthened than the corresponding rays of *C. setipinnis*. The bright silvery edges of the scales are not so sharply defined and distinguished from the discs, which in this fish are leek-green above the lateral line, and gradually change to pearl-gray towards the belly. The upper parts of the head are dark olive-green. The dorsal and caudal approach to blackish-green, the latter being very dark; the ventrals and anal are pale and transparent, and the pectoral lemon-yellow. The scales of the lateral line are marked by the same kind of silvery furrows as *M. setipinnis*.

Hab. Chinese seas.

ELOPS MACHNATA, Forskal, No. 100 (*Argentina*). *Synode chinois*, Lacép. v. p. 319. 322. pl. 10. f. 1. *malè*. *Jinagow*, Russell, 179. *Elops machnata*, Richardson, Ichth. of Voy. of Ereb. and Terror, p. 59. pl. 36. fig. 3–5. *Icon.* Reeves, 137; Hardw. Malac. . Chinese name, *Chuh keaou*, "Bamboo ——" (Reeves).

Mr. Reeves has deposited a specimen from Canton in the British Museum. This fish is totally distinct from the *Mugil salmoneus* of Forster, a figure of which is given in the 'Ichthyology of the Voyage of the Erebus and Terror,' pl. 36. fig. 1, 2.

Hab. Seas of China and India. Red sea.

ELOPS PURPURASCENS, Richardson. *Icon.* Reeves, *a.* 53; Hardw. Malac. . Chinese name, *Chuh kin*, "Variegated bamboo" (Reeves). Length of figure 10¾ inches.

This drawing does not differ very greatly from the preceding one in form, but it represents a fish having a more irregular dorsal outline and less arched, a more convex belly, and the lateral line slightly decurved throughout its whole length. The face is gibbous just before the eye, and there is a less marked convexity at the nape. The summit of the back is grass-green, beneath which a blackish-purple band extends from the nape to the upper lobe of the caudal, terminating rather abruptly about half-way to the lateral line. The rest of the side is brightly silvery with a slight gloss of pearl-gray. The top of the head is grass-green. The edges of the maxillaries and gill-pieces are green and crimson. The dorsal and caudal are leek-green, passing into blackish-green on the rays and edges; the ventrals and anal are pale mountain-green with some yellow; and the pectorals are bright sulphur-yellow sprinkled with a few dark green specks. The cluster of black dots on the cheeks and preoperculum of *E. machnata* are not shown in this figure.

Hab. Chinese seas.

CHIROCENTRUS DORAB, Forskal, No. 108 (*Clupea*). *Clupea dentex*, Bl. Schn. 428. *L'Esoce chirocentre*, Lacép. *Wahlah*, Russell, 199; Descript. of Anim. p. 194. fig. 161, taken at Madras and named by Broussonnet *Esox clupeoides*. *Icon.* Reeves, *β.* 47; Hardw. Malac. 237, Chinese; Hardw. Malac. 239, Indian. Chinese name, *Poo taou*, "Cloth knife" (Birch); *Poo tou*, "Knife cloth" (Reeves); *Po to* (Bridgem. Chrest. 90). *Rad.* D. 16; A. 34, first two minute; C. $19\frac{1}{1}\frac{1}{1}$; P. 16; V. 7. Length of spec. 10¼ inches. Genus, *Chirocentrus*, Cuv. Règn. An.

The British Museum possesses a specimen in spirits from Canton presented by Mr. Reeves, which we have not had an opportunity of comparing with the Indian fish. The drawings of the latter differ a little in the position of the ventrals, but as this may have been owing to inattention, we have not kept the Chinese fish distinct.

The Chinese specimen has a long canine on each small transverse intermaxillary. The strap-shaped maxillary reaches to the middle of the orbit and the articulation of the lower jaw; its edge is armed with small subulate teeth, which become very minute towards its tip. Each limb of the lower jaw is furnished with five or six tall slender teeth inclining backwards, and having a short tooth between each pair. The ventrals are as near as possible in the middle of the length, excluding the whole caudal fin from the bases of its lobes. A long nacry appendage exists in front of the pectoral, and there is another in its axilla; but the rest of the skin is wrinkled and smooth, without scales, and resembling fine tinfoil in its lustre. The teeth on the edge of the belly, shown in Mr. Reeves's figure, are not formed by pungent scales, but by the points of the ribs. The belly is acute, like a knife, from the gills to the anal. The cheek is soft and nacry, and the skin of the temples is striated. The head has a scomberoid aspect above and its lateral ridges are smooth.

The colour of the back is pistachio-green, the rest of the fish brightly silvery with purplish reflexions, and the courses of the muscles are shown by oblique lines meeting in the middle height. Fins yellowish-gray, the edges of the caudal shaded with blackish-gray.

Hab. Seas of India and China.

Tribus Apodes.

Fam. Anguillidæ.

Anguilla avisotis, Richardson, Ichth. of Voy. of Sulphur, p. 104. pl. 51. f. 1. *Icon.* Reeves, 222; Hardw. Malac. 288. Chinese name, *Woo urh shen*, "Crow-ear eel" (Birch); *Woo urh shen*, "Black-eared eel" (Reeves).

Hab. Canton.

Anguilla clathrata, Richardson, Ichth. of Voy. of Sulphur, p. 104.

A specimen from Canton exists in the Cambridge Philosophical Institution, to which it was presented by the Rev. George Vachell.

Hab. Canton.

Anguilla sinensis, M'Clelland, Calcutta Journ. Nat. Hist. iv. p. 406. pl. 25. f. 2. and No. 18. p. 208. July 1844.

Hab. Chusan. The British Museum possesses a specimen of Dr. Cantor's.

Anguilla macroptera, M'Clelland, l. c. p. 407. pl. 25. f. 1. et No. 18. p. 208.

Hab. Chusan.

Congrus tricuspidatus, M'Clelland (*Murænesox*), Calc. Jour. N. Hist. iv. p. 408. t. 24. f. 1. and No. 18. p. 210. Richardson, Ichth. of Sulph. p. 105. pl. 51. f. 2. *Icon.* Reeves, *a.* 41; Hardw. Malac. 295. Chinese name, *Ho shen*, "Stork eel" (Birch); "Hook-billed eel" (Reeves).

Specimens collected by the Rev. George Vachell and Sir Everard Home exist in the museums of the Cambridge Philosophical Society and College of Surgeons.

Hab. Chusan. Ningpo. Canton.

Congrus lepturus, Richardson, Ichth. of Sulph. Voy. p. 106. pl. 56. f. 1–6.

Hab. Canton.

Congrus fasciatus, Gray, Cat. Br. Mus. *Icon.* Reeves, 284; Hardw. Malac. 291 et 293. dupl.

In this Conger the vent is a little before the middle of the fish, and the dorsal fin commences over the centre of the ventrals. There is a pair of tubular nostrils or cirrhi on each side of the snout, and a pair of small holes or pores on each side of the mesial line in the interorbital space. The ground colour is ochre-yellow with irregular purplish-black blotches on the dorsal and back, and descending to the middle of the sides. Several of these blotches or bars enclose spots of the ground colour. The top of the head is purplish-black, and three dark spots are placed in a triangular position on the hind head. The cheeks, under part of the head and the anal have the bright ochraceous ground tint, the edge of the latter being dark. The dorsal and ventrals are mountain-green, the blotches on the former forming part of the bars which cross the back. The breadth of the head is equal to half its length, which is an eighth part of the whole length of the fish. Snout rather obtuse, gill-openings lateral. The rays of the caudal fin are shown at the tip of the tail, otherwise this might have been taken for an *Ophisurus*, which it resembles in its banded markings.

Hab. Chinese sea.

Ophisurus dicellurus, Richardson, Ichth. of Voy. of Sulph. p. 106. pl. 48. f. 2–4.

Sir Everard Home presented a specimen to the College of Surgeons.

Hab. Mouth of the river Yang tze keang.

Ophisurus colubrinus, Linn. Gmel. (*Muræna*), Boddaert apud Pall. Beytr. ii. p. 56. t. 2. f. 3; Cuv. Règn. An. ii. p. 351. *La murænophis colubrine*, Lacép. v. p. 641. pl. 19. f. 1. *Muræna annulata*, Thunberg, Spec. Ichth. viii. pl. 1. f. 1. *Gymnothorax annulatus*, Bl. Schn. p. 527. *Ophithorax colubrinus*, M'Clelland, Calc. Journ. Nat. Hist. No. 18. p. 212. July 1844.

Hab. Sea of Japan.

OPHISURUS SPADICEUS, Richardson.

A specimen of this fish was presented to the British Museum by John Reeves, Esq. The snout, though not wide, has a truncated tip, and the distance between its extremity and the anus is to the length of the fish, as 0·43 to 1·0. Three teeth stand in a triangle at the extremity of the upper jaw, and behind them, the jaw teeth, consisting of a single row on each side, meet in an angle on the symphysis, within which there are five or six small teeth on the mesial line. The lower jaw is armed like the upper one with a single series on each limb, but there are none anterior to the point at which these side lines meet. The tip of the jaw is rounded and considerably shorter than the upper one. Nostrils very minute, with an orifice over the eye near its middle, having slightly raised edges, and another terminating a short thickish tube on each side of the snout, and there are two minute lobulets on the edge of the upper lip, the posterior one situated beneath the eye, and the other half-way between it and the end of the snout. The throat forms a slightly plaited bag, and the gill-openings are before the lanceolate acute pectorals and a little lower. The pectorals contain eleven rays; the dorsal commences immediately behind them, and like the anal, which is highest anteriorly, terminates suddenly so as to leave a very short naked tip of the tail. The rays of the fins are pretty conspicuous.

The colour of the specimen, after maceration in spirits, is darkish wood-brown above the lateral line, and whitish beneath, without any defined spotting. Length 13½ inches. Distance between tip of snout and anus, 5·8 inches: length of the pectoral, 0·55 inch; and height of the body, 0·4 inch. This species possesses some of the characters ascribed to *Oph. rostratus* of M'Clelland, but as he knows it merely from a drawing of Buchanan-Hamilton's, and consequently has not said anything of the dentition, we cannot compare them. It is different from those which he has figured in the Calcutta Journal, and also from *Oph. boro* (Ham. Buch.), which has two rows of blunt teeth on the jaws and mesial line of palate, with three in a triangle at the tip of the upper jaw.

Hab. Canton.

OPHISURUS HARANCHA, Buchanan-Hamilton, Ganges, p. 20? M'Clelland, Calc. Journ. v. p. 211. pl. 12. f. 4.? *Icon.* Hardw. Malac. 302.? Gray, Hardw. Ill. Ind. Zool. 95. f. 2.

The British Museum possesses a specimen of the *harancha*, which was presented to General Hardwicke by Buchanan-Hamilton, and also a Chinese *Ophisurus* procured at Canton by Mr. Reeves, which differ from each other so slightly that I hesitate to name them as distinct until more recent specimens have been compared. We have had no assistance in the discrimination of these two specimens either from colour or anatomical structure.

The body of the Chinese fish is nearly cylindrical, and the fish tapers only in the compressed end of the tail. It seems to have rather a smaller head than the Indian specimen and a shorter cleft of the mouth, and exhibits a row of prominent pores on the lateral line, which are not evident in the latter. Both have pores along the upper lip, round the eye and on the snout. The fins in both are pale, and their origins and terminations easily made out. The dorsal commences farther back than the tip of the pectorals, and almost meets the anal at the end of the tail, but the extreme tip of the tail is naked. Teeth stoutly subulate and short in two rows on the fore part of both jaws, but wider apart in the lower jaw: in one row on the limbs of the jaws. Three or four near the symphysis of the upper jaw are a little taller than the rest. They stand in two rows on the fore part of the mesial line of the palate, and in only one row posteriorly.

The Chinese specimen, after a long continuance in spirits, has a dilute wood-brown colour, and when examined through a lens, appears to be mottled with whitish specks mixed with a smaller number of black ones. The whitish specks exist on the belly, but the black ones are wanting there, hence the resulting tint is lighter. The Chinese specimen in the Br. Mus. is nearly 12 inches long; one in the Cambridge Philosophical Institution measures 14¼ inches, and the Indian one is 17¾ inches.

Hab. Canton. India.

OBS. *Ophisurus boro* (Ham. Buch.; Gray, Hardw. Ill. pl. 95. f. 1. *Icon.* Hardw. Malac. 301), of which there is an authenticated Indian specimen in the British Museum, bequeathed to it by General Hardwicke, has two or three rows of flat round teeth on the jaws and middle line of the palate, with three teeth of the same form placed in a triangle at the tip of the upper jaw. The dorsal commences farther forward than that of *harancha*. The same museum possesses also a specimen of *Ophisurus hijala*, Buch. Ham. *Icon.* Hardw. Mal. 300, noted as having been taken in a salt-water lake.

OPHISURUS? VIMINEUS, Richardson, Ichth. of Voy. of Sulph. p. 107. pl. 52. f. 16–20.

This *Ophisurus* differs much from the blunt-toothed species and resembles the *Sphagebranchi* in its acute, elongated snout. Another species of an orange colour and slightly speckled on the back inhabits the Sooloo archipelago on the north side of Borneo. A drawing of it, made by Assistant-Surgeon Arthur Adams of the Samarang, exists in the British Museum.

Hab. China. Specimen in Sir Edward Belcher's collection.

Fam. MURÆNIDÆ, M'Clelland.

MURÆNA ISINGLEENA, Richardson, Ichth. Voy. of Sulphur, p. 108. pl. 48. f. 1. *Icon.* Reeves, 237; Hardw. Mal. 305. Chinese name, *Tsing teen chuy*, "Blue spotted club" (Birch); *Ching teem chuy*, "Blue spotted *muræna*" (Reeves). Genus, *Muræna*, Thunberg; *Gymnothorax*, Bloch. Cuv. Règ. An. ii. p. 351. Div. 1. *dentibus uno ordine*.

Hab. Canton. Mr. Reeves has deposited two specimens in the British Museum.

MURÆNA ——? Temm. et Schl. (*Murænophis*).

A specimen labelled thus exists in the British Museum. It is 22 inches long, is finely mottled and clouded, and has a single row of sharp subulate teeth on the jaws.

Hab. Japan.

MURÆNA VARIEGATA, Temm. et Schl. (*Murænophis*).

A *Muræna*, so named by the authors of the 'Fauna Japonica,' exists in the British Museum. It much resembles *M. thyrsoidea*, but differs in its dentition, viz. in having a single row of conical, compressed and very acute teeth on each jaw, and two rows of minute ones on the roof of the mouth. The specimen is 18 inches long.

Hab. Japan.

MURÆNA REEVESII, Richardson, Ichth. of Voy. of Sulph. p. 109. pl. 48. f. 2. *Icon.* Reeves, 68; Hardw. 304. Chinese name, *Lă chuy*, "Wax club" (Birch); *La chuey*, "Waxen eel" (Reeves). (*Div. incerta.*)

Hab. Canton. No specimen.

MURÆNA THYRSOIDEA, Richardson, Ichth. of Voy. of Sulph. p. 111. pl. 49. f. 1. *Icon.* Reeves, 220; Hardw. 304. Lower figure. Chinese name, *Hwa chuy*, "Flowery club" (Birch); *Ta chuy*, "Flowered chuy" (Reeves). Genus, *Strophidon*, M'Clelland.

The British Museum possesses two of Mr. Reeves's specimens.

Hab. Canton.

OBS. *Muræna tessellata*, Ichth. of Sulph. p. 109. pl. 55. f. 5–8, being part of Sir Edward Belcher's collection, and *M. pavonina*, ibid. p. 110. pl. 53. f. 1–6, may be inhabitants of the Chinese seas, but the place of their capture was not recorded.

MURÆNA CERINO-NIGRA, *Icon.* Reeves, *nullo numero, non* Hardw. Length of drawing 7¾ inches. *Div. incerta.*

This drawing apparently represents a *Muræna* with very low fins. The general colour is a light wax-yellow with greenish tints and many blackish spots. A row of larger, round and nearly equidistant spots runs along the middle of the body, and on the top of the back and margins of the tail the spots assume the form of very short oblique bars. The throat and belly are tinged with carmine. Upper jaw obtuse and projecting slightly beyond the lower one. Nostrils not represented as tubular.

Hab. Canton.

Fam. SPHAGEBRANCHIDÆ, Müller.

MORINGUA LUMBRICOIDEA, Richardson, Ichth. of Voy. of Sulph. p. 113. pl. 56. f. 7–11. Genus, *Moringua*, Gray, Zool. Misc. p. 9.

Hab. China. Specimen in Sir Edward Belcher's collection 10 inches long.

MORINGUA ——? Temm. et Schl.

The British Museum possesses a Japanese *Moringua* of which we do not know the specific name, as the lable originally attached to it had been transposed before it was purchased by the museum. It differs from *M. lumbricoidea* in its more slender, elongated body, narrower fins and longer under-jaw. The rays are perceptible round the end of the tail only, the rest being concealed by the thickness of the membrane. The teeth are similar to those of *lumbricoidea.* Though the specimen is 26½ inches long, it is no thicker than a *lumbricoidea* only ten inches in length. The genus seems to be the same with *Ptyobranchus* of J. M'Clelland, but his Indian species all differ in the shape of the fins.

Hab. Japan.

ICHTHYOPHIS VITTATUS, Richardson, Ichth. of Voy. of Sulphur, p. 114. pl. 53. f. 7, 9. Genus, *Ichthyophis*, Lesson.

We are ignorant of the internal structure of this fish, but from the posterior position of the anus it is probably to be referred to the *Sphagebranchidæ* of Müller (*Ophicardides*, M'Clelland). A stuffed skin exists in the Haslar Museum, which was brought from China by Commissioner Elliot.

Hab. China.

APTERICHTHYS QUADRATUS, Richardson, Ichth. of Voy. of Sulphur, p. 115. pl. 52. f. 8–15 (*Sphagebranchus*). Genus, *Apterichthys*, Dumeril; *Cecilia*, Lacép. Cuv. Règn. An. ii. p. 353.

Hab. China. Specimen in Sir Edward Belcher's collection.

AMPHIPNOUS CINEREUS, M'Clelland (*Pneumabranchus*), Calc. Journ. Nat. Hist. iv. p. 411. pl. 25. f. 3. Genus, *Amphipnous*, Müller, Archiv. p. 15, 1840.

Hab. China. Chusan. Ning poo.

MONOPTERUS LÆVIS, Lacépède (*Unibranchapertura*), v. p. 658. Richardson, Ichth. of Voy. of Sulphur, p. 116. *Monoptere javanais*, Lacép. p. ?

A specimen obtained at Hong Kong by R. A. Bankier, Esq. was presented by him to the museum at Haslar Hospital.

Hab. China. Hong Kong. Malay archipelago?

MONOPTERUS CINEREUS, Richardson, Ichth. of Voy. of Sulphur, p. 117. pl. 52. f. 1–6. synon. exclus.

On consulting Mr. M'Clelland's paper in the 18th number of the Calcutta Journal, I find that, misled by the close similarity of the outline of *Pneumabranchus cinereus* in the fourth volume of the above-mentioned journal to that of this Chinese fish, I erred in considering them to be the same species. This fish has a naked skin, while the bodies of his *Pneumabranchi* (*Amphipnous*, Müller, 1840) are covered with imbricated scales.

Hab. China. Chusan. Woosung.

MONOPTERUS MARMORATUS, Temm. et Schl. (*Unibranchapertura*).

The British Museum possesses an example of this species which was procured by Dr. Cantor at Chusan. It is 17¼ inches long, the part behind the anus measuring 3·45, and being consequently proportionally a little shorter than the tail of either *lævis* or *cinereus.* The head is decidedly larger than in either of these species, and when measured to the posterior corner of the gill-opening, rather exceeds a tenth of the whole fish. A deep furrow runs along the middle of the back, which is narrower than the belly from the head to opposite the anus, and the action of the muscles produces a furrow coincident with the lateral line, which disappears when the parts are stretched. The belly is rounded. The lateral line in the middle of the height is composed of a series of very fine grooves, and is darker than the neighbouring parts. The tail is edged above and below by a very narrow translucent seam of pale skin entirely destitute of rays.

The ground colour, after maceration in spirits, is wood-brown, thickly speckled on the head, back and sides with dark umber-brown. On the top of the back the umber-brown specks are arranged so as to produce three lines, one occupying the mesial groove, and the other two the ridges on each side. On the sides the specks produce two series of short curves which meet at the lateral line in an angle and seem to correspond with the fasciculi of muscular fibres. The specks however are not confined to these lines. The belly is without specks, but is marked by fine oblique brown lines which meet on the mesial line beneath, in an acute angle, and thus produce a series of chevrons reaching from the gill-opening to the anus.

I had given a specific name to Dr. Cantor's specimen, which was altered to *marmoratus*, on a *Monopterus* so named by the authors of the 'Fauna Japonica,' having reached the British Museum. This fish is 23 inches in length, and the vent is rather farther back than in the Chinese example, being only 3·2 inches distant from the point of the tail. Three rays appeared very obscurely in the extreme tip of the tail.

Hab. Chusan.

MONOPTERUS? HELVOLUS. *Icon.* Reeves, t. nullo numero; Hardw. 312.

The figure represents a fish with a depressed head, a blunt snout, no nasal tubes, and the general form of the preceding *Monopteri*. The position of the anal aperture is not indicated. The colour is rich reddish-orange, like that of the *Cyprinus auratus*, varied only by a series of black dots along the lateral line. Eye small, silvery, and placed rather high.

Hab. Canton.

OPHICARDIA XANTHOGNATHA, Richardson (*Monopterus*), Ichth. Voy. Sulph. p. 118. pl. 52. f. 7. *Icon.* Reeves, 221; Hardw. Malac. 311. Chinese name, *Hwang sae shen* (Birch); *Wang sae shen*, "Yellow-jawed eel" (Reeves). Genus, *Ophicardia*, M'Clelland.

We have seen no specimen of this fish, and we were unable at the time of the publication of the 'Ichthyology of the Voyage of the Sulphur,' to place in it its proper genus; but having since received Mr. M'Clelland's important paper on the Apodal fishes of Bengal, and compared his outline figure and account of *Ophicardia phayriana* with Mr. Reeves's drawing, we have no doubt of both being members of one genus. In the Chinese fish the mouth is cleft rather farther past the eye, and this is the chief external difference between it and *phayriana*.

Hab. Canton.

ADDENDA.

The preceding report was drawn up before any portion of the Ichthyology of the 'Fauna Japonica' had reached this country, but as the successive decades of that important work came out, the new scientific names therein published have been substituted for those which I had previously imposed, the descriptions of such species have been struck out, and the Japanese fish which had not been detected on the coasts of China were added. I have also availed myself of the specimens of Japanese fish which the British Museum has from time to time received from Germany, and have adopted the names on their several labels. But notwithstanding every exertion to avoid the introduction of synonymous appellations, this evil cannot be entirely averted, in cases like the present, when several works on the same subjects are coming out simultaneously. In some instances the names proposed by English ichthyologists have the priority over those used in the 'Fauna Japonica,' the authors of this work having probably had no opportunity of consulting the papers of Dr. Cantor and of John M'Clelland, Esq., of the Bengal Medical Service, published in India. There is also some interference of names between the 'Fauna Japonica' and the 'Ichthyology of the Voyage of the Sulphur,' composed of three fasciculi, of which the first one was published in April 1844, and the third in October 1845. I may add also that the genus *Hoplegnathus* proposed by me in March 1841, and published in the Transactions of the Zoological Society of London in 1842, is identical with the *Scarodon* of the 'Fauna Japonica.' The tenth decade of this latter work was brought to this country in March 1846, by its publisher, when the seventh sheet of the Report was in the press, and it is therefore necessary to make such corrections and additions to the previous sheets as are requisite from the decades of the 'Fauna' which reached us after the previous sheets were printed off.

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CARCHARIAS MELANOPTERUS, Temm. et Schl. F. J. Sieb.

A Japanese specimen in the British Museum.

Hab. Sea of Japan, in addition to habitats previously given.

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PRISTIOPHORUS CIRRHATUS, Lath. Linn. Trans. ii. pl. 26 et 27. (*Pristis*), Müll. et Henlê, seite 98. *Squalus tentaculatus*, Shaw, Nat. Misc. 630. *Sq. anisodon*, Lacép. iv. p. 679.

The British Museum possesses various specimens from Australia, which may be divided into two groups; one having a more slender beak and the barbels placed midway between the base and tip, and the other having a wider beak, with the barbels nearer the base. There is a Japanese specimen also in the museum.

Hab. Seas of Japan and Australia.

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PTEROPLATEA JAPONICA, Temm. et Schl. F. J. Sieb.

The British Museum possesses two fœtal specimens from Japan which measure $5\frac{1}{4}$ inches across the disc, 3 along it, and $4\frac{3}{4}$ including the tail. They seem to differ very little from *Pteroplatea micrura*.

Hab. Sea of Japan.

TETRODON PŒCILINOTUS, Temm. et Schl. F. J. Sieb. *Rad.* D. 13; A. 11; C. $8\frac{1}{2}$; P. 15. (Spec. Brit. Mus. 8 inches long.)

This *Tetrodon* is marked much like *T. albo-plumbeus*, but the spines extend further along the back to the tail, and there are some slight differences in the courses of the porous lines. It is probable nevertheless that it is the same species with *albo-plumbeus*, since there are two other Japanese specimens in the British Museum, which are intermediate between the two in the extent of the spiny surface and in other minute characters. This being the case renders it probable that the small specimen which we have reckoned to be a variety of *ocellatus*, under the name of *var. guttulata*, ought also to be referred to *albo-plumbeus*.

Hab. Sea of Japan.

TETRODON RUBRIPES, Temm. et Schl. F. J. Sieb. *Rad.* D. 16; A. 13; C. $9\frac{1}{1}$; P. 17. (Spec. Brit. Mus. from Japan, 19 inches long.)

Hab. Sea of Japan.

(TETRODON LATERNA), *Tetrodon pardalis*, Temm. et Schl. F. J. Sieb. (Spec. Brit. Mus. 13 inches long. *Rad.* D. 11; A. 11; C. 9; P. 17.

The specimen shows more spots than are exhibited in Mr. Reeves's drawing, and the nasal cirrhus is scarcely so much developed, but there is no reason to doubt the identity of *laterna* and *pardalis*. The skin is smooth throughout, but pits slightly on the belly in drying.

Hab. Japan and China. Pulo Condore.

TETRODON XANTHOPTERUS, Temm. et Schl. F. J. Sieb. *Rad.* D. 16; A. 14; C. $9\frac{1}{1}$; P. 18. (Spec. Brit. Mus. $14\frac{1}{2}$ inches long.)

Hab. Sea of Japan.

TETRODON STICTINOTUS, Temm. et Schl. F. J. Sieb. *Rad.* D. 16; A. 14; C. $9\frac{1}{1}$; P. 15. (Spec. Brit. Mus. 15 inches long.)

Hab. Sea of Japan.

TETRODON STRIATUS, Temm. et Schl. F. J. Sieb. *Rad.* D. 11; A. 10; C. $9\frac{1}{1}$; P. 11. (Spec. Br. Mus. $5\frac{1}{2}$ inches long, $3\frac{1}{4}$ in diameter.)

This has the characters ascribed by Linnæus to *hispidus*; and it has much resemblance to *T. lineatus* of Bl. t. 141, in the lines on the belly, but the dorsal stripes are replaced by spots. It is entirely and coarsely hispid, except the lips and trunk of the tail.

Hab. Sea of Japan.

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OSTRACION BREVICORNIS, Temm. et Schl. F. J. Sieb. *Rad.* D. 10; A. 11; C. $9\frac{1}{1}$; P. 11. (Spec. Brit. Mus. $3\frac{3}{4}$ inches long.)

Of the division of *auritus*. Does it differ from *aculeatus* of Houttuyn?

Hab. Sea of Japan.

BALISTES LINEATUS, Bl. Schn. p. 466. t. 87; Temm. et Schl. F. J. Sieb.

The British Museum possesses one of Bürger's Japanese specimens, and there is an individual in excellent condition in Sir Edward Belcher's collection. This was not introduced into our list, from the place of its capture not having been noted, but the existence of the species in the Japanese seas leaves little doubt of Belcher's specimen having been obtained on the coast of China, where the bulk of his collection was made.

Hab. Seas of Japan and China, and the Indian ocean.

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MONACANTHUS CIRRHIFER, Temm. et Schl. F. J. Sieb. *Rad.* D. 1|–33 ad 35; A. 33; C. 12; P. 14. (Three Spec. Brit. Mus. from Japan.)

Hab. Sea of Japan.

MONACANTHUS OBLONGUS, Temm. et Schl. F. J. Sieb. *Rad.* D. 1|–33; A. 32; C. 12; P. 13. (Spec. Brit. Mus. from Japan, 7 inches long.)

Hab. Sea of Japan.

ALEUTERIUS CINEREUS, Temm. et Schl. F. J. Sieb. is *Al. berardi* of the preceding list. (Spec. Brit. Mus. from Japan.)

Hab. Seas of Japan, China, and New Guinea.

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GOBIUS FLAVIMANUS, Temm. et Schl. F. J. Sieb. p. 141. pl. 74. f. 1. "*Rad.* D. 8|–15; A. 12; C. 18; P. 16; V. 5." (l. c.) Length from 8 to 12 inches.

Hab. Mouths of rivers in the bay of Nagasaki, Japan.

GOBIUS BRUNNEUS, Temm. et Schl. F. J. Sieb. p. 142. pl. 74. f. 2. "*Rad.* D. 6|–10; A. 8; C. 18; P. 20; V. 1|5." (*l. c.*) Length 4 or 5 inches.

This is perhaps identical with our *G. platycephalus*.

Hab. Mouths of rivers in the bay of Nagasaki, Japan.

GOBIUS OLIVACEUS, Temm. et Schl. F. J. Sieb. p. 143. pl. 74. f. 3. "*Rad.* D. 6|–10; A. 8; C. 14; P. 18; V. 5." (*l. c.*) Length 5 inches.

Hab. Japan.

GOBIUS VIRGO, Temm. et Schl. F. J. Sieb. p. 143. pl. 74. f. 4. "*Rad.* B. 4; D. 8|–26 ad 28; A. 1|26; C. 20; P. 22; V. 5." (*l. c.*)

Hab. Mouth of the bay of Nagasaki, Japan.

GOBIUS HASTA, Temm. et Schl. F. J. Sieb. p. 144. pl. 76. f. 1. *Rad.* D. 9|–1|19; A. 17; C. $17\frac{1}{1}\frac{3}{4}$; P. 19; V. 1|5. (Spec. in Brit. Mus. from Japan, measuring $9\frac{3}{4}$ inches.)

This fish is more elongated and has a lower dorsal and longer caudal than our *G. ommaturus*, but in other respects approaches very near to it. There are more scales scattered on the cheek, and the jointless rays at the base of the caudal are more numerous and more conspicuous. These are the principal differences elicited by a comparison of specimens. The porous lines on the cheek and jaws and the clusters of scales on the gill-cover and temples are the same in both. The caudal fin of the specimen is an inch and a half long.

Hab. Japan.

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SICYDIUM OBSCURUM, Temm. et Schl. F. J. Sieb. p. 144. pl. 76. f. 1. "*Rad.* D. 6|–11 ; A. 10 vel 11 ; C. 16 ; P. 16 ; V. 10." (*l. c.*) Length 4 inches.

Hab. Rivers in the bay of Nagasaki, Japan.

AMBLYOPUS LACÉPÈDII, Temm. et Schl. F. J. Sieb. p. 145. pl. 75. f. 2. "*Rad.* B. 5 ; D. 6|42 ; A. 1|41 ; C. 15 ; P. 32 ; V. 12." (*l. c.*) Length 15 inches.

This species differs in the length of the caudal, the height of the other fins, and in colour from *Amblyopus rugosus* and *anguillaris*, described in p. 207 of the Report. In the numbers of the rays it approaches the species noticed in the foot note to that page.

Hab. In the mud of bays on the coast of Japan.

PERIOPHTHALMUS MODESTUS, Temm. et Schl. F. J. Sieb. p. 147. pl. 76. f. 2. Length 3 inches.

This fish has fewer rays in the first dorsal than the one similarly named by Cantor in his Report on the Fauna of Chusan, p. 29 (vide ante, p. 208), but his brief description offers no other discrepancy. The authors of the 'Fauna Japonica' do not appear to have been aware of the previous employment of the specific name *modestus*.

Hab. Salt ponds and shallow water on the coast of Japan.

Boleophthalmus boddaertii, Temm. et Schl. F. J. Sieb. p. 148. pl. 76. f. 3. The information given in the 'Fauna Japonica' enables us to increase our list of the places of capture of this fish, by the addition of the seas of Japan, Java and Borneo (vide Report, p. 208).

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ELEOTRIS OBSCURA, Temm. et Schl. F. J. Sieb. p. 149. pl. 77. f. 1, 2, 3. "*Rad.* D. 7|–9 vel 10 ; A. 8 vel 9 ; C. 15 ; P. 15 ; V. 5." (*l. c.*) Length one foot.

The British Museum possesses two small specimens from Japan, measuring respectively 4½ and 7¼ inches.

Hab. Rivers which fall into the bay of Nagasaki, Japan.

ELEOTRIS OXYCEPHALA, Temm. et Schl. F. J. Sieb. p. 150. pl. 77. fig. 4, 5. "*Rad.* D. 6|–9 ; A. 9 ; C. 16 ; P. 17 ; V. 5." (*l. c.*) Length 7½ inches.

The description of this species corresponds in many particulars with the characters of *El. cantherius*, but as the head only is represented in the plate, we cannot determine whether the general resemblance is sufficiently close to justify the suppression of one of the specific names. Mr. Reeves's drawing does not exhibit the gibbosity of the snout, occasioned by the intermaxillary pedicles which is shown in the figure in the 'Fauna Japonica,' and the colours noticed in the description in the latter work being those of the specimen after long maceration in spirits do not agree very closely with the Chinese drawing.

Hab. Japan.

Page 210.

CALLIONYMUS LONGICAUDATUS (Temm. et Schl. F. J. Sieb. p. 151. pl. 78. f. 1)

Is evidently the fish that we have described and figured as the female of *C. reevesii* in the Ichthyology of the Sulphur's Voyage, published in April 1844.

CALLIONYMUS ALTIVELIS, Temm. et Schl. F. J. Sieb. pl. 79. f. 1.

This is a different species from any that is noticed in the body of the Report. The letter-press relating to it has not reached us.

Hab. Sea of Japan.

Page 215.

SEBASTES VENTRICOSUS, Temm. et Schl. F. J. Sieb. p. 48. pl. 20. f. 1, 2. (Spec. Brit. Mus. 9 inches long).

This species was accidentally omitted in the body of the list.
Hab. Sea of Japan.

Page 258.

CRENILABRUS FLAGELLIFER, Temm. et Schl. F. J. Sieb. pl. 86. f. 2.

Notwithstanding some differences in profile and in the illumination of the figures, is very probably the same with the *Ctenolabrus rubellio* of the Report, the blues and reds of the *Labridæ* being, as we have already mentioned, interchangeable after the death of the fish.

CIRRHILABRUS, Temm. et Schl. F. J. Sieb. pl. 86. f. 3. (Letter-press not yet published).

Hab. Japan.

Page 311.

Fam. GADIDÆ.

BROTULA IMBERBIS, Temm. et Schl. F. J.

The British Museum possesses a specimen which is 5¼ inches long.

LEPIDOLEPRUS JAPONICUS, Temm. et Schl. F. J. Sieb.

Snout apiculated and acute; scales less strongly armed than those of the other species. The British Museum possesses two heads.
Hab. Japan.

Haslar Hospital, April 1846.

ERRATA.

P. 187, near the bottom, for *Scomberidæ*, read *Scombrisidæ*.
197, *for* TRYGONIDÆ, *read* TRYGONISIDÆ.
199, *for* OSTINOPTERYGII, M'Leay, *read* OSSEI.
235, *line* 9, *for* a South Australian *Serranus*, *read* the *Plectropoma dentex* of South Australia.
277, add to the references following PLATESSA CHINENSIS, *Icon.* Descriptions of Animals, fig. 104 & 105, pages 133 & 134.
286, second line from the bottom, *for* des, *read* de.
287, *line* 13, *for* Macropterote, *read* Macropteronote.

Report of the Committee, consisting of Prof. Owen, Prof. E. Forbes, Dr. Lankester, Mr. R. Taylor, Mr. Thompson, Mr. Ball, Prof. Allman, Mr. H. E. Strickland, *and* Mr. Babington, *appointed for the purpose of Reporting on the Registration of Periodical Phænomena of Animals and Vegetables.*

The duty assigned to your Committee being to consider and report on the best means of concurring in the system of simultaneous observation of the Periodical Phænomena of Organized Beings adopted by the Belgian and other continental naturalists, as proposed on their behalf at the Meeting of the Association at Plymouth, by M. Quetelet of Brussels, the Committee have judged it best, as a preparatory measure, to recommend to the Section D. (Zoology and Botany) to cause to be translated, and circulated among such naturalists as might be willing to give their assistance, the Instructions published and acted upon for a few years past by the continental naturalists above mentioned.

The translation having been revised and enlarged with the aid of the Rev. L. Jenyns and M. de Selys-Longchamps, it is proposed by the Committee, that copies should be circulated where they may be useful, in order to invite and facilitate the co-operation of observers in various departments of natural history.

INSTRUCTIONS FOR THE OBSERVATION OF PERIODICAL PHÆNOMENA.

Royal Academy, Brussels.

Whilst the earth performs its annual orbit, a series of phænomena is unfolded upon its surface which the periodical return of the seasons regularly brings back in the same order. These phænomena, taken individually, have engaged the attention of observers in all times; but to study them as a whole, and to aim at ascertaining the laws of dependence and relation that exist between them, have been generally neglected*. The phases of the existence of the minutest plant-louse, of the paltriest insect, are bound up with the phases of the existence of the plant that nourishes it; this plant itself, in its gradual development, is in some sort the product of all the anterior modifications of the soil and atmosphere. That would be a most interesting study which should embrace at once all periodical phænomena, both *diurnal* and *annual*; it would form of itself alone a science as extended as instructive.

* There are doubtless few naturalists who have not collected some observations upon periodical phænomena; but the greater part of their labours, from their being isolated, would be nearly useless for the object which we propose to accomplish. The various *calendars* and *dials of Flora* have been framed upon local observations, or such as, being made at different epochs and under circumstances entirely dissimilar, could not be compared with one another nor present that degree of exactness which science demands at the present day. The great Linnæus was fully aware of the utility to be derived from simultaneous researches on the *calendar* of Flora, and considered that, if made in different countries, a comparison of them would be followed by advantages as novel as unexpected. It is, then, this idea of the celebrated Swedish naturalist that we would wish to see realized. The United States of America seem to be the country which has most fixed its attention upon such a system of simultaneous observations: the annual reports of the governors of the University of New York, printed at Albany, regularly contain observations from thirty places on the flowering and fructification of certain plants, on the arrival and departure of birds of passage, and on other natural epochs.

It would not be possible to specify here all the observations of this kind which have heretofore been undertaken; even those made in Belgium by M. Kickx, sen. for 1811 (Flora Brux.) and by Messrs. Pollaert and Dekin (*Alman. du départem. de la Dyle*, an. xii.), or those of our habitual correspondents, Baron d'Hombres Firmas (Rec. de Mém. et d'Obs., &c., Nismes, 1838), Dr. Th. Forster (The Perenn. Calend., Lond. 1824), &c.

It is principally by the *simultaneity* of observations made on a great number of points, that these researches are capable of attaining a high degree of importance. A single plant observed with care, would itself yield us information of the greatest interest. *Synchronic* lines might be traced on the face of the globe for its leafing, flowering, fructification, &c. The lilac, for example, *Syringa vulgaris*, flowers in the neighbourhood of Brussels on the 1st of May; a line may be conceived on the surface of the earth upon which the flowering of this shrub takes place at the same date, as also lines on which its flowering is earlier or later by ten, twenty, or thirty days. Will those lines then be equidistant? will they have analogies with the isothermal lines? what will be the dependencies that will exist between them?* so also as to the *isanthesic* lines or lines of simultaneous flowering, will these have a parallelism with the lines relative to the leafing, or to other clearly-marked phases in the development of the individual? We may conceive, for example, that whilst the lilac is beginning to bloom at Brussels on the 1st of May, there also exists a series of places northwards where this shrub is then only putting forth its leaves; has the line, then, which passes through these places any relations with the *isanthesic* line which answers to the same date? It may also be asked whether the places that have the leafing on the same day, will likewise have the same day of flowering and fructification: it will thus be seen, keeping to even the simplest data, how many curious approximations may be deduced from a system of simultaneous observations established on a large scale. The phænomena relating to the animal kingdom, those especially connected with the migrations of birds of passage, will afford results not less remarkable.

Periodical phænomena may be divided into two great classes: the one belong to the science of physics and natural history; the others belong rather to the domain of statistics, and concern man living in the social state; for society itself, with all its tendencies to withdraw itself as much as possible from natural laws, has not been able to escape from this periodicity of which we are treating.

The *natural* periodical phænomena are in general independent of the *social* periodical phænomena; but this does not hold good of these latter with regard to the former. It would therefore be a first step taken upon this ground so little explored, and which seems to promise so much to the labours of those who know how to cultivate it, to have commenced the simultaneous observation of all the periodical phænomena connected with physics and natural history.

These last phænomena are themselves divisible into several classes, and the study of them presupposes a considerable acquaintance with the meteorological phænomena on which they principally depend. It is moreover not without reason that meteorology should take the lead, and commence this series of continued researches to which those observers who aspire truly to follow nature in all her laws of organization and development will have now to devote themselves.

But meteorology, in spite of its persevering labours, has not hitherto been able to ascertain more than the mean state of the different scientific elements relating to the atmosphere, and the limits within which these elements can vary according to climate and season. It is requisite that it should continue its progress at the same time with the investigation now proposed; and in order to guide our judgement as to the observed results, it should show us,

* Examples of similar researches have been given by Messrs. von Humboldt, Schouw, &c. as to the boundary lines for the culture of the vine, olive, &c. in their relations with isothermal lines.

at each step, whether the atmospheric influences are in a normal state, or whether they manifest any anomalies.

The desire of devoting myself to the study of periodic phænomena upon a rather extensive scale, led me to request several men of science both at home and abroad to aid me with their views and observations*. The favourable reception given to my requests has allowed me to believe that I was not deceived as to the importance of the proposed researches; I likewise saw that it would be possible to compare our climate with those of the neighbouring countries, by direct and simultaneous observations, and to obtain, for Belgium in particular, valuable data which at present we do not possess.

However, to proceed in a useful manner, it is necessary above all things that the observations should be made on the same plan, and it was not without reason that the men of science to whom I applied, requested instructions as to the objects to be observed, and the course to be taken in the observations so as to render them *comparable*, an essential condition for the attainment of the proposed object. The following instructions have been drawn up to meet this demand, from suggestions furnished by MM. Cantraine, De Selys-Longchamps, Dumortier, Kickx, Martens, Mowen, Spring, Wesmael, &c.

There is one important remark to make, that should not be lost sight of, viz. that we should agree upon certain observations which should be made in preference, and essentially bear on the same scientific points in the several countries in which the observations are made. The field to be explored is so immense, that unless some rallying-points are adopted, the different observers will run a great risk of not concurring, and thus almost losing their labour. For instance, when we point out some plants or animals which it will be more especially desirable to observe, we do not wish to underrate the utility of observations made on other species; but this will be in order to obtain points of comparison, or standards around which other observations will easily arrange themselves. Our appeal may probably receive attention only from isolated observers, and it is impossible for them to comply with all the demands which we make respecting periodical phænomena; but if they are desirous of undertaking those labours of detail to which we shall confine our instructions, they will at least learn what should be their starting-points so as to keep within the limits of the system generally adopted.

* The observations on flowering were commenced in 1839, in the garden of the Royal Observatory at Brussels. The results obtained in 1839 and 1840 were printed at the end of the observations on the meteorology, magnetism, and temperatures of the earth in 1840, in vol. xiv. and xv. of the 'Mémoires de l'Académie Royale.' In 1841, the simultaneous observations of MM. Kickx, Cantraine, Fr. Donkelaer, Martens, Morren, V. Deville, De Selys-Longchamps, Robyns, Dr. Gastone, Van Beneden, Galeotti, Spring, Schwann, &c. commenced. This system of observation was further extended in 1842 and 1843, and has been carried beyond the frontiers of Belgium. The new observers are MM. de Spoelberg and Debroe at Louvain, Fredericq and Spae at Ghent, McLeod at Ostend, Vincent at Brussels, De Martius at Munich, De Caisne at Paris, the Baron d'Hombres Firmas, jun. at Alais, B. Valz at Marseilles, Bravais at Lyons, Couch in Cornwall, Blackwall in Wales, De Pierre and Wartmann at Lausanne, M. Achille Costa at Naples, Scherer, Camille Rondani and Colla at Parma, Van Hall at Groningen and the Horticultural Society of Utrecht, who desired to form the central point for the collection of observations made in the kingdom of the Netherlands, which the learned Counsellor von Martius has been so obliging as to do for Bavaria and Germany in general. The new assistance which has been promised in different parts of the globe, give reason to hope that we shall soon be able to deduce the most valuable results from so extensive an association. Among the learned bodies which have promised us their support, we may mention especially the Association of Natural History of Switzerland, the Royal Botanical Society of Ratisbon, the National Institute of Washington, the Philosophical Society of Philadelphia; but we ought especially to congratulate ourselves that one of the most illustrious countrymen of Linnæus, M. Berzelius, has spoken favourably of our scientific crusade in the Academy of Stockholm, where its formation was originally proposed, about a century ago.

METEOROLOGY AND PHYSICS OF THE GLOBE.—Those who are desirous of studying thoroughly the meteorology and physics of the globe, and carefully appreciating all the periodical changes which these two branches of our knowledge present, should have recourse to the special report which has been published on this subject by a committee of the Royal Society of London*. But the observations specified are so numerous and fatiguing, they require the operation of so many persons, that it has been hardly possible to find more than four or five observatories in Europe in which they are carried out to their full extent. In fact it has been undertaken to make observations every two hours, night and day; and even, at a certain period in each month, to observe the magnetic instruments continuously for twenty-four hours†. Fortunately for our plan, such laborious observations are not necessary as far as natural history is concerned; our object is to direct attention much more to the *annual* than the *diurnal* variations, which may in their turn become the object of special and simultaneous study.

The appeal which we now make being addressed especially to naturalists, we would restrict our demands to researches which are directly and essentially connected with the modifications presented by the three kingdoms under the influence of the seasons, and avoid fatiguing observers by requiring too much from them.

The *thermometer* should occupy the first place among instruments to be consulted; and the temperature of the air and earth should be simultaneously determined. The thermometer, exposed to the air, at the distance of some feet above the soil, should face the north in the shade, so that it may not be influenced by reflexion from the adjacent walls. It would be sufficient to note its indication each day at a certain hour; 9 o'clock A.M. would be the best. It would be necessary, moreover, to ascertain daily its minimum and maximum, by means of a thermometer fitted for the purpose. The temperature of the earth, especially of those layers in which the roots of trees are imbedded, deserves special attention. It would be very interesting daily to trace the progress of three or four thermometers, the bulbs of which were equidistant in a vertical line: the bulb of the first should be just beneath the surface of the soil, and that of the last at a depth of 23 to 30 inches. Peculiar thermometers, the stems of which project above the surface of the earth, and whose bulbs are rather large compared with the size of the tube, are constructed for these observations. These instruments should be placed in a soil similar to that in which the plants under observation grow, and which presents an unbroken surface, sheltered from the direct action of the sun. It would, moreover, be interesting to observe, as is done in the garden of the Observatory at Brussels, two series of thermometers, one exposed to and the other sheltered from the direct heat of the sun. The time for observation, as in the thermometer exposed to the air, should be 9 o'clock in the morning.

The *barometer* should also be observed at least once a day, and at a fixed hour. Care should be taken to note its maxima and minima; and each barometric observation should be accompanied by the indication of the thermometer attached to the instrument.

The *hygrometer* also yields valuable indications; but its place may be ad-

* Report of the Committee of Physics, including Meteorology, &c., 8vo. London, R. and J. E. Taylor, 1840. The instructions for different voyages, published by the Royal Academy of Sciences at Paris, particularly those which M. Arago has inserted in the 'Annuaire du Bureau des Longitudes' for 1836, may also be consulted with advantage; we can also recommend the new meteorological work published by M. Lamont at Munich, and entitled 'Annalen für Meteorologie und Erdmagnetismus.'

† These observations have been continued at the Royal Observatory at Brussels since 1841.

vantageously supplied by the *psychrometer*, which is less liable to get out of order, and the indications of which are much more correct.

We do not detail the precautions requisite for these observations, for which we merely refer to the ordinary treatises on physics.

The force and direction of the *winds* should be carefully registered; as also the *state of the sky*. To indicate the degree of serenity, a decimal fraction may be employed; a perfectly serene sky being represented by *unity*, and one completely overcast by *zero*. By this mode of notation the intermediate states can be expressed in 10ths.

The quantities of *water* falling, either as rain, hail or snow, should be collected by the aid of udometers, either immediately after their fall or at fixed times every 24 hours.

The stormy, misty, &c. days should be noted. As to the state of the clouds, Howard's system of notation may be advantageously employed.

For those who are enabled to devote greater attention to the physical phænomena, we would recommend the observation of the electrical states of the air, of terrestrial magnetism, falling stars, auroræ boreales, and earthquakes; as also the temperature of springs, of plants and animals, as well as the analysis of waters and the air. But the latter is now in progress under the direction of M. Dumas, and we may expect the best results from labours directed by so practised a chemist. The appreciation of the quantity of light and heat emanating from the sun, at different periods of the year and at various times of the day, has but little engaged the attention of philosophers, and deserves more notice.

Lastly, to those living at the sea-side, the times and heights of the tides would be interesting subjects of observation.

Vegetable Kingdom.—Observations relative to the vegetable kingdom may be regarded in two points of view, according as they bear upon the annual period or the diurnal period of plants. The annual period is that space of time comprised between two successive returns of the leaves, the flowers and the fruit; the diurnal period is the return of that hour of the day at which certain species of flowers open; for as all plants have fixed periods for their leafing and flowering, so in like manner certain species of plants open and close at certain hours of the day, and always at the same hours in the same place. The results presented by these phænomena are then of the greatest interest, not only to meteorology, but also to botanical geography.

In the study of them the principal object which ought to be aimed at is to render the observations comparable, so that the results obtained on any given point may be compared with those of other countries. The essential point therefore does not consist in the large number of plants submitted to examination, but in the choice of the species and the identity of the comparable conditions.

It is with a view to the attainment of this object, that the following instructions have been drawn up:—

1. *Observation for the annual period.*—The first point in these observations is to discard annuals: in fact, these plants come up frequently at very various periods, according to the time at which they were sown, so that the indications furnished by them would not be comparable*.

This consideration should also lead us to discard the use of biennials, because those which come up but slowly and towards autumn are necessarily

* M. Bergsma, president of the Horticultural Society of Utrecht, has however truly remarked, that annuals might be usefully employed, provided precaution be taken to use in every case the same seeds and to sow them on the same days.

behind those which come up in the spring. We admit of no exceptions except as to the autumnal cerealia, such as rye, wheat, or winter barley, which are always sown about the same time, and the phænomena of the vegetation and flowering of which form the most important point in annual observations, from their relating to plants so extensively cultivated. The period of their being sown and that of the appearance of the ear should be noted.

From what we have said it is evident that the plants to be examined should be perennials or woody. The latter are especially important, because they are more subjected to the double combination of atmospheric and terrestrial modifications; and again, because they are better adapted than perennials for observations on the foliation.

It is of importance that the plants destined for daily observation should have been planted at least a year; for it is well known that vegetables transplanted in the spring present too much uncertainty in the periods of their foliation and flowering, these periods being then subordinate to the formation of the roots.

In the choice of plants for observation we must avoid those which, flowering through all the year, have formed their buds before winter, such as the dandelion, chickweed and common groundsel, because these plants have no determinate period, and the time of their flowering in early spring is irregular.

All those cultivated plants which yield varieties by culture must be equally avoided, as *Tulipa Gesneriana*, the rose-tree, the pear-tree, the cherry-tree, the large-leaved lime-tree; experience shows, that amongst varieties produced in this manner from seed-beds, some flower frequently fifteen days before the others. To be satisfied of the comparative value of the flowering of these plants, it would be necessary to observe everywhere the same variety, which is often impossible.

Such plants as are too nearly allied in respect of species, and difficult clearly to distinguish, should also be avoided: without attention to this, observers might be employing different species, which would prevent the general operation from being comparative.

Finally, all those flowers must be discarded, the æstivation of which does not admit of our accurately noting the exact moment of expansion: such as *Calycanthus*, *Illecebrum*, *Aquilegia*, &c.

The table of species marked out for the daily observations has been formed from these considerations. In the construction of it our object has been to obtain results which might be useful at the same time to meteorology, to botany and to agriculture. With this view, we have aimed at representing all the families of the European plants, excepting those which do not contain plants fit for cultivation; this consideration is of great interest with regard to botanical geography. We have also introduced into it some North American genera cultivated in Europe, as the *Catalpa*, *Tradescantia*, *Menispermum*, &c., in order that this list may be rendered comparable with that of observations made in the United States of America. In each family we have selected in preference the most common and diffused species, and amongst them such species as have the flowers largest and best-developed. Finally, we have selected flowers so as to present some species which blossom in each month of the year. Amongst these plants are some which we especially recommend to the attention of observers, such as rye, wheat, the lilac, the box, &c.: these are distinguished by italics.

The period at which rye, barley and winter wheat come into ear should be carefully examined, this point being of great importance in agriculture. In the district of Tournay it is a farmer's axiom that *April is never seen to* *go out without corn in the ear*; it is curious to determine at what period these cerealia put forth the ear in the various parts of Belgium and Europe.

According to the request of a large number of observers, we have classed the plants recommended to their attention in alphabetical order. The list has been increased by the addition of some new plants; but on the other hand, the Academy has resolved not to include in its publication any plants but those selected for the observers. To admit all observations indiscriminately would be to encumber the Memoirs of the Academy, and to render comparisons almost impossible; whilst, by the arrangement we have adopted, an analysis of the lists may readily be made, and we shall be able to publish with each plant the dates relating to it in each locality.

Having detailed the views by which we have been guided in drawing up the table for annual observations, it remains for us to speak of the duties of the observer.

Linnæus, who first understood all that was to be deduced from the application of meteorology to the vegetable kingdom, pointed out four periods for observation, viz. the foliation, the flowering, the fructification, and the fall of the leaf. Other authors have gone further; they have multiplied the details. In experiments intended to assume a general character, this appears to us neither necessary nor useful; for by heaping up detail upon detail, these observations cease to be comparable, and thus lose their principal utility. Even in the data of Linnæus, there are some which are only applicable to a few vegetables. For instance, the foliation and defoliation can hardly be determined except on woody plants. It thus appears to us that we must confine ourselves to the four data we have pointed out, paying special attention to the most important of all, that which alone would in case of necessity suffice, viz. the flowering. We leave to each observer the care of noting any peculiarities which may appear to him worthy of notice.

In the order of observations, two methods may be employed; we may either note the plants in their wild state or in their cultivated state. We think that the former does not present sufficient facilities, and is subject to too much uncertainty, for the observer would be compelled to traverse daily very different regions, at great distances apart, and would never be sure of making a second observation on the same plant that he had first examined. Where in Europe can we find two localities in which the same species of perennial plants are to be met with upon a space sufficiently limited for making the daily observations? It is impossible for the naturalist to observe daily the fields, the woods and the meadows of his country; he must then confine himself to approximations. Now that which is essential is, that the daily observation of the plants fixed on for comparison should be made in similar positions. From this consideration, we are of opinion that these observations should be made on individuals planted in an airy garden. The plants should neither be sheltered nor exposed to a south wall. As regards trees, they should be selected in open fields, but not in woods, which always afford very unequal shelter.

As to the indication of the periods, they should be made, for the foliation, when the first leaves burst the buds and become visible; and for the flowering, when the anthers are visible; the same will hold good for the flowers of the *Compositæ*. The period for noting the foliation may offer difficulties, from its presenting different phases, which, especially in spring, may cause considerable differences. It is requisite, therefore, to have a fixed period easily ascertained by every one. We propose to select the moment when, from the advance of the vernation, the upper face of the outer leaves becomes exposed to the action of the atmosphere and commences its vital functions. The fructification should be noted at the time of the dehiscence of the pericarp in dehiscent fruits, and these form the largest number; the indehiscent fruits should be noted when they have evidently arrived at maturity. Lastly, the defoliation should be noted when the greater part of the leaves of the year have fallen off, it being fully understood that what relates to leaves can only apply to the woody plants, excluding moreover the evergreens, the defoliation of which is successive.

To the preceding indications, the observers would do well to append those of all such phænomena as they might consider of interest; such are the modifications which occur in the odours and colours of flowers or leaves, &c.*; it would be especially desirable that they should annex the daily indications of the mean temperatures, or what is still better, the maximum and minimum temperature of each day.

2. *Observations for the diurnal period.*—Independently of the annotations of each day, which form the calendar of Flora, it is of much interest to register in each locality the hour at which certain plants expand and shut up which are endowed with the faculty of performing these functions at a determinate hour. But with regard to this, it may be thought too tedious to require the results for every day; it is proposed therefore to limit them to the equinoxes and the summer solstice.

In the formation of the table which relates to these plants, we need take no notice of the views that have guided us in constructing the table for the observation of the annual phænomena. It will be conceived, that it is indifferent whether the plant submitted to horary observation be annual or not, whether in the open earth or the orangery, &c.; all that is requisite is that the plant be healthy and exposed to the open air.

We recommend especially the dandelion, *Leontodon taraxacum*, which, flowering throughout the year, will furnish a subject for curious observations.

(*See below the tables of plants to be observed.*)

From the commencement of 1840, observations on the flowering of plants have been combined with the meteorological observations at the observatory of Prague†; these observations, made by M. Fritsch, relate to the flowering, considered under five phases: the commencement of the flowering, the semi-flowering, full flowering, the semi-defloration, and the defloration. We have not thought it necessary to enter into these details in what concerns the general system of observations.

To keep account of the exposure of the plants as far as possible, it is indicated at Prague by the letters N, E, S, O, whether this exposure is more particularly to the north, east, south or west. The signs — and + indicate, moreover, whether the plants grow in the shade, or in the full sun. We might adopt a similar notation; the absence of any sign would express an intermediate state.

Animal Kingdom.—The department of science to which our attention is directed, rests upon the physiological principle that every organic being, whether an animal or plant, is essentially dependent on atmospheric air, as well for its development as for the preservation of its existence; and that both its development and the exercise of its functions and habits are checked or modified by the modifications of this same atmospheric air. Thus we observe that epidemic and endemic maladies predominate in certain sea-

* For the detail of the observations, see the instructions given by M. Spring in the ninth vol. of the 'Bulletins de l'Académie,' p. 124, &c.

† The magnetic and meteorological observations of Prague are made upon a very large scale, under the direction of M. Kreil, and deserve, in several respects, to serve as a model for investigations of this kind.—*Magnetische und Meteorologische Beobachtungen zu Prag.* Three quarto volumes have at present appeared.

sons and certain years; that the offspring of the common hare is not always equally well developed; that several Rodentia increase in one year in a certain locality, whilst the following year barely the normal number is to be found there; the stag and the roebuck shed their antlers at a period which is not invariably the same each year: to cite a few more examples only, readily comprehended, do we not see the common partridge bring up its numerous family with various success; the swallow, the martin, and the nightingale arrive in our countries, and leave them, at an earlier or later period of the year? the caterpillar and the common cockchafer alarm us sometimes by their numbers in our plantations? Our object should be, to observe the degree of connexion subsisting between the animal, the plant, and the atmospheric air,—to show, by continued and accurate observations, the influence to which these beings are subjected from the medium in which they live, and to attempt, by this method, to explain in a positive manner such phænomena as those we have mentioned above. In animals (in the wild state), the period of coupling, or the season of love, that of birth, that of moulting, whether double or single, that of migration, that of becoming torpid and of awaking, that of the first appearance, the rarity or the remarkable abundance of any species, are the points which should be observed and indicated with exactness, conjointly with meteorological observations. Unity of time and place, two indispensable conditions, should exist between these two kinds of observations, because it is from the data afforded by these observations that general consequences are to be deduced.

Each observer should form a table of his observations, and enter in it in technical terms, as far as possible, the animals which he has observed. It is the result drawn from these partial tables that will form the starting-point of the inductions or corollaries serving to establish some of nature's laws. It will be seen therefore that these tables should be made up with the greatest exactness. It cannot be denied that many difficulties attend such researches, but it must not be lost sight of that the first attempts in every science are always difficult, especially when they require the co-operation of a large number of persons.

In order to render the mode of the *simultaneous* observations uniform, we shall now enumerate some of the principal points to which we consider we ought to call the especial attention of observers, reminding them that the most common species, and such as exist in the greatest number of countries, must for several reasons inspire the greatest interest, and that the most important observations will be such as are made in the country.

Mammalia.—1. Appearance and retreat of the bats.

2. Frequency or rarity of some Insectivora (*Talpa europæa*, mole; *Sorex*, shrew mouse; of some Rodentia of the genera *Mus* and *Arvicola*).

3. Commencement and termination of the lethargic sleep of the dormouse (*Myoxus*).

4. Moulting of the genus *Mustela* of the Carnivora. Appearance and retirement of the badger (*Meles taxus*, after its hybernation).

Reptiles.—Retirement, reappearance and pairing of the Batrachia (frogs, tree-frogs, toads, salamanders and efts).

Mollusca.—The period at which the land and fresh-water gasteropods quit their retreat, the former to creep on the soil, the latter to swim on the surface of the water.

That at which cases of poisoning by muscles occur*.

Insects.—Appearance of the following species. *For these see the amended List at the end of this Report, as recommended by the Committee.*

* In the preceding remarks we have followed the indications of Professor Cantraine.

Fishes.—1. To point out, at stations situated on rivers—

The period of spring at which the species of the genus *Clupea*, denominated allis, *Clupea alosa*, L., the sardine, and shad, *C. finta* (in Flemish *meyvisch*) ascend.

The same with salmon and salmon-trout, *Salmo salar*, and *S. trutta*, L.

The same for the sturgeon, *Acipenser*, L.

2. As regards the fish which never leave the sea, to observe in the sea-ports or on the coasts, the periods at which the following arrive:—

The earliest herrings, *Clupea harengus*, L.

The earliest mackerel, *Scomber scombrus*, L., and some other quite common migrating fish.

Birds.—As regards birds, we think we cannot do better than republish an extract of the notice of M. de Selys-Longchamps, presented to the Zoological Section of the British Association at its last meeting in Plymouth:—

"Zoology and botany should be first interrogated, to enable us to ascertain each year to what degree the variations in the meteorological constitution is capable of advancing or retarding the appearance of certain animals or the foliation and flowering of plants.

"The Belgian naturalists have seen in how great a degree these observations, with the precise dates, and repeated during several years, will render more exact the means sought to be established in local faunas and floras, nay, even in the general fauna of Europe. . . . .

"It is with the view of insuring the possibility of these comparisons which I consider useful for ornithology, that I would earnestly invite naturalists to concentrate their observations upon a certain number of species which are diffused throughout Europe, or nearly so. I have thought it best, for this purpose, to select terrestrial in preference to aquatic species, because their migrations are extended more regularly over all regions, and the determination of them is easier, insomuch that whilst living in a town we can make observations by means of common sportsmen, all these birds having a vernacular name in the different European dialects. I am far from denying the utility of similar observations made upon the migrations of aquatic birds; but, I repeat, that I believe, during the first years, for want of a sufficient number of stations, we should have difficulty in collecting data for the deduction of general results upon these species, which are only found ordinarily in large marshes or on the sea-coast.

"I propose then, setting out from 1842, to study the precise date of the migrations of about forty species, which may be divided into four sections:—

1. Those birds (as the swallow and nightingale) which come and pass the summer and breed with us;

2. Such (like the crane) as are regular in their passage, but which merely pass, without remaining;

3. Those birds (as the gray crow and the siskin) which sojourn in our country throughout the winter and disappear in the fine season;

4. Such birds (as the waxwing and the stormy petrel) the passage of which is accidental at indeterminate periods. I have departed from the principles mentioned in selecting this latter class, but I thought it would be important to direct attention to two or three species the causes of whose appearance are unknown, as the waxwing, or are closely connected with the occurrence of sea tempests, as the *Procellaria pelagica*.

"The first division will, I believe, consist of the same species for all Europe; but it will be different with the other three: in one country, for instance Holland, the stork will be in the first division, whilst elsewhere it will belong to the second, as in Belgium. The same will hold good with the third and fourth, according to the more or less northern latitude at which the observations are made; and it is just these corrections which will, I hope, serve to show the utility of the work which we are desirous of seeing undertaken in the greatest possible number of localities."

Birds selected for the observations. (See this List at the end, as amended by the Committee for the use of English Observers.)

M. de Selys thinks the determination of the period of departure needs less to be insisted upon, being aware of the great difficulty attending it; however, exceptions should be made, especially in the case of swallows, quails, wagtails (*Mot. alba*), and the crow.

To the observations on the arrival and departure of birds, we may advantageously append those which M. Cantraine proposes:—

Of the period at which crows, starlings (*Sturnus vulgaris*, L.) form into flocks, or pair off;

Of the period at which the magpie (*Corvus pica*, L.) commences its nest;

Of the period of moulting;

Of the period at which the sparrow (*Fringilla domestica*, L.) selects a companion, a time remarkable for scenes of quarreling, which are often more readily distinguished by the ear than the eye. The period at which it begins to build should also be noticed.

The thrush (*Turdus musicus*), the field-fare (*Turdus pilaris*) and the missel thrush (*Turdus viscivorus*) deserve particular attention, inasmuch as they are regular birds of passage throughout the greater part of Europe. These birds are also the more readily observed, as, being in request for the table, they are found in all the markets.

As M. Cantraine has observed, "we should point out, as far as possible, the local circumstances which may cause any species to prolong its stay in any particular place. Thus, on the 9th of October 1841, swallows were still in immense numbers in the vicinity of the north and south stations on the Brussels railroad, whereas they had quitted Ghent about the 17th of September, and but few individuals were to be seen at Ath on the 25th of that month. Should not this long stay be attributed to a more elevated temperature, caused by the locomotive engines stationed there, as well as to a greater abundance of food, the consequence of this?"

The naturalists of the south of Europe will not allow the arrival and departure of the flamingo (*Phœnicopterus antiquorum*), nor of some species of sea-gulls (*Larus melanocephalus*, &c.), nor of the tunny (*Scomber thynnus*), to escape their attention.

A. Quetelet.

Brussels, December 1, 1843.

N.B. Such persons as are desirous of taking a part in these researches, are requested to address their results to Mr. Phillips, the Assistant Secretary of the British Association, to the care of Messrs. R. & J. E. Taylor, Red Lion Court, Fleet Street.

List of Plants to be observed for the periods of Foliation and Defoliation.

Acer campestre, *L.*
—— pseudo-platanus, *L.*
—— saccharinum, *L.*
—— tataricum, *L.*
Æsculus hippocastanum, *L.*
—— lutea, *Pers.*
—— pavia, *L.*
—— macrostachys, *Mich.*
Amygdalus communis, *L.*
Amygdalus persica, *L.* (β. *Madeleine*).
Aristolochia sipho, *L.*
Betula alba, *L.*
—— alnus, *L.*
Berberis vulgaris, *L.*
Bignonia catalpa, *L.*
—— radicans, *L.*
Carpinus americana, *Mich.*
Carpinus betulus, *L.*
—— orientalis, *L.*
Celtis cordata, *Desf.*
—— orientalis, *L.*
Cercis siliquastrum, *L.*
Chionanthus virginica, *L.*
Corchorus japonicus, *L.*
Corylus avellana, *L.*
—— colurna, *L.*

Corylus tubulosa, *Willd.*
Cratægus coccinea, *L.*
—— monogyna, *Jacq.*
—— oxyacantha, *L.*
Cytisus laburnum, *L.*
—— sessilifolius, *L.*
Euonymus europæus, *L.*
—— latifolius, *Mill.*
—— verrucosus, *Scop.*
Fagus castanea, *L.*
—— sylvatica, *L.*
Fraxinus excelsior, *L.*
—— juglandifolia, *Lam.*
—— ornus, *L.*
Ginkgo biloba.
Gleditschia inermis, *L.*
—— horrida, *Willd.*
—— triacanthos, *L.*
Gymnocladus canadensis, *Lam.*
Halesia tetraptera, *L.*
Hippophaë rhamnoïdes, *L.*
Hydrangea arborescens, *L.*
Juglans regia, *L.*
—— nigra, *L.*
Lonicera periclymenum, *L.*
—— symphoricarpos, *L.*
—— tatarica, *L.*
—— xylosteum, *L.*
Lyriodendron tulipifera, *L.*
Magnolia tripetala, *L.*
—— yulan, *Desf.*
Mespilus germanica, *L.*
Morus nigra, *L.*
Philadelphus coronarius, *L.*
—— latifolius, *Schrad.*
Platanus acerifolia, *Willd.*
—— occidentalis, *L.*
Populus alba, *L.*
—— balsamifera, *L.*
—— tremula, *L.*
Prunus armeniaca, *L.* (β. *abricotier*).
—— cerasus, *L.* (β. *bigar. noir*).
—— domest. (β. *gr. dam. viol.*)
—— padus, *L.*
Ptelia trifoliata, *L.*
Pyrus communis (β. *bergamot*).
—— japonica, *L.*
—— malus (β. *calvill. d'été*).
—— spectabilis, *Ait.*
Quercus pedunculata, *Willd.*
—— sessiliflora, *Smith.*
Rhamnus catharticus, *L.*
—— frangula, *L.*
Rhus coriaria, *L.*
—— cotinus, *L.*
—— typhina, *L.*
Ribes alpinum, *L.*
—— grossularia, *L.*
—— nigrum, *L.*
—— rubrum, *L.*
Robinia pseudo-acacia, *L.*
Robinia viscosa, *Vent.*
Rosa centifolia, *L.*
—— gallica, *L.*
Rubus idæus.
—— odoratus, *L.*
Salix alba, *L.*
Sambucus ebulus, *L.*
—— nigra, *L.*
—— racemosa.
Sorbus aucuparia, *L.*
—— domestica, *L.*
Spiræa bella, *Sims.*
—— hypericifolia, *L.*
—— lævigata, *L.*
Staphylea pennata, *L.*
—— trifolia, *L.*
Syringa persica, *L.*
—— rothomagensis, *Hort.*
—— vulgaris, *L.*
Tilia americana, *L.*
—— parvifolia, *Hoffm.*
—— platyphylla, *Vent.*
Ulmus campestris, *L.*
Vaccinium myrtillus, *L.*
Viburnum lantana, *L.*
—— opulus, *L. fl. simpl.*
—— ——, *L. fl. plen.*
Vitex agnus-castus, *L.*
—— incisa, *Lam.*
Vitis vinifera (β. *chass. dore*).

List of Plants to be observed for the periods of Flowering and Ripening of the Fruit.

Acanthis mollis, *L.*
Acer campestre, *L.*
—— pseudo-platanus, *L.*
—— saccharinum, *L.*
—— tataricum, *L.*
Achillea biserrata, *Bbrst.*
—— millefolium, *L.*
Aconitum napellus, *L.*
Æsculus hippocastanum, *L.*
—— Lutea, *Pers.*
—— macrostachys, *Mich.*
—— pavia, *L.*
Ajuga reptans, *L.*
Alcea rosea, *L.*
Allium ursinum, *L.*
Alisma plantago, *L.*
Althæa officinalis, *L.*
Amygdalus communis, *L.*
—— persica, *L.* (β. *Madeleine*).
Anchusa sempervirens, *L.*
Andromeda polifolia, *L.*
—— acuminata, *Ait.*
—— racemosa, *L.*
Anemone nemorosa, *L.*
—— hepatica, *L.*
—— ranunculoïdes, *L.*
Angelica archangelica, *L.*
Antirrhinum majus, *L.*
Apocynum androsæmifolium, *L.*
Arabis caucasica, *Willd.*
Arbutus uva-ursi, *L.*
Aristolochia clematites, *L.*
—— sipho, *L.*
Arum maculatum, *L.*
Asarum europæum, *L.*
Asclepias tuberosa, *L.*
—— incarnata, *L.*
—— syriaca, *L.*
—— vincetoxicum, *L.*
Asperula odorata, *L.*
—— taurina, *L.*
Aster dumosus, *L.*
—— novæ angliæ, *L.*
—— paniculatus, *Willd.*
Astragalus onobrychis, *L.*
Astrantia major, *L.*
Atropa belladonna, *L.*
Avena sativa, *L.*
Bellis perennis, *L.*
Berberis vulgaris, *L.*
Betula alba, *L.*
—— alnus, *L.*
Bignonia Catalpa, *L.*
—— radicans, *L.*
Bryonia alba, *L.*
—— dioica, *Jacq.*
Buphthalmum cordifolium, *W.*
Buxus sempervirens, *L.*
Campanula persicifolia, *L.*
Carduus marianus, *L.*
Carpinus americana, *Mich.*
—— betulus, *L.*
—— orientalis, *L.*
Cassia marylandica, *L.*
Ceanothus americanus, *L.*
Celtis cordata, *Desf.*
—— orientalis, *L.*
Cercis siliquastrum, *L.*
Chrysanthemum leucanthemum, *L.*
Chelidonium majus, *L.*
Chenopodium bonus Henricus, *L.*
Chionanthus virginica, *L.*
Chrysocoma linosyris, *L.*
Clethra alnifolia, *L.*
Colchicum autumnale, *L.*
Colutea arborescens, *L.*
Convallaria bifolia, *L.*
—— majalis, *L.*
Convolvulus arvensis, *L.*
—— sepium, *L.*
Corchorus japonicus, *L.*
Coreopsis tinctoria, *Nutt.*
—— tripteris, *L.*
Cornus mascula, *L.*
—— sanguinea, *L.*
Coronilla emerus, *L.*
Corydalis digitata, *Pers.*
Corylus avellana, *L.*

Corylus colurna, *L.*
—— tubulosa, *Willd.*
Cratægus coccinea, *L.*
—— oxyacantha, *L.*
—— monogyna, *Jacq.*
Crocus mæsiacus, *Curt.*
—— sativus, *Sm.*
—— vernus, *Sw.*
Cyclamen europæum, *L.*
—— hederæfolium, *Ait.*
Cynara scolymus, *L.*
Cytisus laburnum, *L.*
—— sessilifolius, *L.*
Daphne laureola, *L.*
—— mezereum, *L.*
Dianthus caryop. *L.* (v. *grenad.*)
Dictamnus albus, *L.*
—— ——, *fl. purpureo.*
Digitalis purpurea, *L.*
Echinops sphærocephalus, *L.*
Epilobium spicatum, *Lam.*
Erica tetralix, *L.*
—— vulgaris, *L.*
Erythrina crista-galli, *L.*
Escholtzia californica, *Chmss.*
Euonymus europæus, *L.*
—— latifolius, *Mill.*
—— verrucosus, *Scop.*
Fagus castanea, *L.*
—— sylvatica, *L.*
Fragaria vesca, *L.* (β. *hortensis*).
Fraxinus excelsior, *L.*
—— juglandifolia, *Lam.*
—— ornus, *L.*
Fritillaria imperialis, *L.*
Galanthus nivalis, *L.*
Gentiana asclepiadea, *L.*
—— cruciata, *L.*
Geranium pratense, *L.*
Gladiolus communis, *L.*
Glechoma hederaceum, *L.*
Gleditschia horrida, *Willd.*
—— inermis, *L.*
—— triacanthos, *L.*
Gymnocladus canadensis, *Lam.*
Hallesia tetraptera, *L.*
Hedera helix, *L.*
Hedysarum onobrychis, *L.*
Helenium autumnale, *L.*
Helleborus fœtidus, *L.*
—— hiemalis, *L.*
—— niger, *L.*
—— viridis, *L.*
Helianthus tuberosus, *L.*
Hemerocallis cærulea, *Andrs.*
—— flava, *L.*
—— fulva, *L.*
Hieracium aurantiacum, *L.*
Hippophaë rhamnoïdes, *L.*
Hordeum hexastichum, *L.*
—— vulgare, *L.*
Hibiscus syriacus, *L.*
Hydrangea arborescens, *L.*
—— hortensis, *Sm.*
Hydrocharis morsus-ranæ, *L.*
Hypericum perforatum, *L.*

Iberis sempervirens, *L.*
Iris florentina, *L.*
—— germanica, *L.*
Juglans nigra, *L.*
—— regia, *L.*
Kalmia latifolia, *L.*
Koelreuteria paniculata, *L.*
Lamium album, *L.*
Leucojum æstivum, *L.*
—— vernum, *L.*
Ligustrum vulgare, *L.*
Lilium candidum, *L.*
—— flavum, *L.*
Linum perenne, *L.*
Liriodendron tulipifera, *L.*
Lonicera periclymenum, *L.*
—— symphoricarpos, *L.*
—— tatarica, *L.*
—— xylosteum, *L.*
Lupinus polyphyllus, *Dougl.*
Lychnis chalcedonica, *L.*
Lysimachia nemorum, *L.*
Lythrum salicaria, *L.*
Magnolia tripetala, *L.*
—— yulan, *L.*
Malope trifida, *L.*
Malva sylvestris, *L.*
Melissa officinalis, *L.*
Mellitis melissophyllum, *L.*
Menispermum canadense, *L.*
Mentha piperita, *L.*
Mespilus germanica, *L.*
Mitella grandiflora, *Pursch.*
Morus nigra, *L.*
Narcissus pseudo-narcissus, *L.*
Nepeta cataria, *L.*
Nymphæa alba, *L.*
—— lutea, *L.*
Orchis latifolia, *L.*
Orobus vernus, *L.*
Oxalis acetosella, *L.*
—— stricta, *L.*
Papaver bracteatum, *L.*
—— orientale, *L.*
Paris quadrifolia, *L.*
Philadelphus coronarius, *L.*
—— latifolius, *Schrad.*
Phlox divaricata, *L.*
—— setacea, *L.*
Physalis alkekengi, *L.*
Plantago major, *L.*
Platanus acerifolia, *Willd.*
—— occidentalis, *L.*
Polemonium cæruleum, *L.*
Polygonum bistorta, *L.*
Populus alba, *L.*
—— balsamifera, *L.*
—— tremula, *L.*
Primula elatior, *L.*
Prunus armeniaca, *L.* (β. *abricotin*).
—— cerasus (β. *bigarr. noir*).
—— domest. (β. *gr. dam. viol.*).
—— padus, *L.*
Ptelia trifoliata, *L.*
Pulmonaria officinalis, *L.*

Pulmonaria virginica, *L.*
Pyrus communis (*bergamotte*).
—— cydonia, *L.*
—— japonica, *L.*
—— malus (*calville d'hiver*).
—— spectabilis, *Ait.*
Quercus pedunculata, *Willd.*
—— sessiliflora, *Smith.*
Ranunculus acris, *L.* (*fl. plen.*).
—— ficaria, *L.*
—— lingua, *L.*
Rhamnus catharticus, *L.*
—— frangula, *L.*
Rheum undulatum, *L.*
Rhododendron ferrugineum, *L.*
—— ponticum, *L.*
Rhus coriaria, *L.*
—— cotinus, *L.*
—— typhina, *L.*
Ribes alpinum, *L.*
—— grossularia, *L.* (*fr. virid.*).
—— —— (*f. rubent.*).
—— nigrum, *L.*
—— rubrum, *L.*
—— —— *fruct. alb.*
Robinia pseudo-acacia, *L.*
—— viscosa, *Vent.*
Rosa centifolia, *L.*
—— gallica, *L.*
Rosmarinus officinalis, *L.*
Rubia tinctorum, *L.*
Rubus idæus, *L.*
—— odoratus, *L.*
Ruta graveolens, *L.*
Salix alba, *L.*
Sagittaria sagittifolia, *L.*
Salvia officinalis, *L.*
Sambucus ebulus, *L.*
—— nigra, *L.*
—— racemosa.
Sanguinaria canadensis, *L.*
Satureja montana, *L.*
Saxifraga crassifolia, *L.*
Scabiosa arvensis, *L.*
—— succisa, *L.*
Scrophularia nodosa, *L.*
Secale cereale, *L.*
Sedum acre, *L.*
—— album, *L.*
—— telephium, *L.*
Solanum dulcamara, *L.*
Sorbus aucuparia, *L.*
—— domestica, *L.*
—— hybrida, *L.*
Spartium scoparium, *L.*
Spiræa bella, *Sims.*
—— filipendula, *L.*
—— hypericifolia, *L.*
—— lævigata, *L.*
Staphylea pinnata, *L.*
—— trifolia, *L.*
Statice armeria, *L.*
—— limonium, *L.*
Symphytum officinale, *L.*
Syringa persica, *L.*
—— rothomagensis, *Hort.*

Syringa vulgaris, *L.*
Taxus baccata, *L.*
Tiarella cordifolia, *L.*
Thymus serpyllum, *L.*
—— vulgaris, *L.*
Tilia americana, *L.*
—— microphylla, *Vent.*
—— platyphylla, *Vent.*
Tradescantia virginica, *L.*
Trifolium pratense, *L.*
—— sativum, *L.*
Triticum sativum, *L. α. æstivum.*
—— ——, *β. hybern.*
Tussilago fragrans, *L.*
—— petasites, *L.*
Ulmus campestris, *L.*
Vaccinium myrtillus, *L.*
Veratrum album, *L.*
Verbena officinalis, *L.*
Veronica gentianoïdes, *L.*
—— spicata, *L.*
Viburnum lantana, *L.*
—— opulus, *fl. simpl.*
—— ——, *fl. plen.*
Vinca minor, *L.*
Viola odorata, *L.*
Vitex agnus-castus, *L.*
—— incisa, *Lam.*
Vitis vinifera, *L.* (*β. chasselas doré*).
Waldsteinia geoïdes, *Kit.*

List of Plants to be observed at the Vernal and Autumnal Equinoxes and Summer Solstice, for the hours of opening and closing their Flowers.

Anagallis arvensis, *L.*
Arenaria purpurea, *Pers.*
Calendula officinalis.
—— arvensis, *L.*
Campanula speculum, *L.*
Cichorium endivia, *L.*
Convolvulus tricolor, *L.*
Crepis rubra, *L.*
Datura stramonium, *L.*
—— ceratocaula, *Jacq.*
Dianthus prolifer, *L.*
Hemerocallis fulva, *L.*
Lactuca sativa, *L.*
Leontodon taraxacum, *L.*
Malva sylvestris, *L.*
Mesembryanthemum crystallinum, *L.*
—— coccineum, *Haw.*
—— pomeridianum, *L.*
Mirabilis longiflora, *L.*
—— jalapa, *L.*
Nymphæa alba, *L.*
Œnothera biennis, *L.*
Ornithogalum umbellatum, *L.*
Picridium tingitanum, *Desf.*
Portulaca oleracea sativa, *L.*
Sonchus oleraceus, *L.*
Trapa natans, *L.*
Tigridia pavonia, *L.*
Tradescantia virginica, *L.*
Tragopogon pratensis, *L.*
—— porrifolius, *L.*

LISTS FOR THE ANIMAL KINGDOM*.

MAMMALS.

Meles taxus (*Badger*), appearance and retreat.
Mustela erminea (*Stoat*), periods of moult.
Myoxus avellanarius (*Dormouse*), commencement and termination of winter sleep.
Vespertilio pipistrellus (*Bat*†), first appearance and disappearance.

BIRDS.

Regular Summer migrants, of which the first appearance is to be observed.

Caprimulgus europæus (*Goat-sucker*).
Columba turtur (*Turtle-dove*).
Crex pratensis (*Land-rail*).
Cuculus canorus (*Cuckoo*).
Cypselus apus (*Swift*).
Hirundo riparia (*Bank Martin*).
—— rustica (*Swallow*).
—— urbica (*House Martin*).
Motacilla yarrellii (*Pied Wagtail*‡).
Muscicapa grisola (*Spotted Flycatcher*).
Perdix coturnix (*Quail*).
Saxicola œnanthe (*Wheatear*).
—— rubetra (*Whinchat*).
Sylvia atricapilla (*Blackcap Warbler*).
—— cinerea (*Whitethroat*).
—— curruca (*Lesser Whitethroat*).
—— hortensis (*Garden Warbler*).
—— luscinia (*Nightingale*).
—— arundinacea (*Reed Warbler*).
—— phœnicurus (*Redstart*).
—— trochilus (*Willow Warbler*).
Yunx torquilla (*Wryneck*).

* These lists contain some species not in those originally proposed in M. Quetelet's memoir. This is at the suggestion of M. Edm. De Selys-Longchamps and the Rev. L. Jenyns, the former of whom assisted M. Quetelet in the first instance in drawing the lists up, especially that of birds. These gentlemen met and reconsidered the subject at the period of the Meeting of the British Association at Cambridge in June 1845, and the following are the revised lists which they propose to be adopted. In this instance they are particularly arranged with a view to English observers; some of the species of birds originally named being extremely rare or accidental in this country, if they occur at all; and others, which are regular migrants on many parts of the continent, being stationary in Britain throughout the year.

N.B. All the lists are arranged in alphabetical order.

† Care must be taken precisely to determine the species of Bat observed.

‡ This species is stationary in the south of England, but in some of the northern counties as well as in Scotland is migratory.

Rare, or only occasional, Summer migrants *.

Emberiza hortulana (*Ortolan Bunting*).
Lanius rufus (*Woodchat Shrike*).
Motacilla flava, *Temm.* (*Gray-headed Wagtail*).
Muscicapa luctuosa, *Temm.* (*Pied Flycatcher*).
Oriolus galbula (*Golden Oriole*).
Sylvia tithys (*Black Redstart*).
Upupa epops (*Hoopoe*†).

Regular Winter migrants.

Anser segetum (*Bean Goose*).
Corvus cornix (*Hooded Crow*).
Cygnus ferus (*Hooper* or *Wild Swan*).
Fringilla montifringilla (*Mountain Finch*).
Fringilla spinus (*Siskin*).
Scolopax rusticola (*Woodcock*).
Turdus pilaris (*Fieldfare*).

Occasional Winter migrant.

Bombycilla garrula (*Bohemian Waxwing*).

Of accidental occurrence.

Procellaria leachii (*Fork-tailed Petrel*‡).
Procellaria pelagica (*Stormy Petrel*‡).

Species to be observed for the periods of departure §.

Cypselus apus (*Swift*).
Hirundo riparia (*Bank Martin*).
Hirundo rustica (*Swallow* ‖).
—— urbica (*House Martin* ‖).

Species to be observed for the periods of collecting into flocks and pairing off in the Spring.

Fringilla cannabina (*Common Linnet*).
Sturnus vulgaris (*Starling*).

Species to be observed for the periods of commencing song or note.

Columba palumbus (*Ring-dove*).
Emberiza citrinella (*Yellow-hammer*).
Fringilla cannabina (*Linnet*).
—— chloris (*Greenfinch*).
—— cœlebs (*Chaffinch*).
Parus major (*Great Titmouse*).
Turdus merula (*Blackbird*).
—— musicus (*Thrush*).
—— viscivorus (*Missel-thrush*).

Species to be observed for the periods of building.

Corvus frugilegus (*Rook*).
—— pica (*Magpie*).
Fringilla domestica (*House Sparrow*).

* It was thought desirable to make a separate list of these species, all of which are included amongst the regular migrating birds selected for observation in M. Quetelet's original list, but which in this country are either very local, or of only accidental occurrence. Wherever or whenever observers have an opportunity of noticing them, the dates should be preserved.

† This species generally occurs in this country in the autumn, or at least not till after the breeding-season.

‡ Both these species are particularly inserted in M. Quetelet's list, it being thought that their occasional appearance inland is generally more or less connected with tempestuous weather. Their occurrence, however, would not seem to be confined to any particular season.

§ It would be desirable to note, wherever it can be done, the exact period of departure of any of the species in the foregoing lists of summer and winter migrants; but as it is in general difficult to determine this, it is only especially recommended in the case of the swallow tribe.

‖ In the case of these species it will be well to notice the period at which the great bulk take their departure, as well as the date of the last individual's being seen. It will also be proper to notice the exact time of swallows and martins *congregating*, which takes place for a longer or shorter period before they depart.

REPTILES.

Natrix torquata (*Common Snake*). Zootoca vivipara (*Common Lizard*).	First appearance.
Bufo vulgaris (*Common Toad*). Rana temporaria (*Common Frog*). Triton palustris (*Warty Eft*).	Ditto; also period of spawning.

FISH *.

Acipenser sturio (*Sturgeon*). Clupea alosa (*Allis*). —— finta (*Shad*). Salmo salar (*Common Salmon*). —— trutta (*Salmon Trout*).	Period of ascending rivers.
Clupea harengus (*Common Herring*). Scomber vulgaris (*Common Mackerel*).	First arrival on the coast.

MOLLUSKS.

Helix aspersa. —— nemoralis.	First appearance.

INSECTS.

First appearance of the following species.

(*Coleoptera.*)

Geotrupes stercorarius.
Lytta vesicatoria †.
Meloë proscarabæus.
Melolontha vulgaris.
—— solstitialis.
Pœcilus cupreus.
Telephorus rusticus.
Timarcha tenebricosa.

(*Orthoptera.*)

Acrida viridissima ‡.
Locusta §.

(*Neuroptera.*)

Æschna maculatissima.
Calepteryx virgo.
Ephemera vulgata.
Libellula depressa.
Panorpa communis.
Sialis lutarius.

(*Hymenoptera.*)

Anthophora retusa.
Apis mellifica.
Bombus ||.
Formica ||.
Vespa vulgaris.

(*Lepidoptera.*)

Catocala nupta.
Gonepteryx rhamni.
Hipparchia janira.
Plusia gamma.
Polyommatus alexis.
Pontia brassicæ.
—— cardamines.
—— napi.
—— rapæ.
Vanessa io.
—— polychloros.
—— urticæ.

(*Diptera.*)

Bibio hortulanus.
—— marci.
Bombylius medius.
Culex pipiens.
Eristalis tenax.
Hæmatopota pluvialis.
Mesembrina meridiana.
Rhyphus fenestralis.
Stomoxys calcitrans.
Tipula oleracea.
Trichocera hiemalis.
Xylota pipiens.

* The observations on this class of animals are especially recommended to such naturalists as are situated in the neighbourhood of large rivers, or on the sea-coast.

† This species is inserted as being in M. Quetelet's original list: in England it is rare, and not often met with.

‡ In this species the commencement of the stridulous cry of the male should be especially noted.

§ As the species of this genus strongly resemble one another, and appear much about the same period of the summer, it will be sufficient to notice the first appearance of the *genus* only.

Note.—It should be borne in mind that the names *Acrida* and *Locusta* are differently applied by the continental entomologists; the genus here termed *Acrida* being with them *Locusta*, and *Locusta* their *Acridium.*

|| Note here, as in the case of *Locusta*, the first appearance of the *genus* only. Under *Formica*, mark, besides the first coming abroad in the early part of the year, the period of the summer or autumn when the *winged ants migrate.*

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

These experiments have been commenced as in previous years, in accordance with the specified instructions.

The Committee have this year expended 9*l.* 15*s.* 10*d.* in the purchase of seeds and incidental expenses (including Curator's salary).

Seeds of 23 genera have been added to the *Seminarium* at Oxford, of which 1 was contributed by H. E. Strickland, Esq., 4 were gathered in the Oxford Botanic Garden, and 18 were purchased of Mr. Charlwood.

The increasing difficulty of procuring a sufficient quantity of seeds of genera not previously subjected to experiment, induces the Committee again earnestly to solicit contributions of seeds, either of a recent or of any known date, from all persons interested in the inquiry who may have such at their disposal. To be addressed to the Curator, W. H. Baxter, Botanic Garden, Oxford.

The following is a list of the seeds distributed this season:—

Name and Date when gathered.	No. sown.	No. of Seeds of each Species which vegetated at			Time of vegetating in days at			Remarks.
		Oxford.	Hitcham.	Chiswick.	Oxford.	Hitcham.	Chiswick.	
1837.								
1. Daucus Carota	300	20	9	8	11	16	30	
1842.								
2. Aconitum Napellus	100	......	....	13	......	....	28	
3. Adonis autumnalis	50	29	14	36	15	20	18	
4. Amaranthus caudatus	100	90	11	77	4	10	18	
5. Anagallis arvensis	100	9	7	73	11	25	15	
6. Buffonia annua	100	......	....	16	......	....	21	
7. Buphthalmum cordifolium	100	11	....	15	14	....	28	At Hitcham
8. Bupleurum rotundifolium	100	27	3	37	10	47	21	1 plant was
9. Conium maculatum	100	56	26	62	11	16	28	variegated.
10. Cytisus Laburnum	50	5	9	7	15	14	35	
11. Dipsacus laciniatus	50	28	24	8	12	18	28	
12. Elsholtzia cristata	100	19	5	20	12	17	21	
13. Erysimum Peroffskianum	100	10	4	68	8	21	21	At Oxford
14. Helianthus indicus	25	24	24	20	4	9	25	on slight
15. Heracleum elegans	50	......	....	17	......	....	30	heat.
16. Hyoscyamus niger	100	......	....	7	......	....	30	
17. Iberis umbellata	100	100	?	50	6	11	21	
18. Iris sibirica	50	......	....	14	......	....	35	
19. Lathyrus heterophyllus	50	41	37	27	20	20	30	
20. Leonurus Cardiaca	100	41	9	28	11	17	25	
21. Malcomia maritima	100	76	37	65	5	9	35	
22. Malope grandiflora	100	32	20	75	5	9	21	
23. Momordica Elaterium	25	......	....	13	......	....	21	
24. Nepeta Cataria	100	3	....	40	21	....	35	
25. Nicandra physaloides	100	80	9	54	5	13	30	
26. Nigella nana	50	15	10	15	12	16	30	
27. Orobus niger	50	1	....	17	?	....	35	
28. Stenactis speciosa	100	3	....	15	?	....	30	
29. Tetragonolobus purpureus	25	8	11	21	9	14	21	
30. Trigonella fœnum-græcum	50	28	34	27	5	8	30	
31. Tropæolum majus	25	16	14	22	7	12	18	At Oxford
32. Cucurbita	15	14	9	14	4	14	15	on hot-bed.
33. Gilia achilleæfolia	100	......	....	69	......	....	30	
34. Capsicum	25	15	5	13	9	23	21	

Name and Date when gathered.	No. sown.	No. of Seeds of each Species which vegetated at			Time of vegetating in days at			Remarks.
		Oxford.	Hitcham.	Chiswick.	Oxford.	Hitcham.	Chiswick.	
1842 (*continued*).								
35. Medicago maculata	100	7	2	62	14	38	25	
36. Calandrinia speciosa	100	66	30	75	4	8	30	
37. Callichroa platyglossa ...	100	14	18	60	6	8	30	
38. Collomia coccinea	100	......	9	55	......	14	35	
39. Coreopsis atrosanguinea...	100	54	2	82	7	41	35	
40. Cotoneaster rotundifolia .	20	5	....	11	......	....	40	
41. Cratægus macracantha ...	50	......	....	4	......	....	40	
42. ——— punctata	50	......	....	3	......	....	45	
43. Cynoglossum glochidatum	100	1	2	42	8	47	30	
44. Digitalis lutea...............	100	20	....	26	9	....	25	
45. Eutoca viscida	100	8	....	76	9	....	21	
46. Glaucium rubrum	100	......	....	47	......	....	21	
47. Godetia Lindleyana	100	16	....	74	12	....	18	
48. Gladiolus psittacinus......	100	6	....	11	35	....	40	
49. Impatiens glanduligera ...	50	......	....	34	......	....	15	
50. Lupinus succulentus	100	35	23	27	5	7	21	
51. Nolana atriplicifolia	100	75	26	49	5	10	21	At Oxford on slight heat.
52. Oxyura chrysanthemoides	100	22	9	36	5	10	21	
53. Papaver amœnum	100	17	6	24	8	15	18	
54. Phacelia tanacetifolia ...	100	27	13	82	10	11	30	
55. Potentilla nepalensis	100	28	....	24	?	....	40	
56. Sphenogyne speciosa......	100	5	....	70	8	....	35	
57. Acacia pseud-acacia	100	9	9	12	7	11	45	It is the practice to sow these seeds immediately after they are gathered.
58. Alstrœmeria pelegrina ...	20	1	....	4	40	....	45	
59. Betula alba..................	200							
60. Carpinus Betula...........	100	...	....	......	......	....	......	
61. Catalpa cordifolia	50							
62. Cercis canadensis	50	1	1	2	40	41	45	
63. Cerinthe major	50	36	26	17	8	14	21	
64. Cichorium Endivia	150	72	78	110	6	8	21	
65. Cobæa scandens...........	6	......	....	3	......	....	21	
66. Cuphea procumbens	50	10	3	32	6	36	30	Seeds of holly should be sown fresh from the tree.
67. Dolichos lignosus	25	25	17	19	8	34	35	
68. Galinsogea trilobata	100	27	31	42	6	15	35	
69. Ilex Aquifolium	100							
70. Juniperus communis	100	...	....	......	......	....	......	
71. Liriodendron Tulipiferum	50							
72. Loasa nitida	100	3	31	18	12	16	30	At Oxford on slight heat.
73. Magnolia, sp.	15	......	....	4	......	....	45	At Oxford 1 vegetated on the 9th day, the rest from then till 60 days.
74. Martynia proboscidea ...	20	8	....	2	9	....	35	
75. Mesembryanthemum crystallinum	100	30	....	64	6	....	21	
76. Mirabilis Jalapa	25	8	11	11	5	15	30	At Oxford, Nos. 75, 76, and 78 on heat.
77. Morus nigra	100	22	9	28	20	....	45	
78. Ricinus communis.........	15	8	....	7	7	....	20	
79. Rudbeckia amplexicaulis .	150	10	1	44	12	15	35	
80. Scorpiurus sulcatus	25	10	7	5	8	16	20	
81. Tetragonia expansa	15	3	8	11	20	18	21	
82. Ulex europæa...............	100	20	30	63	14	18	45	
83. Quercus Robur	10	......	....	3	......	....	45	
84. Phœnix Dactylifera	3	3	....	2	41	....	40	At Oxford on hot-bed.
1844.								
85. Ammobium alatum	200	62	8	61	5	15	18	Placed at Oxford on slight heat.
86. Asparagus officinalis	150	93	36	122	20	21	33	
87. Alstrœmeria aurantia......	100	1	... .	11	......	....	30	
88. Argemone alba	100	33	12	68	10	20	16	
89. Bryonia dioica	100	......	9	72	......	9	20	

Name and Date when gathered.	No. sown.	No. of Seeds of each Species which vegetated at			Time of vegetating in days at			Remarks.
		Oxford.	Hitcham.	Chiswick.	Oxford.	Hitcham.	Chiswick.	
1844 (*continued*).								
90. Carthamus tinctorius......	100	68	27	11	6	9	28	
91. Carum Carui	200	176	40	118	9	15	17	At Oxford on slight heat.
92. Catananche cærulea	200	140	43	103	6	20	21	
93. Crambe maritima	100	36	38	31	16	20	30	
94. Chenopodium Botrys......	200	108	19	93	5	8	18	
95. Eschscholtzia californica .	200	21	36	117	11	14	22	
96. Helleborus fœtidus.........	150	......	60	30	...	In Jan. 1846.	30	
97. Linaria Prezii...............	200	27	4	136	30	45	21	
98. Malva mauritiana	200	70	80	133	5	8	21	
99. Madia splendens............	200	81	93	61	7	8	25	
100. Scorzonera hispanica......	200	145	139	96	5	9	18	
101. Saponaria annua	150	101	82	54	6	10	20	Placed at Oxford on hot-bed.
102. Solanum ovigerum.........	200	119	2	19	5	20	15	
103. Sium Sisarum...............	200	......	....	73	......	....	20	
104. Sanvitalia procumbens ...	200	40	3	111	4	17	20	Ditto.
105. Tragopogon porrifolius ...	200	99	145	23	6	9	25	
106. Vesicaria grandiflora	150	116	76	107	11	14	25	

WILLIAM H. BAXTER, Curator.
June 12, 1845.

C. B. DAUBENY.
H. E. STRICKLAND.

APPENDIX.

On the Reduction of Stars in the 'Histoire Céleste' of Lalande and the 'Cœlum Australe Stelliferum' of Lacaille.

THE Committee appointed at the York Meeting of the British Association in 1844, and consisting of Sir J. Herschel, the Astronomer Royal, and Lieutenant W. S. Stratford, R.N., to continue the reduction of the stars in the 'Histoire Céleste' of Lalande and the 'Cœlum Australe Stelliferum' of Lacaille, report,—

1. That the whole of the stars in the 'Histoire Céleste' have been reduced.

2. That the press-work has proceeded as far as sheet 2 T, ending with No. 26240 of the Catalogue.

3. That the whole will be ready for publication before the next meeting of the Association.

4. That the whole of Lacaille's Stars have been reduced.

5. That the Catalogue is printed, and there remain to be prepared the Preface and Notes, both of which have been delayed by the lamented decease of Professor Henderson.

6. That this Catalogue will also be ready for publication before the meeting in 1846.

7. That the balance of the Government grant of 1000*l.* for printing these Catalogues was at the previous meeting .... £934 2*s.*
Out of which there has been paid to the printers, on account 300 0

Leaving a balance of £634 2
the whole of which will be required before the next meeting.

8. That the appointment of a Committee, to continue the printing of these works, is necessary.

Nautical Almanac Office,
June 16th, 1845.

W. S. STRATFORD.

On the Catalogue of Stars of the British Association.

THE Committee appointed at the York Meeting of the British Association in 1844, and consisting of the Rev. Dr. Robinson, the Rev. James Challis, and Lieutenant W. S. Stratford, R.N., for the purpose of continuing the publication of the British Association's Catalogue of Stars, with the sum of 615*l.* at their disposal, report,—

1. That the Catalogue is completed and ready for publication.

2. That the following Works and MSS. relating to the formation of the Catalogue have been deposited at the Kew Observatory:—

Taylor's Madras Observations, 4 vols. 4to. (two copies).
Brisbane's Catalogue, 1 vol. 4to. (two copies).
Johnson's Catalogue and Henderson's Catalogue, in 1 vol. 4to. (two copies).
Groombridge's Catalogue, 1 vol. 4to.
Wrottesley's Catalogue, 1 vol. 4to.
Mayer's Catalogue by Baily, 1 vol. 4to.
Sundry Calculations, 1 vol. 8vo.
MSS. Calculations, 24 vols. 4to.
MSS. Synonyms, notes, &c., 24 vols.
MS. copy of the Catalogue, 1 vol.

3. That the whole of the expenses incurred in the production of the Catalogue (500 copies) have been paid, and that no further grant will be needed.

4. That of the Grant of		£615 0 0
There has been expended agreeably to the accounts sent herewith—		
For press-work	£40 0 0	
Printing and paper	511 15 0	
Binding MSS.	11 14 6	
		£563 9 6
Leaving a balance of....................		£51 10 6

5. That the entire cost of the Catalogue has been—

1. For books	£4 0 0
2. Skeleton forms..........................	64 0 0
3. Calculations	537 16 6
4. Printing and paper	511 15 0
5. Press-work	75 0 0
6. Binding MSS.	11 14 6
Total..	£1204 6 0

Which is equivalent to nearly 2*l.* 8*s.* for each copy.

Nautical Almanac Office,
June 16th, 1845.

W. S. STRATFORD.

On the Kew Observations. *By* Francis Ronalds, *Esq.*

Mr. Francis Ronalds, on presenting the Annual Journal of Electro-meteorological Observations made at the Kew Observatory, confined himself almost exclusively to an enumeration of its different heads.

The introductory portion begins with the description of a little variation in the cap of the principal conductor, which variation might possibly (he said) affect *slightly* its electrical indications.

He secondly described (for the possible safety and convenience of future observers) a method of raising and lowering the principal conductor.

Thirdly, the result of his experience as to the best method of maintaining the little collecting flame (of Volta) in a fit condition, &c., in strong gales, &c.

Fourthly. Three registering electrometers, the principle of which consists in causing the hand or arm of a clock connected with the principal conductor to charge electrometers contained in air-tight vessels, together with chloride of calcium, and to leave the electrometers thus charged entirely separated from any other body than their supports.

Fifthly. A pluvio-electrometer, which is a large copper dish properly insulated on a warmed glass column (as usual) upon the roof, and connected with electrometers in the interior of the Observatory. This apparatus has exhibited *strong* signs of *positive electrization* at moments when the principal conductor was charged *negatively* (the latter much more highly, of course). The phænomenon occurred when a storm was imminent, but before any rain had fallen, and the result had been expected.

Sixthly. A simple modification of the Coulomb electrometer, which renders this excellent instrument capable of employment in all states of the air (as to humidity): in using it, the usual kind of tedious manipulation is in a very great degree diminished. The principal alteration consists in placing the vibrating (or moveable) needle in perfect metallic contact with the fixed needle. [There are other improvements.]

Seventhly. A few details concerning improvements of his Balance Anemometer.

The Journal itself is preceded by some necessary explanations, &c., which show that the regular number of observations of many instruments per diem has been greatly enlarged since the 1st of January (1845). The registering electrometers enable the observer to add the hours of 12, 2 and 4 to the other hours of observation, and thus to complete two-hourly observations of atmospheric electricity for the whole day.

Under the head of *experiments*, &c., are detailed a few on the electrical insulation, at two different heights, of two conductors, whose upper extremities had the same height above the earth. The object was to obtain a few useful data for other observers of atmospheric electricity.

And another on a rather extraordinary case of electrization without insulation (in the usual sense of the word): it was a case of the St. Elmo fire probably.

Provisional Reports and Notices of Progress were read on the following Subjects:—

Investigation of the Marine Zoology of Britain by means of the Dredge. By Prof. E. Forbes.

On Marine Animals of Cornwall. By C. W. Peach.

On the undescribed Species of Anoplura. By H. Denny.
On the Varieties of the Human Race. By Dr. Hodgkin.
On Subterranean Temperature in Ireland. By Prof. Oldham.
On the Statistics of Sickness and Mortality at York. By T. Laycock, M.D.
On the Microscopic Structure of Shells. By W. Carpenter, M.D., F.R.S.

NOTICES

AND

ABSTRACTS OF COMMUNICATIONS

TO THE

BRITISH ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE,

AT THE

CAMBRIDGE MEETING, JUNE 1845.

ADVERTISEMENT.

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

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NOTICES AND ABSTRACTS

OF

MISCELLANEOUS COMMUNICATIONS TO THE SECTIONS.

MATHEMATICS AND PHYSICS.

On Algebraic Equivalence. By the Rev. T. Jarrett, *Professor of Arabic in the University of Cambridge.*

Many algebraic series, when applied to particular cases, have been found to involve numerical absurdities. Attempts have been made to explain these contradictions by means of metaphysical refinements, but in most cases without success. The object of the paper was to remind mathematicians that the series in question arise, in most cases, from a succession of operations, in each of which a portion of the result is neglected, and that the accumulated effect of these omissions shows itself in a numerical absurdity in particular cases. The writer took the binomial theorem as an instance, and showed in what way the demonstration would most naturally proceed, from the simple case of the index being positive and integral, to the cases of a negative integer, and of fractions both positive and negative. This was done by means of a notation* which expresses any series by its general term, and by means of which the operations of multiplication and involution can be as readily performed on a series as on a single term. The result arrived at was, that no dependence ought to be placed on, nor any use made of, the binomial theorem without the express limitation that either the index must be an integer, or that the second term must be less than the first.

Many eminent mathematicians have explained the above-mentioned numerical absurdities, by making a distinction between algebraic and arithmetical equality, as founded on an assumed difference between symbolical and arithmetical algebra, and resulting in a separation between equivalence and equality. The writer called in question the justice of this distinction, and asked for information on a point so important in estimating the truth and value of analytical investigations.

On Imaginary Zeros, &c. By Professor Young.

The principal object of this paper was to remove certain contradictions involved in the prevalent theories of conjugate points, and to supply correct principles for their determination. These principles are thus announced :—1. Let the equation be solved for one of the variables; then, if any pair of values for x and y, which satisfy this explicit equation, differ from real values only by the entrance of an imaginary zero—in whichever direction that zero be reached—those real values will be the coordinates of a conjugate point. 2. If it be inconvenient to solve the equation for one of the variables, we may take a differential coefficient of any order whatever: then, if a pair of values for x and y render this coefficient imaginary, and at the same time satisfy the rational equation of the curve, those values will belong to a conjugate point.

The author further shows that it is equally correct to regard a conjugate point as an evanescent oval, or as a real point through which an imaginary curve passes: in the former view the differential coefficient, at the point, is indeterminate and real; in the latter view it is determinate and imaginary.

* A full account of this notation, with numerous applications to pure analysis, will be found in the writer's 'Essay on Algebraic Development.'

On Triplets. By the Rev. C. GRAVES, *M.R.I.A., Professor of Mathematics in the University of Dublin.*

An abstract of this communication will be found in the 'Proceedings of the Royal Irish Academy,' vol. iii. part i.

On the Equation of Laplace's *Functions. By* GEORGE BOOLE.

The method by which the integral was obtained is the one developed in a paper on a General Method in Analysis, published in the Philosophical Transactions for the past year, and I may be allowed to express my opinion, founded on a very careful examination of the subject, in which I have obtained no less than six distinct forms of the integral, that this is the only way in which we can obtain a symmetrical solution free from integral signs.

The equation of Laplace is

$$\frac{d}{d\mu}\left(1-\mu^2\right)\frac{du}{d\mu}+\frac{1}{1-\mu^2}\frac{d^2u}{d\phi^2}+n(n+1)\,u=0,$$

and the integral in question

$$u=\mathrm{F}\left(\frac{\sqrt{1-\mu^2}\,\varepsilon^{\phi\sqrt{-1}}}{\mu}\right),$$

where

$$\mathrm{F}\left(\varepsilon^{\phi\sqrt{-1}}\right)=\mu^n\left(\frac{d}{d\mu}\frac{1}{\mu}\right)^n\left\{(\mu+\mu^2)^n\,\psi\left(\frac{\mu\,\varepsilon^{\phi\sqrt{-1}}}{1+\mu}\right)+(\mu-\mu^2)^n\,\chi\left(\frac{\mu\,\varepsilon^{\phi\sqrt{-1}}}{1-\mu}\right)\right\},$$

ψ and χ denoting arbitrary functions. This integral consists of two particular ones, and I have proved that when the arbitrary functions which they involve are so assumed as to produce together real forms for u, the results are the same as would be got by confining ourselves to one solution, and equating separately to 0 the real and the imaginary portions. This seems to be an usual, perhaps it is a general property of differential equations which involve in their solution the imaginary unit $\sqrt{-1}$; and it is important, because it shows that a particular integral taken with this license of interpretation becomes a general one.

By giving to the arbitrary functions the general form $c\,\varepsilon^{r\phi\sqrt{-1}}+c^1\,\varepsilon^{-r\phi\sqrt{-1}}$, and prefixing Σ to the result, I have obtained the following real form of solution,

$$u=\Sigma\{af(\mu)+bf(-\mu)\}\cos r\phi;$$

with a similar one in multiple sines, a and b being arbitrary, and

$$f(\mu)=(1-\mu^2)^{\frac{r}{2}}\,\mu^{n-r}\left(\frac{d}{d\mu}\frac{1}{\mu}\right)^n\mu^{n+r}(1+\mu)^{n-r}.$$

The summation is quite unlimited with respect to r, that is, r may be positive or negative, integral or fractional. In all cases the coefficient of $\cos r\phi$ is a finite function of μ, which is an unexpected result.

In the case of Laplace's functions, the summation extends from 0 to n, including only integer values of r. On determining the constants, we get

$$\mathrm{P}=\mathrm{A}_0+2\left(\mathrm{A}_1\cos\phi+\mathrm{A}_2\cos 2\phi\,..+\mathrm{A}_n\cos n\phi\right),$$

where in general

$$\mathrm{A}_r=\frac{f(\mu)f(\mu')}{1.2..n+r\;\;1.2..n-r},$$

and $f(\mu)$ is as above. I think it is evident that in deducing these functions from the general integral of the equation which they satisfy, we not only employ the natural and direct method of analysis, but also gain something in the final result, as respects simplicity of form and elegance of expression.

On the Premises of Geometry. By H. WEDGWOOD, *M.A.*

The conception of geometrical figure, as traced out by the motion of a point, necessarily supposes in the student the capacity of comparing the direction of that motion at successive instants of time, and of distinguishing, at a second point in the course pursued, a direction identical with a given direction at a former point. He will accordingly be able to form a conception of the path traced out by the generating point moving continuously in a single constant direction, or returning again to the same constant direction after having quitted it, and moved for awhile in a path of any other description, and he might thus originally acquire the notion, in the former case, of a straight line; in the latter, of parallel straight lines.

Again, the possibility of drawing a straight line direct to any given point in space, involving (as it does) the identification of points determined by different paths diverging from a common starting-point, supposes in the student the capacity of estimating the distance virtually advanced in the direction of given coordinates whilst actually moving in a path of any description. Hence the fundamental standard of position expressed in the following definition. *Certain points are said to coincide or occupy the same position when the whole space by which respectively they are separated from a point antecedently known is identical in respect both of distance and direction.*

In the conception of superficial figure the *inclination* at each successive point (measured by the direction of the resistance, supposing the surface to be that of a hard body) is analogous to the *direction* in the case of linear figure. The superficial figure corresponding to a straight line will accordingly be a surface opposing (when solid) at every point an absolute resistance to pressure in a certain constant direction, and the fundamental definition of a plane will be *a surface passing through every point which can be reached from a given point under the condition of a total negation of motion in a certain constant direction.*

Exposition of a System of Quaternions. By Sir WILLIAM R. HAMILTON, *M.R.I.A.*

In this system letters did not mean quantities but directions, and the operations analogous to addition, multiplication, &c., had neither the same meaning, nor were they governed by the rules of these operations in common algebra. It was to an explanation of their meaning and exemplifications of the application of this calculus, and the facility which it afforded of arriving very simply at results of difficult attainment by the ordinary methods, that Sir W. Hamilton confined himself in this communication. Sir W. Hamilton said that he wished to have placed on the records the following conjecture as to a future application of quaternions: is there not an analogy between the fundamental pair of equations, $ij = k, ji = -k$, and the facts of opposite currents of electricity corresponding to opposite rotations?

A description of a Machine for finding the Numerical Roots of Equations, and tracing a variety of useful Curves. By F. BASHFORTH, *B.A., Fellow of St. John's College, Cambridge.*

The machine described is capable of tracing curves whose equations are of the form

$$\varrho = a \cos (m\theta + \alpha) + b \cos (n\theta + \beta) + c \cos (r\theta + \gamma) + \&c. \&c.,$$

$$\text{or } \varrho = \Sigma a \cos (m\theta + \alpha),$$

where $a\,b\,c \ldots\ldots m\,n\,r \ldots\ldots$ are integers or fractions.

It may be applied to the solution of equations in the following manner. Suppose that the proposed equation is

$$p_0 x^n + p_1 x^{n-1} + \ldots\ldots + p_n = 0, \quad \ldots \quad (\alpha.)$$

where $p_0 p_1 \ldots\ldots p_n$ and n represent known numerical quantities. For all values of x not beyond $+1$ and -1, we may make

$$x = \cos \theta.$$

Substituting in (α.), we get

$$p_0 \cos^n \theta + p_1 \cos^{n-1} \theta + \ldots\ldots + p_n = 0; \quad \ldots \quad (\beta.)$$

and expanding $\cos^n \theta$, $\cos^{n-1} \theta \ldots\ldots$ in series of cosines of multiples of θ, we get an equation of the form

$$q_0 \cos n\theta + q_1 \cos (n-1)\theta + \ldots\ldots + q_n = 0. \quad \ldots \quad (\gamma.)$$

If now about a point we describe a circle with radius a, and also about the same point trace the curve

$$\varrho = a + \{q_0 \cos n\theta + q_1 \cos \overline{n-1}\,\theta + \ldots\ldots + q_n\}, \quad . \quad . \quad (\delta.)$$

and read off the values of θ when this curve cuts the circle, *i. e.* when $\varrho = a$, we thus get all the values of θ that satisfy the equation,

$$q_0 \cos n\theta + q_1 \cos \overline{n-1}\,\theta + \ldots\ldots + q_n = 0,$$

or which satisfy (β.); and taking the cosines of these angles, we get the values of x not beyond the limits $+ 1$ and $- 1$ which satisfy α.

To find the remainder of the real roots of (α.), we may write $\frac{1}{y}$ for x, and find the values of y between $+ 1$ and $- 1$; and inverting these, we find the values of x which satisfy (α.) that lie beyond the limits $+ 1$ and $- 1$.

This solution, in fact, depends on a ready method of trying all values of x between $+ 1$ and $- 1$, and selecting those which satisfy the equation.

It may be observed, that

as θ changes from 0 to π, x or $\cos\theta$ changes from $+ 1$ to $- 1$;
and as θ ... ... π to 2π, x or $\cos\theta$ ... ... $- 1$ to $+ 1$;

and therefore it is evident, from the form of (β.), that the curve (δ.) will have an axis, and for every root of (α.) we shall have two readings. If the readings give the same value of x, this will probably be the true value; if different, they will most probably be limits, as in one case x is in the course of being gradually diminished from $+ 1$ to $- 1$, and in the other of being increased from $- 1$ to $+ 1$.

We have also a means of estimating the probable correctness of a root furnished by the several angles at which the curve cuts the circle. By the help of this engine we may also trace curves of the form

$$\varrho = \Sigma\, b \cos m \left\{\cos n\left[\cos (r\theta + \alpha) + \alpha'\right] + \alpha''\right\}.$$

On a System of Numerical Notation. By THOMAS WRIGHT HILL.

This was proposed to be founded upon the number 16, and those derived from it by successive division by 2,—such as 8, 4, 2, 1. By the combinations of these all numbers were to be formed, and by attaching letters as the marks or names for the elementary numbers, a system of nomenclature was obtained. The plan also provided figures and names for them essentially negative, and thus fit for promiscuous incorporation with positive numerals on whatever scale of notation.

On the Nebula 25 Herschel, *or* 61 *of* Messier's *Catalogue. By the* EARL OF ROSSE.

Lord Rosse exhibited to the Section what he called his working plan of this nebula, and explained his method. He first laid down, by an accurate scale, the great features of the nebula as seen in his smallest telescope, which, being mounted equatorially, enabled him to take accurate measurements; he then filled in the other parts, which could not be distinguished in that telescope, by the aid of the great telescope; but as the equatorial mounting of this latter was not yet complete, he could not lay these smaller portions down with rigorous accuracy; yet as he had repeatedly gone over them, and verified them with much care, though by estimation, he did not think the drawing would be found to need much future correction.

Sir J. Herschel exhibited a model of the globe of the moon in relief, expressing the forms and elevations of its mountains as seen in a good telescope. This beautiful and exquisite work he stated to be the performance of a Hanoverian lady, Madame Witte; modelled by her from actual observation through an excellent Fraunhofer telescope, in a small observatory at the top of her own dwelling-house; the selenographical positions and general contours of the principal craters and other leading features being first laid down on the smooth surface from Messrs. Beer and Maedler's micrometrical measures and charts. The diameter of the model is 12 inches $8\frac{1}{2}$ lines (Rheinland measure), or one 10,000,000th part of the moon's actual diameter. The scale of heights is, however, necessarily enlarged to double this amount, as otherwise the relief would be too low for distinctness. The material is a composition of mastic and wax, and the whole is worked out in such perfection of detail as to represent *every* visible crater and mountain peak, nay, even the minuter lines of elevation which streak the so-called seas, &c. in their true forms and conventional proportions. In consequence, when properly illuminated, and placed at thirty or forty feet distance, and viewed through a good telescope, the artificial is scarcely distinguishable from the real moon. The delicacy and precision of the work can only be appreciated by a microscopic examination. In fact, the whole model is stated by Madame Witte to have been executed with the aid of magnifying glasses. Sir J. Herschel accompanied his explanation of this model with several remarks on the physical constitution of the moon in respect of climate, atmosphere, moisture, &c., and compared its surface with the chart of part of Mount Etna, lent him for that purpose by Baron von Waltershausen, and with a drawing of his own of one of the principal craters as seen in his 20-feet reflector, placing the volcanic character of the ring mountains beyond all doubt. By the aid of a large chart by Messrs. Beer and Maedler, several of these, such as Aristarchus, Tycho, Kepler, Copernicus, &c., were pointed out and their peculiarities described, their places on the model being fixed by the aid of brass circles, representing the moon's equator and meridians. This work, it is understood, will be submitted to the inspection of the Astronomical Society, on the resumption of their meetings in November. Speaking of the climate of the moon, Sir J. Herschel considered as probable the attainment of a very high temperature (far above that of boiling water) by its surface, after exposure to unmitigated and continual sunshine during nearly a whole fortnight. The moon therefore, when at the full, and for a few days after, must be, in some small degree, a source of heat to the earth; but this heat, being of the nature rather of culinary than of solar heat (as emanating from a body below the temperature of ignition), will never reach the earth's surface, being arrested and absorbed in the upper strata of an atmosphere where its whole effect will necessarily be expended in the conversion of visible cloud into transparent vapour. The phænomenon of the rapid dissipation of cloud (in moderate weather) soon after the appearance of the full moon (or of a moon so nearly full as to appear round to the unassisted eye), which he stated himself to have observed on so many occasions as to be fully convinced of the reality of *a strong tendency in that direction*, seemed to him explicable only on this principle*.

On the Projection of a Star on the Dark Limb of the Moon just before its Occultation. By Professor Stevelly.

This the Professor considered to be a result of diffraction. Sir Isaac Newton having observed the shadow of a hair placed in a strong beam of sunlight to be broader than the hair itself, was led to investigate the course of a ray as it passed by the edge of a body, like the edge of a knife placed across a hole in the window-shutter, through which a sunbeam is admitted. Beyond a certain distance the rays proceeded in their usual straight courses; at that distance they were bent towards the edge; but the courses of the nearest rays were bent away from the edge, so as to form curves convex towards it. The undulatory theory enables us to trace these curves, and they are known to be of the nature of the hyperbola, with asymptotic branches extending onwards from the diffracting edge. Prof. Stevelly conceived the dark limb of the moon to be such a diffracting edge to the slender beam of light which reached us from a fixed star; and that as the curve was, at the last moment the light was allowed to pass, convex towards the moon, the portion of the ray which last enters our eye before the star disappears, being the direction in which we should then see the star, if produced backwards, would meet the moon on her dark surface.

* On the conclusion of Sir J. Herschel's explanation, Baron von Waltershausen entered into further particulars of the nature of the volcanic phænomena on the surface of Etna, as represented in the elaborate chart above alluded to, of the environs of Nicolosi, and pointed out many particulars of resemblance to the lunar volcanoes.

On the Heat of the Solar Spots.
By Professor Henry, *of Princeton College, New Jersey.*

Sir D. Brewster read an extract of a letter which he had just received from Prof. Henry, who had recently been engaged in a series of experiments on the heat of the sun, as observed by means of a thermo-electrical apparatus applied to an image of the luminary thrown on a screen from a telescope in a dark room. He found that the solar spots were perceptibly colder than the surrounding light surface. Prof. Henry also converted the same apparatus into a telescope, by placing the thermo-pile instead of the eye-glass of a reflecting telescope. The heat of the smallest cloud on the verge of the horizon was instantaneously perceptible, and that of a breeze four or five miles off could also be readily perceived.

Description of a Universal Stand applicable to the Use of Astronomical Telescopes. By M. Boguslawski. *Communicated by the* Rev. Prof. Challis.

A solid cylindrical axis, which in its normal position is vertical, carries at its upper extremity the two supports of a horizontal axis, at one extremity of which is a graduated circle A, and at the other, the telescope having its direction of collimation perpendicular to this axis. The solid cylinder turns in a hollow cylinder of double the length of the telescope, and having at its upper end another graduated circle B. The hollow cylinder rests at about its middle on two supports, which stand on a circular base adjustible by foot screws. It is also capable of motion about a horizontal axis, and carries at its lower end a counterpoise to the weight of the telescope and circles, and a graduated arc, by means of which its axis may be set to any required elevation. The instrument may consequently be either a portable transit, or a transit-circle, or an altitude and azimuth instrument, A being the altitude and B the azimuth circle, or, lastly, an equatorial, in which case A is the declination circle and B the hour circle. The telescope is in no case in a position in which observation is impracticable.

On certain Points in the Elliptic Polarization of Light by Metallic Reflexion. By the Rev. Professor Powell, *M.A., F.R.S.*

The object of this communication was supplementary to one given last year (see Sectional Proceedings, 1844), since which time the author has continued his researches into some parts of the subject not before adverted to.

The original plane of polarization being inclined 45° to that of incidence on the metal, in the lower degrees of ellipticity, i. e. at lesser incidences, the dislocated rings preserve the distinction of the dark and bright systems; which they lose when the vibrations are absolutely circular: also at the position of the analyser intermediate to the rectangular positions, the coloured arcs assumed a peculiar distorted appearance.

A generalization of the formula, employed in the author's paper, Phil. Trans. 1843, so as to include all positions of the polarizer and analyser, and assuming the component vibrations with general or unequal coefficients, is necessary for explaining the last-mentioned phænomenon; while the former supplies the best means of directly observing the change in the *virtual* plane of polarization of the reflected ray, by means of the position necessary to be given to the analyser to restore the same system of rings: as e. g. that for dark branches.

These changes in general are *analogous* to, but *not* the *same* as, those in the reflexion from transparent bodies examined by Fresnel. But at the incidence for the maximum, as well as at that nearest the perpendicular, they *are* the *same*.

At small incidences, in his former communication*, the author mentioned that he had been led to suppose an *anomaly* in this respect, the arc appearing to deviate from 45°. But more recent and careful repetitions have shown that the results are really conformable to the law in this case.

He has carried on a considerable series of observations of the change of plane at different incidences, and for various metals, &c. In regard to the maximum ellipti-

* See British Association Report, 1844, Sectional Proceedings, p. 7.

city, he has traced a relation to the constant arcs of restoration after two metallic reflexions, determined by Sir D. Brewster (Phil. Trans. 1830).

The change of plane cannot yet be explained by *theory*; though the empirical formulas of Prof. MacCullagh appear to give a good representation of it, when the data for *steel* resulting from that investigation are introduced into the author's formula.

On a New Polarity of Light, with an Examination of Mr. Airy's *Explanation of it on the Undulatory Theory. By* Sir David Brewster, *F.R.S.L. & E., M.R.I.A.*

Notwithstanding the great power of the undulatory theory in explaining phænomena, and its occasional success in predicting them, I have never been able to consider it as a representation of that interesting assemblage of facts which constitute physical optics. When a theory of high pretensions, and remarkable for its powers of accommodation, is found incapable of explaining *whole classes* of well-observed and distinctly marked phænomena, those who have discovered or studied these phænomena may be excused for withholding from it their assent, and for not wholly abandoning older, though less popular views, which were sanctioned by such authorities as those of Newton and Laplace. It has fallen to my lot to lay before the public several of the facts to which I refer; but as it is not the object of this notice to discuss the general merits of the undulatory theory, I shall mention only *two* of those classes of facts which the undulatory theory has failed to explain. The first of these, which was communicated to the Royal Society about fifteen years ago, embraces the phænomena of *transverse fringes* which cross the fringes produced by grooved surfaces, and produce, both in common and homogeneous light, a series of phænomena equally beautiful and singular. In these phænomena we witness the extraordinary fact, that a stripe of polished metal is incapable, at various angles of incidence, of reflecting a single ray of homogeneous light; while, at intermediate angles of incidence, it reflects that light freely. The undulatory theory has never ventured to explain these phænomena, and I feel confident that they are beyond its power; and hence the phænomena themselves have excited no notice, and have shared the fate of all such intractable discoveries as refuse submission to the prevailing theory of the day. The second group of phænomena which the undulatory theory is equally incapable of explaining, present themselves in looking at a perfect solar spectrum, or a diffraction spectrum, through the edge of a thin plate of *glass, quartz,* or *mica*. If we cover one-half of the pupil of the eye with such a plate, and thus view the spectrum so that the rays which pass by the edge of the plate may interfere with those which pass through it, then if the plate is on the same side as the *violet space*, the spectrum is seen crossed with numerous black and nearly equidistant bands, parallel to Fraunhofer's fixed lines, and, generally speaking, increasing with the thinness of the plate; but if the plate is on the same side as the *red space*, no bands whatever are seen, though all the other conditions of their production are the same. When the transparent plate is very thin the fringes of thin plates are produced, whether we cover the half or the whole of the pupil; but these have nothing to do with the phænomenon under consideration. The singular fact of the fringes being seen only in one position of the plate appeared to me to indicate a *new polarity* in the simple elements of light. I therefore communicated it to the British Association at Liverpool, in 1836; and in 1837 I submitted to the same body additional observations, which excited some discussion. The singular phænomena contained in these notices, though pressed upon the attention of the supporters of the undulatory theory, remained unexplained for more than *three* years. They at last attracted the regard of Prof. Airy, in October 1839, when that distinguished mathematician repeated my experiments; and in 1840 he made them the subject of an elaborate memoir, constituting the Bakerian Lecture of that year, entitled, 'On the Theoretical Explanation of an apparent New Polarity in Light.' [Sir D. Brewster read the parts of Prof. Airy's paper which could be readily understood by the Section.] Previous to the publication of this ingenious paper, Prof. Airy gave an account of it at the meeting of the British Association in Glasgow, in 1839. On that occasion I made a few observations upon it; but specially marking the fact, that whereas Prof. Airy's explanation referred solely to very faint bands seen when the spectrum was *out of focus*, I had seen the bands perfectly distinct, and most vivid and intensely black, when the spectrum was *in focus*. The explanation, therefore, given in this memoir had nothing to do with the bands which I had discovered and described. Prof. Airy was accordingly led to resume the investigation; and he has published the results of it in a Supplement to his first paper, which appeared in the Philosophical Transactions for 1840. The following is the account which he gives of the results which he obtained:—

"In the Second Part," says Prof. Airy, "of the Transactions for 1840, the Royal Society has published a memoir by me, explaining on the undulatory theory of light the apparent new polarity discovered by Sir D. Brewster, which explanation is based on the assumption that the spectrum is viewed out of focus; an assumption which corresponded to the circumstances of my own observations, and to those of some other persons. Since the publication of that memoir, I have been assured by Sir D. Brewster that the phænomenon was most certainly observed with great distinctness, when the spectrum was viewed so accurately in focus that many of Fraunhofer's finer lines could be seen. This observation appeared to be contradictory to those of Mr. Talbot, cited by me in p. 226 of my memoir, as well as to my own. With the view of removing the obscurity that still appeared to embarrass this subject, I have continued the theoretical investigations for that case which was omitted in the former memoir, namely, when the spectrum is viewed in focus, or when $a=0$; and I have arrived at a result which appears completely to reconcile the seemingly conflicting statements."—Phil. Trans. 1841, p. 1.

Now, in the investigations which this paper contains, and which Prof. Airy considers satisfactory, there are two points which require special attention. The *first* of these is the assumption, necessary for the explanation, that even when any single point of the spectrum is seen accurately in focus, it forms a diffused image on the retina, the extent of the diffusion being exceedingly less than the interval between the bands. The supposition appears to me quite untenable, and one which cannot for a moment be admitted. The *second* point relates to the expression of $\frac{2\lambda\epsilon}{h}$, which Prof. Airy obtains for the interval between the bands; from which it follows, that this interval is inversely as the radius of the pupil, or the area of the object-glass. But the intervals *have no such relation*, and Prof. Airy does not say that such a relation was ever noticed in any of his experiments. I have made the experiment repeatedly and carefully, and can state with confidence *that the fringes do not vary with the diameter of the pupil or the apertures of the object-glass*. Their interval remains the same, whether we look through a pin-hole or with the pupil in its fullest expansion; and it is equally invariable when the aperture of the object-glass is made to vary from a quarter of an inch to four inches. Hence it follows that the system of bands to which Mr. Airy's theory is applicable has no existence in nature; that the phænomena which I discovered are still unexplained by the undulatory theory, and may still be regarded as indicative of a new species of polarity, till they are brought under the dominion of some general principle. Since the publication of the two memoirs of Prof. Airy, I have devoted much time to the examination and measurement of the bands under consideration, and I have been led to the observation of many new and complex phænomena. [Sir D. Brewster read an account of these new phænomena.] I am still, however, as ignorant as ever of the cause of the singular property to which this notice relates, though I have succeeded in tracing the phænomena to the true class of interferences to which they belong.

Notice of Two New Properties of the Retina.
By Sir David Brewster, *F.R.S.L. & E., Hon. M.R.I.A.*

One of these properties related to the inferior sensibility of the retina at that part of it which corresponds to the *Foramen centrale* of Soemmering, and which opens itself only when the eyes are directed to a faintly illuminated surface. The other property of the retina appeared after the observer's eye had been impressed with the luminous stripes seen by looking out of a railway carriage in rapid motion at the stones, or other white bodies lying near the rails. When the eye is quickly shut under this impression, a motion is perceived in a direction transverse to the real impression on the retina; and there is the appearance of lines complementary in the same transverse direction.

On the Aberration of Light. By the Rev. Professor Challis, *M.A.*

The phænomenon of aberration was explained by assuming the direction of vision to be always coincident with the direction of the propagation of light. A star, according to this supposition, is seen in its proper direction, while an object which moves with the spectator is seen in a direction which, with respect to the earth's motion, is *behind* its true place. Astronomical observation does not determine whether aberration affects the apparent position of the wire of the telescope, or of the star. Assuming the position of the star to be changed, it follows from this view, that the star must be considered to be *in advance* of its true place as regards the direction of the earth's motion, and this result is in accordance with the principle on which corrections for aberration are applied in astronomical calculations.

On the Aberration of Light. By G. G. Stokes, *M.A.*

In this paper the author adopts the undulatory theory of light. He supposes that the luminiferous æther is displaced by the motion of the earth and planets through it, in a manner similar to that in which ordinary fluids are displaced by solids moving through them, though not necessarily according to the same laws. He supposes that the æther close to the surface of the earth is at rest relatively to that surface, being entangled in the earth's atmosphere. Consequently, experiments on reflexion, refraction, and interference, made with the light coming from any particular star, will lead to the same result at whatever time of year they are made, conformably with experiment. He supposes that light is propagated through the æther in motion in the same way that sound is propagated through air in motion; that is to say, he supposes that the displacement of a small portion of a wave's front in a very short time is compounded of the displacement which would exist if the æther were at rest, and of the displacement of the æther itself, so that in general the direction of a normal to that portion of the wave's front is changed by the motion of the æther. The law of aberration which results from this supposition is complicated, so long as we suppose the motion of the æther arbitrary; but if we suppose its motion such that $u\,dx + v\,dy + w\,dz$ is an exact differential, where u, v, w are the resolved parts along the rectangular axes of x, y, z, of the velocity of the particle of æther whose coordinates are x, y, z, then the law of aberration which is derived from the theory coincides with the law which is the result of observation (Philosophical Magazine, July 1845).

On the Caustics produced by two Mirrors in Rotation. By Prof. Anderson.

Prof. Anderson exhibited the curves traced on the ceiling by the reflected light from the two revolving mirrors placed in a beam of sunlight, and pointed out mathematical rules for tracing the curves for the several angles at which the mirrors might be set, and the angle which the beam of sunlight makes with the plane of rotation.

On the Rotation of Minute Crystals in the Cavities of Topaz.
By Sir David Brewster, *F.R.S. L. & E., Hon. M.R.I.A.*

This paper is printed in the Edinburgh Transactions, vol. xvi. part i. p. 19.

On the Condition of Topaz subsequent to the formation of certain Classes of Cavities within it. By Sir David Brewster, *F.R.S. L. & E., M.R.I.A.*

This paper is printed in the Edinburgh Transactions, vol. xvi. part i. p. 7–9.

On the Rings which surround the Image of a Star formed by the Object-glass of a Telescope. By the Rev. S. Earnshaw.

The object is to draw the attention of persons, who take an interest in optical phænomena and their theoretical explication, to the fact, that the rings which are ordinarily seen round the image of a star are not the whole of the phænomenon optically due to the experiment. If a point of sunlight be substituted for the star, additional parts become visible, which before were not appreciable by the eye on account of the feebleness of the light emitted by the star. If the experiment be varied (as was done by Fraunhofer and Sir John Herschel) by placing an annular aperture before the object-glass, two remarkable changes take place; viz. a great increase in the number of rings seen round the central spot, and the spreading of a diffused light over the field of view. The diffusion is not uniform, but the brightness decreases from the centre to a minimum, then increases to a maximum; then it decreases to a minimum, and so on. The black rings occur at tolerably equal intervals, within the part comprehended by the first ring of minimum brightness just spoken of. The two circumstances which attend the substitution of an annular aperture for a complete circular aperture were pointed out as phænomena for which the undulatory theory has hitherto been unable to account, though the attempt has been made by one who has been perhaps more successful than any other person in applying the methods and principles of that theory to observed phænomena.

A reference was also made to Fraunhofer's experiments with annular apertures, for the purpose of remarking that, on account of the narrowness of his annuli and the low power of his telescope, it was not possible for him to observe some part of the phænomenon seen by Sir John Herschel; while, on account of the feebleness of starlight, the latter experimenter was not able to see the whole as a single phænomenon, but was induced, by the imperfection of the image presented by his telescope, to refer the two portions which he did see to distinct causes. There can be no doubt however upon the mind of an observer, who employs sunlight, that the rings and halos are parts of a certain phænomenon, the whole of which is due to one cause; and as such must be both included in the explanation of theory, before the theory can be said to have succeeded. The author considers that its not having been able to include these two parts in one investigation, is a sufficient proof that either the investigation is defective, or the theory in some of its details erroneous.

An Improvement in the Method of taking Positive Talbotypes (Calotypes). By Sir David Brewster, *F.R.S. L. & E., Hon. M.R.I.A.*

In the method now in use the face of the negative Talbotype is placed directly upon the side of the paper which has been brushed over with a solution of nitrate, or ammonia-nitrate, of silver, and which is to receive the positive picture. In strong sunlight the picture is thus taken very quickly; but there is a roughness in the shades, owing to the formation of black specks, which destroys the softness of the picture, and in portraits gives a disagreeable harshness to the human face. In order to remove this defect, the author first interposed thin plates of glass, with their surfaces sometimes ground and sometimes polished; but, though the divergency or diffusion of the light, passing through the *negative* picture, produced great softness in the *positive*, yet the outlines were too indistinct, though the Talbotypes looked very well, when placed at a distance. He then tried the effect of interposing a sheet of writing paper, without the water-mark and of uniform texture. The result of this experiment fully answered his expectations. The diffusion of the light thus occasioned shaded off, as it were, all the sharp lines and points, and gave a high degree of softness to the picture. The effect was even improved by interposing *two* sheets of clean paper; and, with a very bright meridian sun, he found that *three* sheets may be used with advantage. A similar effect may be obtained, in a smaller degree, by placing the *back* of the negative upon the positive paper, so as to cause the light to traverse the thickness of the negative, and this may be combined with one or more sheets of clean paper. This, of course, will be appropriate only with portraits; and it has the advantage (sometimes required) of making the figure look another way. To those who see the experiments above described for the first time, the effect is almost magical. When the negative is removed, we see only a blank sheet of white paper; and our surprise is very great when, upon lifting this sheet, we discover beneath it a perfect picture, which seems as it were to have passed through the opake and impervious screen. Sir D. Brewster exhibited specimens of portraits produced in this manner, and also specimens produced by the transmission of light through two perfectly coincident negatives of different degrees of strength; together with specimens of positives produced by placing the positive paper between two perfectly coincident negatives, and acted upon by light incident on both sides of the picture. Sir D. Brewster mentioned some unexpected theoretical results which these experiments indicated, but which required further investigation.

On the Elementary Laws of Statical Electricity. By William Thomson, *B.A., St. Peter's College.*

The author, after noticing the labours of Coulomb, Poisson, and Green, on this subject, observes that of late years some eminent experimentalists, and especially Harris and Faraday, have begun to doubt, to a certain extent, the truth of Coulomb's laws, and have entered upon the investigation of various phænomena which appeared to be incompatible with them. The principal subject of this paper is an attempt to show that almost all the results adduced in their memoirs, which refer to electricity in equilibrium, are necessary consequences of the mathematical theory, and that none are at variance with it.

In the first part of the paper a number of laws of a very simple nature, arrived at by Harris, are shown to be approximate results of Coulomb's theory. There is, however, one part of Mr. Harris's investigations, that which refers to the "striking distance" or to the insulating power of the atmosphere, which, though it does not bear directly upon the laws of statical electricity, is yet of great importance in enabling us to fix upon an absolute standard of electrical density or intensity. The result which Mr. Harris arrives at is, that the intensity necessary to produce a spark depends solely upon the density of the air, being otherwise independent of the pressure and temperature.

In the second part of the paper Faraday's researches on electro-statical induction are considered, and it is attempted to show that the theory there developed is one of two elementary methods of viewing the phænomena of statical electricity, or in fact generally, of attraction varying inversely as the square of the distance. Either of these views, one of which has presented itself to Coulomb, and the other to Faraday, may be made the foundation of the present mathematical theory, and therefore, as far as this is concerned, they may be adopted indifferently. It must be admitted, however, that for simplicity of conception the elementary laws of Coulomb have great advantage, and from them, by very simple analysis, given first by Green, we arrive at the elementary laws of Faraday, as theorems.

Faraday's memoir also contains the account of an investigation which brings to light a very remarkable electrical action, which he terms that of dielectrics, hitherto entirely unknown (if we except the observation of Nicholson, that the *dissimulating power* of a Leyden phial depends on the kind of glass of which it is made, as well as on the thickness). In the present paper a short account of the results of these researches of Faraday is given, and their relation with the general theory explained. The laws of the *dielectric* action have not yet been fully determined by experiment, but it seems probable that it may be perfectly assimilated to that of soft iron when under the influence of magnetic bodies. An extensive and rigorous series of experiments and measurements would however be required to establish this or any other hypothesis on the subject, but still the idea might be adopted to indicate the nature of the experiments from which it would receive its most decided test.

There are, besides, some remarkable questions relative to the physical state of dielectrics, which present themselves as objects for experimental inquiry. Thus it may be conceived that a dielectric in motion might present properties analogous to those discovered by Arago in magnetism, and exhibited in his experiment of the revolving disc. As however a very distinct element, that of electrical currents, enters in the latter case in a way which could probably have no analogy in the former, it could hardly be expected that any remarkable agreement of the phænomena presented by the bodies in motion should be found to exist.

Another question, which can only be decided by experiment, is whether a transparent dielectric in a highly *polarized* state affects light transmitted in the same manner as a uniaxal crystal*. All analogy would certainly lead us at least to look for such an action in a plate of glass of which the particles are kept in a constrained state by means of opposite electrical charges on the two faces, especially when we consider that the constraint may be elevated to such an extent as to make the substance be on the point of cracking.

Before concluding this abstract, it may perhaps be permitted to call attention to another object of experimental research. All the measurements of Coulomb have been made solely for the purpose of comparing electrical forces with one another, but to complete the theory, we should have the means of comparing electrical forces with weights, to which every other kind of force is ultimately referred. For this purpose a standard intensity must be chosen, and the diminution of atmospheric pressure at a point of conducting surface, possessing this intensity, either determined by direct measurement, or deduced from experiments in which the repulsion between bodies charged to a given intensity is measured by weights.

The standard intensity is furnished by the result of Mr. Harris mentioned above, and might be taken as the intensity immediately before a spark, in a given state of the atmosphere. The series of experiments necessary to complete the investigation would be of an extremely delicate nature, and might be long and laborious; but if the result were arrived at, and if the laws of action of dielectrics were thoroughly known, the experimental elements of the theory would be complete.

Remarks on the Periodicity of Magnetic Disturbances. *By the* Rev. H. Lloyd, *F.R.S., M.R.I.A.*

When we examine, for the first time, the chart of the changes of one of the magnetic elements during a day of disturbance, we do not hesitate to pronounce that the causes which produce these changes, so apparently capricious, belong to the class which, from our ignorance of their laws, we are accustomed to denominate "accidental" or "irregular." Experience, however, has shown that these phænomena, and therefore also the forces which produce them, are *subject to laws*, which require multiplied observations alone for their development. A few months of systematic observation is sufficient to show that these apparently abnormal movements of the magnet recur more frequently at certain hours of the day than at others. Prof. Kreil seems to have been the first to notify this remarkable fact. In a letter addressed to M. Kupffer, dated in January 1839, he observes, that "all hours of the day do not appear to be equally favourable to the development of this phænomenon;" that disturbances begin "much more frequently in the evening than in the morning hours," and "hardly ever begin in the latter hours of the forenoon." In a letter addressed to Col. Sabine, dated in July 1840, Prof. Kreil has entered more minutely into the question, with the light of the observations of an additional year. He there observes, that "the *least* disturbance takes place in the declination from 8 to 10 A.M., and the *greatest* from 8 to 10 P.M.;" that "the declination is *increased* by the disturbances of the forenoon and middle of the day, and *diminished* by those occurring in the evening hours;" that the effect of disturbances upon the horizontal intensity is, in general, a *diminution* of that element, this diminution being however more considerable "during the hours of the night and morning, than in the forenoon and afternoon."

A more elaborate examination of this question has been since made by Col. Sabine, in the discussion of the results of the first two years' observations, made at the Magnetic Observatory of Toronto, under the direction of Lieut. Riddell. The mode of examination is, for the most part, the same as that of Prof. Kreil, namely, to *separate* the individual results, which differ from the monthly mean, corresponding to the same hour, by a quantity exceeding a certain arbitrary limit; to treat them as the effects of perturbing causes; and to examine the *frequency of their occurrence* at the

* Since this paper was read the author has found that Mr. Faraday had previously proposed and examined experimentally the question here suggested, arriving only at negative results. See 'Experimental Researches,' § 955.

several hours of regular observation. By this mode of examination Col. Sabine has been led to the result—a result partly agreeing with, and partly differing from that deduced by Prof. Kreil—that "the causes which produce *easterly* deflections have their maximum frequency of effect at ten hours, and those which occasion the *westerly* deflections their maximum at twenty hours. The minimum of both occurs nearly at the same hour, viz. about two or four hours." Analogous conclusions are deduced respecting the disturbances of the horizontal intensity. These disturbances, which are on the whole subtractive, have their minimum at 4 P.M., the hour of maximum intensity; their maximum, on the other hand, occurs about the time of the nocturnal minimum of the intensity, or from ten to sixteen hours. Col. Sabine then proceeds to compare the monthly means at the several hours of observation, as deduced from the *whole* body of the observations, and as deduced from the *remaining* observations, when the excessive deflections already referred to are laid aside. Of the propriety of this separation, and of the results thence deduced, Dr. Lloyd said that he would not now speak, as the remarks which he had to offer had no immediate connexion with that question. With respect to an *annual period* in these remarkable phænomena, Prof. Kreil and Col. Sabine have arrived at different conclusions. According to Prof. Kreil, "the perturbations are much more frequent in the winter than in the summer months;" and that, not merely because the cause which produces the regular diurnal change is then more feeble, but also because (according to Prof. Kreil) the disturbing forces are then actually of greater intensity. According to Col. Sabine, "the disturbances [of declination] appear to be distributed throughout the year without any marked inequality either as to number or direction," except that their number appears to preponderate somewhat in the month of October. With respect to the horizontal intensity, Col. Sabine appears to agree with Prof. Kreil, and to find that the number of observed disturbances of that element is greater in the winter than in the summer months.

Having thus stated the conclusions which have been hitherto drawn, in connexion with this subject, Dr. Lloyd proceeded to lay before the Section the results to which he had himself arrived, by a different mode of investigation, as applied to the observations made in the magnetical observatory of Dublin.

The problem which he proposed to himself had for its object to determine the *law of probability* of disturbances, as dependent upon the hour of the day, and upon the season of the year—a question the solution of which will be seen to be of very great importance with reference to any physical theory of the phænomenon. The methods hitherto applied, although they indicate in a general manner the times of greater and less disturbance, do not solve this question. In the investigations of Prof. Kreil and Col. Sabine, no account is taken except of disturbances exceeding a certain arbitrary limit; and, with respect to these, the results are not combined in such a manner as to give the law in question. The deduction of this law, although somewhat laborious, is nevertheless simple in principle. We have only to take the differences between each individual result and the monthly mean corresponding to the same hour, and to combine these in the same manner as the errors of observation (to which they are analogous) are combined in the calculus of probabilities. Thus, the square root of the mean of the sum of the squares of these differences is a quantity analogous to the *mean error*, in the partial observations of a constant quantity; and *the probable disturbance* at any hour is inferred from this, by multiplying it by a constant factor. The values of this function (which Dr. Lloyd proposed to call the *mean disturbance*) have been deduced for the several hours of observation in each month. The corresponding values for the entire year are deduced from those of the separate months, by a repetition of the same process; they are given, reduced to minutes of arc, in the following table:—

1	3	5	7	9	11	13	15	17	19	21	23
2'·16	2'·09	2'·09	2'·45	3'·46	4'·10	2'·81	2'·52	2'·16	1'·94	1'·87	1'·94

The *mean daily disturbance*, deduced in a similar manner from the mean disturbance corresponding to the several hours, is 2'·56. It will be at once seen, from the mere inspection of these numbers, or, still better, by projecting them in a curve, that the mean disturbance follows a law of remarkable regularity, as depending upon the hour of the day. During the day, i. e. from 18 to 6 hours, it is *nearly constant.* At 6 hours, i. e. at the time of mean sunset, it begins to *increase*; it arrives at a *maximum* a little after 10 hours; it then decreases with the same regularity, and is reduced to its constant day value, at about 18 hours, i. e. at sunrise. The maximum value at night is about double of the constant day value.

The function whose values have been hitherto considered is independent of the *direction* of the disturbance. If, however, we take the sum of the squares of the easterly and westerly deviations separately, it is found that the easterly disturbance preponderates during the night, and the westerly during the day, the former being much more considerable than the latter, and the difference reaching a maximum about 10 hours.

It thus appears that the tendency to disturbance observes a *regular period,* both in magnitude and direction, connected with the diurnal movement. In order to perceive their relation to the *regular* diurnal variations, it will be necessary to regard the latter in a somewhat different point of view from that in which they have been usually considered. From the very small amount of the regular change of declination, which takes place during the night, and from the manifest connexion of the day movement with the position of the sun, Dr. Lloyd said, that he was led to consider the position of the magnet during the night as its *normal* position, from which it was made to deviate during the day by the influence of the sun. In this point of view, the regular diurnal progression may be described, in its main features, as a westerly deviation of the north end of the magnet, commencing about an hour after sunrise, reaching its maximum a little after 1 P.M., and thence diminishing until a few hours after sunset, when the magnet returns nearly to its normal position. Now the *mean disturbance,* it will be remarked, observes a period nearly the reverse of this, both in magnitude and direction; its value being nearly constant during the day, while it is largely developed during the night, in a direction opposed to that of the *regular* day movement. From these remarkable relations, which hold also between the changes, regular and irregular, of the horizontal intensity, it seems evident that the two classes of phænomena are *physically connected.* Without entering into the question of the mode of this connexion, Dr. Lloyd said that he regarded the disturbance of the two elements (in part at least) as an *irregular reaction* from the regular day movement, and dependent upon it both for its periodical character and for its amount. If this hypothesis be a just one, it will of course follow that the magnitude of the mean disturbance will vary in some direct proportion to the *daily range,* and should therefore be greater in summer than in winter. Now this (which is contrary to the results deduced by Prof. Kreil and Col. Sabine, with reference to the frequency of disturbances exceeding a certain limit) appears to be the fact. If we calculate the mean disturbance of the declination for the several quarters of the year, we find it to be as follows:—

Spring.	Summer.	Autumn.	Winter.
$2'{\cdot}66$	$3'{\cdot}02$	$2'{\cdot}52$	$1'{\cdot}80$.

From these results, it appears that the mean disturbance observes an *annual* as well as a diurnal period; its *maximum* occurring in summer, its *minimum* in winter, while in spring and autumn its values are nearly equal. This important relation appears to confirm, in a remarkable manner, the views above given.

It by no means necessarily follows, from the results above stated, that the periodical character necessarily belongs to *all* disturbances. It may be that there are *two classes* of disturbances, the results of distinct physical causes, of which one observes a period, while the other is wholly irregular; for it is obvious that on such an hypothesis, the period of the former would necessarily be impressed upon the resultant disturbance, and that the latter would have no effect in effacing it, provided the observations from which it was inferred were sufficiently numerous. There are many circumstances which seem to render this supposition highly probable; and if it be established, the next step in the investigation will be to distinguish these two kinds of disturbances by their external characters, and to resolve the complex resultant, where they happen to be combined, into its more simple elements. Dr. Lloyd stated that he had commenced a series of observations in Dublin, upon a plan which seemed likely to conduct to the solution of this problem—a problem which must be solved before we can ascend with certainty to the physical causes of the phænomena.

On the Results of the Magnetic and Meteorological Observations at General Sir Thomas M. Brisbane's *Observatory, at Makerstoun, in the year* 1842. *By* J. A. Broun.

The following are the points of chief importance in the paper. From a comparison of five months, in 1841, with the corresponding five months of 1842, the yearly movement of the north end of the declination magnet is about five minutes towards the east. The horizontal component of the earth's magnetic intensity increases, and the vertical component diminishes considerably in the year; the diminution of magnetic dip being about five minutes. A new method has been adopted in order to obtain the temperature corrections for the bifilar and balance magnets; it is described in the sixteenth volume of the Transactions of the Royal Society of Edinburgh. It was mentioned that very consistent results had been obtained by different methods of comparison of the usual observations for the positions and temperatures of the magnets. When the observations of the balance magnetometer are corrected by this method, the diurnal range of the vertical intensity has been found, like that for the horizontal intensity and declination, to increase regularly from the winter months to the summer months. The annual period of the horizontal intensity, as deduced from the corrected observations of the bifilar magnetometer for 1842, is striking; a minimum of intensity occurs before or about each equinox, and a maximum before or about each solstice. The observations at Toronto in Canada, in 1842, when corrected by the same method, indicate *exactly* the same periods. The monthly means for Makerstoun and Toronto were projected in curves, which were exhibited; the two curves were almost identical, the increase of horizontal intensity being greatest in the end of the year at Makerstoun. The corrected observations of the balance magnetometer confirm in some sense the results from the bifilar, inasmuch as they also show the same annual periods of maxima and minima for the vertical intensity. As a severe test of the accuracy of the instruments and the methods adopted, the results for the magnetic dip deduced from the two force magnetometers were compared, both as to diurnal and yearly change of dip, with the results obtained from the inclinometer, and they were found to agree very nearly. From the meteorological observations, it was found that the range of the monthly means of the pressure of dry air was nearly the same as for the moist air. The mean of the three-monthly maxima and minima of temperature for each quarter of the year, was found to differ only by a fractional part of a degree from the mean of all the daily maxima and minima for the same period. The mean of the monthly maxima and minima of atmospheric pressure is less than the mean pressure for the whole year. This, it is conceived, has been found to hold always true, at least for places within the latitudes 50° and 60° north; the reverse probably takes place in lower latitudes—it does so at Pekin; in 1841, the means of the monthly maxima and minima being in almost every month above the mean pressure. The curve of the relative humidity of the atmosphere for the year, deduced from the observations of the psychrometer, was shown to agree completely in its inflexions with the curve of the mean quantity of clouds covering the sky, this quantity being merely estimated.

On a large Magnetic Machine.
By the Rev. William Scoresby, *D.D., F.R.S.L. & E., Cor. Mem. Inst. France.*

The principal part of the machine consists of two cases, or fasciculi of magnetic bars, of unusually large dimensions, on principles developed in the author's recent work, entitled 'Magnetical Investigations,' which principles may be thus summarily stated:—1. That magnetic bars designed for large combinations may be conveniently constructed of various pieces. 2. That the separation of a long bar, say of three or four feet, into several portions, is not disadvantageous in regard to power; and that the resulting power is similar, whether, in the combining of several series of short bars, the elementary bars be of the same or of unequal lengths. 3. That the relative powers of magnets, whether single or compound, when different in mass, but proportional in all their dimensions, are not in the ratio of the masses, the large masses being less strong proportionally than the smaller. 4. That whilst magnets of large dimensions are less powerful with respect to their masses than small magnets to which they are exactly proportional in all their dimensions; and whilst the increase of the dimensions continually deteriorates from the energy due to the mass; yet magnets may be combined in such proportional dimensions with a constant increase of power *ad infinitum*. From this last result, it follows that magnets indefinitely small must be indefinitely strong; and may indicate that the mutually attractive forces of the ultimate magnetic elements may be as strong as that by which the metallic elements are themselves combined. It must also be kept in mind that the steel should be perfectly hard; and the elementary plates of the magnet should be made of steel, converted out of one or other of the very best qualities of foreign iron. All the conditions, with the exception of thinness, were attended to in the large magnet constructed by Dr. Scoresby. A magnet on this principle, of the size of the lower mast of a first-rate ship of war (which might be constructed of plates of very hard cast iron), would produce a deviation of nearly 1′ at the distance of a mile, and a sensible effect much beyond that. The two fasciculi of Dr. Scoresby's magnetical machine were about 4 feet in length each, 4½ inches in breadth, and about 6 inches in depth. Nearly 600 running feet of steel, in 504 bars, were originally provided, weighing altogether 750 lbs.; but many were rejected, not being found hard enough to stand the magnetic test. The attractive force, though not a favourable arrangement for sustaining weight, was sufficient to carry 400 lbs. The inductive energy on iron bars or keys, held at 6 to 12 inches distance, was extraordinary, sufficient to sustain a chain of six keys of considerable size. With a deal board of 0·4 inch interposed betwixt the magnet and the conductor, a weight of 15 lbs. was sustained. The following electrical effects were produced by Dr. Scoresby's magnet with a very imperfect armature. It decomposed water rapidly, producing about one cubic inch of the gases a minute; with about sixty-five yards of coiled wire, the effervescence seemed as violent as during the action of dilute sulphuric acid on zinc. Copper was deposited from a solution of sulphate of copper at the rate of about 1·2 grains per minute. Shocks were powerful, and scintillations were thrown out; and sparks were visible in daylight, and emitted audible sounds when the armature revolved so slowly as once in sixteen seconds.

On the Baron de Bode's *Insulated Compass. By* JOSEPH YORK OLIVER.

The object was to insulate the compass from the action of the iron of the ship. The contrivance was this: a double glass bowl, the intermediate space being filled with mercury, was made to act as the bowl of the ordinary compass. It was hung in gymbals, and surrounded by lead for protection. The author remarked on the utility of employing a similar apparatus for securing chronometers from the local attraction of the iron on shipboard.

On a Method of suspending a Ship's Compass. By E. J. DENT, *F.R.A.S.*

An account of this instrument was communicated to the Association at its last meeting in York. Mr. Dent now read extracts from a report of the working of this compass during six months at sea, as ordered by the Lords of the Admiralty, to the effect that his compass was found "to be extremely sensitive, moving exactly and admirably with the ship's head, when the helm was put hard-a-port and hard-a-starboard; while the other compasses with which it was compared were always in arrear."

On the Connection between Magnetic Variation with certain peculiarities of the Earth's Structure. By S. M. SAXBY.

Mr. Saxby was of opinion that it will be found, on examining the direction of the various mountain ridges of the globe, that there is a remarkable *angular coincidence* between such line of direction and the *local curve of equal magnetic variation*, the one crossing the other at angles of from 65° to 70°.

On the amount of Rain which had fallen, with the different winds, at Toomavara, in the County of Limerick, during five consecutive years. By the Rev. Thomas Knox, *M.R.I.A.*

The Rev. H. Lloyd said that he had already brought before the Section, at a former meeting, the results of these observations, while in progress; he had now the pleasure, at Mr. Knox's desire, of submitting to its notice the conclusions derived from the entire and completed series of five years' uninterrupted observation. After explaining briefly the principle of the instrument, by which the amount of rain with different winds is measured by Mr. Knox, and the mode in which the results are graphically represented, he proceeded to read the following remarks, in the words of the author himself:—

"There are one or two points to which I wish to draw attention. First of all, taking the average monthly rain at three inches, the first six months of the year are below the average, the other six months above it. November and July are by far the two wettest months in the year, and in each the greatest amount of rain is from S.W. April is much the driest month, and there is nearly as much rain in it from the northern portion of the compass as from the southern.

"With regard to the gross amount which fell from each point in the entire year, that which fell from S., S.W. and W., is much above the average; from the other points it is below it. If the polygon which characterizes the yearly rain be divided by a line running N.E. and S.W., then the rain at equal intervals on either side of this line is equal, to all but a fraction of an inch. This is the more remarkable, as these two points had been fixed on by Professor Dove, in his paper on the Winds, as being the points of greatest and least barometric pressure; that is to say, the wind being supposed at S.W., any shift of it either towards S. or W. produces a rise of the barometer, and also any shift on either side of N.E. a corresponding fall. Now, in the rain, the greatest amount is from S.W., corresponding with the least height of the barometer: the least is from N.E., where also the barometer is highest; and on either side of this line it varies regularly. For instance, the amounts from W. and S. are nearly equal, and both less than that from S.W.: N.W. and S.E. are also equal, but still less; and so on.

"There is one particular in which this separation of the gross amount of rain into the eight portions, as brought by different winds, may be useful, viz. in ascertaining the respective specific gravities, and the amount of saline matter, brought from each direction. This may be useful in regard to agricultural matters. For instance, we could easily suppose a case of two portions of land, not many miles asunder, but on different sides of a high range of hills, getting very different amounts of salt, from one being exposed to, and the other sheltered from that wind in which the greatest amount was found. But by this mode of collecting the rain, an accurate mode of estimating this is within our reach. To this question, namely, the amounts of solid and gaseous matter brought in the rain from each direction, I hope on a future occasion to turn my attention."

The Tables which accompany this communication give the amount of the rain corresponding to each wind, for each separate month in the five years. The following are the yearly mean results, deduced from the whole series:—

S.	S.W.	W.	N.W.	N.	N.E.	E.	S.E.	Total.
6·548	10·639	6·034	2·789	2·352	2·172	2·251	3·173	35·958

On a Thermometer Stand. By Henry Lawson, *F.R.S.*

The Meteorological Thermometer Stand, which was regularly used at the author's observatory in Bath, was stated to possess the following requisites:—It can be placed on any open eligible spot. Its four sides can and must be placed to face the cardinal points; commanding, therefore, a true north and south aspect. It can be visited on every side, and be free from all surrounding objects. The instruments or thermometers used can be read off with great facility; and the whole will be at a known distance from the ground. The instruments placed on the south face will have the meridian sun; and those on the north face will be always in the shade, in consequence of the projecting wings. It can be employed by any meteorologist wherever resident. It is of a determinate form, height and size. It is not costly, and may be constructed by any intelligent carpenter. By the general adoption of this stand, instruments placed upon it will be all observed under similar circumstances, and can be compared with far less chance of error than has hitherto been the case. A model was exhibited, and a working plan and description distributed.

On a New Anemometer. *By* James Thomas Goddard.

The author described some further improvements which he had made in the construction of his anemometer, and called attention to the investigations in which it would be of service, and to the most suitable localities for the employment of it.

Meteorological Observations made in 1844 *at Huggate, Wold, Yorkshire.* *By the* Rev. T. Rankin.

Mr. Rankin exhibited Tables. The chief results were—

The elevation was about 700 feet above the level of the sea. The greatest monthly range of the barometer was	0·850
Greatest daily range	0·290
The highest barometer, February 24th	29·950
The lowest, May 15th	28·240
The highest thermometer, July 25th	74°
The lowest, February 23rd	20°
Greatest monthly range of thermometer (May)	34°
Greatest daily range, May 9th	29°

The deficiency of rain for the year was 10 inches. In the month of December, Millington Springs, in the adjoining parish, and which flow from the top of a bed of clay lying below a chalk rock above 200 feet thick, were as low as in the summer of 1826.

Additional Thermometrical Observations in a deep well at Huggate. *By the* Rev. T. Rankin.

The well is 348 feet in depth.

December 9th, 1844	top of well	38	degrees, at 4 P.M.
„	150 feet deep	42	„
„	300 feet deep	45	„
„	water at bottom	43	„
March 11th, 1845	top of well	32	degrees, at 6 P.M.
„	150 feet down	38	„
„	300 feet down	44	„
„	water	43	„
April 5th, 1845	top of well	50	degrees, at 2½ P.M.
„	100 feet deep	45	„
„	200 feet deep	45	„
„	300 feet deep	43	„
„	water	42	„
April 23rd, 1845	top of well	59	degrees, at 2 P.M.
„	100 feet deep	55	„
„	200 feet deep	50	„
„	300 feet deep	47	„
„	water	45	„
June 3rd, 1845	top of well	70	degrees, at 1 P.M.
„	100 feet down	65	„
„	150 feet down	60	„
„	200 feet down	55	„
„	300 feet down	52	„
„	water	46	„

The average of these five was—of the shaft	47·08
„ „ of the water	43·8

On Fog-rings observed in America. *By* Sir David Brewster, *F.R.S.L. & E., Hon. M.R.I.A.*

This notice was communicated to Sir D. Brewster by Sir John P. Boileau. It relates to a fog-bow which had been seen in January 1808, by Sir George Rose, when off the Montgomery Reach, in the Potomac, in Virginia. Early in the morning a milk-white fog came on, so thick that the captain of the packet found it necessary to anchor, not knowing where he was. About half-past eleven he came up to Sir George, and remarked that they should have all clear soon, "for the fog-eater was come." The captain explained himself by pointing to the head of the vessel, where there was visible a ring of thicker white fog than that in which they were enveloped, apparently about sixty feet in diameter, the belt of the ring appearing about two feet broad. Within this ring was another, two feet in diameter, suspended in its centre, and with prismatic colours. It lasted about 20′ or 30′, after which the fog cleared away. There was a severe frost on the following day.

Tables of Meteorological Observations for the Year 1844, *made by* J. R. Crowe, *Esq., the British Consul-General of Norway at Christiana. Latitude* 59° 54′ 1″ *North, Longitude* 10° 45′ 0″ *East.*

(Communicated by Dr. Lee.) [These Tables are a continuation of others made in the year 1843, and presented to the British Association at York, and noticed in the volume of the Proceedings of the Association for 1844, at p. 27 of the abstracts of communications to the Section of Mathematics and Physics.]

They consist of observations of the thermometer and barometer made on every day in the year, at 7 A.M., 9 A.M., 2 P.M., 4 P.M. and 10 P.M., with the means of each column for each month, and the mean temperature calculated for each month, and the quantity of rain in cubic inches.

Also tables of the *prevailing winds* for each month, the sixteen directions of the winds being noted for 9 A.M., 2 P.M. and 4 P.M. on each day, and the totals for each month. In February, the state of the wind is also given at 4 P.M. in addition.

The daily calculations for December are not complete; those for the 11th to the 20th inclusive are wanting. But the barometrical and thermometrical means for the whole month at the five above-mentioned hours are given, and the tables of the prevailing winds are calculated for 7 A.M., 9 A.M., 2 P.M. and 4 P.M.

The following notice was also communicated by Dr. Lee:—

A Description of the Lightning and Thunder of the 16*th of August* 1844, *which took place at Alten, in Norwegian Lapland, by* J. F. Cole, *Esq. N. Latitude* 69° 50′ ± *and Longitude* 23° ± *East.*

Mr. Cole is the gentleman who, in 1844, presented a paper on the *Aurora Borealis,* as seen frequently at Alten; also a paper on *a sudden fall of rain,* with a clear sky, at Alten; also a paper, or table, on the Forces and Directions of the Winds, the Barometer and Thermometer, &c. &c.

Dr. Lee remarked, on presenting these two papers, that although of inferior value compared to many which have been presented to the Section, still that they were not without some interest, as being a continuation of the series of papers which had arrived from Norway and Lapland in 1844, and which are likely to be continued in future years.

Any observations from Alten are interesting, on account of its *high northern latitude,* and being the *most northern town in the world,* and where it might be highly advantageous for science that a magnetic observatory should be established, and which might be done at present with facility, as there is a British mining company established at Alten, and several of the young men in the employ of the company, both English and Norwegians, already have a public library and an astronomical and meteorological observatory, and devote their leisure time to these studies, and with due encouragement and assistance, the work of a magnetic observatory would be materially assisted by them.

Either Alten or Hammarfest (which is near it) would be a desirable spot for a magnetic observatory, and as our distinguished secretary Colonel Sabine has swung the pendulum during his important voyage in the northern seas at Hammarfest, Dr. Lee states that his superior opinion on this subject could be consulted with advantage.

Also, on account of the northern position of Alten or Hammarfest, *observations on refraction* might be made with great advantage, and some results obtained from them which would be highly beneficial to astronomy.

Alten is also the region of auroras; they abound in that latitude, and their connexion with magnetism might be traced with more advantage at Alten than at any other place.

During the visit of the King of Sweden and Norway to Christiana in the winter of 1844, his Majesty is said to have expressed his readiness to give every patronage in his power to the arts and sciences in Scandinavia, and he has already authorised Baron Wrede and Professor Selander, the Astronomer Royal of Stockholm, to make arrangements during the summer of 1845, for the measuring of an arc of latitude from Tornea in the gulf of Bothnia to the North Cape during the summer of 1846, and Baron Wrede is now engaged on that grand work.

This is an additional reason for the establishment of a magnetic observatory at Alten, under the patronage of the British Association, in the spring of the year 1846.

Dr. Lee expressed his wish, that the friends of the Association would authorize the committee to establish a series of magnetic observatories at Edinburgh, Inverness, Thurso, the Shetland Isles, Drontheim in Norway, and Alten in Lapland, in order that regular tables of observations might be produced from them for the benefit of the Association.

Researches on Shooting Stars. By M. Coulvier Gravier.

The observations were made at Rheims and at Paris, and were continued without intermission from July 1841 to February 1845 inclusive. The mean number seen in an hour followed a remarkable law of progression throughout the year. The hourly mean number for January was 3·6, for February 3·6, for March 3·7, for April 3·7, for May 3·8, for June 3·2, for July 7·0, for August 8·5, for September 6·8, for October 9, for November 9·5, for December 7·9; thus during the first six months the hourly number is nearly the same each month, while in the next six months there is a progressive increase, first until August, and then until October or November, periods at which the hourly number is more than double those of the other six months, which well agrees with the facts proved in those countries as to August and November. The second part of the memoir contains tabulated results of the hourly variations of the shooting stars observed from six in the evening to six in the morning, which also observed a remarkable progression from 3·3, the hourly mean number observed between 6 and 7 P.M., to 8·2, the hourly mean of those seen between 5 and 6 A.M. This result was illustrated by curves, in which a very obvious law of hourly progression was to be observed.

On Remarkable Lunar Periodicities in Earthquakes, extraordinary Oscillations of the Sea, and great Atmospherical Changes. By Richard Edmonds, *jun.*

The following nine days remarkable for earthquakes, extraordinary oscillations of the sea, or very unusual states of the atmosphere, occurred near the moon's first quarters, at successive intervals of about four lunations each.

1842, November 9.—Earthquake at Montreal and other parts of Canada*, when "the waters of the St. Lawrence were violently agitated." This was the day *before* the moon's first quarter. On the 11th, the day *after* it, the barometer at Penzance† was 29·00, lower than for 247 days before and 13 days afterwards.

1843, March 10.—Earthquake at Manchester‡; barometer at Chiswick§ on the preceding days 30·380, higher‖ than for 49 days before and 179 days after.

* The newspapers are the authorities unless others are mentioned.

† Kept at the Penzance Public Library. ‡ British Association Report, 1843, p. 121.

§ At the Gardens of the Horticultural Society.

‖ On the day of the great earthquake of Lisbon, the barometer at Penzance was higher than it had been for *three years* before.—Borlase's *Natural History of Cornwall*, p. 53.

July 5.—Extraordinary oscillation of the sea in Penzance*, Plymouth, Scotland, &c., and a great thunderstorm † throughout the island. Barometer at Penzance at the time of the oscillation there 29·50, lower than for twenty-five days before and forty-seven days after. Thermometer at Chiswick 88°, at Brighton 78°, the maxima for the year at those places.

October 30.—Similar oscillations of the sea at Penzance and Plymouth ‡. Barometer at Penzance at the time of the oscillation 29·00, which, except the minimum of the 27th, was lower than for 223 days before and 115 days after.

1844, February 26.—Barometer at Chiswick 28·624, lower than for 409 days before and ever since. At Penzance it was 28·50, having fallen nearly two inches in thirty-six hours.

June 23.—An unusually severe and protracted thunderstorm this evening throughout Cornwall and in Dumfries-shire, and on the following morning at Boston and Liverpool, at which latter place "pebbles and small eels descended in the streets §." Thermometer at Chiswick on the 23rd, 91°; highest for the year except one day in July. In the weekly meteorological report from the Greenwich Observatory, it is stated as an extraordinary fact, that "at 1 o'clock P.M. (of the 23rd) a thermometer placed on a small piece of raw wool in the sun's rays, rose in seven minutes to 155°, and was still rising when the thermometer was taken away."

October 18.—The town of Buffalo on Lake Erie almost destroyed by a hurricane. This was the day of the moon's first quarter, and almost exactly twenty-four lunations after the earthquake in that neighbourhood already mentioned. At Chiswick this day the maximum of the thermometer was less by 3° than for several months before, and the barometer on the 16th was at a minimum of 28·940, lower than since the 26th of February.

1845, February 12.—The greatest cold experienced in England probably during the present century. Thermometer at Blackheath, at half past 7 A.M., 33½° below the freezing-point; at Chiswick 35° below that point. Barometer at the latter place 30·409, higher than for nine months before, except on the 21st of December.

June 13.—Extraordinary oscillation of the sea in Kent ||, and a "terrific" thunderstorm at Chatham. The temperature very high in all parts of England; thermometer at Penzance being 77°, higher than on any other day of the year hitherto ¶.

Not one of the phænomena for which the above nine days are remarkable, was forty-eight hours from the moon's first change or quarter. Three of the days were each at the moon's first quarter nearest the solstice; of these the first and last were distinguished for extraordinary oscillations of the sea, while all were remarkable for great thunderstorms and unusually warm weather**.

The author's attention was drawn to the interval of four lunations by having remarked †† that interval, or 118 days, between the two oscillations of the sea, at and

* The author, who witnessed this oscillation in Mounts-bay, has given a minute description of it in the Transactions of the Royal Geological Society of Cornwall, 1843, p. 114, and considers that such phænomena result from submarine shocks or vibrations of the earth, which, after being transmitted through the sea, more rapidly than sound through air, exhaust themselves on reaching the shore, in a succession of long waves or tide-like oscillations. See also Jameson's Edinburgh Philosophical Journal for April 1845, pp. 271–279.

† Mr. Milne has described this storm and the oscillations of the sea observed in different parts of Great Britain, in the Transactions of the Royal Society of Edinburgh, vol. xv. pp. 609–638.

‡ Transactions of the Geological Society of Cornwall, 1843, p. 120.

§ Literary Gazette, p. 420.

|| This was observed at Folkstone at 4 P.M., and is thus described in the newspapers:—"The tide then flowing changed to ebbing three different and continuous times, causing much agitation of the sea at the harbour's mouth. This had been preceded by a heavy and brief whirlwind from the S.E. The rise of the water appeared to be about three feet, and its sudden receding produced the agitation."

¶ Higher than on any other day of the year except the 9th and 10th of September, exactly three lunations afterwards, when it was 77° and 78°.

** So also in 1842, the hottest day of the hottest June in Boston in Lincolnshire since 1826, was the 14th, the day before the moon's first quarter, the thermometer at Chiswick being then 88°, the same as on the 5th July 1843.

†† Transactions of Geological Society of Cornwall, 1843, p. 120.

after the great earthquake of 1755, and 119 days* between those at and after the great earthquake of 1761.

But while such remarkable days have occurred at intervals of *four lunations*, others were mentioned as having taken place at intervals of either single lunations or some multiple of a lunation†; and the great earthquakes throughout Mexico on the 9th of March and the 7th of April last, are almost exactly one lunation from each other. So also, in reference to the six known‡ shocks of the earth and extraordinary oscillations of the sea in Cornwall during the last century, the interval between any two of them is almost exactly some multiple of a lunation. The same observation applies to the six which have occurred in the present century, except that of the 20th of October 1837. With this single exception they have all happened at or near the moon's first quarters.

From the facts above noticed, it would appear that an earthquake or any very disturbed or extraordinary state of the atmosphere, is generally preceded or followed either by other earthquakes or by unusual states of the atmosphere occurring at intervals of single lunations, or of some multiple of a lunation; and that the phænomena which happen at intervals of four lunations, are more striking than those at the shorter periods. There seems reason therefore for supposing that earthquakes and great atmospherical changes are in many, if not most instances, occasioned principally by the action of the moon.

On the Nature and Origin of the Aurora Borealis. By the Rev. George Fisher, *M.A., F.R.S.*

The following is an abstract of this paper, and the results which the author has endeavoured to establish:—

That the principal displays of the aurora occur in the vicinity of the edge or margin of the frozen sea, and occasionally at those places in more temperate climates, where humid vapours are accumulated, and by the operation of certain causes, such as tides, winds, &c., are brought suddenly within the influence of a cold and dry atmosphere, and thereby subject to congelation. That the aurora is an electrical phænomenon, and arises from the positive electricity developed by the congelation of these vapours, and the consequent induced negative electricity of the upper and surrounding portions of dry atmosphere. It is the accompanying indication of the restoration of the electrical equilibrium, which equilibrium is restored by the intervention and conducting power of minute frozen particles, which particles are rendered luminous by the transmission of the electricity, and thereby give rise to the various appearances of the phænomena.

From the author's observations at Winter island and at the island of Igloolik (the two winter stations of Capt. Parry's second expedition to the polar regions, which expedition he accompanied as astronomer), he was led to the conclusion that those places at which the aurora took its rise, were chiefly confined to the edge or margin of the frozen sea. He observed at each of these places, that in the early part of the winter, before the sea around was frozen over, the aurora was of a general and diffused character, and extended through the zenith in every direction. As the winter advanced and the edge of the ice in consequence became more remote, so the aurora diminished in splendour, assumed a low-arch appearance, and was seen only in the direction of the *open-water*, fringing the upper surfaces of dark masses of vapours, known by the name of "Sea-blink," which hung over and were apparently in contact with the exposed surface of the sea. He gives additional evidence as to this particular locality of the phænomenon from the observations of Captains Sir John Franklin, Beechey, Biscoe, and others; and he observes, that its

* On the last of these 119 days, when the second oscillation occurred in Mounts-bay in 1761, a very violent thunderstorm happened there in the evening, distant thunder having been heard occasionally all the day, and the weather very sultry and calm.—*Phil. Trans.*, vol. lii. p. 507.

† These have since been inserted in Jameson's Edinburgh Philosophical Journal for October 1845, pp. 386–389.

‡ The dates are given in the Transactions of the Geological Society of Cornwall, 1843, p. 111, and 1844, p. 209.

usual height above the surface of the earth is very inconsiderable in high latitudes, since it has been observed at one place in the zenith, forming a confused mass of flashes and beams; and at another, not many miles distant, having the appearance of a low illumined arch in the direction of the former place.

The sudden deposition of extremely minute frozen particles, when auroral displays took place near to the zenith, was several times observed by the author; and it appears that the same singular fact has been alluded to by Lieut. Hood and also by Dr. Richardson, but more especially by Professor Joslyn of New York, in Silliman's Journal, Oct. 1838, who concludes, from numerous observations made in North America, that "the aurora is an electrical phænomenon,—that it is intimately connected with the elements of the clouds, and with these elements only, when they are generated in air intensely cold, as well as nearly saturated with humidity,—that it requires for its development a cold adequate to the crystallization of aqueous vapours,—that crystals of snow, more minute and simple than those which produce halos, are always present in the atmosphere above the region of ordinary clouds during the appearance of this meteor,—that those seasons of the year, and those hours of the night when the aurora most frequently occurs, are favourable both to the presence and congelation of aqueous vapours in the atmosphere." The author remarks upon the singular agreement between these results of Professor Joslyn and those communicated by himself four years before, in an unpublished paper to the Royal Society. He considers, however, that perhaps the strongest proof of the important agency of these particles in an auroral display, is to be derived from the fact, that the auroral light can be distinctly traced to those localities where humid vapours are known to be undergoing rapid congelation, and where such particles must in consequence abound; and that in the usual arch-formation, whatever may be the *nature* of the light, yet the auroral fringe clearly arises from the illumination of the frozen particles which are formed from the exterior portion of the vapours, being under the influence of the cold atmosphere immediately above them. From the circumstance that congelation is a known source of electrical development, he infers that strong evidence is thereby afforded of the nature as well as the locality of the aurora.

Although he considers sufficient evidence was obtained as to the direction and situation of the *open-water* during the winter season, from the usual indications of the sea-blink, and also from the information obtained from the Esquimaux, yet a singular confirmation in this respect was afforded by the circumstance, that the refraction due to the star Sirius, which was usually observed through a low aurora in the south-east direction at the island of Igloolik during the second winter, was generally about 1′ less than the corresponding refraction of the same star when observed at equal altitudes and temperature towards the south-west; in which latter direction the visual ray passed over land covered with ice and snow, thereby indicating a diminished density of the lower stratum of atmosphere in the former direction, in which the aurora was seen, from its being under the influence of the comparatively higher temperature of an exposed surface of the sea.

The author remarks, that when a display of aurora commenced with the arch-formation, the upper stratum of vapour, which formed the exterior limit or upper edge of the arch, was usually of a very dense and dark appearance, apparently highly charged with humidity, and exhibited by the contrast the auroral fringe immediately above it with splendid effect; but that the lower portion, being of a higher temperature, from being nearer to the exposed surface of the water, became frequently so dilated and transparent as to render stars visible within the arch.

To form an estimate of the prodigious extent to which congelation goes on during the winter season near the margin of the frozen sea, and at those places within it, where, by reason of the spring tides, the ice is continually broken and separated from the land, and the water in consequence suddenly exposed to the action of the low temperatures which then prevail, he observes, that a difference of more than 70° Fahr. continually occurs between the temperature of the exposed surface-water and that of the atmosphere above it, and that the latter in consequence becomes immediately impregnated with extremely minute frozen particles, known by the name of "Frost-smoke," which, when seen at a distance, has a white silvery appearance.

The immense mass of vapours which are known to accumulate near the edge of the ice are invariably confined at this period of the year to very low altitudes above the surface of the earth, so as never to form clouds in the usual acceptation of the term; but as the season advances and the temperature increases, the aurora occurs less frequently; the vapours become entirely detached from the sea, rise to a greater height in the atmosphere, and begin to acquire the ordinary appearance of clouds. The aurora is no longer confined to their upper surfaces, but a faint auroral light is usually seen to fringe the whole of their circumferences, until the vapours are dissipated by congelation. The author conceives the alternate opening and closing of the ice, by which means different portions of vapours are detached from the surface of the sea consecutively, give rise to the appearance of different concentric arches of aurora, which are occasionally seen.

As extreme dryness is the peculiar character of the higher atmosphere consequent upon low temperatures (which is a state most favourable for electrical induction), he concludes that this portion of the atmosphere acquires an opposite state of electricity to that below; and since there are no means, such as exist in more temperate latitudes, of effecting the restoration of the electrical equilibrium thus disturbed by congelation; and moreover, since within the tropics the aurora is never seen, and thunder and lightning are of almost daily occurrence, the latter phænomenon indicates the means which nature employs for the maintenance of the equilibrium nearer the equator; and on the other hand, the aurora points out the mode by which the same end is silently effected in the cloudless atmosphere of a polar winter, and other places where it occasionally occurs, by the interposition and conducting power of the frozen particles that are then and there formed; that as these particles are generated in the same proportion as the electricity is developed, so the means of restoring the equilibrium are at all times adequate for the purpose.

He considers the formation of vertical streamers to arise from the illumination of columns of these particles in performing the office of restoring the electrical equilibrium between the upper and lower strata of atmosphere; that their vertical ascension is due to the electrical attraction caused by the strata being in opposite states of electricity by induction, and in accordance with this he observed that when the streamers were projected from an auroral arch, the fringe of light upon the latter usually became extinct, or very much diminished in intensity. That the particles are subsequently distributed by the winds in various directions, and give rise by their illumination to the different places and appearances which constitute a diffused aurora, which is usually terminated by a deposition of the particles when they have performed their office.

He found by repeated trials, which were suggested to him by the late Sir Humphry Davy at a committee of the Royal Society held previous to the sailing of the expedition, that ice is an electrical conductor at very low, as well as at mean temperatures. The experiments were made with various electrometers, and the friction made with silk, woollen cloth, &c., but without producing the least electrical indication, although, from the perfect dryness of the atmosphere at low temperatures, the electrometers were extremely sensible of the slightest approach of an excited electric. A similar conclusion was obtained by completing, by means of ice, the connexion in M. Orsteds galvanic apparatus. Mr. Fisher also observes, that the conducting power of the frozen particles floating in the atmosphere defeated every attempt to determine the state of the atmospherical electricity, by means of the apparatus suspended from the royal mast-head of the ship, during the time they were frozen up each winter, by reason of their deposition upon the insulating glass rods of the copper chain used for the purpose; and he has reason to think, had the insulation been perfect, some very interesting results would have been obtained.

Taking this view of the subject, the author considers that there exists an irregular belt or zone of congelation, circumscribing the pole of each hemisphere, in different parts of which displays of aurora more or less occur, according to the amount of the required conditions of low temperatures and humidity; and that those parts of the zones which cross the northern Atlantic, or in other words, the winter limits of the frozen sea which extend from the American to the northern coast of Europe, will be most favourable to the production of the aurora, from the circumstance of there being there the greatest supply of humidity. This, he observes, is confirmed by observation, and is further corroborated by the fact, that gales of wind from the south, which bring to the ice portions of atmosphere saturated with moisture from sea-weed, most frequently accompany these auroral displays.

Having endeavoured to trace the aurora to these localities, he concludes his paper by identifying these auroral zones with the existence of electrical currents and their application to the theory of terrestrial magnetism. He considers that these zones will not approach nearer to either pole of the earth than the margin of the fixed ice, from the absence of humidity in the atmosphere over the fixed ice; but that they will extend themselves indefinitely towards the equator, and also in height above the surface of the earth. And since the general configuration or curvature of the zones must obviously approximate to that of the isothermal lines, which latter are known to accord in a very remarkable way with the magnetic curves, he thinks there are good grounds for concluding that Ampère's theory is founded in truth, and that these currents circulate within the zones from east to west; the exciting cause of the circulation of the currents in this direction being probably the action of the sun, as each portion of the zones is brought consecutively by the diurnal rotation of the earth within the solar influence; the magnetic needle being thereby induced to place itself at right angles to the direction of the currents. It will follow also, that the electrical development in each zone will be greater in winter than in the summer of the corresponding hemisphere; and that the magnetic force will also be a maximum in the winter time, which is found to be the case.

He suggests, that upon the same principle the force soliciting the horizontal magnetic needle will be a minimum during that period of the day when the solar influence is most effective in diminishing the electrical development in that part of the zone which is situated in the direction of the magnetic meridian; that the diurnal deflection of the north end of the needle (as observed in Europe) towards the west in the morning, and the contrary motion in the afternoon, may be also thus reconciled; and, finally, that the aurora will produce a similar effect by restoring the electrical equilibrium, and cause a diminution of the magnetic intensity of the horizontal needle when a display happens in or near the direction of the magnetic meridian, and also a corresponding deflection in declination from that part of the zone where the phænomenon occurs. These conclusions the author has reason to believe are confirmed by observations.

On the Measurement of Two Arcs of the Meridian in India, the middle point being in latitude 24° 7′ 11″, *the southern extremity in latitude* 18° 3′ 15″, *and the northern in latitude* 29° 30′ 49″. *By* Lieut.-Colonel EVEREST, *F.R.S., &c., late Surveyor-General of India.*

Colonel Everest described the apparatus employed in the measurement of three bases connected with this work, as also the instruments used in determining the celestial arcs of amplitude and in the terrestrial operations, and exhibited engravings illustrative thereof.

On a Lunar Meteorological Cycle. By LUKE HOWARD, *F.R.S.*

Mr. Howard reports that the facts of the last two years compel him to modify his anticipations as to the extent to which the lunar cycle will enable him or others to become "weather prophets." But he says the deferred heat (to be expected from the corresponding period of the cycle in 1825 to 1828) may prove to be only defeated cold; and the absence of so great an elevation of the mean temperature now, may spare us a repetition for many seasons to come of the cold which occurred between the years 1835 and 1840. To show, however, that causes exist for these periodical alternations of warmth and cold, much more extended in their effects than any which are peculiar to our own climate, he proceeds in detail to place in review together the annual mean temperature for eighteen years (ending with 1823) at Geneva and London. It will be seen that the two cities differ little in their climatic or *annual mean*; the more southern latitude of the former being counteracted by its greater elevation above the sea. See Plate IV.

Years.							
1806	Geneva.	Reaum.	+8°·73	Fahr.	51°·645	London	50°·734
1807	,,	,,	7·78	,,	49·505	,,	48·367
1808	,,	,,	6·68	,,	47·030	,,	48·633
1809	,,	,,	7·54	,,	48·965	,,	49·546
1810	,,	,,	8·57	,,	51·2825	,,	49·507
1811	,,	,,	8·89	,,	52·0025	,,	51·190
1812	,,	,,	7·10	,,	47·975	,,	47·743
1813	,,	,,	7·48	,,	48·830	,,	49·762
1814	,,	,,	7·34	,,	48·515	,,	46·967
1815	,,	,,	8·03	,,	50·0675	,,	49·630
1816	,,	,,	7·09	,,	47·9525	,,	46·572
1817	,,	,,	8·11	,,	50·2475	,,	47·834
1818	,,	,,	7·96	,,	49·910	,,	50·028
1819	,,	,,	8·21	,,	50·4725	,,	50·030
1820	,,	,,	7·63	,,	49·1675	,,	47·950
1821	,,	,,	8·28	,,	50·630	,,	49·810
1822	,,	,,	8·28	,,	50·630	,,	51·405
1823	,,	,,	6·50	,,	46·625	,,	48·331
			+7·789		49·525		49·113
Mean of first nine years......			7·790				49·161
Mean of second nine years...			7·777				49·065

On the Strength of Stone Columns. *By* Eaton Hodgkinson, *F.R.S.*

This paper contained the results of some experiments to determine the force necessary to crush small columns of stone. The columns were of different heights, varying from 1 inch to 40 inches; they were square uniform prisms, the sides of the bases of which were 1 inch and $1\frac{3}{4}$ inch, and the crushing weight was applied in the direction of the strata. All the columns were cut out of the same block of stone, which was very uniform, and is of the strongest kind used for architectural purposes in the neighbourhood of Manchester. It is from the Peel Delph, Littleborough, Lancashire, on the confines of Yorkshire. The columns were cut, as near to the prescribed size as was practicable, by the mason, and were afterwards squared up with great care. They were crushed, by means of a powerful lever, between two flat surfaces of hardened steel, which from the nature of the apparatus were necessarily parallel. The apparatus was similar to that used in the author's previous experiments on the strength of pillars, and the only difference in these experiments from the preceding ones was, that a thin sheet of lead was placed over and under the specimen to equalize the pressure.

From the experiments on the two series of pillars, it appears that there is a falling off in strength in all columns from the shortest to the longest; but that the diminution is so small, when the height of the column is not greater than about 12 times the side of its square, that the strength may be considered as uniform; the mean being 10,000 lbs. per square inch or upwards.

From the experiments on the columns 1 inch square, it appears that when the height is 15 times the side of the square, the strength is slightly reduced; when the height is 24 times the base, the falling off is from 138 to 96 nearly; when it is 30 times the base, the strength is reduced from 138 to 75; and when it is 40 times the base, the strength is reduced to 52, or to little more than one-third. These numbers will be modified to some extent by the experiments in progress.

In all columns shorter than 30 times the side of the square, fracture took place by one of the ends failing, showing the ends to be the weakest part; and the increased weakness of the longer columns over that of the shorter ones seemed to arise from the former being deflected more than the latter, and therefore exposing a smaller part of the ends to the crushing force. The cause of failure is the tendency of rigid materials to form wedges with sharp ends, these wedges splitting the body up in a manner which is always pretty nearly the same. Some attempts to explain this matter theoretically were made by Coulomb. As long columns always give way first at the ends, showing that part to be the weakest, we might economize the material by making the areas of the ends larger than that of the middle, increasing the strength from the middle both ways towards the ends. If the areas of the ends be to the area in the middle as the strength of a short column is to that of a long one, we should have for a column, whose height was 24 times the breadth, the area of the ends and middle as 13,766 to 9595 nearly. This however would make the ends somewhat too strong, since the weakness of long columns arises from their flexure, and increasing the ends would diminish that flexure.

Another mode of increasing the strength of the ends would be that of preventing flexure by increasing the dimensions of the middle.

From the experiments, it would appear that the Grecian columns, which seldom had their length more than about 10 times the diameter, were nearly of the form capable of bearing the greatest weight when their shafts were uniform; and that columns, tapering from the bottom to the top, were only capable of bearing weights due to the smallest part of their section, though the larger end might serve to prevent lateral thrusts. This last remark applies too to the Egyptian columns, the strength of the column being only that of the smallest part of the section.

From the two series of experiments, it appeared that the strength of a short column is nearly in proportion to the area of the section, though the strength of the larger one is somewhat less than in that proportion.

CHEMISTRY.

Experiments on the Spheroidal State of Bodies, and its Application to Steam-Boilers, and on the Freezing of Water in red-hot Vessels. By M. Boutigny. (*d'Evreux.*)

M. Boutigny, who made his communication in the French language, first proceeded to show that a drop of water projected upon a red-hot plate does not touch it; but that a repulsive action is exerted between the plate and the fluid, which keeps the latter in a state of rapid vibration. At a white heat, this repulsion acts with the greatest energy, whilst at a brown-red heat it ceases and the ordinary process of evaporation takes place. The temperature of the water whilst in the spheroidal state is found to be only 96°, and this temperature is maintained so long as the heat of the plate is kept up. To bring the water to the boiling-point (212°), it is therefore necessary to cool the plate. These phænomena are explained by M. Boutigny on the supposition that the sphere of water has a perfect reflecting surface, and consequently that the heat of the incandescent plate is reflected back upon it; and some experiments have been made, which show that this is the case, the plate becoming visibly redder over those parts on which the vibrating globule played. Several experiments were made in proof of this necessary cooling to produce ebullition. The red-hot plate, with its spheroidal drop, was removed from the spirit-lamp, and after a minute or two the water began to boil, and was rapidly dissipated in steam. Ammonia and æther were shown, although so exceedingly volatile, to act in the same manner; the æther, however, being decomposed whilst in the vibratory condition, in the same manner as it is by the action of platina wire, forming a peculiar acid. Iodine put upon the heated plate became fluid, and revolved in the same manner as other fluids, no vapours escaping whilst the high temperature of the metal was maintained; but when allowed to cool to the point of dull redness, it was immediately dissipated in violet vapours. The nitrate of ammonia, when fused on the glowing hot plate, vibrated with great energy; but on cooling the capsule, the salt entered into vivid combustion. The repulsive action was shown by plunging a lump of silver at a glowing red heat into a glass of water. As long as its bright redness was maintained, there was no ebullition; but as it slowly cooled, boiling took place. In this experiment, it appeared as if the glowing metal formed around itself an atmosphere; and the contiguous surfaces of the water appeared like a silver plate. The application of the principles involved in these phænomena to the tempering of metals was then explained. If a metal to be tempered is in a highly incandescent state, the necessary hardening will not take place on plunging it into water. It is therefore necessary that a certain temperature should be observed. Experiments were made to show that the repulsive power of the spheroidal fluid existed, not merely between it and the hot plate, but between it and other fluids. Æther and water thus repelled each other, and water rested on and rolled over turpentine. The bursting of steam-boilers came next under consideration; and it was shown that many serious explosions may be referred to the phænomena under consideration. In a great many cases, the explosions have occurred during the cooling of the boilers after the withdrawal of the fire. An experiment was shown in proof of the view entertained by M. Boutigny. A sphere of copper, fitted with a safety-valve, was heated, and a little water being put into it, it was securely corked up, and withdrawn from the lamp. As long as the metal remained red, everything was quiet; but upon cooling, the cork was blown out with explosive violence. The concluding experiment excited great interest—the production of ice in a vessel at a glowing red heat. It was successfully performed by M. Boutigny, in the following manner:—A deep platina capsule was brought to a glowing red heat, and at the same moment water and liquid sulphureous acid, which had been preserved in the liquid state by a freezing mixture, were poured into the vessel. The rapid evaporation of the volatile sulphureous acid, which enters into ebullition at the freezing-point, produced such an intense degree of cold, that a large lump of ice was immediately formed, and being thrown out of the red-hot vessel, handed round for examination.

On a New Property of Gases. By Professor Graham, *M.A., F.R.S. L. & E.*

After explaining the law which regulated the diffusion of gases, and stating the fact, that the lighter gases diffused themselves much more speedily than the more dense ones,—the velocity of their diffusion being equal to the square root of their densities,—he proceeded to relate his experiments on the passage of gases into a vacuum. To this passage the term Effusion has been applied. The velocity of air being 1·, the velocity of oxygen was found to be 0·9500 by experiment, and by calculation 0·9487. Carbonic acid being much heavier than air, gave the number 0·821, the theoretical number being 0·812. Carburetted hydrogen gave 0·1322 as the velocity of its effusion, the theoretical number being 1·341. Hydrogen gave as the velocity of effusion 3·613 by experiment, which was nearly the amount given by theory (0·379). The interference of friction, even of minute orifices, was then described, and shown to admit of easy correction. Some useful applications were mentioned; as in the manufacture of coal-gas, where it is desirable to ascertain the quality, as well as the quantity of gas manufactured. As the gas will pass the orifice on its way to a vacuum the quicker the lighter it is, and the more slowly as it increases in density, and as the superior carburetted hydrogen is heaviest, it would be easy to construct an instrument to register this velocity, and thus mark at once the required quality and quantity of gas. It was also proposed that an instrument might be used in mines to detect the presence of light carburetted hydrogen (fire-damp). The passage of gases under pressure through porous bodies was termed by Prof. Graham, Transpiration. The mode adopted in experiment was, to take a glass receiver, open at the top, which was closed with a plate of stucco. This was placed on an air-pump, and the air exhausted by the pump, the velocity with which the air passed through the stucco being marked by the mercurial gauge of the pump. The transpiration of atmospheric air was found to be more rapid than that of oxygen. Carbonic acid is found to be more transpirable than oxygen, or even, under low pressure, than atmospheric air. The transpiration of hydrogen is one-third more rapid than that of oxygen. The applicability of this process of experimenting to the explanation of exosmose and endosmose action in the passage of fluids through porous bodies was pointed out.

On the Action of Gases on the Prismatic Spectrum. By Dr. Miller.

Referring, in the first instance, to the experiments of Sir D. Brewster on the changes produced on the fixed lines of the prismatic spectrum by various absorptive media, Dr. Miller proceeded to explain his method of examining the subject. The light, being admitted by a longitudinal slit in a plate of metal, one half of this slit was covered with a vessel containing the gaseous medium, the other half transmitted ordinary light; the image of the slit, after falling on a prism of Munich glass, was observed by a telescope. It was found that the dark lines of the spectrum materially changed their positions as different coloured gases were used; and that, by subjecting the spectrum to the absorptive influences of chlorine, nitrous acid vapour, the vapours of iodine, bromine, perchloride, manganese, &c., numerous dark bands, not previously observed, were brought into view. Several of the oxides of chlorine were examined, and it was found that the chlorous acid, peroxide of oxide of chlorine and euchlorine all gave the same series of lines. The spectra produced by coloured flames were also examined, and many curious conditions observed. Dr. Miller had sought to ascertain if any relation could be found between the chemical characters of the bodies under examination and their properties of exhibiting Fraunhofer's lines; but as yet no such relation could be detected.

Contributions to Actino-Chemistry.—On the Chemical Changes produced by the Solar Rays, and the Influence of Actinism in disturbing Electrical Forces. By ROBERT HUNT.

He detailed a great number of experiments which supported his views, that a certain class of chemical compounds possessed the property of fixing the chemical principle of light. The result of the researches of the author, since the York meeting, was that in all cases chemical action was either accelerated or retarded by the influence of the actinic force, whatever it may be. It was evident that the peculiar electrical condition of the compound regulated the disposing power of the actinic rays; but it was not yet determined if any constant relation was maintained between the electrical state and the action of this chemical power. The author found in all cases, that weak electrical currents which were sufficient to precipitate the metals from solutions *in the dark*, were not capable of doing so when they were exposed *to sunshine, or even diffused daylight*. The power of this principle in producing molecular disturbance was also mentioned, and many additional experiments were described.

On the Manufacture of a Coloured Glass. By M. SPLITTGERBER.

I have the honour to present herewith small pieces of white glass, which are quite transparent, but contain however a portion of gold, which was added to the grit as chlorate of gold*, and which gives to this glass the curious quality to become red by slightly re-heating it over the alcohol lamp; a greater heat changes the colour, and the gold is restored to its characteristic tint, which quality has been long known, and employed by the crystal glass manufacturer. It is now the question, *in what state the gold* is contained in the glass, when not at all coloured, and when coloured. In my opinion, the gold is in the white glass in the most oxidated state, analogous to the state of the lead in the white crystal glass, but, by re-heating, it loses a part of the oxygen, and becomes more and more reduced.

According to the opinion of other German philosophers, the gold is contained even in the white glass in the metallic state, but in a state of the greatest diffusion; and in the coloured condition in a state of less and less diffusion. I am not of this opinion, because I have, by melting the red glass with a blowpipe supplied with oxygen gas, made it again colourless, but only to a very small extent; and it is not very clear, I think, that the change of colour of this glass is the result of different states of deoxidation of the gold in it. But it is very curious that the glass does not become red by its first melting, and I can give no reason for this phænomenon. In the Annals of M. Poggendorff I have noticed it last year; but I think that this phænomenon would be also interesting for a further optical investigation.

* The composition of this glass is,—

	40 grains of ...	sand.
	25	soda.
	5	chalk.
and	0·52	gold.

On Recent Experiments on the Gas Voltaic Battery. *By* Professor Grove.

No previous description of the gas battery having been communicated to the Association, Prof. Grove entered into an explanation of the action of hydrogen gas upon spongy platina, and gave a description of the first gas battery constructed with platina wire sealed into glass tubes in pairs,—hydrogen being put into one tube, and oxygen into the other. An arrangement of this kind being connected with a voltameter, it was found that exactly the same quantity of gases was eliminated in the tubes of that instrument as combined in the tubes of the battery. Experiments have been made by Prof. Grove with a view of ascertaining if other gases might be used in the battery, and it was discovered that a great variety of gases might be so used; and he then pointed out how perfectly any eudiometric analyses might be carried on with the gas battery, provided some attention was paid to a few sources of error. A form of the instrument as hitherto constructed by Prof. Grove was described, for the purpose of avoiding the absorption of atmospheric air by the fluid in the cells of the battery. A more recent construction of the battery was next described, in which many other applications of the voltaic battery are attained, being a combination in which several pairs of gas tubes are connected in one compact body. A main advantage arising from this battery is the really constant condition of it; once charged, it appears that the action will go on for years, requiring nothing more than occasionally, at long intervals, adding a little zinc to the acidulated solution in one cell, for the purpose of supplying the loss of hydrogen in the tubes. The results of experiment have shown, that the most invariable action may be calculated on for years; and that, by this instrument, researches requiring for a long period the constant flow of a galvanic current may be most effectually carried out. Some experiments on the combination of phosphorus and sulphur with oxygen in the battery were then detailed; by which it was found that any inflammable body capable of volatilization gave a galvanic action with oxygen in the other tube. Camphor, alcohol, æther, and other bodies proved the generality of this effect. It was then stated, that throughout these researches it had been found that chemical action and voltaic action were convertible into each other.

On the Voltaic Reduction of Alloys. *By* C. V. Walker.

This communication was intended to explain the methods by which the author has succeeded in throwing down metallic alloys from compound solutions by the action of galvanic electricity. The process adopted is to prepare a strong solution of cyanide of potassium, and commence electrolyzing it by means of a copper anode; as soon as copper begins to be dissolved, the copper anode is removed, and its place supplied with one of zinc; after the action has continued for some little time, brass will be liberated on the cathode. The solution is now ready for use, and is operated upon by two or three Daniell's cells, and with a brass anode. By similar means alloys of gold and copper, or gold and silver, may be deposited. The author reasons, that true brass is a definite chemical compound; and states, it appears possible that the anode, which is a brass of commerce, is a true alloy, plus an excess of zinc; that the solution it produces is a mixed solution, which consists of the potassio-cyanide of brass and the potassio-cyanide of zinc. This solution is very readily decomposable; it is therefore necessary to prepare it a short time previously to its use. Many specimens were exhibited of copper and other metals coated with brass. The author makes some remarks on the theory of the action; and concludes by stating that it will be quite possible to determine, within certain limits, the character of the alloy that shall present itself, and that we may be enabled to throw down gold and silver according to standard.

Description of a Colossal Hydro-Electric Machine, with a Notice of some Phænomena attending the production of Electricity by Steam. *By* W. G. Armstrong.

The machine described by the author, and which has recently been sent out to the United States of America, resembles the machine at the Polytechnic Institution in external dimensions, but is more powerful.

As an illustration of the power of this machine, Mr. Armstrong stated that it had fully charged a battery containing thirty-three square feet of coated surface upwards of sixty times in a minute. He also mentioned that by interrupting the electric current and causing it to pass through the thin wire coil of Colladon's apparatus for inductive effects, he had obtained a secondary current in the thick wire coil, answering in all respects to an alternating voltaic current, and sufficient to occasion a permanent though slight scintillation of two pieces of steel attached to opposite ends of the wire, and rubbed against each other.

Mr. Armstrong reiterated his conviction that the excitation of electricity in the hydro-electric machine was due to the friction sustained by particles of water in passing through the escape aperture, for by no other explanation was it possible to account for the prodigious influence which is exercised by the form of the escape orifice,—by the material against which the current is rubbed,—by the presence of water in the issuing steam,—and by the condition of such water with respect to extraneous substances contained in it.

He adverted to Professor Faraday's experiment of reversing the electricity of the boiler and steam-cloud by introducing oil of turpentine into the steam passages, which effect had been attributed by Faraday to the particles of water becoming invested with a film of turpentine; but Mr. Armstrong stated that there were many *soluble* substances which were equally effective in reversing the electricity, and so sensitive were the electric properties of the water to the influence of foreign substances, that even the inappreciable quantity of extraneous matter which the water appeared to acquire by contact with condensing pipes of different materials was sufficient to affect the excitation of the electricity.

On the Mechanical Equivalent of Heat. *By* James P. Joule.

The author gave the results of some new experiments, in order to confirm the views he had already derived from experiments on the heat evolved by magneto-electricity, and from experiments on the changes of temperature produced by the condensation and rarefaction of elastic fluids. He exhibited to the Section an apparatus consisting of a can of peculiar construction filled with water. A sort of paddle-wheel was placed in the can, to which motion could be communicated by means of weights thrown over two pulleys working in contrary directions. He stated, that the force spent in revolving the paddle-wheel produced a certain increment in the temperature of the water, and hence he drew the conclusion, that when the temperature of a lb. of water is increased by one degree of Fahrenheit's scale, an amount of *vis viva* is communicated to it equal to that acquired by a weight of 890 lbs. after falling from an altitude of one foot.

On Atomic Volumes. *By* Dr. Lyon Playfair.

Outlines of a Natural System of Organic Chemistry. *By* George Kemp, *M.D., F.C.P.S.*

The object of the following paper is to furnish what has hitherto been a desideratum,—an arrangement of organic bodies with reference to their natural affinities, and which, being based on the operations which are observable in living organized bodies, will, it is hoped, furnish the student with a means of grouping the results of his labours, and the philosopher with safe materials for developing those general laws, to which every organized being owes its capability of replacing its own ever-wasting structure, and reproducing a form analogous to itself.

Assuming, then, that all organic bodies of which nitrogen forms no part have been originally derived from starch, and that those, on the other hand, in which nitrogen is an essential element proceed from proteine, we have at once two general classes, which we may denominate amylogenic and proteunogenic.

Class I. Amylogenic Bodies.

Order 1. Products which result from the direct operation of natural causes.
Order 2. Bodies produced by the application of artificial agents.
Order 1. Genus 1. Formula for amylon merely modified by the addition or subtrac-

tion of the elements of water, included between the limits $C_{12} H_8 O_8$ and $C_{12} H_{14} O_{14}$, as lignine, inuline, &c. &c.

Order 1. Genus 2. Formula being that for amylon, minus a certain number of equivalents of oxygen, and all being allied to fatty matters.

Order 2. Genus 1. Products effected by contact with bodies in which the ultimate elements are in the act of assuming new arrangements.

Order 2. Genus 2. Products effected by heat. (Pyrogenic bodies.)

Order 2. Genus 3. Products effected by oxidizing agents.

Class II. Proteunogenic Bodies.

Order 1. Results of organization.

Order 2. Artificial products.

Order 1. Genus 1. Variable in the quantity of inorganic matter they contain; as albumen and fibrine.

Order 1. Genus 2. Variable in the quantity of oxygen which they contain, the carbon and nitrogen remaining constant; as the middle coat of arteries and mucus.

Order 1. Genus 3. Bodies in which all the organic elements assume a new proportion to each other, but which may be considered as compounds of proteine and a non-nitrogenized body included in Class 1. Order 1.

Order 2. Genus 1. Products resulting from the disturbance of the molecular equilibrium of proteine compounds when deprived of vitality, the action being much promoted by moderate increase of temperature and moisture. (Eremacasis of Liebig.)

Order 2. Genus 2. Products effected by a high temperature. (Pyrogenic bodies.)

Order 2. Genus 3. Results of the action of oxidizing agents; these are very numerous.

The author believes that no difficulty will occur in referring any organic body to one or other of the above divisions, and proceeds to give, as an instance of the application of the system, the interpretation of the analysis of the food of the milch cow.

On Gutta Percha, a new variety of Caoutchouc. By Edward Solly, *F.R.S.*

Within the last two or three years, a very remarkable substance has been transmitted to this country from Sincapore under the name of Gutta Percha; it was first sent over by Dr. Montgomerie, who received the gold medal of the Society for the Encouragement of Arts, &c., for its introduction into this country as a new and hitherto unknown substance likely to be useful for several purposes in the arts. He was however unable to ascertain the tree from which it is procured, or indeed any more of its history than that it is obtained in large quantities by cutting down the trees which yield it, and that it is employed by the natives to make the handles of knives and other tools, being preferred by them for this purpose even to buffalo's horn. Mr. Solly described Gutta Percha as being a white or dirty pinkish-coloured solid, having little or no smell, insoluble in water and consequently tasteless, having a silky fibrous texture, and feeling smooth and almost greasy to the fingers; at the same time that it presents considerable resistance to any substance which is rubbed or drawn across it, thus enabling it to be grasped or held with great firmness in the hand.

At temperatures below 50° it is hard, tough, and in thin pieces flexible, a good deal resembling horn in its physical characters. From 50° to 70° it becomes more flexible and slightly elastic, still however retaining its remarkable stiffness and toughness. When forcibly extended it shows very little power of contraction, requiring considerable force to extend it, and retaining the form which has been given to it after the force which was applied is discontinued. At a temperature between 140° and 160° it becomes soft and remarkably plastic, its tenacity being at the same time greatly diminished. In this state two or more pieces may be joined together with the greatest facility (far greater than is the case with caoutchouc), and in a manner which may almost be compared to bees'-wax, inasmuch as whether the pieces are clean or dirty they unite on the slightest pressure and form a perfect joint.

When in the soft and plastic state, Gutta Percha may be pressed or moulded into any required shape; as it cools it gradually re-acquires its former tough and rigid nature. The casts which are obtained in this manner from coins, medals, &c., are remarkably sharp and perfect. Gutta Percha at ordinary temperature is divided by a knife with great difficulty, behaving like cold hard caoutchouc; its division is much facilitated by the use of a wet knife. Its specific gravity is greater than that of caoutchouc, being 0·9791, whilst the latter is about 0·9355. Kept for some time at a temperature of near 200° it gradually parts with a small quantity of moisture, and becomes dark-coloured and translucent: it however assumes its original appearance again if steeped for some time in water. Exposed to a higher temperature, it melts, is decomposed, and finally burns with a very smoky flame like caoutchouc. Analysis shows it to be a hydrocarbon, identical in composition with ordinary caoutchouc. Ordinary solvents exert little or no action on Gutta Percha; water, alcohol, oils, alkaline solutions, muriatic and acetic acids produce no effect whatever. Strong sulphuric acid slowly chars it, concentrated nitric acid gradually oxidizes it, and æther, essential oils and coal-tar naphtha in time soften and partially dissolve it. The most perfect solvent appeared to be oil of turpentine, which formed a clear transparent solution, from which the pure Gutta Percha was readily obtained on evaporating the oil of turpentine.

The physical properties of this substance are such as to place it amongst the substitutes for leather, and will probably render it a valuable article of import. Its chemical properties show it to be a variety of caoutchouc.

Notice of the Oil of Assafœtida. By Thomas Tilley, *Professor of Chemistry in the Queen's College, Birmingham, and* Douglas Maclagan, *M.D., F.R.S.E.*

The authors describe the analytical processes which they followed, and state the numerical results. They prove that the oil of assafœtida contains, and is chiefly composed of, the sulphuret of allyl and an oil heavier than water, also containing sulphur. They conclude by the following summary:—

It has been shown by the investigations of other chemists and ourselves, that the class of substances used as condiments of the onion order of flavour, though produced in different zones and by different natural orders, contains the same organic radical united to sulphur of plants or sulpho-cyanogen.

The oil of garlic, from a liliaceous plant; the oil of mustard, a compound of allyl with sulpho-cyanogen from the Cruciferæ; the oil of assafœtida, so much used in India for a condiment, from the Umbelliferæ, all contain the same organic radical, and form a parallel case to the tea, the coffee, and the Paraguay tea-plants, which also contain the same substance, theine, and which are used for similar purposes. The authors are still continuing this investigation.

On the Chemical Principles involved in the Rotation of Crops. By Professor Daubeny, *F.R.S.*

Professor Daubeny made some remarks on the chemical principles involved in the rotation of crops, stating the conclusions which he had deduced from a series of experiments carried on within the Botanic Garden at Oxford, and intended to ascertain the rate of diminution in the produce of several plots of ground that had been sown for ten years, either continuously with the same, or successively with different crops, in either case without the addition of manure throughout the course of the trials. He stated, that although, as might have been anticipated, a diminution in the latter years' produce took place both in the permanent and in the shifting crops, and although a smaller average amount was obtained in the former than in the latter, yet that after the expiration of the whole period the ground still continued unexhausted; and that an analysis of it showed it still to contain sufficient of the phosphates to supply materials for nineteen crops of barley, sufficient of potass for fifteen, and sufficient of soda for forty-five. The actual diminution of produce during the latter years he therefore attributed to the circumstance of these ingredients not being in a soluble condition, it being found, that from the soil so long drawn upon, water impregnated with carbonic acid took up much less of the above ingredients than it did from the same that had not been so cropped and but recently manured. The greater diminution in the permanent than in the shifting crop he attributed to the circumstance of the latter being supplied with a larger amount of organic matter, derived from the fallow crop intercalated, owing to which the plants would be more fully developed, through the influence of the carbonic acid and ammonia, which would be imparted to them during the decomposition of the *humus*. He pointed out, how the mere introduction of healthy plants into a soil might aid in rendering the phosphates and alkaline salts, locked up within the latter, more speedily soluble, and hence inferred that a larger amount of these substances might be extracted where the plants were stimulated into activity by the presence of decomposing organic matter. He also was led to inquire whether, in the event of a scantier supply of one of the alkalies or of the earths than was common, a plant would substitute *ad libitum* another which might be presented to it in greater abundance. To determine this, he obtained from Mr. Way, late assistant to Professor Graham, an analysis of three samples of six different kinds of crop, viz. potatoes, barley, turnips, hemp, flax, and beans; one sample being that cultivated for ten successive years in the same ground without manure; the second from a similar plot which had grown different crops for the same period without manure; the third from a plot in a contiguous part of the garden which had been recently manured. From the results obtained, it would appear that the aggregate amount of *bases*, in the three samples, was about the same; but the proportion of these bases one to the other varied considerably, a circumstance at first sight appearing to confirm the theory of substitution. The author, however, conceives, that this may be explained by supposing a different degree of development of the several parts or proximate principles in the respective samples, as he finds a great discrepancy in the amount of phosphoric acid present in gluten and in starch, and thinks it probable that the same diversity may extend to other of the principles contained in each plant. That potass is better adapted for the organization of a plant than soda, seems to follow from the circumstance, that whilst the soil usually contained an excess of soda, the plant always was most rich in potass. The author, therefore, in accordance with the views of Liebig, throws out as a conjecture, that the soda found in the ash may be that circulating through the vegetable tissue, and contained in the sap, whilst the potass is actually assimilated, and constitutes a part of the vegetable tissue. The former, as Liebig supposes, may be useful in conveying carbonic acid to the plant, but cannot be substituted for potass, at least without injury to its healthy condition. It appears also, from the analyses referred to, that land-plants have not the power of decomposing common salt; so that this substance cannot, as has been supposed, be serviceable to vegetation by affording a supply of alkali. We may also infer, that it does not follow, because a soil is benefited by manuring, that it is destitute of the ingredients which the manure supplies, since it may happen that these ingredients are present in the soil in an insoluble, and therefore not in an available condition. Chemical and mechanical means may no doubt be effectual in bringing into a soluble condition the phosphates and alkaline salts thus locked up within the soil, but as this is brought about by Nature herself, we might often spare ourselves the necessity of resorting to such means, if we would only resolve not to counteract *her* beneficial agency, by suffering to run to waste the various excrementitious matters which *she* has placed at our disposal. The analyses given, from their great discrepancy with those of Sprengel, may also show the importance of that investigation of the constituents of the ashes of plants, which is now about to be undertaken under the auspices of the Royal Agricultural Society. The author also conceived that the line of research which he had pursued might be useful, in illustrating that system of scientific book-keeping which he had proposed at a former meeting of the Association, at once as an useful exercise to the agricultural student, and as a means of introducing greater precision into the conduct of our experiments on such subjects.

On the Chemical Principles of Rotation of Crops. By Professor Johnston.

On the Analysis of the Ashes of Plants.
By J. Thomas Way, *Professor of Chemistry, Royal Agricultural College.*

The method here described was that pursued by the author in the analyses which are detailed in Dr. Daubeny's paper "On the Rotation of Crops," (see p. 33). It is founded on that of Will and Fresenius (Chemical Memoirs, part ix.), but differs in several essential particulars, more especially in the estimation of the phosphoric acid.

Two hundred grs. of the prepared ash are dissolved in hydrochloric acid. The solution is evaporated to dryness to separate sand and charcoal and the silica of the ash. The silica is dissolved out from the former impurities by dilute solution of caustic alkali, and estimated in the usual manner. The sand and charcoal are also weighed. The solution of the ash is now divided by measure into four equal portions. From one portion peroxide of iron, lime and magnesia are obtained. In a second quantity the phosphoric acid is estimated. In a third the alkalies, potash and soda are found, and the fourth is reserved.

Estimation of Peroxide of Iron, Lime and Magnesia.—The determination of the oxide of iron is indirect; it is obtained by throwing it down in combination with the phosphoric acid of the ash. To the acid solution (partly neutralized by ammonia) acetate of ammonia is added in the cold, phosphate of iron precipitates, is collected and weighed; 100 parts contain 56·08 parts of peroxide of iron. The filtered liquid affords lime by treatment with oxalate of ammonia (the acetic acid remaining in excess), and magnesia by the subsequent addition of phosphate of soda and ammonia.

Second portion. Estimation of Phosphoric Acid.—The estimation of the phosphoric acid is also indirect. A portion of clean iron wire is weighed out and dissolved in nitric acid. The solution is added to that of the ash, and the whole is partially neutralized by ammonia. Acetate of ammonia is added, and the liquid is brought to the boiling-point. A precipitate of phosphate and peroxide of iron (which is of a buff-brown colour, provided the iron is in proper excess) is obtained. This is collected, burnt and weighed; the phosphoric acid is calculated by subtracting the weight of peroxide of iron originally present in the ash, and that to which the metallic iron added is equivalent; it sometimes happens that a little iron remains in the liquid; this must be thrown down by ammonia, collected separately on a small filter, and its weight added to that of the former precipitate previous to the calculation.

The alkalies are obtained (from the third portion of liquid) precisely as recommended by Will and Fresenius. For the estimation of the chlorine and sulphuric acid, a separate portion of ash is dissolved in nitric acid, and precipitated successively by nitrate of barytes and nitrate of silver.

In the statement of the analyses, the chlorine is always apportioned to the sodium of the soda found, or in default of this to its equivalent quantity of potassium. (See Dr. Daubeny's paper.) From the constant use of this process during a period of six months spent in the analysis of the ashes of plants, the author recommends it as by far the most easy of execution and satisfactory in its results of any at present employed.

Observations on the Ashes of Plants. By Professor Johnston.

On the Ashes of Oats. By J. P. Norton (*Connecticut, United States*).

The following are the results of numerous analyses made during the past year by the author:—

1. The quantity of ash varies in different parts of the same plant. I have divided the plant into seven portions,—the grain, the husk, the straw at three different heights, the leaf, and the chaff. I give the extremes of my trials with numerous samples. In the grain the per-centage ranges from 1·81 to 2·32; in the husk from 5·27 to 7·11; in the top straw from 4·95 to 9·22; in the middle straw from 4·23 to 7·89; in the bottom straw from 5·18 to 9·76; in the leaf from 7·19 to 14·59; in the chaff from 6·71 to 18·59. I do not give these as the true extremes, but merely as the extremes of my trials. I have not found that regular gradation from top to bottom which has been observed in wheat and rye; there seems to be no general rule. These ashes are of course all calculated dry, and no per-centage ever considered to be ascertained until three or four trials agreed.

2. The quality of the ash varies in the several parts of the same plant. This is shown by instances from a table of the composition of one of the samples which I have analysed. The ash from the grain contains 49·24 per cent. of phosphoric acid, 31·15 of potash and soda, 13·93 salts of lime and magnesia, 0·80 of soluble silica, 0·93 of insoluble silica, &c. The ash from the husk has very little phosphoric acid, but 11·61 of sulphuric acid; potash and soda 7·41; lime and magnesia 2·33; while the soluble silica is 5·46, and the insoluble 68·39.

Equally striking differences are observed in the other parts. In the top straw were 38·56 per cent. of salts soluble in water; in the middle straw 53·56; in the bottom straw 77·46. As the soluble salts increase from the top downwards, so the silica increases from the bottom upwards. The per-centage of soluble and insoluble silica in the bottom straw is 17·28; in the middle 40·48; in the top 48·44. The leaf is in its composition not very unlike the top straw. In the chaff, phosphoric acid again appears in the watery solution, seldom present in that solution from the ash of the straw or leaf, and the per-centage of soluble silica is very great.

3. The quality of ash varies in the same parts in different samples. This even extends to the same variety of oats. I compare two samples of Hopeton oats, one grown in Northumberland and the other in Fife. There are differences in every part, but I will illustrate my point by the straw. In the top, middle and bottom straw, respectively, of the Northumberland sample, the proportions of salts soluble in water are 41·96, 53·22, 77·46; while in the same divisions of that from Fife they are 71·70, 84·03, 90·26. There is a corresponding difference in the silica, increasing upwards as before. The same excess of soluble salts prevails through the whole of this sample.

These examples illustrate the proposed points, and show the necessity of further investigation. This is all that I proposed to do in the present incomplete state of my researches.

On the Ashes of Narcotic Plants. By F. C. Wrightson.

The great problem of chemistry of the present day in its application to agriculture is, to determine the conditions necessary for a soil to produce the largest amount of any given crop of animal food—of food for man or beast. The solution to this question will in some measure be found when we have ascertained the proportions of mineral constituents required by plants of culture for attaining full perfection. The analysis of these plants alone, however, is not sufficient; we must have analyses of the weeds growing upon soils, of plants unfit for the sustenance of animals; for it is shown that they rob the farmer, not only of a large amount of mineral manure, but also of considerable quantities of that valuable ingredient, ammonia; and we shall not have obtained the data necessary for an improved and rational system of culture until we include in our ash-analyses a considerable number of weeds and useless plants, especially those of the most destructive kind. Some of them are well known to the farmer to be of serious injury to his crops mechanically; with respect to their abstracting important constituents of the soil, their injurious effects cannot be questioned. These plants contain more than 8 per cent. chlorine, and from 30 to 50 per cent. alkalies in their ashes. The *dried leaves* contained between 6 and 8 per cent. of nitrogen.

On the Ashes of Wheat. By William Sharp, *F.R.S.*

Mr. Sharp noticed that the amount of the ashes of wheat was given by Professor Johnston from Sprengel as 1·177 per cent., whereas Sprengel himself (p. 446. vol. ii. of his 'Chemie für Landwirthe') states it to be 1·777; Dr. Daubeny, on the other hand, gives Sprengel's analysis as 2·137, both of which alterations are made on the supposition of a misprint in Sprengel's book. This led Mr. Sharp to undertake some experiments in order to ascertain the truth; and about a hundred experiments were performed, with great care, on varieties of red and white wheat, grown on different soils and climates in England, Germany, Sweden, Poland, Holland and Saxony. The results gave answers to the following questions:—1st. What is the average amount of inorganic matter in the grain of wheat? This varies within the limits of 1·5 and 1·75 per cent. 2nd. Does the quantity of inorganic matter bear any relative proportion to the specific gravity of the grain, that is, to its weight per bushel? The experiments show that a steady *inverse ratio* is maintained between the proportionate weight per bushel and the amount of ashes. Wheat weighing 64 lbs. per bushel yields 1·5 per cent.; and this amount gradually increases till wheat weighing 58 lbs. per bushel gives 1·75 per cent. of incombustible matter. 3rd. How much inorganic matter is removed from the soil of an acre of land by the grain of a crop of wheat? The answer to this practical question is *one pound per bushel.* From these experiments the farmer may learn with certainty, that if his fields produce five quarters of wheat per acre, that grain carries along with it to the market *forty pounds* weight of the *earthy* material of each acre of ground. It must be obvious that if this be not restored in quantity and quality, in the shape of manure, his fields must be correspondingly impoverished.

Several substances, particularly nitric acid, were tried in order to ascertain if any chemical preparation could be added to the specimens experimented upon, before or during the combustion, which would facilitate the otherwise tedious process; but they all failed to give satisfactory results. The per-centage left by nitric acid was always less, but not uniformly less than it ought to have been.

Analysis of three species of Fucus. *By* E. G. Schweitzer.

The author described his method of analysis, and remarks, if we refer to the table of analyses there will be perceived a marked difference in the proportions of the various ingredients, particularly between those of the Laminaria and those of the two other Fuci, which difference may offer no small advantage to agriculture. We have in the *Laminaria saccharina* the alkaline carbonates predominating, whereas in the two other Fuci, the sulphates. The preponderating quantity of potassa over that of soda in the Laminaria is remarkable; it contains 22·4 per cent. of potassa to 18·8 per cent. of soda, whilst *Fucus vesiculosus* has 17·4 per cent. of potassa to 27·4 per cent. of soda, and *Fucus serratus* 15 per cent. of potassa to 25 per cent. of soda. But sea-water contains only in 1000 parts 0·76 chloride of potassium to 27·05 of chloride of sodium; it is therefore obvious that by the influence of vitality the potassa must have been powerfully attracted and assimilated; a similar fact is more particularly evinced in the quantity of iodine, of which the Laminaria contains 3·6 per cent., and the sea-water scarcely one-millionth part of its own weight. However, all the ingredients contained in sea-plants must have been derived from the sea-water, and though phosphoric acid is not discernible in the residue from the evaporation of the quantity of water usually employed in quantitative analysis, nevertheless there can be no doubt that it exists in it, and would be found if larger quantities of water were subjected to analysis.

An experiment was performed to ascertain if iodine is exhaled from the *Laminaria saccharina* when exposed to the rays of the sun. Several pounds of this sea-weed were introduced into a large glass vessel, closed by a cork, from which was suspended a small vessel containing a weak solution of nitrate of silver and a slip of paper with amylum paste. This apparatus was for six weeks subjected to the direct influence of a summer's sun (but so that the rays did not fall upon the tests), yet no turbidity in the silver solution, nor any reaction upon the amylum paste was visible. But I have to notice the fact that the plant began slightly to ferment, and that the glass vessel was filled with alcoholic vapours. It has been asserted that the saccharine matter in this Fucus is only mannite, but we know that mannite does not undergo fermentation, it must therefore contain another substance, from which the vinous fermentation proceeds. This will form a subject for future inquiry. The slimy fluid of the Laminaria in its fresh state is perfectly neutral, but when exposed to the air it soon indicates an acid reaction. Eight ounces of this Fucus were mixed with pure water and distilled, but neither in the distilled fluid was iodine indicated, nor was a slip of paper with amylum paste, kept during distillation before the tube that conducted the vapours, acted upon. The distilled fluid contained no essential oil, but was strongly impregnated with the peculiar odour belonging to sea-plants, which odour seems therefore not to be derived from the presence of iodine, or if so, the olfactory nerves must be a superior test to those employed. I have omitted to state that the above Fuci indicated but faint traces of bromine in 50 grs. of ashes.

Table of Analyses of three of the most common Fuci.

I. Results as obtained from 100 parts of Ash.			
Ingredients.	Laminaria saccharina.	Fucus vesiculosus.	Fucus serratus.
Potassa	22·456	17·409	14·925
Soda	1·667	5·688	5·597
Lime	10·042	7·368	9·076
Magnesia	7·374	6·786	7·076
Chloride of sodium	30·579	34·839	36·083
Iodide of sodium	4·257	0·129	0·249
Phosphate of peroxide of iron	0·683	0·350	0·599
Phosphoric acid	3·474	2·273	2·100
Sulphuric acid	9·611	23·353	17·101
Carbonic acid	9·737	1·220	6·375
Silica	0·526	0·278	0·374
Charcoal and sand	0·341	0·111	0·225
Total	100·747	99·804	99·780
II. The above results in 100 parts of Ash, deducting Carbonic Acid, Charcoal and Sand.			
Potassa	24·768	17·679	16·017
Soda	1·839	5·776	6·006
Lime	11·076	7·482	9·744
Magnesia	8·133	6·892	7·594
Chloride of sodium	33·722	35·380	38·724
Iodide of sodium	4·695	0·130	0·267
Phosphate of peroxide of iron	0·753	0·356	0·642
Phosphoric acid	3·832	2·308	2·253
Sulphuric acid	10·601	23·715	18·352
Silica	0·581	0·282	0·401
Total	100·000	100·000	100·000
Per-centage of ashes derived from Fucus dried at 212° F.	9·785	20·560	25·830

On the Composition of Slate Rocks, and the Soils formed from them. By J. P. Norton (*Connecticut*).

The analyses were undertaken at the suggestion of Prof. Johnston, with a view of determining how far rocks of the same formation varied in different strata as to their chemical composition. The specimens were seven in number, collected in Wigtonshire.

In slate No. 1, the quantity of carbonate of lime was very great, 12·50 per cent., it being intersected with small veins of it; in No. 2, it was 0·40; in No. 3, 3·75; in No. 4, 0·45; in No. 5, 0·39; in No. 6, 0·30; in No. 7, 0·34. The magnesia is more uniformly in considerable quantity:—No. 1, 3·80; No. 4, 2·15; No. 5, 1·66; No. 7, 3·09. The proportion of soluble iron and alumina is generally large:—No. 2, 19·5; No. 3, 18·75; No. 6, 12·13.; the others are smaller. Thus much for the portion soluble in acid. In the insoluble portion, the same substances were always present, but the lime generally in small quantity; in No. 1 alone was it more than 1 per cent. The magnesia, on the other hand, frequently increased, being in No. 1, 2·30; No. 5, 2·90; No. 6, 3·04; No. 7, ·279. This was also the case with the iron and alumina. In No. 2 it was 15·3; in No. 4, 9·45; in No. 5, 21·49; in No. 6, 39·41; in No. 7, 13·61. With these great variations, from 9 to nearly 40, the silica of course also varies: in No. 1, about 60; in No. 3, 45·6; No. 4, 75·79; No. 5, 67·59; No. 6, 37·82; No. 7, 72·05.

I would now direct attention to some characteristics of the soils derived from the decomposition of these slates. Directing our attention to carbonate of lime, that which is immediately available, we see a range from 12·50 to 0·83 per cent: then to carbonate of magnesia, there is in one 3·06, and another 0·35. So as to iron and alumina; in one there is 19·5, in another 4·82. These, with from 1 to 8 per cent. of alkaline matter, constitute the soluble portion from which the plant is directly to derive its support.

In No. 1, then, we have a soil rich in carbonate of lime, with a proper portion of magnesia and alkalies, its only defect being the large quantity of iron. No. 3 has nearly the same characteristics, though the lime is much smaller in quantity. In No. 7 there is but 0·34 of carbonate of lime, 0·35 of carbonate of magnesia; while in No. 6 there is 3·33 carbonate of lime, 3·09 carbonate of magnesia, and 12·13 of iron and alumina. This soil would obviously in its natural state be very unproductive. That quantity of magnesia might be injurious without lime, and much of the iron was protoxide. There is little to hope from the decomposition of the insoluble portion either, for it has only 0·17 of carbonate of lime; while there is 3·06 carbonate of magnesia, and 39·40 of iron and alumina. This is the worst example, though Nos. 5 and 2 are not many degrees better.

These seven slates, then, all picked up within a small extent of country, afford seven different soils, varying from very good to very bad.

The physical state of this section of Wigtonshire is to a great extent unimproved, the land being excessively cold and wet; leaving this out of view, however, or rather supposing drainage complete the excess of iron, we may see in the variation of the per-centage of lime an explanation of many conflicting opinions that prevail respecting its use as a manure.

On Mineral Manure. By Professor LIEBIG. *A verbal communication by* ERNEST DIEFFENBACH, *M.D.* (*of Berlin.*)

After alluding to the varying conditions of soils under the circumstances of geological and geographical position, Dr. Dieffenbach proceeded to point out the advantages of using such a compound that it should meet these circumstances; for instance, that for a moist climate it would be necessary so to prepare the saline manure that, although slowly decomposing to meet the requirements of vegetation, it should not be so soluble as to be washed out of the soil by the rains. This is proposed to be effected by Prof. Liebig; and having ascertained the mineral constituents removed from the soil, it will be the object of the manufacturer to supply their place in the mineral manure. It was then pointed out that the manures required for wheat, oats, leguminous plants and the potatoe must necessarily be different; and the object in view in the manufacture of this saline manure is to prepare it with the essential constituents for particular crops.

On Malacca Guano. By Dr. CANTER.

This communication described a peculiar substance, of which recently samples have been sent to England. It was stated to be inferior to both the African and the Peruvian, and curiously enough to consist almost entirely of the legs and other indigestible parts of beetles.

On Masses of Salt discovered in the lowest portions of Guano on the Island of Ichaboe. By THOMAS J. PEARSALL.

The salt was transparent and colourless, very soluble in water, and contained phosphoric acid, soda and ammonia, and a trace of some organic matter, which became carbonaceous at a high temperature. The salt therefore appears to be a microcosmic salt, phosphate of soda, ammonia, and water of crystallization.

Contributions to the Chemistry of Diabetes. By JOHN PERCY, *M.D.*

In this paper the author communicates the results of nine ultimate analyses of human fæces, viz. two of the fæces in health, six in diabetes, and one in jaundice.

Proximate analyses of the fæces of the following cases are also given. In 100 parts of the dried residue of the fæces of a man in perfect health and living on an ordinary mixed diet, there were—

Substances soluble in æther (brownish yellow fat) ...	11·95
" alcohol of ·830	10·74
" water (brown resinous matter)	11·61
Organic matter insoluble in the above menstrua......	49·33
Salts soluble in water....................................	4·76
Salts insoluble in water..................................	11·61

In 100 parts of the dried fæces of a man (Flint) labouring under confirmed diabetes and living almost entirely on animal food, there were found—

Substances soluble in æther	22·00
" alcohol	11·13
" water	12·02
Organic matter insoluble in the above menstrua......	45·49
Ash...	9·36

On a subsequent examination, the dried fæces of this individual yielded 51·55 per cent. of fat. The results of his ultimate analyses are given in the following table:—

	Man in health. Ordinary diet.	Man in training.	Child. Diabetes.	Man. Diabetes.	Man. Diabetes.	Man. Diabetes.	Man. Diabetes.	Man. Diabetes.	Girl with Jaundice.
	1.	2.	3.	4.	5.	6.	7.	8.	9.
C.........	46·20	49·79	43·86	54·35	60·34	53·09	45·81	45·97	51·51
H	6·72	7·06	6·96	7·57	9·25	7·97	7·59	7·27	7·29
N & O...	30·71	28·64	29·09	28·72	17·18	21·34	25·42	24·66	29·10
Ash......	16·37	14·51	20·09	9·36	13·23	17·60	21·18	22·10	12·10
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00

Table of Composition, exclusive of Ash.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
C.........	55·24	58·24	54·88	59·96	69·53	64·43	58·11	59·01	58·60
H	8·03	8·25	8·70	8·35	10·66	9·67	9·62	9·33	8·29
N & O...	36·73	33·51	36·42	31·69	19·81	25·90	32·27	31·66	33·11
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00

GEOLOGY AND PHYSICAL GEOGRAPHY.

On the Geology of the Neighbourhood of Cambridge, including the Formations between the Chalk Escarpment and the Great Bedford Level. By the Rev. Professor Sedgwick, *&c.*

The author first called attention to the map of the immediate neighbourhood, and pointed out the great irregularity of the chalk escarpment. There is indeed a pretty well-defined terrace, composed of chalk with flint, running eight or ten miles to the east of Cambridge, and seen in the hills near Royston and Newmarket; but several miles in advance of this terrace are great spurs of the lower chalk, one of which forms the well-known ridge of the Gogmagog hills. Some of these formations or spurs of lower chalk have, by faults and denudations, been cut off from the general mass and thus form a series of obscure outliers, the exact limits of which it is extremely difficult to define, in consequence of the featureless nature of the country and the great beds of drifted clay and gravel which cover many parts of the more regular formations. A small patch of chalk near Castle hill, and the chalk quarries near Madingley, worked under a thick covering of drifted brown clay, are given as examples. To the west of this irregular escarpment or boundary of the chalk, the following formations break out in a regular descending order:—1. Upper greensand; 2. Galt; 3. Lower greensand; 4. Kimmeridge clay; 5. Coral rag; 6. Oxford clay, which forms the subsoil of the great Bedford Level.

1. *Upper Greensand.*—This appears, as far as regards its thickness, in a very degenerate form. The portion to which the term greensand is strictly applicable is only a few inches thick, and above it there is sometimes an ambiguous deposit of a few feet which forms a passage into the lower chalk. It is not true, as has formerly been stated, that the chalk marl forms a passage into the galt; for the upper greensand, without a single exception, makes a natural break between them. As the chalk formation is generally pervious to water and the galt always impervious, it necessarily follows that copious springs are thrown out by the greensand bed. The springs at Cherry Hinton, the Nine-springs at the foot of the Gogmagog hills, and those of Coton and Madingley, are given as examples; and if a curved line be drawn through the principal springs of the neighbourhood, it will give a good approximation to the true line of outcrop of the lower greensand. Thus it appears, by reference to the map, that Cambridge is situate on the galt in a bay formed by two irregular spurs of the lower chalk. Though the greensand is thus degenerate, its fossils are numerous and extremely characteristic. Well known species of *Exogyra* and *Terebratula* are in great abundance; characteristic greensand Ammonites are not rare; Hippurites occur occasionally; sharks' teeth and fish palates of several families are abundant. Many fragments of the head-bones of several species of *Chimæra* occur here and there, and paddle-bones and teeth of a Plesiosaurus have been found abundantly near Barnwell, though mutilated and ill-preserved. But the most abundant fossils are the well-known black nodules which resemble *coprolites,* but have none of the structure of those bodies, being generally almost amorphous. They contain however a large per-centage of phosphate of lime. The author does not consider that their origin is yet well made out. The greensand, though partly incoherent and of such inconsiderable thickness, yet appears to have protected the upper surface of the galt from denudation; for it spreads out over a considerable area to the west of the chalk, forming the upper surface of the galt where that formation rises into the dry lands that skirt the neighbouring marshes.

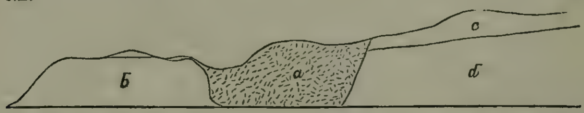
2. *Galt.*—This formation, as has been proved by repeated borings for Artesian wells, is more than 150 feet thick. None of the borings, though apparently commencing at the top of the formation, reach 200 feet. As this formation occupies a country almost at a dead level, and partially covered by marsh lands and gravel, its superficial extent cannot be accurately represented. Its western limits are however, here and there, well-defined by the outcrop of the lower greensand. The fossils from this formation are derived from the upper part of it, as seen in the brick-pits near Cambridge, and they agree very closely, so far as they go, with the fossils of the Folkstone clay. *Hamites, Crioceratites,* and shells of the genus *Inoceramus,* &c. abound. A few shells of the genus *Plicatula* appear to be of the same species with those found in the lower beds of the neighbouring chalk marl.

3. *Lower Greensand and Sandstone.*—This formation is well seen at Denny Abbey, on the road to Ely. To the east of that place it is, for many miles, concealed under the marshes and makes no escarpment; but it is probably continuous, as it breaks out in greater force, forming an under terrace to the chalk escarpment of Norfolk, and, as is well known, may be traced to the sea at Hunstanton Cliff. It is seen near Cottenham, Rampton and Willingham (as represented on a map). It then crosses the Huntingdon road about the seventh milestone, buried however under a great thickness of the brown clay (*Till*). Again, it breaks out at Elsworth, and in a denudation between Caxton and Bourne, and at Great Gransden. Beyond the last-named place it increases in thickness and blends itself with the sand-hills of Bedfordshire. In the range above given it is perhaps, on the average, not more than

twenty feet thick. It is composed of beds of sand and hard sandstone, sometimes slightly calcareous, and is generally of a yellowish or rusty-brown colour, resembling the upper beds of the formation seen on the south coast of England. Its fossils are few in number and obscure, being composed of ferruginous mineralized fragments of dicotyledonous wood, of fragments of shells, and bones of fishes. Good characteristic fossil fishes have however been found in the formation near Lynn. As it is pervious to water, is imbedded between two impervious strata of clay, and crops out (on the confines of Huntingdonshire and Bedfordshire) at a higher level than the surface of the galt at Cambridge, it readily affords a supply of water to the Artesian wells, as appears by the accompanying section*.

The most remarkable exhibition of the lower greensand is seen in an outlying ridge (surrounded by low fen-lands and forming the true Isle of Ely) extending from Ely to Kilrow, west of Haddenham. The ridge cannot be accounted for by the regular rise of the strata towards the west, combined with a subsequent denudation; but has been produced by a fault elevating the ridge above the mean level of the surrounding fens. This has been satisfactorily proved by the recent cuttings for the railroad, which expose the chalk marl *in situ* at the base of the hill composed of Kimmeridge clay and lower greensand. This chalk, to be on its true geological level, ought to be about 150 feet above the top of the ridge. It is presumed, therefore, that there is on the south-east side of the ridge a fault or upcast of about 150 feet, as appears by the accompanying sections.

1st section exhibited at the brown-clay pits at Ross Hill on the N.E. side of Ely.



a. Brown-clay with large boulders. *b.* Lower chalk, shaken and slightly contorted.
c. Lower greensand. *d.* Kimmeridge clay.

2nd section, below the preceding, laid bare by the cuttings of the new railroad.

a. Brown-clay. *b.* Chalk marl or lower chalk. *d.* Kimmeridge clay.

In this section, which is at a lower level, the lower greensand does not appear.

The author thinks from the appearance of the sections that the *fault* took place immediately before the deposit of the *brown clay*.

4. *Kimmeridge clay.*—This deposit is best seen in the great clay-pits near Ely. It

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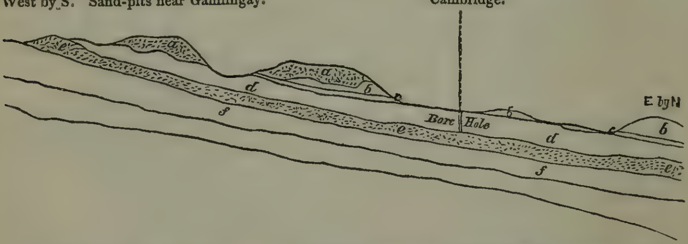
* West by S. Sand-pits near Gamlingay. Cambridge.



a. Overlying brown clay (*Till*). *b.* Chalk marl. *c.* Upper greensand. *d.* Galt.
e. Lower greensand. *f.* Kimmeridge and Oxford clay. Thickness unknown.

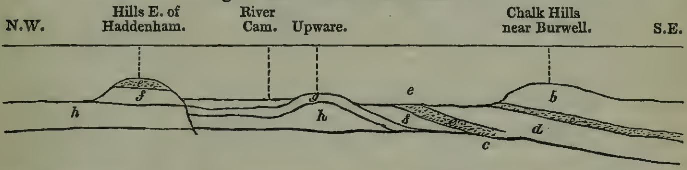
The bore-holes at Cambridge through *d.* of the section admit the ascent of the water which enters, at a higher level, by the outcrop of the sand *e.*

is full of characteristic fossils, such as *Ostrea deltoidea, Gryphæa virgula, Ichthyodorulites,* reptiles' bones, &c. In other places, however (*e. g.* at Great Gransden and Elsworth), the lower greensand appears to overlap the Kimmeridge clay and rests immediately on a clay full of Oxford clay fossils, such as *Gryphæa dilatata,* &c. In this respect the relations of the lower greensand to the inferior formations is only analogous to what is so often seen on the south coast of England.

5. *Coral Rag or Middle Oolite.*—It is well known that this formation, of a great thickness on the south coast of England, gradually thins off in its range towards the north, and comes to an edge in Buckinghamshire. In its further range towards the north-east, for more than 100 miles, it almost entirely disappears, and the Oxford clay and Kimmeridge clay are brought together without the intervention of any stone bands to break the uniformity of the surface. The consequence is, that they form a great plain occupying a part of Cambridgeshire, Norfolk, and Lincolnshire. To this remark there is one striking exception; for at Upware, about eight miles below Cambridge, a low ridge, extending about a mile in length and a few hundred yards in breadth, rises out of the fen-lands. It is formed by a saddle of most characteristic *coral rag,* with many characteristic fossils. The author conjectures that this elevation was effected by the same disturbing forces which produced the great fault, above noticed, at Ely. This deposit is not exposed to its base, but cannot, it is thought, be more than fifteen or twenty feet thick, and it is certain that it does not form a continuous band concealed under the fens, as several wells have been sunk (between Cambridge and Lynn) through the *Kimmeridge clay* into the *Oxford clay* without passing through any beds which bore a resemblance to the coral rag.

The accompanying section will explain the above short description.

Section from the chalk hills near Burwell to the great outlying ridge of lower greensand near Haddenham.



b. Lower chalk. *c.* Upper greensand. *d.* Galt. *e.* Lower greensand.
f. Kimmeridge clay. *g.* Coral rag. *h.* Oxford clay.

On the right-hand side of the section, *c d e f* are buried under the marsh land. But to the west of the Cam *f* (Kimmeridge clay) is worked in several pits; and *h* (Oxford clay) breaks out on the north-west side of Haddenham ridge; but on that side no trace of the coral rag has been discovered.

6. *Oxford Clay.*—This formation occupies by far the largest portion of the great Bedford Level, and is of very great but unknown thickness. Its western boundary is defined by the outcrop of the great oolite, and does not belong to the geology of the neighbourhood of Cambridge. Its eastern boundary is very ill defined, often passing under marsh lands where the subsoil is concealed from the view. At Great Gransden and Elsworth, as stated above, it breaks out from beneath the *lower greensand.* All the low lands between Conington and St. Ives are composed of it. The fen lands extending from Cottenham to Ely are on the Kimmeridge clay; and in consequence of the *upcast fault,* which has produced the great outlier of Ely and Haddenham, the Oxford clay is thrown more towards the north-west, so that its upper beds crop out on the north-west side of the ridge, as appears in the preceding section.

Such are the principal facts connected with the stratification of the country near Cambridge, and the localities where they are best exhibited may be examined a day's excursion from Cambridge.

Irregular overlying Deposits, not now in progress of formation and unconnected with the present action of the Surface Waters.

1. *Great Brown Clay.*—This seems very closely to resemble the *till* of Scotland,

but no proof has yet been given that it is of the same date or exactly of the same origin, and therefore the author gives it its local and provincial name. It is of considerable but very irregular thickness, of which 200 feet may be stated as about the *maximum* for the country near Cambridge. In general its thickness is much less. The higher table-lands on the confines of Cambridgeshire, Bedfordshire and Huntingdonshire, are almost entirely composed of it; but it is found also at lower levels, and sometimes immediately under the marsh lands. It contains innumerable pebbles and fragments of chalk, and multitudes of septaria and other stony concretions drifted out of the great fen-clay. Entangled in its mass are occasionally found blocks of greensand, several tons in weight, and driven several miles from the parent rock. The author affirms his conviction that ninety-nine parts out of a hundred of the whole mass are derived from the country of the great fen-clay. Icebergs may, during the period, have transported boulders from a great distance, and dropped them among the superficial deposits of the country. But no conceivable action of icebergs could have scooped out the great hollow of the fens and spread the materials, far and wide, over all the higher lands on the south-east side of the great level. The *brown clay* has been pushed bodily onward by the propelling force of water, the propelling force having been probably brought into action by some sudden elevation and change of level between land and water, of which the faults above noticed may give a partial evidence. In this neighbourhood there are no old local *freshwater deposits* above the *brown clay* like those which have been noticed on the coast of Norfolk.

2. *Flint Gravel.*—This generally occupies the low country, and is too well-known to need description in this sketch. Its level is however by no means constant, and as it sometimes contains blocks of stone brought from a great distance, the author refers it to the ill-defined period when the great *erratic blocks* were transported over so many parts of England. That it was mainly produced by the action of the sea during changes of level, cannot admit of doubt; but in a few places (*e. g.* near Barnwell) its finer sandy beds contain many well-preserved specimens both of land and freshwater shells, most of which are of existing species. It is conjectured that these shells may have been chiefly derived from old freshwater deposits (like those of Norfolk) which existed, here and there, on the surface of the brown clay, at the time the flint gravel was in progress of formation. The facts at any rate are interesting; and in the finer beds of gravel near Barnwell, these shells are found associated with drifted mammals' bones of many species, most of which are extinct, *e. g.* Mammoth, Rhinoceros, Hippopotamus, gigantic Bos, Equus, &c. This association of fossils is described in a paper by the Rev. T. B. Brodie, in the 'Cambridge Transactions,' and the same fact was noticed twenty-five years since in a communication by J. Okes, Esq.

Modern Deposits connected with the present Drainage of the Country.

The towns and villages upon the great level are generally built on hummocks of the *brown clay*, or on patches of the flint gravel, which raise them out of the reach of the floods by which the lower fen-lands are occasionally submerged. The outcrop of the lower greensand gives a swelling surface of dry land, so that its range through the marshes may sometimes be traced by a line of villages and steeples. In like manner the great outlier of lower greensand (the true Isle of Ely, which William the Conqueror could only reach by an artificial causeway across the marsh of the *Kimmeridge clay*) is marked by the towers of Ely Cathedral and the steeples of Wilburton and Haddenham. With the exception of these elevations, all the country above described to the west of the chalk, is at a nearly dead level. Immediately under the vegetable soil are found silt of various kinds, remains of ancient forests, and bog-earth occasionally of considerable thickness. In some places the deposit is simple, in others complex, indicating many successive changes in the condition of drainage. Among these marsh lands are many traces of works by the hands of man. But the most interesting remains are those which occur at the base of the series, on the immediate surface of the older deposits, and they give an indication of the condition of the country before the turf-bogs dammed up the old water-courses, or the labours of man interfered with their distribution. Among these remains the author only notices such as are found in the Cambridge collection, and to the inspection of which the Association was invited. Among these are the following :—

Bear, Wolf, Wild Boar, Beaver, Roe-buck, Red-deer, and the long-faced and straight-horned gigantic Bos. The first two species are rare; the last five are found in considerable abundance. To this list might be added the bones of many species still flourishing in the immediate neighbourhood. In the overlying marshes are occasionally found many organic remains of living species and many curious remains of ancient workmanship; but their description came not within the objects of the communication.

The author exhibited a map of the Bedford Level for the purpose of explaining some of the remarkable changes in the drainage of country during the last seven hundred years. The older historical facts were chiefly derived from the descriptions and charts of Dugdale and Badeslade, and they are briefly enumerated in the following appendix to the paper.

Appendix.

Changes in the River Drainage of the Bedford Level, produced by the silting up of the old water-courses, and the consequent accumulation of Turf-bog and Marsh Lands, &c.

The parts of the great level immediately bordering on the sea, from the mouth of the Lynn river to the northern extremity of the Wash of Lincolnshire, chiefly consist of marsh lands gained from the sea, partly by artificial embankments (some of very ancient date), and partly by the natural encroachments of the increasing delta. But as under such conditions the outfall of the several rivers was liable to silt up, and the rivers themselves to shift their channels, it followed that many of the lower districts in the interior of the great level must have been liable to continued inundations from back-water. The consequence was, the formation of extensive tracts of fen-land and turf-bog through all the lower levels in the interior of the country. The following facts are chiefly derived from Dugdale, 'On the History of Imbanking and Drayninge,' and from Badeslade, 'On the Navigation of King's-Lynn and of Cambridge,' and are given in this place for the purpose of showing how much the whole surface of a delta may be changed, by alluvial accumulations, in course of a few hundred years. In the early periods within the reach of authentic records (which go back more than 600 years, no notice being here taken of the old embankments made by the Romans), the drainage of the great level was effected in the following manner:—

1. By the channel of the Witham, which had then nearly the same course which it has at the present time.

2. By the Welland river, which, after descending by Stamford, Crowland and Spalding, united with the waters of the Glen in the estuary north of Holland fen.

3. By the Nene, which after passing Wansford and Peterborough, descended by Whittlesea-meer, Ugg-meer and Ramsey-meer to Benwick, at which place it was joined by the *Old West-water*, one of the branches of the Great Ouse*. From Benwick it flowed on the north side of March and Doddington to Upwell, where it was joined by the Welney river, then the principal channel of the Great Ouse; and from Upwell the united waters proceeded directly to Wisbeach, anciently called Ousebeach, and fell into the estuary.

4. By the Great Ouse, which, after passing Huntingdon and St. Ives, descended to Erith (a village at the south-west end of the old and new Bedford rivers), where it divided into two channels. One of them, called the *Old West-water*, ran to Benwick, as before stated, and there united with the waters of the Nene. The other channel, now called the Old Ouse (sometimes erroneously marked as the Old West-water), descended by Cottenham fen, and was joined by the Cam a few miles above Ely. The Old Ouse, after passing Ely, was joined by the Mildenhall river, and it then passed, by the way of Littleport and Welney, to Upwell, where, as before stated, it joined the waters of the Nene, and so descended to the sea at Wisbeach.

5. By the Little Ouse (once a very inconsiderable river), which (after passing Brandon and being joined by some small tributary streams from the chalk hills of

* The Old West-water was given off by the Ouse at Erith (near the south-west end of the old and new Bedford rivers), and ran to Benwick, not far from Ramsey-meer. It was filled up and had almost entirely disappeared so early as 1618, as is stated in the old surveys, and it is never traced on any modern maps. The term *Old West-water* cannot therefore be correctly applied to the old course of the Ouse from Erith down Cottenham fen to Ely.

Norfolk) fell into the sea at Lynn.—In the preceding account all the old artificial drains, and several minute bifurcations of the rivers, after they reached the great alluvial delta, are intentionally omitted.

As early as the 12th century the accumulations of alluvial silt near the mouths of the Welland and Nene, caused a great back-water which overspread some of the lower portions of the Bedford Level. The formation of great tracts of peat-bog was the necessary consequence, by which the levels of the fen-lands were changed, and the river courses still further interrupted; and as early as the 13th century the outfall of the waters through some of the old channels had almost entirely failed. Meantime the bed of the Little Ouse, not having been exposed to the same accidents, was much below the level of the great alluvial delta that extended to the mouths of the other rivers above mentioned. A great drain was therefore cut from Littleport Chair to Rebeck, making the first direct communication between the Great and Little Ouse. The effect was just what might have been anticipated. Not only the waters of the Great Ouse, but the back-waters which had been pent up at a higher level in the interior of the delta, descended with irresistible force through this new drain into the channel of the Little Ouse, and so escaped into the sea at Lynn. About this time the outfall below Spalding had so completely failed, that the waters of the Welland found their way through the Catswater into the Nene; and a reverse direction having been given to all the main currents, in consequence of a channel being thus opened below the level of the ancient outfall at Wisbeach, all the back-waters of the Welland, and all the united waters of the Nene, now flowed into the Great Ouse through the Old West-water, through the Welney branch, and through all the great cross-drains of the neighbouring country, and were then conveyed by the new cut into the Little Ouse and so entered the sea at Lynn. In this way, for many years afterwards, nearly all the waters of the great level, to the south of the Witham, had their outlet at Lynn; and the Little Ouse (now confounded with the Great Ouse), which had formerly run between banks not more than twelve perches asunder, became, in consequence of the changes above mentioned, more than a mile wide. Many attempts were made to prevent this unnatural discharge of nearly all the waters of the Bedford Level by one channel at Lynn (formerly called, as before stated, the Little Ouse). Thus, in 1292 several dams were constructed across the Upwell channel to prevent the back-waters of the Nene from joining the Ouse. But they produced such ruinous effects on many tracts of fen-lands, some of them bordering on the upper parts of the Ouse itself, that in 1332 they were destroyed under the direction of a parliamentary commission; and for many years afterwards the great drainage of the delta was effected in the manner above described. Notwithstanding the very indirect nature of this drainage, which conveyed the greater part of the waters of the Welland, the Nene and the Ouse into the sea by the Lynn channel, the fens appear, during many subsequent years, to have been in a good condition, a fact which can only be explained by the low level of the new outfall. In course of time however the new channels began to silt up, and new works became necessary to prevent the ruinous effects of the consequent back-water. In 1490 the discharge of the Ouse was partially relieved by a cut (called Morton's *Leam*) from Peterborough to Guyhirn and Wisbeach. It was intended to convey the waters of the Nene to their ancient outfall at Wisbeach; but it was never entirely effective till the year 1638, when Vermuyden (under the direction of King Charles I.) erected high banks on each side of the *Leam*, and opened out a better channel to the sea. Since then the Nene has continued to flow, by its ancient out-fall, into the sea below Wisbeach. About the same time other great works were undertaken and were continued in succession by two Earls of Bedford. Two great cuts were made from Erith to Salter's Lode, a distance of about twenty miles, and were completed in 1648. By these channels (now called the old and new Bedford rivers) the waters of the Ouse, instead of their former devious course by Cottenham and Ely, were conveyed, by two unbending lines, down the great fen on the north-west side of the Ely and Haddenham outlier before mentioned; and from Ely to Salter's Lode (near Denver) the old channel of the Ouse now carried only the waters of the Cam and its tributaries. These new works, however beneficial in other respects, appear from the first to have injured the low lands bordering on the Cam, and the old channel of the Ouse between Ely and Salter's Lode; for the new straight channels of the Ouse were not cut down to the level of the old channel at Salter's *Lode*; and the floods from the upper parts of the Ouse commonly reached this spot, through the straight artificial channels, much sooner than the floods of the Cam. A new and unlooked-for evil was the consequence; the banks of the Cam were continually liable to floods from the back-waters of the Ouse. One great flood of the Ouse, in 1720, is said to have backed up the Cam from Salter's Lode, for twenty days, and to have silted up one part of the old channel below Ely to the thickness of three or four feet. Ruinous effects of this kind were prevented by the erection of various sluices, of which Denver sluice was most effective. But although affording a cure for an immediate evil, and necessary to the internal navigation of the Great Level, they have ultimately contributed to the very evil they were intended to remedy; for partly by their agency the whole bed of the Cam (as well as of the old Ouse below Ely) was gradually silted up to a much higher level, injurious to all the neighbouring fen-lands. The causes which produced these remarkable changes continued to operate, and from time to time compelled the execution of new works. By way of conclusion, those works which have been effected within the last thirty or forty years may be briefly noticed:—

1. All the fen-lands, in the interior of every part of the great Bedford Level, are so far above the mean level of the sea, that they might be effectually drained by artificial cuts to low-water mark; and the drainage might then be maintained permanently and effectually without the enormous expense of water-mills and other artificial means. This has been partially effected by great works near the mouth of the Witham, and by other similar works to the north of Morton's Leam, which give a natural and uniform descent to the waters of Thorney fen and a part of South-Holland fen.

2. Within the same period a new channel has been cut for the Nene below Wisbeach, and by an artificial embankment the upper part of the estuary has been gained from the sea. Since then the lower part of the estuary has continued to warp up to a higher level, and other artificial encroachments upon the sea are now in progress. Had the bed of the Nene been lowered as far as Guyhirn, many thousand acres of unreclaimed fen (including Whittlesea-meer) might have been drained by a direct cut to that place. At present there is a violent rapid which conveys the waters of the upper level to the level of the new river course below Wisbeach. In consequence of this most injurious condition of the Nene, works are now in progress for the drainage of Whittlesea-meer and the neighbouring fens by a longer and more indirect cut to the lower part of the Ouse near Lynn.

3. A great delta had been formed above Lynn during the time that the waters of the Bedford Level were discharged (as above described) by the mouth of what was once called the Little Ouse. This delta gave a slow discharge to the great land-floods and caused much back-water. The artificial cut, called the Eau Brink, has in a great measure abated this evil. Many large tracts of fen-lands (on the Cam and the Ouse), which were once poisoned by stagnant water, are now well-drained and made productive by a top-dressing of clay; and floods, which formerly hung on these lands for many weeks, now disappear in a few days.

Local improvements, from the lowering of the river courses and the introduction of steam-power, are not here noticed. Many of them are but local expedients to meet an existing evil, which could not recur were a more uniform and systematic drainage of the Great Level ever carried into effect. Enough has been stated in this Appendix to explain the appearance of forest-trees and other indications of dry land in many places of the Great Level, now sunk under many feet of bog-earth and alluvial silt: and if such remarkable effects have been thus produced by the accumulations of alluvial matter and the growth of fen-land in the course of six or seven hundred years, we may be well assured that the whole form of the neighbouring coast must have been greatly changed in more ancient times by the same causes acting without interruption and with less modification from the works of man.

On the occurrence of Silurian rocks at the villages of Ober and Neu Schmollen, near Breslau, in Silesia, and covering an area of about eight square English miles. By M. Ferdinand Oswald *of Oels, in a letter to* Mr. Murchison.

Mr. Murchison considered this an interesting discovery, as throughout Germany the older palæozoic rocks belonged almost exclusively to the carboniferous or Devonian systems, and the country around Prague was the only one from which Silurian fossils had been derived. It was a question whether this was really a little island of Silurian rocks *in situ*, or whether it was only a part of the drift of that region, which often contained Silurian rocks derived from Scandinavia and Russia. In Mr. Oswald's copious list of fossils were mentioned *Illænus crassicauda*, *Sphæronites*, and other characteristic lower Silurian fossils, together with almost all the best-marked corals of Wenlock and Dudley, a remarkable and unexpected mixture of the fossils of two different members of the same series.

Tabular view of Fossil Plants. By Professor GÖPPERT *of Breslau. Communicated by* Mr. MURCHISON.

Mr. Murchison announced the general results obtained by M. Göppert from the formation of a tabular view of the fossil plants which had been discovered up to the present time all over the globe. Mr. Murchison stated, that Professor Göppert's general *résumé* of the fossil flora of the globe would be borne out by detailed proofs about to be given in a general synopsis of well-known fossil species, animal and vegetable, now preparing by Bronn, Göppert and Herman von Meyer, and in which these distinguished naturalists follow to a great extent the same plan as that published by Mr. Morris in his 'Catalogue of British Fossils.' The number of fossil plants known to M. Adolphe Brongniart in 1836, was 527. In the new list they amounted to 1792; and as in the 80,000 plants now known to exist in different parts of the globe, a large proportion consists of fucoids and fungi and other tribes, which would disappear in the process of fossilization, it would be seen that the total number of known fossil species bore a more considerable proportion to those now existing than was commonly admitted. Their numerical distribution in the different rocks is stated by M. Göppert to be as follows:—

Palæozoic *	52
Carboniferous	819
Permian	58
Triassic	86
Oolitic	234
Wealden	16
Cretaceous	62
Tertiary	454
Unknown	11
Total	1792

From this table it appeared, that the carboniferous group contained more than half the known species of fossil plants, a remarkable circumstance when it was considered that the great herbivorous land quadrupeds had no ascertained existence before the tertiary period.

On the Agency of Land Snails in forming holes and trackways in Compact Limestone. By Dr. BUCKLAND.

This notice was a continuation of one made at the Plymouth meeting, in which the author ascribed certain perforations discovered by him on the under side of ledges of limestone rock at Tenby, Boulogne and Plymouth, to the agency of projecting the acid secretions of land snails, which resorted to these rocks daily for shelter. The additional instances now described were discovered by Dr. Buckland

* I beg to observe, that the plants here alluded to under the term palæozoic, are all (with the exception of a few fucoids) found in the rocks called Devonian, which lie immediately at the base of the carboniferous system; no well-characterized land plants having yet been observed in the Silurian or oldest palæozoic rocks. Some, indeed, of the so-called palæozoic plants of M. Göppert may, I suspect, belong to what English geologists term the "lower limestone (carboniferous) shale," which has very generally been merged with the grauwacke of German geologists. I need scarcely remark, that the word "palæozoic" is not here used according to the sense in which most modern geologists would employ it, viz. as embracing the Silurian, Devonian, carboniferous and Permian deposits.—*R. I. Murchison.*

in Cumberland during a visit made in 1842, with Mr. Hopkins; at Cannington Park in Somersetshire, by Mr. W. Baker of Bridgewater; in the stringcourses of the Roman castle at Richborough, made of Kentish rag; in the roof of a cromlech of dolomite at St. Nicholas, near Cardiff, and in the rock work in Mr. Dillwyn's garden of mountain limestone brought from Gower. Dr. Buckland exhibited specimens of limestone rock from several localities, showing perforations occupied by snails, and grooves or furrows leading to the perforations, and he insisted that these were unlike those produced by any marine animal, or by atmospheric causes. The perforated rocks were stated to be only found in districts affording a rich vegetation, and were always met with at the junction of a slate region, with one entirely composed of limestone, and near luxuriant herbage. Dr. Buckland attached great importance to the perforations at Richborough Castle, which, he said, afforded a measure of the time necessary for such operations; the deepest holes he had seen in limestone rocks rarely exceeded three inches, and he considered it probable that these had occupied as many thousand years in their formation; the holes were only found in the hardest limestone rocks, because in softer limestones they would be obliterated by atmospheric action.

On the Coal Deposits of the Asturias. By S. P. Pratt, *F.R.S.*

Mr. Pratt gave a general account of a section taken from the neighbourhood of Leon in a north-west direction to the coast passing through Oviedo. The strata rise from beneath tertiary deposits which cover the plains of Leon and Castile, at an angle of 30°, which soon becomes nearly vertical, dipping north by west. They consist of numerous alternations of grit and shale with thin beds of limestone, and contain within about three miles of their rise a bed of good coal, nearly nine feet thick. Between this point and the summit of the Pass, a distance of five leagues, several extensive faults occur, by which the dip is more than once reversed, and several large mountain masses of limestone appear, underlying the grits, &c.; this limestone contains numerous fossils which indicate a period older than the mountain limestone, although several species are found intermixed, which can scarcely be separated from it. Hard grits and shales, highly inclined, succeed, and form the higher parts of the Pass, extending about a league beyond it to the north, after which coal plants are found abundantly in the grits and shales; no coal however is seen until near Pola de Lena situate about four leagues from the top of the Pass; from hence following the road to Oviedo, in a distance of ten miles, more than seventy seams of good workable coal are crossed; near the upper part of the series a bed of conglomerate occurs, formed of rolled masses of grit, limestone, and coal; another such deposit, probably exceeding 1500 feet in thickness, appears near the lowest part of the series, in which the coal boulders are more abundant, varying from the size of an egg to a foot in diameter, and possess the same character with the coal of the associated beds; one good coal-seam occurs in the conglomerate, and two or three below it. The coal deposits are terminated by a narrow valley, beyond which the limestone rises from beneath them to a considerable elevation; a depression of the surface soon after occurs, forming a plain of cretaceous deposits of the Hippurite period, upon which the city of Oviedo stands, and which extends for twenty or thirty miles east and west. Beyond Oviedo to the north, the limestone again rises, and coal deposits appear between this point and the coast; in one of these the coal forms beds of from three to seven feet, interstratified with the limestone, which, with the shales that occur in it, contains an abundance of fossils, chiefly shells and corals, with but few traces of plants, whilst those before mentioned in the series south of Oviedo, were chiefly *Calamites*, *Sigillariæ*, and *Lepidodendra*. Another of these deposits, containing the same fossils, crops out on the sea-shore near the port of Aviles, which is to form the termination of the North of Spain Railroad to Madrid. It appears therefore that, besides extensive coal-beds corresponding with those of England and other countries, this province possesses a considerable deposit belonging to an earlier period, which was probably the source of the boulders occurring in the conglomerate of the upper series. Connected with the coal, and always below it, are several beds of hæmatite, one of which is extraordinary, the pure unmixed ore being fifty feet thick, and extending for a considerable distance; it appears from its mineralogical character to have been a mechanical or aqueous deposit.

On the Denudation of South Wales and the adjacent Counties. By A. C. Ramsay, *F.G.S.*

On the Geology of New Zealand. By Dr. Dieffenbach.

New Zealand forms a group of mountainous islands nearly as large as England and Wales, and its geological structure is rendered difficult of discovery by the primitive forests that fringe the coast, or, where these have been destroyed, by impenetrable thickets of the esculent fern. The fundamental rock is everywhere clay-slate, frequently containing greenstone dykes, as at Port Nicholson, Queen Charlotte's Sound and Cloudy Bay; in the neighbourhood of the dykes the clay-slate sometimes assumes the character of a roofing-slate. On the banks of the rivers Eritonga and Waibo are terraces, or horizontal plateaux, fifty feet high, formed of boulders of the oldest trap-rocks, and similar terraces are seen on the sea coast round Cape Palliser, fifty or sixty feet above the sea. Anthracite coal crops out in the small harbour of Wangarrie on the west coast of Middle Island, and there is a thin seam of anthracite in the hard gray sandstone on the east coast of the Northern Island. Limestone is described as occurring in the harbours of Kauria and Waingaroa on the west coast of the Northern Island; it is crystalline, and contains fossils of the genera *Pecten*, *Ostrea*, *Terebratula* and *Spatangus*. Limestone is also found on the river Kaipara in the Bay of Islands, and copper pyrites has been obtained from the great Barrier Island, where it forms veins in the clay-slate. The coasts are in many places fringed with recent horizontal sedimentary deposits, consisting of loam, with fragments of wood and tree-ferns, blades of the Typha, &c.; and on the Northern Island the coast is often formed of volcanic conglomerate, containing magnetic iron sand near Cape Egmont, and *Turritellæ* and oyster shells at the harbour of Parenga; near Tauranga, it is composed of decomposing tufa, containing lignite and shells of *Pectunculus*, *Natica*, *Pyrula* and *Ancillaria*. The small rocky islands of trachyte, lying off the coast of Northern Island, also bear marks of wave-action to the height of 100 feet above the present sea level. On the western coast of this island formations of sand are now accumulating, driven over the forests by the prevalent westerly gales. The interior of the Northern Island affords but a scanty vegetation, and the surface is everywhere covered with ordinary volcanic productions, derived from the lofty central group of mountains, some of which are extinct, others still active volcanoes; the lava appears to have been principally erupted from the base of the craters. The highest of these craters are Tongariro, 6000 feet in elevation, according to Mr. Bidwell, and Mount Egmont about 9000 feet, by Dr. Dieffenbach's thermometrical observations. There are also many lakes which appear to occupy ancient craters. The mountain chains of the Middle Island are supposed to consist of primary rocks; quartzose sandstone and gray-wacke are met with at the height of 3000 feet; the lofty pyramidal summits are covered with snow, and deep narrow valleys separate the various ridges, and radiate from the central cones. Dr. Dieffenbach enumerates many localities at which he observed mineral springs, particularly between the Bay of Islands and Hokianga, where their temperature varied from 124° to 154°, and having an alkaline taste; the surface was covered with sublimations of sulphur. Along the delta of the Waikato, hot springs rise from the escarpments of the hills, forming deposits like those of Iceland and St. Michael, Azores, containing 75 per cent. of silica. There is also a cold silicifying spring near Cape Maria.

Dr. Dieffenbach has examined into all the traditions respecting the existence of the Moa, or great bird of New Zealand, and concludes that it has never been seen alive by any natives of New Zealand; the rivers in which its bones have been found flow between banks from thirty to sixty feet high, and as they are continually changing their course the remains of the Moa may have been derived from tertiary fluviatile strata.

On the Lake Parima, the El Dorado of Sir Walter Raleigh, *and the Geography of Guiana. By* Sir R. Schomburgk.

The author commenced by alluding to the ill-fated expeditions at the close of the 16th and commencement of the 17th centuries, in search of the El Dorado and its reputed riches. Manoa, the capital of El Dorado, was said to be built on a large lake, which Hondius first represented in his map of Guiana as 200 leagues long and forty broad, assigning as its locality the isthmus between the Rupununi and Rio Branco; subsequent geographers retained the Laguna Parima, or Mar Blanco, but varied its locality; and although Humboldt, by reasoning founded upon personal experience and the inspection of every document relating to the country, asserted that such a lake could have no real existence, yet within the last few years maps have been published upon which the lake still figures. At the time Humboldt published his Atlas, the regions north of the Amazon, three times as large as Spain, were unknown. It was this country which the author had been engaged in exploring since 1835, and the large maps which illustrated his paper proved the correctness of Humboldt's judgement. The fable of the "Mar Blanco" had doubtless arisen from the annual inundations of the vast savannahs between the Rupununi and Rio Branco and the Pacaraima Mountains and the thick forests of Essequibo, covering an extent of 14,000 square miles. These might once have formed an inland lake, but not within the historic period. The author then gave a sketch of the geography of Guiana, which, although the largest British colony in South America, was so little known as to be sometimes spoken of as an island. The province is bounded in its widest extent by the rivers Amazon and Orinoco, and comprises an area of 690,000 square miles; the Casiquiare canal connects the Orinoco with the Rio Negro and the Amazon; so that, in this way, the province may be circumnavigated. The fertility of the country is surprising to those accustomed only to the vegetation of the temperate zone; but the author gives it as his opinion, that no natives of the north of Europe could endure the climate as labourers in the open air. The rivers of Guiana, aided by short overland portages, afford inland communication with Monte Video at the mouth of the La Plata, with Cuzio, Lima, and Santa Fé de Bogotà. The Parime and Pacaraima Mountains separate the fertile plains of the Lower Orinoco from those of the Rio Negro and the Amazon; the loftiest summits are in the most southern ranges, and in those most northerly. Maravacca, near the Orinoco, rises to 11,000 feet, and Roraima, the culminating point of the Pacaraima Mountains, is 8000 feet above the sea; they are composed of the older red sandstone, and exhibit mural cliffs 1000 and 1600 feet high. From the walls of the latter mountains the river Kamaiba precipitates itself, in a cascade of nearly 1500 feet, surpassing the Cascade de Gavarnie in the Pyrenees, which is 1266 feet. In the neighbourhood of these mural mountains, porphyry, jasper and rock crystals are found.

Notice and Drawings of the Footprints of various Animals on the New Red Sandstone of Corncockle Muir. By H. E. Strickland, *F.G.S.*

On Nodules, apparently Coprolitic, from the Red Crag, London Clay, and Greensand. By Professor Henslow.

The supply of phosphate of lime used in agriculture, and hitherto obtained from bones, having of late years become insufficient, Dr. Daubeny had been induced to visit Spain, in order to learn whether this deficiency could be supplied from the deposit of phosphorite in Estremadura. From his report, there appeared to be difficulty attending the project; but so important was it deemed, that a second expedition had been made for the sake of further investigation. In October 1843, Prof. Henslow had called attention to the occurrence of phosphate of lime in pebbly beds of the red crag at Felixstow, in Suffolk; these nodules, though extremely hard, presented external indications of an animal origin, and yielded, upon analysis, 56 per cent. of phosphate of lime. Mr. Brown of Stanway, had subsequently obtained several analyses of these pebbles, and also of similar nodules obtained from the London clay in the vicinity of Euston-square, and found the same amount of phosphate of lime, viz. 50 or 60 per cent. in each. The crag pebbles occasionally contain remains of small crabs and fish like those in the London clay, leading Mr. Brown to the conclusion that they were derived from the destruction of certain beds of that series. The crag nodules were so abundant, that a gentleman had obtained two tons of them—which, after being prepared, were found upon analysis to contain 53 per cent. phosphate of lime; 13 phosphate of iron, and the remainder carbonate of lime and volatile matter. The stratum of greensand, with similar nodules, had been described by Mr. Sedgwick; although never more than a foot thick, it occurred near the surface over many square miles in the vicinity of Cambridge; and the pebbles it contained yielded 61 per cent. of earthy phosphates and 24 of carbonate of lime, the rest being insoluble. These were also considered to be possibly coprolitic by Mr. Henslow; they frequently contained vertebræ and teeth of fishes, crab-shells, and other substances, apparently half-digested. In illustration of the origin of such extensive layers of coprolitic matter in the marine formations, Mr. Henslow read a notice respecting the Appearance of Sharks on the Coast of Norway.

On the Mechanical Action of Animals on Hard and Soft Substances during the Progress of Stratification. By the Rev. Dr. Buckland.

Dr. Buckland remarked, that remains of animals which perforate rocks and organized substances for their shelter and abode were almost unknown in the older strata, but that many instances occurred in the secondary period of extensive rock surfaces covered with the holes of boring shells and worms. A familiar example occurred at Vallis near Frome, where the mountain limestone, covered by the inferior oolite, was penetrated by the bivalve mollusks and annelids. A similar instance occurs at Marquise near Boulogne; and it is not uncommon to find thick shells and fragments of saurian bone perforated or incrusted by parasitic animals. Similar operations might be observed on our own coasts at the present time, some of the animals apparently making holes only by the accidental circumstance of living on one spot for a long time, as in the case of the limpet and *Echinus saxatilis*; others, like the Pholas and Lithodomus, requiring it as a necessary condition of their existence.

Extract of a Letter from Mr. Hopkins *respecting Traces resembling Ornithichnites.*

This letter, dated "Bogotà, November 15, 1844," contained a drawing and description of certain tridactylous footprints observed by the writer on the soft sandy banks of the river Magdalena in Mexico.

On some New Additions among the Mammalia to the Fossil Fauna of India, from Perim Island, in the Gulf of Cambay. By Dr. Falconer.

Remarks on Fossil Trees at St. Helen's, Lancashire, which exhibit Stigmariæ as their Roots. By E. W. Binney, *F.G.S.*

The fossil trees described in this memoir were discovered two years ago, standing upright in a bed of indurated clay, called the "Warren," and a notice of them was given, by Mr. Binney, at the meeting at Cork. Subsequently, Mr. Binney had obtained a more complete examination of the first and largest of the trees, and a fourth had also been discovered.

On the Subsidence of the Land at Puzzuoli. By James Smith, *F.G.S.*

When the writer visited the temple of Jupiter Serapis at Puzzuoli, in March 1819, its floor was elevated about six inches above the level of the sea; but on the 11th of May in the present year, it was covered to the depth of eighteen inches at low water, and twenty-eight and a half at high tide; the sea being calm at the time. The *custode* of the building told Mr. Smith that this change was progressive, amounting to one English inch and a quarter per annum. The *cicerone*, too, who had exercised his profession for thirty years, said he knew a difference of at least three feet six inches in the height of the sea upon the piers of the bridge of Caligula, giving the same amount of subsidence yearly. There were, besides, many similar proofs in the partly submerged houses and causeways of Puzzuoli. The author adds some notices of the evidence of both gradual and sudden elevations having at different times affected Puzzuoli.

On the Methods of Working and Ventilating the Coal-mines of the North of England, with reference to the Accidents that occur in such Mines from the Explosion of Firedamp. By Professor ANSTED, *M.A., F.R.S., Vice-Sec. G.S., &c.*

The object of this communication was partly to explain the methods of working coal adopted in the Newcastle coal-field, and partly to suggest certain methods which, in the author's opinion, were calculated to diminish the risk of accidents arising from the explosion of firedamp, without interfering with the œconomical working of the mines.

In the district in question, the extent of coal worked by one company and from a single pair of shafts is very considerable, amounting, in fact, in some cases, to as much as 1000 acres. The depth of the sinkings is enormous, being rarely less than 150 fathoms, and sometimes upwards of 300. The competition amongst the various proprietors is very great, and the expense of sinking such deep shafts, often through untried ground and with a vast body of water pouring in from quicksands, is so enormous, that there seems no hope of adding very considerably to the number of the shafts in each mine; nor does the author consider that to increase this number beyond certain limits would diminish to any extent the danger of explosion.

The coal in the north of England and elsewhere is well known to give off during working a considerable quantity of light carburetted hydrogen, and occasionally, it is supposed, a small quantity of olefiant and sulphuretted hydrogen gas, and when the gases thus given off are mixed with a certain quantity of ordinary atmospheric air, they become highly explosive.

The ordinary processes of ventilation, effected by placing a furnace at the bottom of one shaft, or one compartment of a shaft, and thus causing a current of air to descend another shaft, and move with a regulated rapidity through all the workings, were described by the author as sufficient for the carrying off the gases thus liberated under ordinary circumstances; but besides these there are occasionally met with sudden and violent puffs of gas, called *blowers*, proceeding either from faults or from cavities in the coal, and against them no process of ventilation is a sufficient safeguard. Owing also to the nature of the associated strata, and the great depth of the workings, it happens that when workings have been carried on to any extent under ground, a considerable portion of the district left empty by the extraction of the coal is partially filled by the broken roof, which, however, not occupying the space entirely, affords cavities, sometimes of great size, into which the lighter inflammable gases naturally collect, and there become slowly mixed with atmospheric air. Such cavities therefore are often full of explosive mixture, ready to take fire at any instant, and occasionally, owing to a change in the pressure of the air, or from other causes, the explosive mixture actually emerges into those passages in which open lights are used and causes accidents. Each of these spaces, filled with rubbish, and thus forming a magazine of foul air, is called, technically, a *goaf*.

Referring to the explanation of the nature and action of the goaf, as given in the 'Report on the Haswell Explosion' by Messrs. Lyell and Faraday, the author expressed his opinion that in the north of England there is not such a degree of regularity in the mechanical limits and condition of this goaf as would admit of any separate system of ventilation or gas-draining for such parts of a mine, and he also urged that the rise side of the goaf was by no means always the place of danger, or the origin of accidents in the greater number of instances.

The author then suggested the following methods to be generally introduced in working coal mines:—

1. *The having at least two shafts in each colliery.*—This is absolutely essential, and, though generally acted on, requires to be enforced in every instance, since in case of an accident in a mine with only a single shaft, it is extremely probable that the partitions at the bottom will be blown away, and thus all those persons employed in parts which the explosion has not reached will almost necessarily perish, since the ventilation is instantly stopped by the accident, or only the poisonous air called *after-damp* circulates through the workings. Besides this there are many accidents to which a pit is liable, such as the falling in of brick-work, &c., which, by pre-

venting the necessary communication, may cause the death of the men under ground if there is no way of escape.

2. *The working panels of moderate and regulated dimensions, so that no air-course shall be of greater length than a given distance.*—It is well known that in the method formerly in use of *coursing* the air through all the main passages of a mine, there were often instances in which the air had to pass through from fifty to seventy miles, or even more, between the downcast and upcast shafts. Since it has been found that the quantity of air introduced by a shaft of given magnitude can be very much increased by dividing the underground current into several currents, each taking a different direction, the length of the air-courses in well-managed mines has been greatly reduced, and is now rarely more than three or four miles. The advantage of this is manifest; but although the principle is generally acknowledged, there is good reason to believe that many collieries are worked without regard to such improved methods. Besides the greater quantity of air actually introduced by thus splitting the current, the destruction of life consequent upon an explosion may be also much diminished thereby, provided the detached portions of work called *panels* are of moderate size, and do not so communicate with one another as to render it impossible to escape from any one to the pit bottom without passing through air affected by the condition of the rest.

The author added, with reference to these two methods, that they were already adopted to a very great extent in the well-regulated collieries of the Newcastle coal-field, and rather needed to be enforced in some cases of exception than be looked upon as expressing any new views.

Passing on then to the case of the great explosion in the Haswell colliery on the 28th September 1844, the author pointed out that of the whole number of sufferers on that occasion, not less than thirty might have been saved had there been a free separate communication to the bottom of the downcast shaft from a panel adjoining that in which it is presumed the accident happened. Since accidents must happen occasionally, it is manifestly extremely important that their fatal results should be as far as possible limited to the actual spot in which they occur, and not involve, as they have frequently done, the lives of those at work in distant parts of the pit. It is therefore proposed that

3. *An air-drift should be cut from each separate panel communicating with the bottom of the downcast shaft.* The driving a gallery through coal is not looked on as any expense in working, since the coal extracted pays for the work done, and this method is therefore suggested as a practical, inexpensive, and efficient method of avoiding at least some of the fatal results when an explosion does take place.

But the author does not consider that the working of the pillars and the vicinity of the goaf is by any means the most usual cause of such emissions of gas as lead to explosions, and he quoted the example of a recent explosion in the Killingworth colliery, which took place on the 16th of April, as an instance in point. Then, and in many other explosions on record, the immediate cause of danger arose from a sudden outburst of gas in workings where the coal had only been recently laid bare, and where a small fault was met with. These outbursts of gas, called, locally, *blowers*, are sudden, and often instantaneous, giving no warning whatever of their approach, and therefore not to be guarded against. The ventilation, as now effected, being generally sufficient for all purposes, it could not, the author believes, be so far increased as to prevent accidents from these eruptions of gas, while, on the contrary, it might happen that by a more rapid admixture with pure air and quicker transmission of the explosive current through a great part of the air-course, greater damage might arise than even now, when flame was reached and the gas became fired. In such cases, and in all mines where any quantity of gas is expelled by blowers, the author considers that there is only one means of safety to be adopted, namely,

4. *The exclusive use of the Davy lamp in all underground workings in fiery mines.*

"This is a measure which at present has scarcely been adopted in full in any mine, but which is certainly well worthy of consideration. There may be mentioned, I am aware, two very different objections to its use, but I have good reason to believe that neither of them is very valid, and I am therefore anxious to press most earnestly on the consideration of all those engaged in coal-mining operations the importance of this plan. It will be said, on one hand, that the expense is too great, and that the men object; and, on the other hand, that the Davy is by no means a perfect instrument. To the first objection I can refer in reply to the experience of more than one of the best-regulated collieries of the north of England, where a vast number of Davys are in daily use: about 130 of these instruments being employed in the Wallsend pit, and in others a still larger number. The workmen also on the whole prefer to work at the same wages with the rest with the comparatively obscure light and the greater danger, because the coal is somewhat more tender. To the other objection, that the Davy is useless, I can only say, that with regard to all cases of explosive mixture that have been fairly met with underground, and all rates of motion hitherto attempted, the united experience of wastemen and viewers for the last thirty years cannot but be considered of some value, and is unanimously, as far as I can learn, on the side of its great practical value. I have trusted my own life to these instruments, and would do so again without the slightest hesitation, provided of course that proper care is employed. The instrument is simple, easily kept in order, and what is perhaps of yet more importance, easily and quickly examined; and if, as is done in well-regulated pits, the gauze of every lamp was examined and locked before being delivered to the men, I cannot believe that an accident could happen except by such a falling of the roof as would injure the gauze, and this would also destroy every other contrivance hitherto imagined for giving safe light.

"In conclusion, I am anxious to express my own firm conviction that no great improvement can take place in coal-working generally without some external interference. The coal trade is now hardly remunerative; it is a struggle in which every one endeavours to bring into the market saleable coal at a low price, and a struggle obliging those concerned to compete with the utmost energy. Such a state of things is not likely to admit of any great improvement of the kind here advocated, since the supply of labour is greater than the demand, and few proprietors will be found to risk money where the return is so doubtful. But the interests at stake are not only those of monied men; the lives of thousands and the well-being of the population of large districts are also involved, and it is the duty of government to watch over and protect these. This can be done properly only by a most careful superintendence over *all* those engaged in the employment. It ought to be considered absolutely necessary that ventilation should be conducted in every individual mine on the best principles, and that in each the safety of the pitman should be secured by insisting on every reasonable means of preventing accidents being equally adopted by all. But this can only be done by the interference of government, and even the full necessity of it can only be learnt by a strict and careful investigation, since it would be impossible to ascertain otherwise how far the greater number of the collieries (amounting in the Newcastle district to nearly 200) are properly conducted or not.

"My object has been to show that much may be done by simple, practical and inexpensive methods to diminish the loss of life in collieries arising from noxious gases. Experiments however are still greatly needed, not only in picked mines, where the ventilation is as good as under the circumstances it can be, but also in the numerous other pits little heard of, but still employing an important proportion of the whole colliery population. These experiments should be made with a view to the solution of various questions not at present fully determined, among which I would instance—(1) the actual nature of the gas given off by the coal where the singing noise is chiefly heard; (2) the real extent to which splitting the air may be carried with a view to shortening the air-courses; (3) the extent of the ventilation at the floor, the walls and the roof of a mine when an ordinary current is passing along the middle. I mention these, but they are only a few among many points hitherto undecided in coal-working, and yet bearing most importantly on the subject of ventilation; but I might greatly extend the list, and I feel quite certain that when the attention of competent chemists and practical geologists is directed not only to the goaf, which I must consider, from documentary evidence, as among the least important subjects of investigation, but also to the whole coal when first worked, and the small hitches and faults so abundant in every coal-field, there will be accumulated a heap of evidence bearing on these points and leading ultimately to some important practical result. At present I can only suggest the methods which have struck me as at once reasonable and useful,—I mean the not working too large an area of coal from one pair of shafts; never working at all with less than a pair; working the panels or districts of coal perfectly distinct from one another, and each communicating by its own drift with the upcast; and the working in fiery mines only with the safety-lamp and with no open lights whatever. These are all points which are in the strictest sense of the words, practical and œconomical. They would not entirely prevent the occurrence of accidents; nor do I believe that any human means can ever do so, for so long as men are careless and ignorant, so long will this carelessness and ignorance produce its usual effects; but they would, I am convinced, diminish greatly the frequency of accidents, while they would diminish also, in some measure, their extent; and these are certainly objects, the attainment of which would be in the highest degree important and advantageous."

Notice of the Toadstones of Derbyshire. *By* E. Hall.

On the Fossil Bodies regarded by M. Agassiz *as the Teeth of a Fish, and upon which he has founded his supposed genus* Sphenonchus. *By* Edward Charlesworth, *F.G.S.*

The object of this communication was to call attention to the history of the fossil bodies from the lias and newer secondary rocks, upon the character of which M. Agassiz proposes to establish a new genus, under the supposition that they are teeth; but he adduces no facts in support of this view, nor does he attempt to invalidate the previously published evidence in favour of their being dermal spines. Mr. Charlesworth considers that an Ichthyolite in the possession of Mr. E. T. Higgins of Clifton, in addition to other evidence which he has collected upon the subject, is conclusive as to the fact of these fossil bodies being spines, and not teeth.

Mr. Charlesworth then made some observations on the occurrence of otolites in the London clay and coralline crag.

Notice of Fossil Fish from Antigua. *By* Mr. Turner.

A method of exhibiting, at one view, the results of a given Geological Survey. By Francis Whishaw, *Civil Engineer, Secretary of the Society of Arts.*

The author, after noticing Mr. Sopwith's system of modelling, thus describes his own process. The modeller, having before him a plan of the district of country to be represented, with all the necessary sections and levels (the plan and sections being drawn to suitable scales), provides a base or foundation of wood about three quarters of an inch larger all round than the plan of the district to be modelled: this foundation must be well-clamped to prevent it from warping. It must then be prepared to receive a coating of *papier maché*, or other suitable material, to be moulded into the proper shape, corresponding with the lower stratum or strata to be represented in the model. Longitudinal and cross sections, showing accurately the strata, having been already prepared, slips of glass are to be provided corresponding in shape with the various sections, which are to be traced on the glass, painted, and burnt in in the usual manner. The various sections of glass are to be let into grooves cut in the foundation, and cemented thereto, and the vertical edges of the several pieces of glass, when meeting together, are to be cemented by means of marine glue. When the vertical glass sections are all fixed in their relative positions, it is necessary to provide a lid or cover for the whole, which I have thought may also be made of glass, but at any rate wood will answer; if of glass, the surface of the country will be made of the same material, the rivers, buildings, &c. being coloured and burnt in according to the taste of the modeller; but if wood is used, it must be superposed by *papier maché* or other suitable material, already used by modellers, and the mountainous parts, rivers, churches and other buildings, represented in the usual manner. In the lower part of the cover grooves must be formed, answering to the different glass sections, so as to cover in the whole in a compact form; ivory or metal scales, to measure distances and depths, will complete the contrivance.

Some Remarks on the Structure and Relations of Cornulites, *and other allied Silurian Fossils. By* J. W. SALTER, *A.L.S.*

The anomalous nature of the fossils in question having led to great diversity of opinion with regard to their place in the system, the author endeavours to trace out their affinity from the internal structure. The *Cornulites serpularius*, Schl., ranges through the Silurian rocks of Gothland, Britain and North America, and is most abundant in the Wenlock limestone. Its general form is that of an elongate, knotted, thick tube, four or five inches long, appearing like a pile of conical cups, placed one in the other, the highest at the small end of the shell. The interior cast has a similar appearance. The shells, in the young state, grow in pairs attached to corals and other bodies: they are covered with a thin coat, finely striated lengthwise; beneath this the edges of the cups or nodes appear covered with concave pits; two or three raised lines run along various portions of the inner surface.

The step-like form of the nodes or varices gives it some resemblance to the stems of *Crinoidea*, to which family Eichwald and Hisinger have referred it; and Dr. Volborth of Berlin has published a memoir identifying our fossil with the tapering, jointed stems of Echinocrinus, which it imitates in form and in the ornamented surface. In ordinary testaceous mollusks, the laminæ of growth, and consequently the varices, are conical, with their bases towards the aperture of the shell, and it is the apparently reversed position in this case which appears to have misled naturalists. But in truth the growth is not reversed; a longitudinal section shows that at each varix the laminæ are more distant than on the sides of the cups, and also bullated or puckered up, leaving cells in the interstices; it is just such a form as would result from the periodical advances of an animal with a large inversely conical head in its shell. The mantle would corrugate in the space left behind it, and the shelly matter grow on this as a mould. Instances of this occur in the septa of Cirrus, *Serpula? polythalamia*, and the large interlaminar spaces in the shells of *Ostrea*, *Spondylus*, &c. Its analogy with corals, to which a most excellent naturalist, J. D. C. Sowerby, has referred it with doubt, seems incomplete: if it be regarded as a single polype, there are no internal plates or rays, or if the separate cells be those of polypes, they are without ostiolæ, or if they had them, they must have opened exteriorly, where they are covered by a striated film. On the whole, it bears much more analogy to the *Serpulinæ*, in the attachment of the young shell and its gregarious habits.

The other group noticed is that of the *Tentaculites* of Schlotheim, of equal or greater range in the Silurian system, and consisting of several species. They have many points in common with *Cornulites*, but their exterior is more symmetrical; a section longitudinally will show the thickened and inverted cup-shaped nodes on the cast; but the laminæ are not undulated at these parts, and the greater thickness there is all that indicates a looser texture; observations with the microscope will determine this point. The unjointed tube sufficiently separates them from the Crinoidea, as does also their conical terete form. Schlotheim, who first described both them and the *Cornulites*, refers them to that family, supposing they formed a coronet of brachia. Goldfuss has also assigned them to *Cyathocrinites pinnatus* as auxiliary side-arms. It is possible they might be straight mollusca like Dentalium, but neither in their exterior or internal characters do they resemble that genus; and they have so many points in common with *Cornulites*, that, if this be accepted as belonging to the *Serpulina*, they must be admitted also as free members of the same family. They are certainly never attached; and it would be a curious, though not a solitary fact in palæontology, that the earliest forms of a genus should exhibit a complex structure, and a variation from the general type of their successors. Systematic zoologists will determine whether the structures indicated claim distinction for the *Cornulitidæ* as a separate family, a subsection of the *Serpulinæ*, and whether they should be divided into the free and attached groups.

Notice of some important additions to the Fossils of the Silurian Rocks. By J. W. SALTER, *A.L.S.*

On the results of recent Researches into the Fossil Insects of the Secondary Formations of Britain. By H. E. Strickland, *M.A.*, *F.G.S.*

Fossil insects were, till recently, very little known in the secondary rocks of Britain, and the only examples were those from the Stonesfield slate, one from the lias, and a few from the coal measures. The very large additions to our knowledge of fossil entomology, made by the Rev. P. B. Brodie, have been derived from two principal groups, the Wealden and the lias. In the Wealden no less than seventy-four insect forms have been described and figured by Mr. Westwood from Mr. Brodie's specimens. These are generally remarkable for their small size, from which, and from their zoological characters, Mr. Westwood infers that they belong to a temperate climate. The gigantic beetles, locusts and *Cicadæ* of our modern tropics are here wanting, and the specimens consist, with very few exceptions, of small *Curculionidæ*, *Tipulæ*, *Libellulæ* and *Aphides*, such as swarm at this moment in European climates.

This then is a very remarkable fact, when taken in connection with the gigantic reptiles and remarkable forms of vegetable life which occur in the Wealden formation, and which by analogy we must refer to a tropical climate. We must either suppose, what is scarcely conceivable, that insects of European forms could co-exist with tree-ferns and other tropical productions, or what is perhaps more probable, that the insects of a cooler climate floated down some vast river into the great Wealden æstuary, just as the insects of Upper Canada or the Rocky Mountains might be carried by the Mississippi, in the present day, into juxtaposition with the alligators and palm-trees of the Gulf of Mexico. A similar anomaly is presented by the insects, first discovered by Mr. Brodie, and afterwards collected by Mr. Hope, the author, and others, in the lower lias of Gloucestershire and the adjacent counties. Of many hundred specimens examined by Mr. Westwood, the whole present indications of a temperate climate, a conclusion wholly opposed to that which we are accustomed to draw from the vertebrate and molluscous fauna of the same epoch. We must here, as in the case of the Wealden insects, reconcile this apparent discrepancy by supposing that the insects were drifted from cooler climates to the spots where we now find them. There are probably no organic bodies of such delicate structures which are capable of floating to so great distances as insects; their extreme lightness, and the strong materials of which their corneous parts consist, would enable them to float down rivers and to be diffused far and wide over the sea, there to be imbedded with truly marine products. In conformity with this view, we find that the insects of the Wealden, and still more so of the lias, consist chiefly of Coleoptera and other strongly compacted forms, that they most commonly present only detached portions of the entire insect, and such portions (chiefly wings and wing-cases) as are the most compact and durable. There is therefore no doubt that these insect remains have been drifted from the land into the sea, in other words, from higher ground to lower; and we have only to suppose that the original habitat of these insects was sufficiently elevated to supply them with a cool or temperate climate, and the whole difficulty is removed.

Another very unexpected result of the examination, by a skilful entomologist, of these fossil insects, is the remarkable affinity which they present to existing forms; even in so ancient a deposit as the lias, we find no insects of decidedly new types of organization; they are in almost every instance referrible to families, and frequently to genera, which belong to the existing fauna. In one instance only has Mr. Westwood ventured to propose a new generic name, and it is remarkable that the peculiar form so indicated is common both to the Wealden and the lias. It would appear, therefore, that from the time of the lias to the present day, the class Insecta has undergone a far less amount of alteration, either by the extinction of old forms or the introduction of new, than any other large group of the animal or vegetable kingdom with which we are acquainted. It was indeed well known that the different classes of the animal kingdom vary greatly in what we may call their amount of durability; that the higher groups of vertebrata, for instance, present a rapid succession of forms as we descend the chronological scale, while certain molluscous and infusorial structures are continued with little or no change during vast geological periods; but perhaps there is no other instance of so remarkable a persistency of character in a whole class of animals, as that which is presented to us in comparing the insects of the lias and Wealden with those of the existing fauna.

On a remarkable Phænomenon presented by the Fossils in the Freshwater Tertiary of the Island of Cos. By Professor E. Forbes and Lieut. Spratt, *R.N.*

In the island of Cos there is an extensive deposit of freshwater tertiary strata, apparently agreeing in age with the freshwater tertiaries of Lycia, which the authors had shown to be of an age subsequent to the miocene, and certainly of older date than the newer pliocene period, as these freshwater beds are anterior to and form the unconformable walls of a well-defined marine formation, containing numerous newer pliocene fossils. In the freshwater strata are found abundant and well-preserved shells of the genera *Paludina, Neritina, Melanopsis, Melania, Valvata* and *Unio*. Examples of the first three of these genera are most numerous, and are found throughout the vertical extent of the formation, distributed in three successive series of horizons. In each of these horizons is a species of Paludina and of Neritina, and in each of the two lower ones are two species of Melanopsis. The lowermost species of each genus are smooth, those of the centre partially plicated, and those of the upper part strongly and regularly ribbed. The forms of the examples of these several genera in the several zones are so very distinct and well-marked, that at first examination it would appear that each series of horizons was characterized by a Paludina, Neritina and Melanopsis of its own and representative of each other. If the species are regarded as distinct, either such conclusion must be come to, involving the supposition of a succession of creations and extinctions during the (geologically) short period in which the lake existed, or a transmutation of species must be maintained.

The authors propose the following solution of this geological problem without having recourse to such extreme suppositions. In the uppermost part of these beds there is evidence of the influx of the sea converting the fresh into brackish water. The *Cardium edule* occurs there. Finding that the smooth shells of several existing mollusca under such conditions become distorted and plicated, they are inclined to refer the appearances described to such a cause, and to regard these three *Paludinæ* as one species: so also with the other genera. Referring to the facts made known by Mr. Forbes, that races of mollusca cannot remain for more than a limited time on the same horizontal area, though they may reappear when the ground is sufficiently changed, (their embryos, which have been swimming free under a rudimentary and pteropodous state, in the meantime developing themselves on the new ground,) the authors hold that, by the time the ground was renewed for the development of the progeny, of the lowermost of the *Paludinæ* for instance, the composition of the water had changed so far as to affect, though not destroy, their form during their development; and that this was again and still more the case when the germs of the middle *Paludinæ*, &c. assumed the last form under which the several species appeared.

Abstract of a Paper on the Physico-Geographical Description of Mount Etna. By Baron von Waltershausen.

Baron von Waltershausen began his researches in the year 1835, accompanied by Professor Listing of Göttingen, and continued them on his second journey during the years 1838 to 1843 with M. Peters of Flensburg and M. Cavallari of Palermo. The fruits of his labours are in the course of being published under the title, 'The Etna and its Revolutions.' A large atlas will accompany this work, with an introduction written both in German and French. The principal object will be to give an exact representation of the mathematical, physical and geographical relations of Mount Etna, including an accurate historical survey of all the different eruptions, beginning from the earliest times up to the year 1843. The atlas, engraved by M. Cavallari, of which the first section has just been published, will contain a topographical and geological map of this volcano on the scale of 1 in 50,000, besides a large number of views, sections and other interesting details. The author hopes to be able to give a complete theory of the formation of the mountain and the revolutions it has undergone in the course of time, and to have arrived, by comparison with other volcanoes of Southern Europe (Vesuvius, the Liparian Islands), to results applicable to volcanoes in general. It may, perhaps, be stated that in this work, which the author considers as the principal labour of his life, the first attempt will be made to put the observation of geological phænomena on a mathematical foundation.

On the Occurrence of the Mosasaurus in the Essex Chalk, and on the Discovery of Flint within the Pulp-cavities of its Teeth. By EDWARD CHARLESWORTH, *F.G.S.*

This communication relates to the Saurian teeth figured in the 'Odontography' of Professor Owen under the generic name *Leiodon*, and to a fragment of a jaw of this reptile in Mr. Charlesworth's possession from one of the chalk quarries on the banks of the Thames. Mr. Charlesworth contends that there are no grounds to warrant the establishment of the genus *Leiodon*. He refers the teeth described under that name to the genus *Mosasaurus*, and proposes the specific name *stenodon* (narrow-toothed) to distinguish the English fossil from its congener, the *Mosasaurus Hoffmanni*. A section of the jaw made at right angles to its long axis, and through one of the conical bases upon which the teeth are implanted, exposed a piece of black flint, filling the extension of the pulp-cavity into the substance of the jaw. Two more of the pulp-cavities, upon being laid open, exhibited the same phænomenon; in one case the flint filling the entire cavity, so as to occupy the hollow of the tooth itself; but no deposit of flinty matter had taken place in the bony material of the jaw. Mr. Charlesworth considers that the discovery of flint under these remarkable circumstances is strong presumptive evidence in favour of its having been deposited from an aqueous solution, and is opposed to the respective theories advanced by M. Ehrenberg and Mr. Bowerbank to explain the formation of flints in chalk.

Notice of the Jaws of an Ichthyosaurus from the Chalk in the neighbourhood of Cambridge. By Mr. CARTER.

The author supposed these remains would constitute a new species, the teeth differing in a very remarkable manner from those of any Ichthyosaurus which he had been able to examine, or of which he could find published descriptions. The dental groove of the lower jaw is placed in a different plane from that of the upper, and the apposition of the upper and lower ranges of teeth is effected by the roots of the lower teeth developing themselves in a curved direction. Considering it probable that this peculiarity is characteristic of the species, he proposes to give it the name campylodon, from the Greek word *kampulos*, 'bowed or bent.'

Mr. Carter has also discovered teeth and vertebræ of the same species in the upper greensand near Cambridge.

On Posidonian Schist amidst Trappæan Beds, and on Traces of Drift-ice in the South of the Isle of Man. By the Rev. J. G. CUMMING, *M.A., of Emmanuel College, Cambridge, and Vice-Principal of King William's College, Isle of Man.*

The steps of St. Paul's cathedral, presented by the venerable Bishop Thomas Wilson, are the produce of certain quarries at Poolvash in the Isle of Man.

The bed from which they were taken is an impure schistose black limestone, characterized by very fine and perfect *Posidoniæ*. It is remarkably interposed between beds of regularly stratified trap-tuff, and though the order of superposition shows it to be of later date than the light-coloured limestone of Poolvash; in mineralogical and palæontological character it presents a return to the lowest limestone of this basin.

The first object of this paper is to trace out the condition of this area at the period of this deposit; and the second, to notice some of the more remarkable changes which have since passed over it.

The elevation at different periods of the schists and other older rocks which constitute the mountain-chain of the island, running irregularly nearly north-north-east and south-south-west from the Calf of Man to Maughold Head, has formed on the south-western side around Castletown a semi-elliptical basin, the extremity of the major axis being Coshnahawin in the north-east, and Perwick Bay near Port le Murray in the south-west. These schists seem to be lower Silurian, but, containing only a few fucoids (as far as seen hitherto), their exact age is uncertain.

Resting unconformably upon them, we have the old red conglomerate, which is never developed to a thickness greater than fifty feet in the south of the island. This conglomerate seems to pass regularly into the superior dark limestone by a gradual abstraction of the larger quartz pebbles and the substitution of a brownish carbonaceous paste in place of the previous ochreous and gritty matrix. The characteristic fossils of these lower dark limestones are *Orthis Sharpei*, *Leptæna papilionacea*, *Phillipsia Kellii*, a *Creseis* and *Posidonia*, with abundance of the larger corals and *Productæ*.

Some sudden change, however, appears after a time to have taken place in the physical condition of the basin, probably by an elevation of the sea-bottom, for the dark limestones are at once replaced by a series of light-coloured beds without shale, and abundantly charged with fossils which coincide with those of the lower scar limestone of Yorkshire, the dark limestone fossils resembling those of the lowest Northumbrian shales and of Hook Point in the south of Ireland. These light-coloured limestones attain a thickness of rather more than fifty feet. There is evidence again of another very sudden change having taken place in this area owing to a disturbance, accompanied with an outpouring of trap, along a line from the Stack of Scarlet to the hill above Balladoole; and subsequently, for some time, deposits of volcanic ash were constantly being accumulated in this area, and along with them the regular carboniferous deposits of this period were developed. This formed a trappæan limestone; and when at one particular period a quiescence of the volcanic eruptions took place, the bed of Posidonia schist which forms the marble quarry at Poolvash was deposited.

Another eruption broke up this bed, carrying along with it fragments which are mingled with the trap, so as to form a breccia; and subsequently the whole mass appears to have been subjected to considerable heat, and has suffered disturbance, being traversed by trap-dykes which intersect the area in directions generally northwest and south-east.

The author then noticed some remarkable bosses on the surface of this area, both in Poolvash Bay and elsewhere. The origin of them he attributed to the intrusion of trap amidst the old red conglomerate betwixt the schists and the tough limestones.

He then observed that the greater part of this southern basin of the Isle of Man was covered up by masses of boulder-clay and by an accumulation of diluvium; and he proceeded to some notice of the direction in which the materials appear to have been moved into the locality where they now are. He directed attention to two slabs obtained from Poolvash Bay and Scarlet strongly marked with parallel groovings and scratches, in directions east-north-east and west-south-west, and he accounted for them by observing that at the period of this formation the present Isle of Man was divided into three islands, and that most probably, through the channels between them, currents would run, as at the present time, between the Calf of Man and the main island. Icebergs drifting along through the southern channel, and carrying with them hard pebbles and blocks of the harder limestones, in passing over their basset edge, which lies to the north-east of Castletown Bay, would score and polish every more eminent flat surface exposed in the channel as those at Poolvash and Scarlet. The shales would form abundantly the clay of the period. By a comparison of the contained rocks, he showed that the drift-current came from the east-north-east and not from the west-south-west. The overspreading diluvium appears to have come in quite a different direction, viz. from the north-west, bringing down rolled blocks of granite of South Barrule. It contains also, amongst other travelled rocks, chalk-flints, which must be referred for their origin to the north of Ireland.

ZOOLOGY AND BOTANY.

On the Scientific Principles on which Classification in the higher Departments of Zoology should be based. By William Ogilby, *F.L.S.*

The dental system was no doubt a valuable means of diagnosis, and this depended upon the fact that it had a relation to the stomach, and other viscera intended for the digestion of food. Just in the same way, the extremities of the mammalia, more particularly the fore-arm, are the exponents of the habits, mental power, and œconomy of animals. The fore-arm is the seat of the function of locomotion, of manipulation and touch. According to the real position of an animal in the scale of organization will be the character of its fore-arm. This position was illustrated by examples from the various families of mammalia. He thought that in our usual systems of zoology a too exclusive regard had been given to the structure and form of the teeth.

On the Fossil Elephantine Animals of India. By Dr. Falconer.

In this communication, which was illustrated by diagrams of the crania, the author gave the results of the investigations by Captain Cautley and himself regarding the fossil Mastodons and Elephants of India, and endeavoured, by a series of teeth sections, to show that there was a gradual and continuous passage in the structure of the teeth between the Mastodon and the Elephant, the forms which have been included under the name of *Mastodon Elephantoides* by Clift, and an undescribed Indian species, constituting the intermediate links.

On the Genus Arvicola; *on the* Libellulidæ *of Europe; on Hybrids of the Genus* Anser. *By* M. Selys de Longchamps.

On the Unity of Organization as exhibited in the Skeleton of Animals. By Dr. Macdonald.

All animals, even the simplest, are possessed of a central as well as peripheral organism, varying in density as we ascend the scale, and are capable of increase by a repetition of segments having the primary elementary characters. As the form becomes lengthened, the central portion also elongates till we have a long axis or central stem. This *Caulis centralis* in the vertebralia is the axis formed by the bodies of the vertebræ, which is too often improperly called the backbone. In the vertebralia the *Caulis centralis* has developed on its posterior or neural aspect a lamina on each side of the mesian lines, and those in the adult forms of the higher mammals are completely ossified together in the spinous process, and also to the bodies of the vertebræ.

The author proposes to distinguish three parts or divisions in each lamina, most easily traced in the membranal laminæ.

I. *Protomeral.*—Single (simplex), orbicular, or when elongated, the shaft having convex or round extremities. Brachium. Femur.

II. *Deutomeral.*—Generally double (duplex); the shaft having concave extremities, and its proximal extremity more or less elongated into an *olecranon.*

III. *Tritomeral.*—Manifold (multiplex), terminal, *orbicular*; as in the carpus and tarsus and digital termination.

Mons. Selys de Longchamps explained in French, at some length, the object which the Academy of Brussels had had in view in obtaining accurate dates for the appearance, pairing, building, &c. of birds, the migration of fishes, the budding, flowering, &c. of plants. By connecting these with meteorological phænomena, we might arrive at an expression of the cause of the phænomena observed.

Periodical Birds observed in the Years 1844 *and* 1845 *near Llanrwst, Denbighshire, North Wales. By* John Blackwall, *F.L.S.*

Birds.	Appeared.	Disappeared.
	1844.	1844.
House Martin, *Hirundo urbica*	....	Oct. 4
Swallow, *Hirundo rustica*	....	,, 7
		1845.
Redwing, *Turdus iliacus*	Oct. 4	March 28
Woodcock, *Scolopax rusticola*	,, 9	April 4
Mountain Finch, *Fringilla montifringilla*	,, 19	
Fieldfare, *Turdus pilaris*	,, 30	March 31
Siskin, *Fringilla spinus*	Nov. 7	
	1845.	
Pied Wagtail, *Motacilla alba*	March 22	
Sand Martin, *Hirundo riparia*	April 4	
Wheat-ear, *Saxicola œnanthe*	,, 9	
Yellow Wren, *Sylvia trochilus*	,, 9	
Tree Pipit, *Anthus arboreus*	,, 16	
Common Sandpiper, *Totanus hypoleucos*	,, 17	
Swallow, *Hirundo rustica*	,, 18	
Cuckoo, *Cuculus canorus*	,, 22	
Black-cap, *Sylvia atricapilla*	,, 22	
Wood Wren, *Sylvia sibilatrix*	,, 23	
White-throat, *Sylvia cinerea*	,, 25	
Redstart, *Sylvia phœnicurus*	,, 25	
Pied Flycatcher, *Muscicapa luctuosa*	,, 27	
House Martin, *Hirundo urbica*	,, 28	
Whinchat, *Saxicola rubetra*	,, 28	
Pettychaps, *Sylvia hortensis*	May 4	
Land Rail, *Gallinula crex*	,, 5	
Swift, *Cypselus murarius*	,, 5	
Red-backed Shrike, *Lanius collurio*	,, 12	
Sedge Warbler, *Sylvia phragmitis*	,, 13	
Spotted Flycatcher, *Muscicapa grisola*	,, 19	
Goatsucker, *Caprimulgus europæus*	,, 20	

On a Gigantic Bird sculptured on the Tomb of an Officer of the Household of Pharaoh. By Joseph Bonomi.

The author having referred to the large nests discovered by Cook and Flinders on the coast of New Holland, and to those discovered by Mr. James Burton on the west coast of the Red Sea, at Gebel Ezzeit, adds the following remarks:—Among the most ancient records of the primæval civilization of the human race that have come down to us, there is described, in the language the most universally intelligible, a gigantic stork bearing, with respect to a man of ordinary dimensions, the proportions exhibited in the drawing before you, which is faithfully copied from the original document. It is a bird of white plumage, straight and large beak, long feathers in the tail; the male bird has a tuft at the back of the head, and another at the breast: its habits apparently gregarious. This very remarkable painted basso-relievo is sculptured on the wall, in the tomb of an officer of the household of Pharaoh Shufu (the Suphis of the Greeks), a monarch of the fourth dynasty, who reigned over Egypt, while yet a great part of the Delta was intersected by lakes overgrown with the papyrus,—while yet the smaller ramifications of the parent stream were inhabited by the crocodile and hippopotamus,—while yet, as it would seem, that favoured land had not been visited by calamity, nor the arts of peace disturbed by war; so the sculpture in these tombs intimate, for there is neither horse nor instrument of war in any one of these tombs. At that period, the period of the building of the Great Pyramid, which, according to some writers on Egyptian matters, was in the year 2100 B.C., which on good authority is the 240th year of the Deluge, this gigantic stork was an inhabitant of the delta or its immediate vicinity; for, as these very interesting documents relate, it was occasionally entrapped by the peasantry of the delta, and brought with other wild animals as matters of curiosity to the great landholders or farmers of the products of the Nile, —of which circumstance this painted sculpture is a representation, the catching of fish and birds, which in these days occupied a large portion of the inhabitants. The birds and fish were salted. That this document gives no exaggerated account of the bird may be presumed from the just proportion that the quadrupeds, in the same picture, bear to the men who are leading them; and, from the absence of any representation of these birds in the less ancient monuments of Egypt, it may also be reasonably conjectured they disappeared soon after the period of the erection of these tombs. With respect to the relation these facts bear to each other, I beg to remark that the colossal nests of Captains Cook and Flinders, and also those of Mr. James Burton, were all on the sea-shore, and all of those about an equal distance from the equator. But whether the Egyptian birds, as described in those very ancient sculptures, bear any analogy to those recorded in the last pages of the great stone-book of nature (the new red sandstone formation), or whether they bear analogy to any of the species determined by Professor Owen from the New Zealand fossils, I am not qualified to say, nor is it indeed the object of this paper to discuss, the intention of which is rather to bring together these facts, and to associate them with that recorded at Gezah, in order to call the attention of those who have opportunity of making further research into this interesting matter.

On the Discovery of Guano in the Faroe Islands. By W. C. Trevelyan, *M.A., F.G.S.*

This guano occurs principally on the shelves, commonly from eight to twenty feet wide, which are formed by the disintegration of the softer beds in the lofty precipices, often rising to the height of more than 1000, and in one instance above 2000 feet. Of such places, sheltered by the projecting rocks above, the sea-fowl take advantage, and considerable deposits of guano are found there, often the collection of many years. In some instances, when it accumulated so much as, from its slope towards the sea, to make an insecure resting-place for the eggs, the Faroese, who did not know its value, but to whom the birds, both on account of their feathers and for food, were of great importance, shovelled it off into the sea. Now, however, they have learnt at least its commercial worth, and collect it carefully,—in many places at considerable risk, the collectors being let down by ropes to the ledges, whence they lower the guano into boats below. A few tons of it have been exported to Lynn, Norfolk.

Remarks on Entomology. By J. O. Westwood, *F.L.S.*

After shortly noticing the general œconomy of the hive-bee as to the production of queens and the swarming of casts, he contended, from the analogy between the circumstances connected with the latter event and those which accompany the swarming of ants, gnats, white ants, may-flies, &c.,—1st, that the swarming of insects has for its principal object the union of the sexes; 2nd, that, from analogy with other insects subject to swarming, it might be inferred that the hive bee does not differ in this respect from other swarming species; and hence 3rdly, that it is the newly-hatched, and not the old queen, which leads off the swarm.

On Noises produced by one of the Notonectidæ. *By* Robert Ball, *M.R.I.A.*

Mr. Ball noticed the fact of one of the Notonectidæ, (*Corixa striata*, Curtis,) emitting loud and powerful sounds somewhat like those of a cricket. These sounds were given out while the animal was about two inches and a half under water, and so loud as to be distinctly audible in an adjoining room through the closed door. The first observation of this fact was made about two years since by Miss M. Ball, who has since frequently verified the original observation. Mr. Ball stated that he had himself heard on the

15th of June instant this remarkable sound. It is probable the sound is only emitted by the male: it has as yet only been heard in the months of May and June.

On a New Genus of Mollusca Nudibranchiata. *By* Messrs. Alder and Hancock.

This new genus is founded on the *Tritonia arborescens* of authors and its allies, which are distinguished from the true Tritoniæ (*T. Hombergii*, &c.) by the form of their tentacula, and the free, arborescent nature of their branchiæ. These characters alone induced the authors to consider them generically distinct, before they had an opportunity of examining their internal structure, in which such important differences in the digestive organs were exhibited as to show that this new genus, for which the name of *Dendronotus* is proposed, should be removed from the family *Tritoniadæ* to that of *Eolididæ*, to be placed first in order, as the connecting link between these two families.

The paper was illustrated by drawings from the work by Messrs. Alder and Hancock on the British Nudibranchiate Mollusca, just published by the Ray Society.

Mr. W. Thompson read a letter from Mr. Alder, dated Salcombe, June 17, 1845, in which the writer stated that he had lately obtained in Torbay at least ten, and perhaps twelve new species of *Mollusca nudibranchiata*, to add to the British Fauna. They consist of four species of *Doris*, five or six of *Eolis*, and an animal of an entirely new genus, approaching nearest to *Tritonia*. A singular species of mollusk obtained at the same time, resembling in general appearance the genus *Pelta* of Quatrefages, was noticed in detail.

A letter was read by the Secretary from Captain Portlock, replying to the remarks made at York by Professor E. Forbes on the results of his dredging at Corfu. The account then read he had not wished to be considered a complete report, but as an indication of progress. In conclusion, Captain Portlock stated, that "in dredging, a conclusion from a very limited range of research is as dangerous as similar conclusions have been in geological inquiries. For example, a hasty deduction from the appearance of an animal at a particular depth of water is evidently imperfect, as the nature of the bottom and the description of the marine vegetation are more likely to modify such appearances. I see, for example, that Professor Bell quotes the discovery of *Eurynome aspera* by Professor Forbes in the deep water of the Egean as a proof that the species is essentially a deep-water one, both in the Mediterranean and the Northern Seas. Here, however, I have found it just at the verge of the rocks where sea-weeds prevail, and therefore in comparatively shallow waters, i. e. from ten to sixteen fathoms. Other northern species, such as *Ebalia Pennantii*, *Achæus Crouchii* (if I am right in my identification of them), I have found under similar circumstances; and I am, therefore, the more inclined to ascribe their existence to the local peculiarities of vegetation than to the depth."

Professor Forbes exhibited a specimen of a Medusa, caught by Mr. M'Andrew, and preserved in Goadby's solution, and pointed out the importance of this means of preserving those soft animals. We know less of the Medusæ than of any other family of animals, from the difficulty of preserving them.

On the Marine Fauna of Cornwall. By Charles William Peach.

He introduced *Natica intricata* of Couch, *Anatifa lævis*, *A. sulcata*, *A. fascicularis*, and *Pollicipes scalpellum*, observing upon their habits, particularly the latter, showing that, notwithstanding it had been considered as solitary, he had found it in bunches of twelve or more in all stages of growth, and attached to the stems of the older ones. He then presented specimens of the *Cineras vittata* of Leach, which he took from the bottom of a vessel, timber laden, discharging at Plymouth from Africa, and then commented on the fact, that though this shell was a native of a warm climate, and was introduced into this country in the midst of the most severe winter experienced for years, it lived and throve well; and he was desirous of recording the fact of the time of its introduction, if at any time it should become general on our shores. He exhibited also what he considered a new *Alcyonium*, and proceeded to notice the immense myriads of Acalephida and purse-like forms which had been so abundant on the coast of Cornwall as to discolour the sea for miles. He spoke of the extreme sensibility of these animals, their luminosity and habits. There was also a notice of a new sponge from Cornwall. The paper was illustrated by specimens and drawings.

Notice of Additions to the Marine Fauna of Britain, discovered by Robert M'Andrew, *Esq. since the last Meeting of the Association. By* Prof. E. Forbes.

The animals described in this communication are,—1st, a new species of Chemnitzia, *C. rufescens*, taken off Arran in from thirty to forty fathoms, and at Oban on sand in fifteen fathoms water. It has nine convex whorls, ribbed longitudinally and striated spirally; brown, with darker bands, and white at the base. It measures $\frac{2}{10}$ths of an inch in length. 2nd. The beautiful and curious *Pecten pes-felis*, hitherto known as an inhabitant of the Mediterranean and Red Sea. Mr. M'Andrew took a small but well-marked living specimen in thirty fathoms in Loch Fine. 3rd. The beautiful coral named *Turbinolia milletiana*, hitherto known only as a fossil of the English and French miocene tertiaries. A living specimen was taken on sand in thirty fathoms on the coast of the Scilly Isles, and a dead one in forty-five fathoms off the Land's End. The beautiful zoophyte *Funicularia quadrangularis*, first announced as British at York last year, has been again taken in the Hebrides, and well-preserved specimens above three feet in length were exhibited at the Section.

A small *Rissoa*, apparently new, was also laid before the meeting, and is remarkable for having been taken in water as deep as 100 fathoms on the west coast of Scotland.

On the Cilia and Ciliary Currents of the Oyster. By the Rev. J. B. Reade, *M.A., F.R.S.*

The author stated, that in a microscopic investigation of Infusoria, which had for some years occupied his attention, he had been led particularly to notice the beautiful contrivance by which many species, when not exerting their powers of locomotion, are supplied with food. When they are examined under the microscope by such an arrangement of transmitted light as makes the Infusoria luminous points on a perfectly dark field, it is immediately seen that the action of the cilia attached to their tentacula produces a strong current in the water, and hereby a countless number of minute living organisms is brought within the influence of the cilia, and a sufficient supply is selected for food. Thus, with respect to Infusoria, it is a known fact, that the absence of the prehensile organs possessed by larger creatures is compensated by this delicate but efficient ciliary apparatus. It is also a fact equally well known, that the lips of the oyster, which surround the orifice of the alimentary canal, are, in the same manner, fringed with cilia; and that these cilia of the oyster, as of Infusoria, equally cause currents in the water. But it has never been suggested and proved by any naturalist that the proper office of the cilia of oysters is to bring to these acephalous mollusks that food which they have no power to follow or to seize. Such, however, without doubt, is the case; and, accordingly, an examination of the contents of the stomachs of oysters discovers to us their infusorial food; and, after undergoing the process of digestion in the stomach, the siliceous shields of these Infusoria, deprived of their organic and carbonaceous integuments, are ejected as effete matter. In a paper communicated last year to the Microscopical Society of London, on animals of the chalk still found in a living state in the stomachs of oysters, these Infusoria were described and enumerated. The apparent identity existing between these recent living Infusoria and the fossil, makes the inquiry of considerable interest to the geologist; for the addition of this connecting link to the chain of organized beings extends a continuous line of the same organic structure from the secondary formation to the tertiary, and seems to preclude the supposition, that below the tertiary formation are no recent species. Whether or not this conclusion be admitted, it is a fact, ascertained by pursuing this inquiry, that the oysters and other bivalves, which are innumerable in the Kimmeridge clay, lived, like recent oysters, upon Infusoria; and consequently the conclusion is unavoidable, that the Kimmeridge clay, like the chalk, contains a considerable per-centage of these minute and indestructible bodies which the microscope discovers in it, and is not the mere comminuted detritus of more ancient and unorganized materials. With these facts established, we may still further conclude, from analogy, that a similar ciliary apparatus, and similar infusorial food were common to the still earlier bivalves in the seas of the transition formation; and we may then ask, What right have we, in the absence of a careful microscopic examination of still earlier rocks, to deny the possibility of any portion of their mass being due to the agency of siliceous Infusoria?

On the Distribution of Endemic Plants, more especially those of the British Islands, considered with regard to Geological Changes. By Professor E. Forbes.

The hypothesis of the descent of all the individuals of a species either from a first pair or from a first individual, and the consequent theory of specific centres being assumed, the isolation of assemblages of individuals from those centres, and the existence of *endemic* or very local plants, remain to be accounted for. Natural transport, the agency of the sea, rivers and winds, and carriage by animals, or through the agency of man, are means, in the majority of cases, insufficient. It is usual to say, that the presence of many plants is determined by soil or climate, as the case may be; but if such plants be found in areas disconnected from their centres by considerable intervals, some other cause than the mere influence of soil or climate must be sought to account for their presence. This cause the author proposes to seek in an ancient connexion of the outposts or isolated areas with the original centres, and the subsequent isolation of the former through geological changes and events, especially those dependent on the elevation and depression of land. Selecting the flora of the British Isles for a first illustration of this view, Professor Forbes calls attention to the fact, well-known to botanists, of certain species of flowering plants being found indigenous in portions of that area at a great distance from the nearest assemblage of individuals of the same species in countries beyond it. Thus many plants peculiar in the British flora to the west of Ireland have the nearest portion of their specific centres in the north-west of Spain; others, confined with us to the south-west promontory of England, are, beyond our shores, found in the Channel Isles and the opposite coast of France; the vegetation of the south-east of England is that of the opposite part of the continent; and the alpine vegetation of Wales and the Scottish highlands is intimately related to that of the Norwegian Alps. The great mass of the British flora has its most intimate relations with that of western Germany. The vegetation of the British Islands may be said to be composed of five floras:—1st, a west Pyrenean, confined to the west of Ireland, and mostly to the mountains of that district; 2nd, a flora related to that of the south-west of France, extending from the Channel Isles, across Devon and Cornwall, to the south-east and part of the south-west of Ireland; 3rd, a flora common to the north of France and south-east of England, and especially developed in the chalk districts; 4th, an Alpine flora, developed in the mountains of Wales, north of England and Scotland; and 5th, a Germanic flora, extending over the greater part of Great Britain and Ireland, mingling with the other floras, and diminishing, though slightly, as we proceed westwards, indicating its easterly origin and relation to the characteristic flora of northern and western Germany. Interspersed among the members of the last-named flora, are a very few specific centres peculiar to the British Isles. The author numbers these floras according to magnitude as to species, and also, in his opinion, according to their relative age and periods of introduction into the area of the British Islands. His conclusions on this point are the following:—

1. The oldest of the floras now composing the vegetation of the British Isles is that of the mountains of the west of Ireland. Though an alpine flora, it is southernmost in character, and quite distinct as a system from the floras of the Scottish and Welsh alps. Its very southern character, its limitation, and its extreme isolation are evidences of its antiquity, pointing to a period when a great mountain barrier extended across the mouth of the Bay of Biscay from Spain to Ireland.

2. The distribution of the second flora, next in point of probable date, depended on the extension of a barrier, the traces of which still remain, from the west of France to the south-west of Britain, and thence to Ireland.

3. The distribution of the third flora depended on the connexion of the coasts of France and England towards the eastern part of the Channel. Of the former existence of this union no geologist doubts.

4. The distribution of the fourth, or alpine flora of Scotland and Wales, was effected during the glacial period, when the mountain summits of Britain were low islands, or members of chains of islands, extending to the area of Norway through a glacial sea, and clothed with an arctic vegetation, which, in the gradual upheaval of the land and consequent change of climate, became limited to the summits of the new-formed and still existing mountains.

5. The distribution of the fifth, or Germanic flora, depended on the upheaval of the bed of the glacial sea, and the consequent connexion of Ireland with England, and of England with Germany, by great plains, the fragments of which still exist, and upon which lived the great elk and other quadrupeds now extinct.

The breaking up or submergence of the first barrier led to the destruction of the second; that of the second to that of the third; but the well-marked epoch of the Germanic flora indicates the subsequent formation of the Straits of Dover and of the Irish Sea, as now existing.

To determine the probable geological epoch of the first or west-Irish flora,—a fragment perhaps with that of north-western Spain, of the vegetation of the true Atlantic,—we must seek among fossil plants for a starting-point in time. This we get in the flora of the London clay or eocene, which is tropical in character, and far anterior to the oldest of the existing floras. The geographical relations of the miocene sea, indicated by the fossils of the coralline crag, give an afterdate certainly to the second and third of the above floras, if not to the first. The epoch of the red or middle crag was probably coeval with the incoming of the second flora; that of the mammaliferous crag with the third. The date of the fourth is too evident to be questioned; and the author regards the glacial region in which it flourished as a local climate, of which no true traces, so far as animal life is concerned, exist southwards of the second and third barriers. This was the newer pliocene epoch. The period of the fifth flora was that of the post-tertiary, when the present aspect of things was organized.

Adopting such a view of the relations of these floras in time, the greatest difficulties in the way of changes of the earth's surface and destruction of barriers—deep sea being now found where land (probably high land) was—are removed when we find that those greater changes must have happened during the epoch immediately subsequent to the miocene period; for we have undoubted evidence that elsewhere, during that epoch, the miocene sea-bed was raised 6000 feet in the chain of the Taurus, and the barriers forming the westward boundary of the Asiatic eocene lakes so completely annihilated, that a sea several hundred fathoms deep now replaces them. The changes required for the events which the author would connect with the peculiar distribution of the British flora need not have been greater than these.

Prof. Forbes maintains that the peculiar distribution of endemic animals, especially of the terrestrial mollusca, bears him out in these views. He proposes to pursue the subject in detail, with reference both to animal and vegetable life, in connexion with the researches of the geological survey.

On the Development of Vegetable Cells. *By* A. Henfrey, *F.L.S.*

After noticing the opinions of MM. Mirbel, Schleiden, Mohl and Nägeli, he stated the conclusions to which he had been conducted by observations, viz.—1. That there is no such thing as the interruption of continuity between the liber and alburnum, called the cambium layer. 2. That the potentiality of the black granules described by Schleiden is not proved, and that the utricle first developed from the so-called cytoblast is not the permanent cell, but the primordial utricle of Mohl, the existence of which in growing tissues seems to be universal. 3. That this primordial utricle is not a layer of mucilage, as stated by Nägeli, but a true membrane. The author regards the nucleolus, or central spot of Schleiden's cytoblast, as the germinal point, and as situated on the wall of the primordial utricle. When a new cell is to be formed the nucleolus divides into two, and a corresponding construction of the primordial utricle takes place until it separates into two, a layer of permanent cell-wall substance being, meanwhile, secreted in this fold from the circumference to the centre, till a complete septum is formed. The lateral walls grow by extension, being moulded on the growing primordial utricle within them. In the nascent cell, the primordial utricle is filled with granular matter, which, during the subsequent growth of the cell, remains aggregated round the nucleolus, and thus gives rise to the appearances whence Schleiden derived his theory of development from a cytoblast.

On the Influence of Galvanic Electricity on the Germination of Seeds. By Professor E. Solly, *F.R.S.*

He commenced by describing the old experiments of Sir H. Davy, in which seeds placed in the vicinity of the positive pole of a voltaic pile, germinated sooner than those near the negative pole, an effect which might be attributed to the oxygen evolved at the positive pole, which of course would accelerate germination, whilst the hydrogen set free at the negative extremity would retard it. These experiments did not in any way prove that germination was *stimulated* by electricity; but judging from the known powers of electricity, it would be reasonable to expect that like light and heat, it would exert marked influence on the growth of vegetables, in fact, act as a stimulus.

In a series of experiments, in which the seeds of barley, wheat, rye, turnips and radish were exposed to the influence of a feeble current of electricity, the plants came up sooner and were healthier than others that had not been electrified. On the other hand, a number of experiments on other seeds had given opposite results, proving either that the germination of some seeds was retarded whilst that of others was facilitated by electricity, or that the effects observed in both cases were accidental. Out of a series of fifty-five experiments on different seeds, twenty appeared in favour of electricity, ten against it, and twenty-five showed no effect whatever; and in carefully counting the whole number of seeds up in the entire series, there were found 1250 of the electrified, and 1253 of the non-electrified. In conclusion, Prof. Solly stated that he felt doubtful whether the effects observed were really due to the influence of electricity.

On the Germination of Plants. By Edwin Lankester, *M.D., F.R.S.*

The phænomena that take place during what is called germination, are,—1, absorption of oxygen from the atmosphere; 2, a disengagement of carbonic acid; 3, a disengagement of ammonia; 4, conversion of starch into dextrine, gum, sugar, &c.; 5, increase in bulk—growth of the embryo. The most commonly adopted theory of germination explained the above phænomena, as being necessarily connected with the last fact mentioned in the above series, the growth of the embryo. It was in fact supposed that the absorption of oxygen and the disengagement of carbonic acid gas was an act of life, a necessary process of the act of germination, and germination and vegetation were regarded as antagonising processes, the one being an oxidating, the other a deoxidating process, whilst the albumen was regarded as a sole source of nourishment; the author proposed to regard the phænomena of germination differently. It is obvious that the only essential process of germination is the growth of the young plant or embryo. The process of development of the embryo from primitive cytoblasts developing its tissues, is precisely the same as that of every other part of the plant, and from an identity of structure, an identity of function might be inferred. But the ordinary theory of germination gave a different function to the tissues of the embryo. The author considered this unnecessary. He believed that the absorption of oxygen, the disengagement of carbonic acid gas and ammonia arose entirely from the decomposition of the starch and protein contained in the albumen or perisperm of the seed, and that the growing cells of the embryo appropriated the carbonic acid and ammonia with water, just in the same way as all other cells in the vegetable kingdom. This theory he conceived was not only more consistent with the phænomena of germination observed in plants containing large quantities of starch in their perisperm, but also consistent with a large class of facts which were opposed to the ordinary view, of which the following were brought forward:—1. In many plants no perisperm was developed, and the conditions required for germination were precisely those for vegetation. 2. Many plants with hard perisperms, as the *Phytelephas macrocarpa*, the *Phœnix dactylifera*, and species of *Bactris*, *Cocos* and *Astrocaryum*, germinate without consuming any appreciable quantity of the perisperm. 3. The quantity of carbonic acid obtained by Saussure varied not according to the number, but according to the mass of the seeds, proving that it arose from the decomposition of the starch as a chemical process, and not from the growth of the embryo as a process of life. 4. De Saussure found that the relation between the oxygen consumed and the carbonic acid gas given out, was different in different plants for the same quantity of the latter, which ought to be constant if the theory of oxidation or combustion during germination be true. 5. Boussingault found that the changes supposed to be peculiar to germination went on in the perisperm after the young plant had developed its radicle and plumule, and was capable of an independent existence. 6. The changes which take place in the chemical composition of the perisperm of the seed during germination can be artificially produced by mixing starch, diastase, &c. together and exposing them to the action of the atmosphere. This theory modifies the view of the use of the albumen or perisperm. It is not deposited essentially for the nourishment of the young plant. In some cases it is an organ of support, and bears the same relation to the embryo as the wood of a branch to the buds upon it. Viewing it morphologically, it might be considered the analogue of the tegmenta of the buds; as they consisted of aborted leaves, so the albumen or perisperm consisted of embryos aborted in their earliest stages of development.

On the Phytelephas Macrocarpa (*Vegetable Ivory or Tagua Plant*). *By* E. Lankester, *M.D.*, *F.R.S.*

The author brought this plant under the notice of the Section, as he was enabled to present a drawing of a young plant, which was now growing in the garden of Messrs. Loddiges of Hackney. A fruit also of this plant existed in the British Museum, of which a drawing was exhibited. This plant had been placed in the natural order *Typhinæ* by Bonpland and Humboldt; with *Pandaneæ* by Brown; with *Cyclanthaceæ* by Lindley. The fruit is of the size of a man's head, and the tree is called by the Spaniards Negro-head. A remarkable point in the œconomy of this plant was, that the horny albumen of the seed appeared to undergo no change during the process of germination. In the plant at Loddiges', which was now five years old, the seed still remained on the surface of the soil, apparently as hard as ever. In germination, the young embryo was carried down by a rhizoma an inch or more long into the earth, and commenced growing at that point.

The perisperms of other palms, as the species of Bactris, of Cocos, and of the *Phœnix dactylifera*, also undergo but little change during germination. The perisperm of a species of Astrocaryum in British Guiana is stated by Sir Robert Schomburgk to be as hard as that of Phytelephas. The structure of the tissue of the seed is remarkable. The walls of the cells are very thick, and in their early stages porous; the pores between the cells are at last closed, and the pores form club-shaped cavities leading out of the cells. Cooper, in his illustration of the microscopic structure of these cells, has drawn a line running between these club-shaped cavities, but this arises from a tube lying underneath, and has no connection with the termination of the pores. The cells by the resorption of their walls become converted into tubes. The tubes under the microscope appear to contain globules of oil. Chemical analyses of the seeds had been made by Payen, Connell and Baumhauer. A more accurate analysis was made, at the author's request, by Dr. Percy of Birmingham. The result of this analysis was as follows:—

Carbon	44·39
Hydrogen	6·63
Oxygen	47·61
Nitrogen	1·37
	100·00

In drying 12·64 per cent. of water was dissipated. The ash contained sulphuric, hydrochloric, phosphoric and carbonic acids in combination with potassa, lime and oxide of iron. The phosphoric acid was partly combined with the potassa. The iron was probably introduced in filing the perisperm for chemical examination.

Description of the Murichi, or Ita Palm, of Guiana. *By* Sir R. Schomburgk.

The author referred to the early accounts which naturalists in Europe received of this beautiful palm, of which Sir Walter Raleigh appears to have brought the first fruits to Europe. Clusius, in his 'Exotic Flora,' describes it as "fructus elegantissimus squamosus similis palmæ-pini," and Father Gumilla, Gili, and the older authors on Guiana extol it in consequence of the various uses the aborigines of Guiana make of it. It serves at different stages of its growth as a vegetable and furnishes a cabbage equal to the Palmetto; at the maturity of its fruits, they are eaten as well in their natural state as prepared into a drink, which, when drunk copiously, proves inebriating. It is remarkable, that when much use is made of the fruit it communicates to the linen a yellow colour after perspiration. The trunk is tapped and a fluid flows from it which possesses much saccharine matter. Of the greatest delicacy however is the saccharine liquor extracted from the unexpanded flower, which affords a liquor resembling champagne in its briskness. The Indians prepare from the pith of its trunk a flour resembling that of the *Sagas farinifera,* which the Warrau Indians call Arù*. Mixed as a pap, it is considered to be an excellent remedy for dysentery. The fan-shaped leaves are used as a thatch for covering houses, and the stump of one of those leaves serves as a broom to sweep them with. The Indians of the Savannahs and mountainous tracts use the base of the half-sheathing leaves for the preparation of sandals. The midribs of the young branches are cut in thin slices, and after having been dried they are connected together with withes, and serve as a sail for the Indian's canoe or as a mat to sleep upon. They are used by the travelling entomologist as a substitute for cork to fix insects upon, or to those who are provided with strong beards as razor-strops. Of the greatest use are however the fibres of the young leaves, which are manufactured into thread and ropes, and they are of such a tenacity that the greater number of Indian tribes fabricate their beds and hammocks of them. The inhabitants of the Rio Negro make a trade of it, and a fine hammock is sold from ten to twelve milreis. Even in its decay the mauritia is of use, and affords a delicacy to the Indians, which likewise many colonists do not refuse, namely, the larvæ of a large beetle; the *Curculio palmarum* is found in large numbers in the pith when the trunk is near its decay, and, when boiled or roasted, resembles in taste beef-marrow.

This useful tree, which extends from the Llanos of Cumana to the western tributaries of the Rio Negro and the mouth of the Amazon, or over an area of 550,000 square miles, was appropriately called by Father Gumilla *arbol de la vida,* the tree of life; and it is related at the Orinoco, that one of the kings of Spain hearing of this wondrous tree, which at once furnished bed, bread and wine, attempted its introduction into the mother country. The author wished to correct finally those who have written on this tree in two points. It is, first, described as a tree scarcely thirty feet high, while it reaches sometimes a height of 120 feet, and its average size in Guiana is not less than fifty feet; and next to this it is asserted, that they are not to be found at a greater height than 800 feet, while the author has met them in numerous groups and of a luxuriant growth at a height of from 3000 to 4000 feet above the sea, growing as usual in groups and in swampy soil.

Description of the Fruit of some of the Hepaticæ. *By* Professor Allman.

In this communication the author demonstrated the existence in the sporangia of Marchantia and Jungermannia of precisely the same form of fibro-cellular tissue which is found in the lining membrane of the anthers of flowering plants. This structure he believed to constitute a beautiful hygroscopic apparatus, through whose agency the dehiscence of the fruit is effected.

Prof. Allman observed, that in *Marchantia conica*, at the period of maturation, the pedicel of the sporangium becomes suddenly increased in size, being all at once gorged with juices, and by acting against the top of the receptacle, forces the sporangium through the margin of this latter structure, and thus brings the peculiar tissue of which it is composed into a condition which enables it to be acted on by the hy-

* The flour which they procure from the arrow-root is called Arù-arù, and our denomination arrow-root is most likely derived from the Indian word.

groscopic powers of the atmosphere, when dehiscence immediately takes place and allows of the escape of the spores and elaters. The origin of the *elaters* Dr. Allman was inclined to refer to a metamorphosis of certain cells of the same nature as those which constituted the walls of the sporangium.

On a Monstrosity occurring in Saxifraga Geum. *By* Professor Allman, *M.R.I.A.*

This monstrosity was discovered by William Andrews, Esq., on the mountains of Kerry, about three years ago. Mr. Andrews has cultivated it in his garden, and finds its characters remarkably persistent, remaining from year to year in the same plant, and being even capable of perpetuation by seed.

The three external verticels are normal, but between the stamens and pistil there is developed a series of adventitious carpels crowded upon the margin of a cup-like production which surrounds the lower half of the pistil.

These adventitious carpels are characterized by the anomalous fact of having their backs turned towards the axis of the flower. They bear numerous ovules, which, as the margins of the carpels never unite, are always exposed, and present the appearance of a gland-like ring surrounding the pistil. The ovules belonging to the adventitious carpels acquire a very considerable degree of development, becoming completely anatropous like those contained within the normal ovary, and a distinct primine, secundine and nucleus, with a well-marked vascular raphe, can plainly be seen.

Dr. Allman explained the singular character of this monstrosity by supposing the existence of a series of secondary axes which are given off in a whorl between the stamens and the primary axis of the flower. These secondary axes terminate each in its flower, which however is reduced nearly to the lowest possible condition of development, the three outer whorls being absent, and all those pistillary carpels which would, if present, have their faces turned to the primary axis, being also in a state of complete abortion. The secondary axes then adhere with each other and with the normal pistil, so as to form the cup just described, and the existing carpels of the secondary axes necessary have their backs turned to the normal pistil, being referable to these axes and not to the primary axis of the flower.

Professor Henslow exhibited a specimen of *Papaver orientale*, in which the filaments of the stamens were converted into bodies bearing ovules.

On Practical Means for the Advancement of Systematic Botany. *By* J. Ball, *M.R.I.A.*

In the present state of systematic botany we require more accurate and extensive observations and experiments with respect to the variations of the forms of plants than have yet been made, and that the forms of descriptive botany should be modified so as to exhibit the whole of the forms contained in the larger groups and their mutual relations in a more philosophical manner.

The great impediment to the progress of natural history has been the want of union between observers and thinkers, those who study the details of the science and those who speculate on its general aspects and theory; in order to facilitate and forward their union, it seems desirable that botanists of both classes should agree upon a well-considered series of observations and experiments which should be conducted in a public botanic garden, where the requisite precautions as to securing the accurate observance of the conditions agreed upon, the preservation of specimens, and the keeping a proper register, might be adopted and enforced; and, finally, where the experiments would not be exposed to the interruptions and other accidents which threaten individual observers.

If, for instance, two groups of plants were selected, in one of which the individual forms approximate very nearly to each other, and in the other the species appear well-characterised by constant characters, and a number of individuals of each of a series of forms were exposed to the action of all the causes which we know to be capable of modifying the development of vegetable form, the best means being taken for isolating the action of each of these causes, so that it may be compared with that of the ordinary action of the causes influencing the plant in its natural condition, if this process were repeated upon the progeny of the original plants, and upon their offspring in continued succession, so as to imitate as far as we can the actual influences which take effect in nature, and the whole series of experiments were continued for a long period; twenty, thirty, perhaps fifty years would scarce be sufficient; then, I think, those who shall succeed us, to whom we bequeathe the results, will be enabled far more safely than we can to establish a theory as to the nature of the relations of individual forms amongst plants.

Even those who conceive the hypothesis of the descent of all the individuals of a species from a common original to be an essential point in natural history, cannot afford to dispense with such a course of inquiry; for admitting the hypothesis, there is yet no practical test afforded by which to recognise the members of the species in groups where these are subject to great variation, nor can such a test be supplied in any other manner. Still more, those who believe it to be unphilosophical and in no way necessary to assume the *truth* of an hypothesis supported merely as the one in question is by *à priori* considerations, whatever probability we may choose to assign to it, will desire that a body of facts bearing so directly on the question should hereafter be forthcoming.

It might also be desirable that a few members of the Section should associate for the purpose of collecting and arranging such well-established facts respecting the variations of plants as observed either in the natural state or in cultivation, as now lie scattered through botanical works, or may hereafter be supplied by observers, with a view to illustrating the value of specific characters in various groups.

As to the modifications proposed in the forms of descriptive botany, it appears to me that it should be an essential point in the character of a genus to assign, not merely the points of structure in which all the species of the genus agree, but also those which, varying from one species to another within the genus, yet remain constant throughout the subordinate varieties of these species, thus supplying what we call the specific characters within the group. An attempt of this kind, however imperfect, would at once ensure an accumulation of important facts, and by embodying these into our systematic arrangement, would prepare the way for important generalisations. An immediate result would be, that we should hereafter less frequently find one supposed species of a genus rejected because its characters had been proved to be variable, while another species of the *same genus* is admitted, though possessing exactly the same and no better distinctive characters.

The other modification which I propose has a similar tendency with the last. It will not be considered improbable to assert as I do, from the study of several complicated groups, that in species of the same genus, the varieties of any single species, considered as diverging from a common typical form, recur in a similar cycle throughout all the species of that genus; and if, as is usual, we indicate varieties by letters of the alphabet, it seems natural to ask, that in describing a given group, the same letter should always indicate the same corresponding variety, each letter receiving from the first a fixed signification. I am inclined to go one step further than this. It is now admitted that there are two very distinct classes of varieties; the first, properly so called, represent the initial variations produced by modifying causes; they appear amongst the offspring of one parent plant, and usually return to the primary form as soon as the modifying action ceases, either in their own persons or in those of their descendants; the second, conveniently named sub-species, are permanent, and only after several successive generations do they return to the typical form, if indeed they be capable of so returning, which is scarcely yet established. Now, I assert, there is evidence to show that if we take the cycle of varieties displayed amongst the offspring of the *original* or typical plant, we shall find a cycle of sub-species, sometimes of course incomplete, exhibiting the same tendencies to variation of form in a more marked manner, while in each sub-species the same cycle of varieties is again repeated. Now if it be admitted that this law may hold good throughout, there will be no objection to designating the varieties each successively by a small letter, and each corresponding sub-species by a large letter of the same kind. It is needless to point out how a range of facts would thus be admitted into our systematic arrangements.

Onthe Specific Characters of Plants, considered in Morphological Connexion. By J. Ball, *M.R.I.A.*

Bearing in mind the two fundamental principles of the unity of primitive structure throughout all the organs of vegetation, and on the other hand, the connexion between function and structure, as the latter is actually modified in nature, it has ever appeared to me a highly probable if not necessary conclusion, that where, in examining a group of vegetable forms, we find in proceeding from one individual to another differences of structure in various organs, these varieties are mutually connected together by fixed laws, so that a variation in one organ shall invariably accompany the variation of another, not by a mere accidental relation, but one which we may hope to trace and to establish. The main difficulty of introducing into botany this method, which has been so successfully employed in comparative anatomy by palæontologists, is, that the latter have been guided and directed by a knowledge of the functions of the several organs whose structural relations they would discover, while in botany, where we have so slight a knowledge of the special functions of the various appendages, we must, if we would at all ascertain their structural relations, seek them in a careful induction from an extensive series of observations; thus only may we hope to reconstruct a lost plant from some single leaf or portion of its inflorescence. The first step will naturally be made in finding the relations between those organs in which the primary function has been the least altered, as between the leaf, the bracts, sepals or corolla, rather than with those of the stamens or pericarp, where the primitive organ has been altogether metamorphosed for the purpose of fulfilling a completely different purpose in the vegetable œconomy. Accordingly we do in fact find in many natural orders examples of this law. I might derive some illustrations from the Compositæ, but for the present shall only refer to a small group of Gramineæ, the whole of which order is well-adapted for this purpose.

The group in question contains three European species of Polypogon, namely, *P. monspeliensis*, Dsf., *P. maritimus*, R. & S., and *P. subspathaceus*, Lois., in which the accordance between the variations of the leaf with unrolled sheath and those of the exterior glume is very remarkable.

On the Geographical Distribution of Plants in British India. By Dr. Royle.

This paper contained an outline of the varied vegetation of India, occupying, as it does, almost the extremes of heat and cold, as well as those of dryness and moisture. The materials of this paper were chiefly supplied from the author's own observations. The number of species in India he estimated at 10,000, belonging to 200 families. The latter part of the paper was occupied with a description of the vegetation of the lakes. Plants are in them excessively abundant, and eventually fill them up with their debris. The author thought that the deposits of vegetable matter in these lakes threw much light on the formation of coal.

Notes on the Irish Species of Robertsonian *Saxifrages. By* Professor Andrews.

The author having studied the Irish Saxifrages, and compared them with those of the Pyrenees, had come to a different conclusion from Mr. Babington, and believed that there were only two true species in Ireland, the *Saxifraga umbrosa* and the *S. Geum*. The other species described by Mr. Babington in his 'Manual,' he regarded as varieties of one or other of these forms.

Capt. L. L. V. S. Ibbetson exhibited a collection of electrotyped plants. Most of the specimens belonged to the family *Orchidaceæ*, but there were many specimens of other plants, and some fungi, with their forms beautifully preserved.

The process by which they were prepared was the ordinary electrotyping process; but various expedients were had recourse to, according to the nature of the plant. Some difficulty was experienced in sinking the plant in the solution of copper. This was always least in plants which were brought from hot-houses. The parts of the plants on the surface were perfectly preserved, and many of them retained their specific characters.

On the Increase of the Ergot upon Grasses. *By* R. G. LATHAM, *M.D.*

The increase of the Ergot upon grasses is real; not merely apparent, and referable to a greater amount of observations. Eight years ago, having found a single specimen upon the *Alopecurus pratensis*, the author sought for it carefully, autumn after autumn, but in vain, until 1842. Since then it has been abundant; being found on a variety of species, and over large areas. Of the eighteen species on which he has found it, it is commonest on the *Lolium perenne*, rarest on the *Hordeum murinum*. It was found last year for the first time on a water-grass, viz. the *Glycerium fluitans*. The *Phleums* and *Fescues* are very subject to it; so is the *Dactylis glomerata*; in other words, some of the best pasture grasses. The *Cynosurus cristatus* is remarkably free from it.

On the Turf of the Cambridgeshire Fens. *By the* Rev. L. JENYNS, *M.A.*, *F.L.S.*, *F.G.S.*

The remarks made by the author in this communication related principally to the fens in the neighbourhood of Swaffham Bulbeck, and to Iselham fen. It was stated that the Cambridgeshire turf was not formed of *Sphagnum*, like the peat found in many of the mosses in England and Scotland, but owed its origin to decomposed aquatic plants of various species associated with the remains of trees. This circumstance appears to have given rise to two kinds of turf, which are distinguished by the turf-diggers in the above districts by the names of *upper* and *lower*. The upper turf is much more compact and heavy than the lower, and generally of a darker colour, though sometimes with a peculiar reddish tinge: this is the best turf for common fires, and burns to a white ash. The lower turf is lighter and lighter-coloured, and its texture becomes more loose and spongy the lower it is dug: this is the best for ovens (though now the only turf used in some places from the scarcity of the other kind), and burns to a red ash. These two kinds of turf appear to pass gradually one into the other, the lower consisting almost entirely of the bark, wood, roots, and branches of former forests, above which the upper has been formed afterwards, and deposited in successive layers. The thickness of the whole bed is very variable. In Swaffham Bulbeck fen it runs, perhaps, in general from two to five feet. In Iselham fen the deposit of upper turf (which is also much more heavy and compact in that locality) is considerably thicker: the men there sometimes dig eight turf deep, each being fifteen inches in length; this however is an exception to the rule, and seldom met with.

The trees which are met with at the bottom of the moor, and which rest immediately on the clay, consist chiefly of oak, yew, hazel and willow. It is said that in Iselham fen they occasionally find the fir and the vine also. The stems of the larger oaks are sound at heart and black throughout, though with the surface somewhat decayed, and presenting an appearance as if charred. But many of the smaller trees, or portions of them, are quite spongy, and may be cut as readily with the knife as soft cheese: these are not unfrequently found penetrated through and through by the rhizoma of the common reed (*Arundo phragmites*) now growing in the fen.

The two sorts of turf above distinguished are not always found together. The upper exists without the lower in localities in which there are no buried trees to have given rise to the latter; but wherever the lower is found, the upper has always existed above it formerly, though now the upper has been so much removed in some districts by digging that the lower alone remains. As the upper turf is due to the decay of aquatic plants in a soil saturated with water, there would be nothing to prevent its growth at the present day if the condition of the fen remained unchanged; but in fact, from repeated drainage, the fen is now much too dry in most places to allow of the turf growing to a sufficient extent to compensate for the large quantity dug for fuel. It is the opinion of the turf-diggers at Iselham that formerly the turf grew about twenty inches in sixteen years (twenty inches being the length of a full-sized turf when first cut). The lower turf, consisting entirely of the remains of trees which grew in the spots in which they are now found before the fen was formed, it is evident, can never be renewed when removed. Hence the time is not far distant when, in some localities, the supply of turf for fuel must fail altogether.

The principal plants observed first to show themselves in pits from which turf has been dug, and which appear to assist greatly in its formation, are the *Chara hispida* and *C. gracilis*, *Utricularia vulgaris*, *Nymphæa alba*, *Potamogeton* (various species), *Sagittaria sagittifolia*, and *Alisma ranunculoides*. The *Chara* and *Utricularia* especially seem well-adapted for causing a rapid accumulation of vegetable remains by the constant decaying of their stems at bottom, while their upper extremities continue to make fresh shoots. After, however, the accumulation has proceeded to a certain extent, the pits are so far lessened in depth that at the present day the water no longer stagnates there in summer. A different kind of vegetation in consequence then takes place. The above plants make way for various species of *Junci*, *Carices*, and other grasses, which tend rapidly to fill the pits up, but which, growing above the level to which the fen is now saturated with water, are not subjected to the conditions under which alone the formation of turf is possible.

On Fizeau's *Process of Etching Daguerréotype Plates, and its Application to Objects of Natural History. By* A. Goadby.

In a Daguerréotype portrait, the black parts of the plate consist of silver, the white of mercury, and the intermediate tint of a mixture of the two, the degree of darkness or light depending upon the excess either of the silver or of the mercury. In converting a Daguerréotype into an engraved plate, it is necessary to etch away the dark parts and to leave the white untouched. This is done by immersing the plate in a fluid, consisting of dilute nitric acid, nitrous acid, chloride of sodium, and nitrate of potash. The nitric acid is so far diluted, that no decomposition can take place until the mixture is heated, when the chloride of sodium and nitrate of potash are decomposed, and chlorine and nitrous acid are evolved. These attack and remove the silver of the *dark* portions of the plate, but have no effect on the mercury, so that the *lights* or the picture, being the mercurialized portions of the plate, constitute the *etching* ground, and effectually defend such portions of the Daguerréotype from the influence of the corroding fluid. After a time, those portions of the plate that have been acted upon by the chlorine, &c. become covered with a protecting coat of the chloride of silver: this must be removed by dilute liquid ammonia, when the biting may be continued by a fresh supply of the mixed acid. Grease and foreign matter must be removed by repeated washings in dilute acid and alkali, and by boiling in caustic potash. These cleansing operations must be repeated after every biting, after washing out the chloride of silver by the ammonia. The plate being thus bitten, but in a slight degree, is to be inked after the ordinary manner of engravers, and allowed to dry; the surface of the plate is then to be thoroughly polished, the ink still remaining in the corroded portions of the plate. It is now to be gilded by the electrotype, those parts alone receiving the gold that have been previously polished. The ink is then to be dissolved out of the hollows by potash: the parts that are gilded now constitute the etching-ground, instead of the mercury, and the biting may be henceforth continued by nitric acid, in the customary usage of engravers. The plate thus etched generally requires to be finished by the hand of the engraver, who has the advantage of a *perfect*, although *faint* picture to work upon. The amount of labour which he must bestow will depend upon the goodness of the Daguerréotype and the success of the etching. M. Claudet has fully established the successful application of this process to the purposes of illustrating natural history, by copying from nature and engraving several delicate and difficult dissections of the lower animals, particularly the nervous system of *Aplysia* and *Tritonia* (the latter much magnified), and the nutrimental organs *in situ* of a caterpillar. [These preparations, together with the engravings of them, were submitted to the examination of the members.]

On an Apparatus for Measuring and Registering two dimensions of the Human Frame, the Height of the Body and the Space from the extremity of the Fingers of one Hand, to the extremity of the Fingers of the other, the arms being extended horizontally. By Joseph Bonomi.

The adoption of the measurements proposed, the author contends, will furnish a more accurate means of identification than the method now in use, and at the same time give important data for ethnological inquiry. The apparatus consists of two graduated scales, each fitted with a sliding gnomon. Taking the corner of the room as a convenient perpendicular, the scales are fixed against the wall at a certain distance from the floor and corner of the room and at certain angles.

On the Ethnography of America. *By* R. G. Latham, *M.D.*

It is considered that the line of demarcation drawn between the Esquimaux languages and those of the rest of America is too broad and definite. The same remark applies to the Esquimaux tongues and those of Asia. By exaggerating these distinctions the *primâ facie* view of the Indian population of America has been disturbed. Further complications have also been introduced, by insisting upon the general grammatical *analogy* between the American languages as a point of *contrast* to the difference in their glossarial details. There is however for the whole of America, North and South, a glossarial as well as a grammatical affinity.

The Esquimaux, Athabascan, Colooch, Oregon, Californian and Mexican groups run so much into each other that no definite line of separation can be drawn. These, dealt with *en masse*, have general affinities with the Algonkin and Iroquois groups. Isolated tongues, like the Blackfoot, Riccaree, Uchee, &c., have miscellaneous affinities with the American tongues in general, and contain Esquimaux words proportionate to the extent of their vocabularies. The North and South American tongues pass into each other. No South American tongue is isolated in the way that the Basque is isolated in Europe. Even the Warow and Fuegian have words common to the other groups, and to the Esquimaux.

On the side of Asia the languages most akin to the Esquimaux are the Curule, Corean and Japanese; after these the Kamskadale, Koriack and Jukageer. Still, the affinity (although undoubted) is less close on the Asiatic than the American side. The difference between the American numerals is explicable on the following hypothesis. Where we count by pure abstract terms like *one, two, three*, &c., there is a greater uniformity for the numerals than for other words; whilst in those ruder languages, where we count by *common* names, as *pair, couple, leash,* the numerals differ where the rest of the language coincides.

On the Ethnography of the Chinese and Indo-Chinese Nations. *By* R. G. Latham, *M.D.*

The distinction between the languages of Thibet and China, as exhibited by Klaproth, must be only provisional. Over and above the grammatical analogy there is an absolute glossarial affinity. Of the languages of the transgangetic peninsula the same may be asserted. Where languages are monosyllabic slight changes make palpable differences. The vocabularies of Brown, for more than a score of the Burmese and Siamese tongues, have provided us with data for ethnographical comparisons. By dealing with these collectively, we find in one dialect words which had been lost in others. The Chinese, Thibet, Bhootan, Burmese, Siamese, and all the so-called monosyllabic languages hitherto known, are allied to each other. The general affinities of the Indo-Chinese tongues are remarkable. With Marsden's and Sir Stamford Raffles's tables on the one side, and those of Brown and Klaproth on the other, it can be shown that a vast number of Malay roots are monosyllabic. The Malay languages are monosyllabic ones, with the superaddition of inflections evolved out of composition, and euphonic processes highly developed.

The next class of tongues akin to the monosyllabic is that of Caucasus. The numerous languages of this class have long been reduced to four groups; the Georgian, the Lesgian, the Circassian, the Mizdzhegi. That these four are fundamentally one, may be seen from Klaproth's tables, whose classification seems only provisional. These tongues, dealt with *en masse*, have their affinities with the monosyllabic tongues. As with the Malay language, the monosyllabic character is modified by the evolution of agglutinational and inflectional processes, but not much by euphonic processes. An original continuity of language, displaced at present by the Turkish and Mongol, is thus assumed for parts between Caucasus and Thibet.

On the present state of Philological Evidence as to the Unity of the Human Race. *By* R. G. Latham, *M.D.*

The languages of America are radically one, compared both with one another, and with those of the north-east of Asia, viz. the Kamskadale, Koriack, Curile, Corean, Japanese. The particular language of the Othomi inhabitants of Mexico, which has been considered as monosyllabic and isolated in character, forms no exception to the previous statement.

A monosyllabic basis of separate words is provisionally assumed as the fundamental element out of which inflections are evolved by agglutination and amalgamation. This makes it possible that poly-synthetic tongues, like the American, may be represented in their earlier stage by monosyllabic tongues like the Chinese. Glossarial investigations confirm both these views. There is a radical unity for the different Siberian groups of the Asia Polyglotta, *e.g.* Yukageer, Yenesean, Samoeide, &c., and *à fortiori*, for the Turk, Mongol, and Manchoo groups. Each and all of these have affinities with the monosyllabic tongues, and through these with the Malay and Caucasian.

Polynesia presents the first appearance of isolation, in the languages of New Guinea, Australia, &c., *i. e.* the Negrito tongues. The philological evidence of their being akin, either to the Malay or Tamul languages, is at present indefinite and inconclusive.

Southern India, and the Indian hill-ranges, present the first appearance of isolation in the languages of Continental Asia. Although unplaced they can scarcely be called isolate.

The African languages have a fundamental unity; philological processes and extended comparisons being sufficient to account for the apparent peculiarities of the Caffrarian tongues.

Europe presents unplaced languages in the Basque and Albanian—unplaced, but not therefore isolate. The higher groups that should contain divisions like the Semitic and Indo-European, &c., have yet to be evolved. These, along with positions for the Basque, Albanian, and Tamul languages, and affinities for the Negrito and African languages in general, are the present *desiderata*. The philological unity of those portions of the human race of which the languages are known, although highly probable, has yet to be exhibited in a definite and conclusive form.

On the Migratory Tribes of Central India. *By* E. Balfour.

It has not been ascertained how many wandering tribes there are: the author confined himself to the description of the manners and habits of seven. Although in many respects they are similar to each other, still there are differences which have interest in an ethnological point of view.

Dr. King exhibited, on the part of Mr. John Brown, a drawing of a specimen of gold casting as illustrative of the state of art of the inhabitants of New Grenada prior to the conquest. It represented the human figure sitting. The original was of fine gold, and weighed 1 oz. 18 dwt. 18 grs.

On the Moral and Intellectual Character of the New Zealanders. *By* Dr. Martin.

The New Zealander may be classed in that stage of man's progression when the indications of sense are not altogether corrected by reflection and intellect; when passion is somewhat tempered, but not controlled by moral and religious feeling; when hatred is stronger than benevolence, and self-love is unrestrained by conscientiousness; when, in fact, the mere intellectual perception of self-interest is the chief regulator of the conduct. As far as mere perceptive faculties are concerned, the New Zealander may be said to be inferior to Europeans, but superior to many other uncivilized people. The New Zealander is a paradox in every light in which we regard his moral character. Religion, veneration, or superstition, are the strongest feelings, and yet they are, in most cases, unaccompanied by conscientiousness, which is so essential to the formation of a moral and religious character. He has laws which define conduct, but they are founded on self-interest, superstition or vanity. Truth and moral feeling cannot be traced as elements in any part of his conduct or customs. His excessive vanity and want of truthfulness make him boastful, and tend to give an exaggerated character to all his statements. Individual quarrels or combats are of rare occurrence; while the most extraordinary disregard for life will be found to exist without courage. Notwithstanding the general character of the New Zealander for benevolence, he is destitute of natural affection as a feeling: neither the parent nor the child cherish towards each other any of that strong regard which is natural to, and frequent among Europeans. His social morality is low, the absence of virtue not being considered even a disgrace, much less a crime.

On Cretinism. By Dr. Twining.

Dr. Twining first described its forms and degrees. Marsden saw goitre in the valleys of the Ural, Baikal and Caucasian mountains; Forbes in the Himalaya, and M'Clelland in the Shore Valley. Sir G. Staunton saw cretins in the narrow valleys of Tartary, and that they lead a mere animal life, acting alone from the impulse of their senses. In Africa there are only two parts known where goitre occurs. Leo Africanus saw goitre in the high mountains of Atlas in Morocco, and Mungo Park among the Kong mountains in Bambara. Of cretinism in America we have fuller accounts. Richardson saw goitre and cretins on the banks of the Saskatchewan, and near the sources of the Elann and Friedeu rivers. Prof. Barton states goitre to be prevalent at Oneida among the Americans and the Dutch settlers, and in all the State of New York, near the Mohawk river. It occurs also in Lower Canada, in marshy districts. In South America goitre occurs independently of cretinism in Nicaragua and Sante Fé. Humboldt saw the most frightful cases of goitre on the Magdalena river, and chiefly higher, to the elevation of 6000 feet above the sea, on the high plain of Bogotà, and states that the copper-coloured natives were generally free from goitre. It occurs also in Quito and the Onachiffa Valley near Lima, under various atmospheric influences, and on the Corderillas. In the Villarica Valley, in Brazil, 4000 feet above the sea, goitre is frequent, not only in man but animals, as the goat; and many villages are filled with cretins. Prof. Pöffig states that in the Andes in Chili, on the east side, in some races he did not see a case of goitre; and yet in the white inhabitants, who live exactly as the natives, it prevails in a great degree. On the Andes, between Santa Rosa and Mendoza, the peasants dwell on the west side as high as 7000 feet above the sea, and on the east to 6000 feet, and are free from goitre, but lower, at 3500 feet, goitre is endemic. The nature of the formation seems to have no direct influence as a cause of cretinism, as cretins are found on all. It would seem that where the springs come from the limestone, goitre is most frequently endemic; but as in many villages where goitre and cretinism prevail there is no lime, it cannot be the sole cause. Dr. Twining concluded by expressing a hope that the many travellers there assembled would, when investigating the geology or the races of the high mountain chains, not forget the state of the inhabitants of the valleys with regard to cretinism. That cretins can become healthy and intelligent has been proved by Dr. Guggenbühl, in the success that his benevolent exertions at the Hospital for cretin children, on the Abenberg, near Interlachen, have met with; but it can only be by the united efforts of many that a scientific account of cretinism can be attained. In order to facilitate such inquiries, Dr. Twining suggested the following method: first, to state the name of the place, its situation and elevation above the sea, and the race; secondly, the geological formation, springs and climate; thirdly, the state of the houses and the habits—whether goitre only prevails, or is accompanied by cretinism.

On the Natives of Old Calebar, Africa. By Professor Daniell.

The natives, although of Eboe extraction, present some physical deviations that serve to distinguish them from other tribes of a similar derivation. The natives of the Bonny Mun, who are purely of Eboe descent, and therefore less mixed with the people of other nations, may be taken as the typical illustration to institute comparisons. They are generally of a short stature, slight form, and light yellow skin. The trunk and other portions of the body are in conformity with this physical configuration, being somewhat robust and symmetrical in mould, with a tendency to great muscular development. The hair of the head of girls is invariably shaved off, with the exception of a small tuft, and is not suffered to grow until they are married; it is then twisted into a number of plaits decorated with beads. Portions of their frame, and particularly the face, are tattooed in circular figures, and the anterior surface of the arm, in men as well as women, is ornamented with round smooth cicatrices of the size of a shilling. The government of this people is a monarchical despotism, rather mild in its general character. They destroy their criminals by poisoning, drowning and decapitation. A simple contract between the parties constitutes the law of marriage; and prior to their residing finally together, they sit in state for several days, well-attended and in gaudy attire. Polygamy exists amongst them in full force. Adultery is atoned for by a dreadful death. Among their funeral rites is that of immolation, on an enormous scale, of men, women and children; and so fearful in former times was the observance of this custom, that many towns narrowly escaped depopulation.

Dr. King reported that in the Journal of General Miller, Consul-General for the Pacific, which had been forwarded to him, light was thrown upon the manners and habits of the South Sea Islanders, and upon many of the complicated or debated problems connected with the population and its intermixture with the Red man of America; upon human sacrifice, cannibalism and infanticide; and upon the effect of isolation and savage solitude upon runaways from ships and from convict labour. Lengthened extracts from General Miller's Journal, upon these several points, were read.

On the Egyptians and Americans. By the Marquis di Spineto.

On certain Traces of Roman Colonization in Lancashire. By Dr. Black.

From historical notices and inferences, conjoined with the affinities mentioned to have existed between the social institutions and languages of the Saxon conquerors and other contemporary emigrants and those of our Briton-Frisians, Dr. Black concludes that the latter would mostly remain in the country, become amalgamated in spirit, action and habits with the newly imported tribes from Germany, rather than seek to keep up a forced conventional polity with their old neighbours, the Britons. They would indeed soon become incorporated with the Saxons; take with them their fate as a nation; and from their numbers in the south of Lancashire, would probably constitute the greatest portion of the population. That many of the inhabitants of this district, especially in the inland and rural parts, have long, and to this day, shown a distinctive variety of form, feature and vernacular dialect from those in the other parts of England, has been remarked by not a few observers. And the man of Heaton and the dark-eyed Lancashire witch still maintain—the one for the picturesque in manners and speech, and the other for her characteristic beauty—their wide-spread distinction among the hardy sons and fair daughters of England.

Tables illustrative of the Height, Weight and Strength of Man. By Mr. Brent.

It appears that there are in 100 Englishmen of all classes:—

6 ft. to 6 ft. 3 in. (very tall)	4	
5 ft. 9 in. to 6 ft. (tall)	26	
	—	30 tall.
5 ft. 6 in. to 5 ft. 9 in. (middle height)		40
5 ft. 3 in. to 5 ft. 6 in. (short)	26	
5 ft. 0 in. to 5 ft. 3 in. (very short)	4	
	—	30 short.
		100

In 100 Paupers in Marylebone Workhouse.		In 100 persons deceased.		In 100 Amateur Rowers.		In 100 Cornish Wrestlers.	
Tall	7	Tall	19	Tall	94	Tall	63
Middling	26	Middling	37	Middling	6	Middling	30
Short............	67	Short............	44	Short............	0	Short............	7
	100		100		100		100

From a calculation of the weight of the Venus di Medicis at different heights, from 4 ft. 6 in. to 6 ft. 9 in., her weight, supposing her height to have been 5 ft., and her dress of the ordinary kind, would be 8 stone 9 lb.—being in the same class with the Discoboli. From a calculation of strength in different classes from slender to exaggerated, the Hercules Farnese being in the exaggerated, the Gladiator being in the middle class, taking the strength of a slender man at 100, that of the Gladiator would equal 173; the Hercules Farnese 362 at the same height.

On Dr. Kombst's *Ethnographic Map of Great Britain and Ireland. By* J. M. Kemble, *M.A.*

On Local and Hereditary Difference of Complexion in Great Britain, with some Incidental Notice of the Cimbri. By the Rev. R. Williams.

Mr. Williams commented on the fact, that in two districts of our island, the same strongly-marked variety of complexion exists which was observed by Tacitus seventeen centuries ago. The primary agent of change was climate; which influenced first the skin, next the hair and eyes, and lastly, with the co-operation, perhaps, of other agents, changed the configuration of the skull. Next to our own climate, that of our ancestors, or the effect of *race*, was to be considered. It had been attempted to explain the xanthous complexion of the Scotch Lowlanders by supposing them originally Gothic, and the darker hues of the S.W. Silurians by calling in the aid of Iberian intermixture. The last was wrong; for as the language of the Welsh contained no Basque element, their physiology could not have been influenced by Biscayans. The former idea had been partially refuted by Chalmers; and looking to the names of the Pictish kings, of places in the Lowlands, comparing the Welsh Aber with the Gaelic Suver, observing the intelligibility of Aneirin's poems among the Britons of the Clyde and those of South Wales, we must conclude that the whole western side of the island, from Glasgow to Cornwall, was inhabited by a people throughout akin, if not absolutely identical. Neither was it true that the Celts could be classed as dark, and the Teutons as xanthous. All ancient authors, and especially Strabo, made the Celts also xanthous. Strabo even thought their usages alike, and their blood akin to the Germans. He called the Britons of greater stature and less yellow-haired than the Gauls. On the whole, this singular phænomenon of a people *homoio*, if not *homo-glottous*, yet differing physiologically so much as the Caledonians and Silurians, and their respective successors at this day, might be referred to the well-ascertained custom of the Celts of migrating in two large divisions, as in the case of Brennus, &c. One division, leaving the Caspian, entered Europe by the Euxine, and the other by the Mediterranean; one acquired the characteristics of a Northern, the others retained those of an Oriental people. Mr. Williams proceeded to show, by tracing various names, that the whole people from Glasgow to Cornwall called themselves Cimbri, or Cymry. This people comprehended the Belgæ, and (excepting only a Teuton inlet from the succeeding tide of population which forced itself along the Rhine) they must have extended from Denmark and the mouth of the Elbe across Belgic Gaul and England to Wales. It was very important to observe that they were not hybrid, but yet formed, in blood and in language, as in geographical position, the connecting link between the Irish Celts who preceded, and the Goths who came after them. Adelung's idea of the Cumraic containing a Gothic infusion arose from the old fallacy of the Celts and Goths being radically alien; whereas one family of languages extended from the Caspian Sea to Ireland and Portugal on the west, and to the extreme of India on the east. Certain peculiarities in the Celtic and Cumraic arose from the very early date at which they successively broke off from the præ-Sanscrit stock.

Sir R. Schomburgk gave a verbal account of the superstitious and astronomical knowledge of the Indians of Guiana, which agreed with the same kind of knowledge current amongst the rest of the uncivilized portion of the globe.

On the Ancient Tumuli in the Yorkshire Wolds. By the Rev. T. RANKIN.

MEDICAL SCIENCE.

Results of Researches on the Scrofulous Tubercle which had reference to its Vascularity. By* Dr. FISHER.

ALL the cases which the author brought forward were illustrated by coloured drawings. He treated of two kinds of tubercle: the one developed in the subserous cellular tissue, as for instance between the laminæ of the mesentery, or between the peritoneum and the muscular coat of the intestine; the other formed at the expense of the parenchyma of an organ, as for instance the lung, a lymphatic gland, &c. In the first case, according to Dr. Fisher's observations, the morbid product would seem, at a certain period of its development, to become surrounded by blood-vessels comparatively large in calibre, and apparently of a new order, which converge towards the tubercle, somewhat after the fashion in which the spokes of a wheel are directed towards its nave. In the second case, where, for instance, the tubercle is seated in the lung, the nutritive vessels of that organ, *i. e.* the bronchial arteries, would appear to assume around the morbid product an increase not only in size, but also in number. The semi-transparent form of tubercle, especially as it is found in lymphatic glands, would appear to be the one most richly endowed with vessels: the latter are much less frequently met with in the opake caseous form; still, in several instances, vessels artificially injected were shown to enter the caseous tubercle, towards the centre of which they appeared to tend.

On a peculiar form of Epidemic affecting the Teeth and Gums of young Children, observed in Dublin in the Winter of 1844–45. *By* JAMES F. DUNCAN, *A.M., M.B., F.C.P. in Ireland, &c.*

This peculiar disease was observed among the children of the North Dublin Union Workhouse, an institution containing nearly 2000 inmates of all classes, and averaging usually from sixty to eighty infants under two years of age, to which the author has been physician since its opening, five years ago. Until last winter he had never observed anything approaching in character to the present affection, of which he met with eight or nine cases. The attack was ushered in by considerable fever, and after an interval of some days the gums were found to be partially ulcerated at the insertion of the teeth, the fangs being exposed; they became also swollen, red and spongy, and exhibited a considerable tendency to bleed, insomuch that hæmoptoe occasionally resulted from this cause. The disease was very severe, and in most cases, either directly or in consequence of a relapse, terminated fatally. It seemed to be essentially only a part of a deeper-seated affection, namely, an enteritis of a most extensive and severe kind. Its importance however, in a pathological point of view, arose from the liability to confound it with that ulceration of the gums which is the consequence of the administration of mercury. In some of these cases no mercury whatever had

* The presence of this tubercle in the lungs is the chief cause of the pulmonary symptoms in consumption. Dr. Fisher read a paper before the Cambridge Philosophical Society on this subject in 1835.

been used, and in none was the quantity sufficient to account for its occurrence. The importance of distinguishing the two affections must be obvious to every one. The diagnosis rests principally on the ulceration being partial and not general over the whole gums, as is the case in mercurial action, in the accompanying ptyalism being moderate in quantity, in the fœtor of the breath being destitute of the peculiar odour of the mineral impregnation, and in the tendency to hæmorrhage. This last seems to connect it rather with *Purpura hæmorrhagica* than with the former affection. The sanguineous discharges were not confined to the gums, but extended also to the rectum and intestines; and the author related a remarkable case of two children, one of whom had the affection of the mouth and the other *Purpura hæmorrhagica.* But the importance of the diagnosis is still further shown from the circumstance that in this disease mercurial remedies can be administered, not only without risk, but even with advantage. The treatment found of greatest benefit was not local but constitutional. The former seemed to exercise very little impression even upon the parts to which it was applied; the latter alone was productive of relief. Acidulated infusions of bark and calumba were particularly serviceable, but the application of a tolerably large blister over the abdomen after it had been stimulated by the mustard poultice, and left on for about an hour, was more effectual in checking the accompanying diarrhœa, lowering the fever and improving the general condition of the patient than anything else.

On the Influence of Galvanism on Endosmose and Exosmose. By H. B. Leeson, *M.A., M.D.*

Whether endosmose and exosmose are dependent on electricity, capillary attraction or chemical affinity, or on some mechanical condition having relation to the magnitude of the particles of the fluids, subjected to its influence and to the pores of the membrane through which they pass, has not at present been satisfactorily determined.

The first idea of Dutrochet, that electricity was the more immediate cause*, is now generally abandoned; nor can we be surprised that Dutrochet himself should have felt some misgivings on the subject, if we refer to the experiments of Porrett and himself, on which that opinion was founded.

The author entered into an examination of these experiments, and then proceeded to explain those in which he is at present engaged. After adverting to the fact now familiar to most persons accustomed to the use of the sustaining galvanic battery, viz. that the liquid on the one side of the porous diaphragm was considerably increased or elevated by the action of the battery, the author explained that such increase could not depend, as had been supposed, upon any mere variation of the specific gravity of the fluids, inasmuch as that the height attained by the liquid, as exhibited in the arrangement of an experiment then exhibited, was much greater than could be due to any alteration of specific gravity, and amounted in some of the author's experiments to several feet. The author then alluded to his experiments, as proving that endosmose and exosmose were greatly promoted by electricity, more especially observing that sulphuric acid, a substance mentioned by Dutrochet as inimical to the influence of endosmose, was in the experiment before them rendered amenable thereto. The author also observed, that although endosmose and exosmose may be induced without any galvanic influence, and are not therefore absolutely dependent upon it, still, inasmuch as the action took place more readily under the influence of the current, and almost ceased when the current was interrupted, we must conclude that endosmose and exosmose are powerfully promoted by it.

The great amount of force or motion generated by the action of endosmose and exosmose was then observed. Endosmose and exosmose continually going on in so many parts of the animal œconomy may be regarded as equivalent to the continued action of a condensing and exhausting syringe, and probably contribute to promote the action of the heart, as stated by the author some years ago in a thesis upon the blood, read by him at Oxford.

The author then adverted to the relative alkaline and acid state of the fluids secreted from the surfaces of different membranes, as presenting conditions favourable to the production of galvanic currents. The author also adverted to the experiments of

* "Ainsi l'endosmose et l'exosmose dépendent entièrement de l'électricité."—*L'Agent immédiat du Mouvement Vital,* 1826.

Matteucci, Galvani and others, as showing that the elements necessary for the production of electric currents exist in animals even where there is no special organization, as in the torpedo, &c.

The author concluded by adverting to the importance of further investigation in relation to this subject, since the healthy performance of all the important functions of the animal œconomy are dependent upon it.

On a new mode of Suture, applicable to Plastic Operations. By CHARLES BROOKE, *M.B., F.R.C.S.E.*

The inconvenience frequently experienced by surgeons in the application of the ordinary modes of suture is that of the stitches cutting through, and therefore failing to keep in contact the parts to be united. In this, the improvement consists in placing two smooth, flat glass beads on the ends of the ligature and securing them by knots, by which the parts may be held together as long as may be required without any tendency to produce irritation or ulceration. The mode of application may be thus explained:—A piece of ligature silk with a knot on one end is doubled, and the loop passed through a bead. A needle of suitable form, having a notch near the point, is then passed through the sides of the fissure to be united; the loop of the ligature is then placed in the notch and the needle retracted, bringing the loop with it. A second bead is then placed on the loop, which is afterwards divided; the two threads being now separate, a knot is tied on the end of that one which has no knot at the other end, and by drawing the two free ends of the threads, the parts intervening may be brought into close contact, and may be maintained in that position by placing knots on the free ends, close to the beads, and thus preventing the latter from receding from each other; at the same time the portions of integument intervening between the beads are not subjected to any pressure whatever.

For external application of the suture, a needle slightly curved at the point is most suitable. For internal application, when the direction of the edges to be united coincides with that of the handle of the instrument, as in a longitudinal fissure in the vagina, a spirally-curved needle is requisite: when the direction of the edges is nearly perpendicular to that of the instrument, as in the posterior part of a cleft palate, or a transverse fissure in the vagina, a moveable needle is most suitable. The principal difficulty attending the internal application of the bead suture, has been the placing the last knots close to the beads, to prevent their receding from each other: this may however be effected by a small conoidal roller at the extremity of a handle, on which the loop forming the knot is placed, and carried on to any required point; it is then tightened by a little fork attached to this instrument, wide enough to receive the thread only. By these means any number of knots may with facility be placed on the same thread close to each other, when entirely out of reach of the fingers.

In order to render the description of the operation complete, it must be remarked, that in the application of external sutures, as in cases of hare-lip, it is generally found desirable to pare the edges with the scalpel, and union by first intention will probably be obtained: in internal sutures, the edges will be much more easily and evenly pared by lightly touching them with potassa fusa, and the needle immediately applied, without waiting for the separation of the superficial slough. To the latter mode of treatment it may be objected, that union can thus be obtained by granulation only; this is not however an objection of any validity, as it is the peculiar property of this suture to hold the parts in contact until sufficient time has elapsed to render the union by granulation complete. A detail of the cases illustrating the advantages of the *bead suture* will be more suitable for a purely medical publication.

On the Communicating Fibres of the Brain in reference to Thought and Action. By THOMAS LAYCOCK, *M.D.*

Dr. Laycock stated, that he considered those views correct which looked on the brain as an extensive periphery of nervous matter, analogous to that on the surface of the body. On this periphery sensorial changes are excited, first, by incident excitor impressions derived from without—the external periphery; secondly, by impressions derived from other portions of the brain—the internal periphery. There was thus a set of intercommunicating fibrils between all parts of each symmetrical half of the brain and spinal cord. Dr. Laycock showed that this intercommunication actually took place in the ganglia of the spinal cord, an impression being diffused through all parts of the ganglia. Dr. Laycock showed that this view of the internal mechanism of the brain explains those cases of paralysis in which the muscles act normally under certain conditions, as, for example, when an individual cannot speak what he thinks, but is able to read aloud, or repeat what is spoken. Dr. Laycock was of opinion that in such an example there was no interruption of continuity between the auditory and optic nerves and that part of the brain which subserves to language, nor between the latter and the anterior or motor tract of the medulla oblongata; but that the cause of the vocal paralysis experienced when the individual attempted to express his thoughts, was an interruption of continuity of the fibrils communicating between the portions of the brain, or internal periphery, subservient to thought and that subservient to language.

A Drawing, representing the appearance of the Surface of the Heart in a case of Purpura hæmorrhagica, *presented by* T. S. Wells, *Assistant Surgeon, Naval Hospital, Malta.*

The subject of the disease was a strong, able seaman, aged twenty-seven, who died eight days after the first symptoms presented themselves. The author presented the drawing as exhibiting a morbid change extremely rare, and seldom noticed by pathologists, Dr. Himmelstein, a physician in the Russian naval service, being the only author known to the writer of the paper who has remarked changes at all similar.

On the State of the Deaf and Dumb. By Dr. Fowler.

Dr. Fowler communicated some further particulars relative to the case of the woman who was blind, deaf and dumb, in Rotherhithe workhouse. Her faculties have much improved by education; she is now occupied by employments and surrounded by enjoyments, which a few years ago appeared to be utterly impossible under her peculiar deprivation. Dr. F., in continuation, made a few observations on the mental faculties of animals in reference to those of man; the chief inferiority he described as the absence, in animals, of all ideas of *relation* and the combinations resulting from it.

Notice of an Apparatus for delineating correctly the relative position and size of the Viscera, either in the Healthy Condition or changed by Disease. By Mr. Sibson.

This apparatus consisted of a square frame, covered by transparent lace or muslin, which will permanently bear chalk-marks. By taking the outlines of the objects to be sketched (deformities, well-marked conditions of thoracic or abdominal viscera, &c.) on the surface looking perpendicularly at the object, a correct outline is easily produced even by those who are not artists; this sketch can be readily transferred to paper by pressure, and if necessary may be reduced by the application of the pentagraph. Mr. Sibson gave an illustration of its use by making sketches from the living body, and entered into numerous pathological details to show the importance of frequent delineation to ascertain the progress of internal and external disease during treatment.

On Cranial Vertebræ. By Dr. Macdonald.

The author commenced by enforcing the value and necessity of the study of what had been termed Transcendental Anatomy. After alluding to the labours of the foreign and British investigators of the subject, Dr. Macdonald laid down the elementary parts forming a vertebra, which he stated to be, first, a body forming part of the *caulis centralis* of the vertebral column; secondly, the posterior laminæ, which meeting on the mesial plane form the arch of the vertebral canal, having the spinous processes more or less developed: each lamina is again subdivided into three elementary divisions, which he denominates protomeral, deutomeral, and tritomeral; besides these there are, thirdly, anterior laminæ connected with the *caulis centralis,* exemplified in the ribs and part of the pelvis, and also in the bones of the face. Retaining these divisions of each vertebra, the author described the cranial vertebræ as three pairs arising from the spine: first, the occipital; secondly, the sphenoidal; thirdly, the ingrasioethmo-frontal; by attentively examining the component laminæ of these vertebræ, he identified all the usually described portions of the cranium. The facial bones he resolved into two pairs of vertebræ: first, the superciliary; secondly, the adnasal. By a minute demonstration the author endeavoured to establish the details of his system which he contended was applicable to all the zoological classes, and as well-marked, in the insect tribe as in the mammalia.

Notice of an Instrument to assist in the discovery of Foreign Bodies by Auscultation. By Dr. BROOKE.

It consisted of a catheter or sound, with a circular sounding-board, six inches in diameter, attached perpendicularly at its extremity, which increases the sensation derived from the contact of its other end against a small calculus or fragment after lithotripsy, which might otherwise escape detection, and lay the foundation of future disease. The effect of the sounding-board was demonstrated. A sound produced by the contact of a small fragment in a small bag, which could scarcely be heard by the holder of the instrument without the sounding-board, became perfectly audible on its application.

Dr. Leeson presented and described an apparatus for minute injection.

Dr. Thurnam gave a short notice of a case of *Spina bifida*, the preparation of which he exhibited to the Section; it demonstrated the exact condition of the bones and ligaments of that portion of the vertebral column where the deficiency from arrest of development occurred.

STATISTICS.

On the University Statistics of Germany. By J. HEYWOOD, *F.R.S.*

THE details of these statistics were collected by Dr. Perry, who resided in the University town of Bonn on the Rhine, and who has taken the degree of Dr. of Philosophy at Göttingen. He stated, that in round numbers, there are 1500 professors in the German universities, and about 15,000 students. Dr. Perry ascribes the origin of duelling among the German students to their being permitted to wear swords as a badge of gentility; but the duels are generally of a harmless nature. Large numbers of students are attracted to particular universities in Germany by the lectures of eminent professors, and when a vacancy occurs in a chair of importance, the new teacher is often chosen on account of his reputation and success in some other university, so that he owes his fresh appointment to his own merit, independent of local influence.

On the Comparative Number of Degrees taken at Cambridge in the Seventeenth and Nineteenth Centuries. By J. HEYWOOD, *F.R.S.*

The comparison showed, that notwithstanding the general increase of wealth and population in Great Britain during the last 200 years, the number of degrees taken at Cambridge had not increased in a corresponding proportion. Thus, in 1620 there were 270 B.A. degrees conferred, and in 1820 only 183; in 1630 there were 291 B.A. degrees taken, and in 1830, 324; in 1640 there were 240, and in 1840, only 339. Nearly one-third of the students leave the university without taking a degree. Conversation ensued, and it was suggested that the more mature age at which students now enter was one cause why graduations have not increased in proportion to the population. Prof. Pryme observed that this might also arise from the comparative cheapness and style of living in ancient times. Mr. Heywood also presented a table of the comparative number of students in Trinity College, Cambridge, who go into lay pursuits and into the church. Of 1443 students admitted in ten years, from 1831 to 1840 inclusive, only 413 took out testimonials for deacons' orders, from which it follows that about two-thirds of the students of Trinity College are intended to be laymen.

On the Trade and Navigation of Norway. *By* R. Valpy.

[This was the abstract of a Report made to the Government by J. B. Crowe, Esq., Consul General for Norway.]

The chief exports are wood, fish, and minerals. The wood consists of deals cut in twelve-feet lengths, and balks either round or square. Proprietors of forests are under no restrictions as to felling; they generally cut down the trees in autumn or winter, and convey them to a river to be floated down the stream. The reproduction of the timber is believed to be equal to the consumption. Formerly England was the chief market for Norwegian produce, and had in return the almost exclusive trade in manufactures; but since the establishment of discriminating duties in favour of Canadian timber the English trade has fallen, and the consumption of English manufactures greatly decreased. Hamburg and the German States have become markets for Norwegian produce, and the manufactures of Germany have superseded those of England. The annual average quantities of timber exported in the seven years from 1835 to 1841 were 618,769 loads of 50 cubic feet, which, with firewood, hoops, and other less valuable timber, may be deemed worth 435,000*l.* The fisheries rank next in importance to the forest, and afford the chief occupation to Norwegian industry. The exports consist of stockfish, round and split, clip-fish, salted cod, and halibut, liver and shark oil, and live lobsters. Stockfish is chiefly exported to the Catholic countries of southern Europe. The exports fluctuate from the varying nature of the fishing trade, but in 1841 they were,—stockfish, 14,196 tons; clip-fish, 11,285 tons; herrings, 608,086 barrels; cod-roes, 20,217 barrels; liver and shark oils, 41,715 barrels; and 552,272 lobsters. Salmon for several years has ceased to be an article of export. The disappearance of this fish is attributed to the swarms of sharks which have recently taken possession of the banks off the coast. These were first observed in 1841, and in 1842 eight vessels were fitted out for the new fishery, and captured no less than 20,000 sharks, without any apparent diminution of the supply. The quantity of oil obtained was about 1000 barrels. The mineral trade is not of much importance, but there is something curious in the fur trade, principally carried on with Russia. The greater part of the skins sold by the Norwegians are obtained from the Hamburg merchants, who buy them in London from the Hudson's Bay Company; the Norwegians convey them to Finmark, and from thence they are taken to Moscow and sold to the caravan traders for the purpose of being bartered with the Chinese for tea at Kiachta! The Norwegian shipping is on the increase, principally owing to the laws which require masters of vessels to give proof of their knowledge and skill by undergoing a strict examination.

On the Liability to Insanity at different Ages. *By* Dr. Thurnam.

The general conclusion was, that the liability to insanity does not, as is generally supposed, increase with years, but that it is greatest between the ages of twenty and forty, and that it subsequently gradually diminishes. The author also adduced facts which appeared to warrant the conclusion, that in some countries and communities the liability to mental disorders is greatest between the ages of twenty and thirty; whilst it is usually highest during the decennial period from thirty to forty years.

Sketch of the Progress and present Extent of Savings Banks in the United Kingdom. *By* G. R. Porter, *F.R.S.*

After a few preliminary remarks on their political and moral value, he stated that these institutions owed their origin to Miss Priscilla Wakefield, who in 1804 induced six gentlemen residing at Tottenham to receive deposits from labourers and servants, paying 5 per cent. as interest. Four years later eight persons, half of whom were ladies, took upon themselves the same responsibility at Bath. The first savings bank regularly organized was formed at Ruthwell, Dumfriesshire; its success led to many imitations, so that before any legislative provision had been made for their management, there were seventy savings banks in England, four in Wales, and four in Ireland. In 1817 an act was passed to encourage banks of savings in England and Ireland, but it was not extended to Scotland until 1835. Tabular statements of the progress of these banks illustrated their great success, but we shall only take for comparison the returns of two years, 1830 and 1844:—

Years.	England.		Wales.		Ireland.		United Kingdom.	
	Depositors.	Amount.	Depositors.	Amount.	Depositors.	Amount.	Depositors.	Amount.
1830	367,812	12,287,606	10,204	314,903	34,201	905,056	412,217	13,507,565
1844	832,290	25,112,865	18,690	599,796	91,243	2,749,017	1,012,047	29,504,861

The deposits are found to be greatest in the years when provisions are cheap and abundant. Instead of giving the absolute numbers we shall quote the centesimal proportions of the different classes of contributors.

	England.	Wales.	Ireland.	Scotland.	United Kingdom.
Not exceeding £20	56·68	52·53	46·09	76·24	57·00
,, 50	25·46	31·01	36·94	17·82	26·08
,, 100	11·28	11·10	11·76	4·72	10·86
,, 150	3·94	3·52	3·35	0·93	3·67
,, 200	2·28	1·63	1·75	0·29	2·08
Exceeding .. £200	0·36	0·21	0·11	..	0·31

The average balances to the credit of each depositor in 1844 were, in England 30*l.*, Wales 32*l.*, Ireland 30*l.*, Scotland 14*l.*, and United Kingdom 29*l.* Tables were then given of the operations of the banks in the several counties. Next to Middlesex, Devonshire exhibited the greatest amount of deposits in proportion to the population, and this satisfactory result was attributed to the admirable management of the Exeter Savings Bank. Lancashire exhibited a very low amount of deposits, but this was explained by the fact that operatives find a more profitable investment for their money. Some fears were expressed of the effect of the reduction in the rate of interest; and the tables of classification of depositors formed by the Exeter and the Manchester Savings Banks were produced and recommended for imitation.

Statistical and Historical Account of the Ancient System of Public Charities in London. By J. Fletcher, *Bart., F.R.S.*

He stated that the necessity of systematic provision for the relief of the poor began to be felt after the suppression of the monasteries and the hospitals governed by monastic rule. In 1544 the site of St. Bartholomew was granted to the Corporation of London, but no provision was made for its endowment and government until 1548; and thus some provision was made for the relief of the sick and infirm. Christ's Hospital, for the education of destitute children, was founded in 1553, and about the same time St. Thomas's Hospital was established for the same purpose as that of St. Bartholomew. The next measure was to provide a place for vagrants and unemployed labourers. The petition sent by the Corporation to the King's Council stated, "it was too evident to all men that beggary and thievery did abound, and we, remembering how many statutes from time to time have been made for the redress of the same, and little amendment hath hitherto followed, thought to search the cause hereof, and after due examination had we evidently perceived that the cause of all this misery and beggary was idleness; and the means and remedy to cure the same must be its contrary, which is labour; and it hath been a speech used of all men to say unto the idle, Work! Work! even as though they would have said, the mean to reform beggary is to fall to work." In consequence of this petition Bridewell was established, and thus public charity was organized for three great objects—the relief of the sick, the education of the young, and the employment of the able-bodied labourer. The hospitals were supported by assessments levied on the citizens and the companies. By the charter of Edward the Sixth the government of these institutions was given to the Corporation of the City of London, but the chief power was seized by the Court of Aldermen. Mr. Fletcher then explained the causes that placed these institutions in the hands of self-elect governors, between whom and the corporation a kind of compromise was effected by Act of Parliament in 1782. But this Act only provides for the election of forty-eight governors annually by the Common Council, twelve for each hospital, Bethlehem being reckoned with Bridewell; and as these form but a small minority among the total number of governors, the anomalous self-elect constitution of these bodies continues to the present day. Mr. Fletcher then entered into an elaborate detail of the various efforts that have been made to suppress mendicancy by penal enactments, some of which were so severe as to vest an arbitrary power of transportation in any two governors of Bridewell. In 1708, the London Workhouse, though of earlier origin, was first brought into full operation; but it fell into a state of inefficiency and was abolished. Mr. Fletcher then contrasted the system of relief attempted by the Royal or Corporation Hospitals with the present pauper administration of London, and showed how widely the hospitals had deviated in practice from the principles at which their founders aimed.

Result of Inquiries into the State of the Agricultural Labourers in the County of Norfolk. By Sir John Boileau, *Bart., F.R.S.*

Out of 680 parishes to which queries had been addressed, 426 sent returns. These parishes contain 664,487 acres, of which 471,399 are arable. The total number of labourers usually employed thereon is 23,058 labourers, of which 18,277 are above 20 years of age, and 4781 above 14 and under 20 years of age. Hence the average of labourers of all kinds to land of all kinds is $3\frac{1}{2}$ to 100 acres. The average of labourers of all kinds to arable land is nearly 5 to 100 acres. Labourers above 20 to 100 acres of all kinds $2\frac{5}{6}$ to 100 acres. Labourers above 20 years of age to arable land is $3\frac{5}{6}$ to 100 acres. Hence it was concluded that there was no surplus supply of labour in the country, and that the land, if judiciously cultivated, would provide employment for the entire population.

On the Police Statistics of Manchester. By W. Nield.

This paper comprised a series of tables, forming the Statistical Returns of the Police of Manchester in the year 1844, with the observations of Mr. Willis, Chief Constable. The total number of apprehensions from the 1st of January to the 31st of December 1844 has amounted to 10,702, being a considerable decrease in the number apprehended, as compared with previous years, and exhibiting much fewer apprehensions during the past year than during any year since the establishment of a day and night police force. The decrease may be, in some measure, attributed to the more prosperous state of trade, which, as compared with previous years, has existed during the period to which the present returns relate. At the same time, as it is a fact well-known to the police, that there is always a large class of persons who never work, and another class who (although employed, and in the receipt of good wages) are in the habit of committing, or attempting to commit, felonies after their hours of labour, there can be no doubt that the decrease in the number of apprehensions is not to be altogether attributed to the state of trade, but must be partly ascribed to the increased efficiency of the police, which has tended in a great measure to prevent the commission of crime. As respects the summary convictions in the year 1843, out of 12,147 apprehensions, there were 2981 summary convictions and 758 committals for trial; whilst in 1844, out of 10,702 apprehensions, there were 3961 summary convictions and 691 committals for trial; or an actual increase in the past year of nearly 1000 convictions, although the number of apprehensions has been less by 1445 individuals. The increase in the number of summary convictions may, in a measure, be attributed to the provisions contained in the New Police Act, which came into operation on the 4th of July 1844, which enables the Justices to punish by fine or imprisonment parties found drunk in the streets, and which power has been frequently exercised. The number of apprehensions for drunkenness is

4156 (being 42 less than in the previous year), and from the persons of this class the sum of 1392*l.* 10*s.* 10*d.* has been taken and restored when discharged. The return also shows, that out of a gross amount of 7658*l.* 6*s.* 11*d.* reported to have been stolen during the year, the sum of 3040*l.* 14*s.* 3*d.* has been recovered by the police; and that out of a sum amounting to 1801*l.* 8*s.* 1*d.* reported to have been accidentally lost, the police have been instrumental in recovering 1126*l.* 6*s.* 3*d.* The only other table which it may be necessary to notice is that which shows that during the past year 2798 premises have been found open and insecure by the police during the night; of this number, 1433 consisted of warehouses and shops, containing property, in which no parties resided, or were left in charge; 649 of houses, shops, and warehouses, containing property, and in which parties did reside; and 538 of empty houses. The same table also shows that the police have, during the past year, restored to their friends 2637 children found apparently lost in the streets.

Plan for the Formation of a Society to collect the Statistics of all Civilized Countries, and opening a communication between all persons engaged in Statistical Inquiries. By M. JULIEN.

On the Statistics of Small-pox. By Dr. STARK.

On the Statistics of Merthyr Tydvil. By Mr. KENRICK.

The mass of the population of Merthyr has been brought into this wild district by the establishment of large ironworks belonging to Messrs. Crawshay, Guest, Hill and Thompson. The total population in 1841 was 32,968; houses, 6145—nearly 5½ persons to a house, and nearly three persons to a sleeping-room. In consequence of the number of unmarried men who come from Cardiganshire, Pembrokeshire, and other adjoining counties, to take advantage of the high wages which are given at the ironworks, the males much exceed the females; the former being in the ratio of 6 to 5 of the latter. Though so near the boundary of an English county, there are only about 4000 English out of a population of 33,000; and there are 11,000, or one-third, who cannot speak English intelligibly, and would not understand an English sermon. Only 1313 children attend the day schools, while there are 6857 children who are of a proper age to receive instruction. Perhaps the number at schools does not exceed each day 1200 children. Most of the places of worship have Sunday schools belonging to them, where, to a certain extent, the deficiency of public day schools is supplied, but the teaching is confined to reading. There is a great neglect of drainage in Merthyr: many of the streets are unpaved, and in bad weather the people have to wade through a stratum of mud from six to twelve inches deep. There are many cellars and miserable hovels that are not fit for men to dwell in. There are many streets without the conveniences which are necessary for the health and comfort of civilized beings. There are no proper infant schools, no good juvenile schools, two only middling; most of the teachers being illiterate, two of them not able to write. There is no taste for literature among the working classes, very few of them having books on general subjects. There is a considerable proportion of the people who never attend a place of worship, and whose enjoyments are low and degrading.

On the Vital Statistics of America. By THOMAS LAYCOCK, *M.D.*

The duration of life is greater in England than in America, greater in the Northern than in the Midland States, and greater in the Midland than in the Southern States.

On the Choice of Sites for Colonial Towns. By the Rev. Mr. BOYS.

On the Iron Trade in Scotland. By Dr. ALEXANDER WATT.

Dr. Watt has lately had occasion to collect full information relative to the iron trade of Scotland from the most authentic sources, and also of the quantity of coals raised in the county of Lanark, and has arranged the information received on these subjects in two separate tables.

On looking at the table constructed by Mr. Jessop for the iron trade, or for the iron produced by the blast furnaces in Scotland for the year ending October 1840, Dr. Watt finds that the increase in the annual quantity of pig iron smelted in that country in April 1845, amounts to 374 per cent. And there is every appearance that before another year expires a proportionate increase will be made in the amount of iron produced in Scotland.

There are 2,047,000 tons of coal raised annually in Lanarkshire. The following is the manner in which that quantity is distributed for consumption:—

	Tons.
It is known that the pig and malleable iron works annually consume about	1,000,000
And that families and public works in Glasgow consume not less than	700,000
The quantity of coal shipped at the harbour for the year ending April 1844, was	120,000
Quantity sent to Greenock by railway is	29,000
Quantity sent by canal to the river Clyde	70,000
Quantity consumed by steam-vessels carrying passengers and goods on the Clyde, to and from all quarters, is about	64,000
Quantity consumed by the Clyde shipping company's luggage- and tug-boats	10,000
Quantity shipped at Port Eglinton per the Paisley canal........	11,000
Quantity consumed in the country around	43,000
	2,047,000

Facts respecting the Iron Trade. By G. R. Porter, *F.R.S.*

Sir J. Guest, of Dowlais Works, in evidence before Import Duties Committee, 1840, stated that—

	Tons.
The iron made at the beginning of this century amounted to...	150,000
In 1806	258,000
In 1823	452,000
In 1825	581,000
In 1828	703,000
In 1835	1,000,000
In 1836	1,200,000
In 1840	1,500,000

Mr. Porter further said, that Mr. Jessop, of the Butterley Works, estimated the annual produce in Great Britain, exclusive of Ireland, in 1840, at 1,396,400 tons, and that the quantity of coal used for smelting that quantity was 4,877,000 tons, besides 2,000,000 tons for converting into wrought iron. To illustrate the importance of iron steamers, he could state that the Aaron Manby iron steam-boat, built in 1820, at the Horsley Iron-works, has been in use ever since, and the repairs to her hull have not altogether cost 50*l.* in those twenty-five years. A small iron steam-boat has been plying upon the Shannon since 1825. She is still in good condition. The number of iron steam-boats launched since 1830 is more than 150. The steam navy of the East India Company consists, in a great part, of iron—25 now in use in India.

On the System of Colonization practised by the Irish Society. By J. Fletcher.

On the different Methods employed to estimate the Amount of Population. By Prof. Pryme.

These were worthy of being investigated; because, in relation to history, some one or other of these methods was the only means available for interpreting facts. He enumerated many records of different countries and ages, to show that statistical information, as a foundation for economic science, had been sought, though errors had been committed as to the right mode of attainment. There were four different bases of calculation laid down, on each of which statistical criticism found cause for objection and correction. 1. Taking the number of houses, and an average to each house: the fallacy of result from this mode was illustrated by reference to various countries, at their various stages in the progress of civilization, and by the different habits of persons in the same district of the same country which affected the average number of persons in each house. 2. The estimate of population from the records of deaths, births, and marriages was still more fallacious. Among other illustrations, he mentioned his having known of five marriages between six people, with only three children as a result; and such perturbating influences are frequent. 3. Comparing a certain part of the population,—as, for instance, those capable of bearing arms, an element often occurring in history; to which he believed that more value was to be attached than any of the preceding methods. 4. Actual enumeration; of course the the most perfect method, but one requiring a more complete machinery than had been hitherto applied.

MECHANICAL SCIENCE.

On Nasmyth's *Steam Hammer for Pile-driving. By* RICHARD GREENE, *M.D.*

THIS machine consists of a steam cylinder, closed at the bottom, but with openings in the top to allow the passage of air: a piston works in it, having its rod passing through a steam-tight aperture in the bottom. To this piston-rod the monkey or driver, which weighs 2½ tons, is attached, and is thus suspended. The machine is worked by high-pressure steam, which, being admitted at the bottom of the cylinder by the induction-pipe, raises the piston, and with it the monkey attached to it. The instant it arrives at the height required it closes the induction-pipe, and opening the eduction-pipe (also at the bottom of the cylinder), the steam escapes, and the piston with the monkey attached to its rod falls freely upon the head of the pile. A large heavy cap of iron, with a hole to allow the head of the pile to pass through, slides between two upright standards and guides the direction of the pile. The monkey and cylinder also follow the course of the pile, guided by the same uprights, between which they slide.

Dr. Greene then added, on the authority of the inventor, the following report of the performance of the machine:—

In the first trial with a part of the machine at the manufactory, it drove a pile fourteen inches square and eighteen feet in length, fifteen feet into the ground with twenty blows of the monkey, the machine then working seventy strokes a minute (the ground was a coarse gravel imbedded in a strong tenacious clay), and performed this work in seventeen seconds. The entire machine is now in full action at Devonport for the embankment to be erected there to keep out the sea, and forms an immense wet dock to contain the royal steam navy. The operations required to be performed on each pile from the time it is floated alongside of the stage, until it is imbedded in the solid foundation of slate-rock, occupy only 4½ minutes. The great stage which carries the machine, boiler, workmen, and everything necessary, trots along on its railway like a wheelbarrow. Having driven one pile it moves onward, the space of the diameter of another; it picks the pile up out of the water, hoists it high in the air, drops it into its exact place, then covers it with the great iron cap, which follows it as it sinks into the ground: then thump goes the monkey on its head, jumping away seventy-five jumps a minute. At the first stroke the pile sunk six feet, its advance gradually diminishing, until in the hard ground above the solid slate-rock it was reduced to nine inches.

Nothing can better prove the superiority of the principle of this invention, of employing a heavy weight moving with small velocity, instead of a light weight moving with great velocity, than the state of the heads of the piles as driven by the two methods.

Dr. Greene called attention to a sketch of two heads of piles. One was fifty-six feet long, driven by a monkey of 12 cwt., falling from a great height, and making only one blow in five minutes, and requiring twenty hours to drive it; this, though protected by a hoop of iron, was so split and shattered on the head that it would require to be re-headed to drive it any further. The other, although sixty-six feet long, was not even supported by an iron hoop, and the head is as smooth as if it were dressed off with a new plane. It was driven with a hammer of 50 cwt., and only three feet fall, making seventy-five blows a minute, and was put in its place and finished in $4\frac{1}{2}$ minutes.

In addition to other great advantages of driving by a heavy weight over that of driving by a light weight, is the immense saving of labour, or whatever moving power is employed.

Dr. Greene advocates the use of this new powerful agent in the contemplated harbours of refuge which are to be formed along our coasts, and in the recovery of vast tracts of land from the sea.

[Since the first communication was received, in consequence of the men becoming more familiar with the manner of working the machine, some of the huge piles have actually been raised from the raft, put in their places, and driven to the required depth in two minutes; the operation seldom occupying more than four minutes.]

On Railway Gradients. By WILLIAM FAIRBAIRN.

The author stated that the object of this communication was simply a notice of experiments then in progress to determine the power of adhesion of the locomotive engine in the first instance, and the force of traction necessary to work gradients in the second. After a brief statement of the progress made in the development of different lines of communication and the improvements effected in the locomotive engine, the paper went on to state the facilities with which even steep gradients were now surmounted by the enlarged powers of the engine, more particularly when compared with those in use at the commencement and subsequent extension of railway traffic.

The author proceeded to examine,—

1st. The resistance due to friction on the machinery or working parts of the engine.

2nd. The resistance of the engine considered as a carriage.

3rd. The resistance of the waggons, carriages, &c. composing a train; and,

Lastly, the resistance of the air.

In treating of these separate heads, the writer instanced the experiments of the Comte de Pambour, Dr. Lardner, and Mr. Woods. According to those authorities, the resistances were variously stated; first by Pambour, who makes the friction of the waggons and steam-engine, when considered as a carriage, equal to 5·76 lbs. per ton, and for the friction of the working parts of the engine 7 lbs. per ton. On this assumption the resistance would be $5{\cdot}76 + 7 = 12{\cdot}76$, or about 13 lbs. per ton for the sum of the friction due to the engine (considered as a carriage) on the one hand, and the whole of its constituent parts taken collectively on the other.

As respects the resistance of the air, the author gave results from similar experiments, and having assumed a velocity of 33 miles an hour, he found a mean resistance of 2·92, or nearly 3 lbs. on every square foot of surface exposed to the action of the air. Mr. Woods in some recent experiments makes the resistance on a calm day (at the same velocity) $\frac{1}{83}$th of the whole weight, which, compared with others, gives a total resistance (including friction) of 25 lbs. per ton. This sum was considered a fair average of the experiments; and assuming 25 lbs. as the maximum resistance to every ton of a railway train, the author laid before the Section a table of gradients, of which the following is an abstract:—

Gradients.	Resistance in lbs. per ton.
1 in 20	137·00
1 „ 40	81·00
1 „ 60	62·33
1 „ 80	53·00
1 „ 100	47·40
1 „ 120	43·66
1 „ 140	40·71
1 „ 160	39·00
1 „ 180	37·44
1 „ 200	36·20

In addition to the resistances, force of traction, &c. already described, the author briefly detailed several experiments made on the Hunts Bânk Incline with two locomotive engines belonging to the Manchester and Leeds Railway Company. Both engines had 14-inch cylinders, and 4 feet 8 inches driving-wheels. The first, with all the six wheels coupled, took a gross load of 82 tons 2 cwt. up a gradient of 1 in 60 for a distance of 1144 yards, and 1 in 46 for a distance of about 900 yards; and the whole distance of 2054 yards was accomplished in 6 minutes.

By the second engine, with only four wheels coupled, the same load was carried and the same distance performed in 5 minutes and 30 seconds, being at the rate of nearly 12 miles an hour.

From these experiments, and others which are still in progress, it is inferred that a great saving may be effected in the first outlay and construction of railways; and instead of spending large sums in tunnels, cuttings and embankments (in order to attain easy gradients), it will ensure much greater œconomy, and prove more conducive to the public interests, leaving out of the question the merits of the atmospheric principle, to increase the powers of the locomotive engine, and work lines with gradients varying from 1 in 100 to 1 in 30.

On a new Method of converting Rectilinear into Rotatory Motion. By the Rev. James Booth, *LL.D., F.R.S., M.R.I.A., Vice-Principal of, and Professor of Mathematics in the Liverpool Collegiate Institution.*

The geometrical property on which this motion is founded is one long known and of great simplicity. Let a right line of constant length move so as to have its extremities always in contact with two fixed lines at right angles to each other, the middle point of this constant right line will describe a circle. The author then institutes a comparison between this method, which he terms the *sliding crank*, and the common crank, as applied to the direct action engine, and shows that in the latter, if x be the distance from the bottom of the cylinder through which the piston has ascended, while the shaft has been revolving through the angle θ, $2a$ and c being the length of the stroke and of the connecting-rod respectively, we shall have the equation,

$$x = 2a \sin^2 \frac{\theta}{2} + P\frac{a^2}{c} \sin^2 \theta + Q\frac{a^4}{c^3} \sin^4 \theta + R\frac{a^6}{c^5} \sin^6 \theta, \&c.,$$

P Q R being numerical coefficients; while in the sliding crank the relation between x, a and θ is $x = 2a \sin^2 \frac{\theta}{2}$. Now these equations become identical, by supposing c, the connecting-rod, indefinitely great; hence it follows that the motion of the sliding-crank is identical with that of a common crank, whose connecting-rod moves parallel to itself, the most perfect theoretical form of the latter. He then discusses the friction on the slides, and proceeds to show that, when the engine is producing its *maximum dynamical effect*, the friction is insensible, and concludes by pointing out the advantages which this method possesses on the ground of compactness, the space occupied by the machinery being very small; so that, while in the direct action-engine the distance between the shaft and the top of the cylinder is equal to one-half the stroke + the length of the connecting-rod, in this construction the distance is one-half the stroke simply,—a property of much importance where room is an object of consideration.

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ALERE FLAMMAM.

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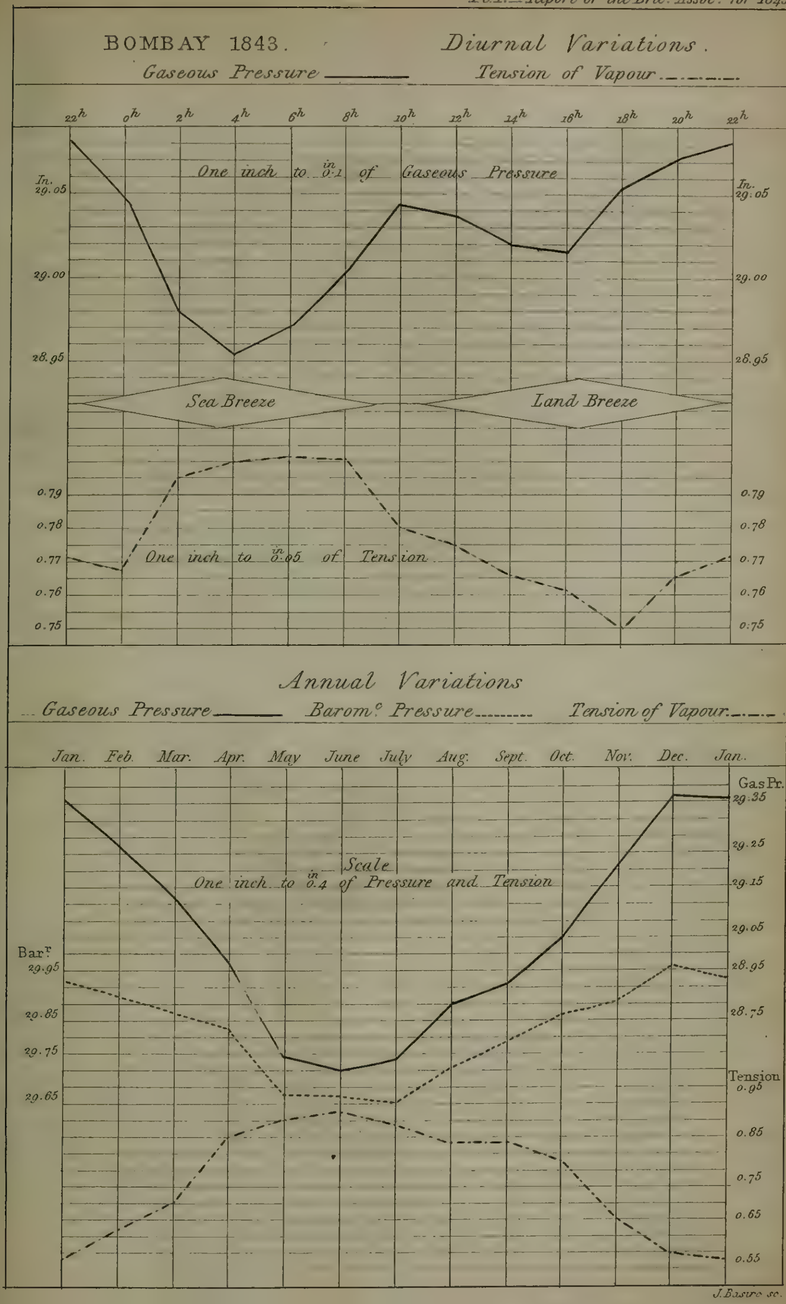

BOMBAY 1843.
Diurnal Variations.
Gaseous Pressure
Tension of Vapour
22h 0h 2h 4h 6h 8h 10h 12h 14h 16h 18h 20h 22h
One inch to 0.1 in of Gaseous Pressure
In. 29.05
29.00
28.95
Sea Breeze
Land Breeze
0.79
0.78
0.77
0.76
0.75
One inch to 0.05 in of Tension
Annual Variations
Gaseous Pressure
Barom^c Pressure
Tension of Vapour
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan.
Gas Pr.
29.35
29.25
29.15
29.05
28.95
28.75
Scale
One inch to 0.4 in of Pressure and Tension
Bar^r
29.95
29.85
29.75
29.65
Tension
0.95
0.85
0.75
0.65
0.55
J. Basire sc.

Fig. 1.

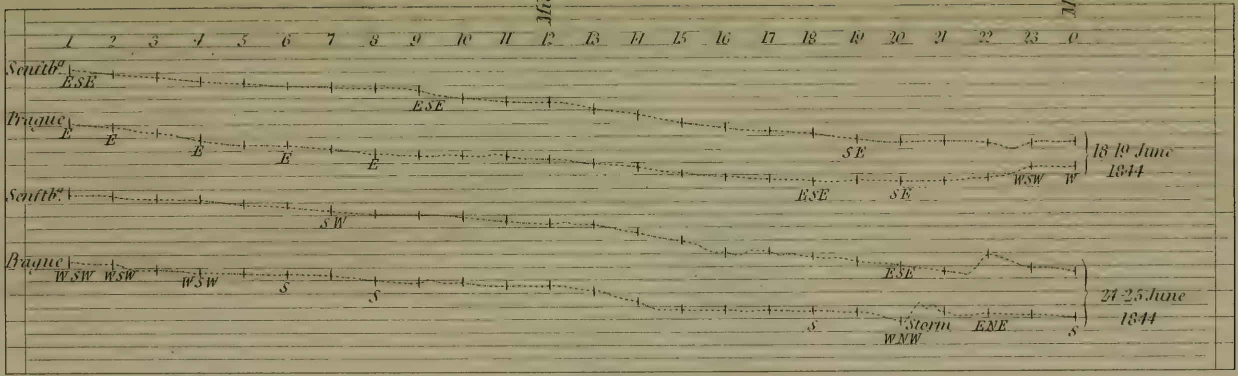
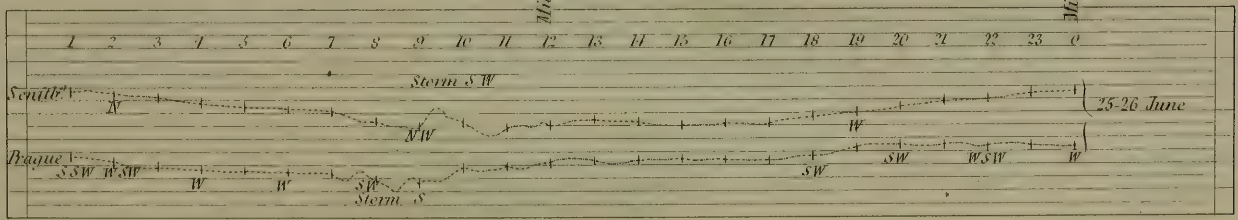
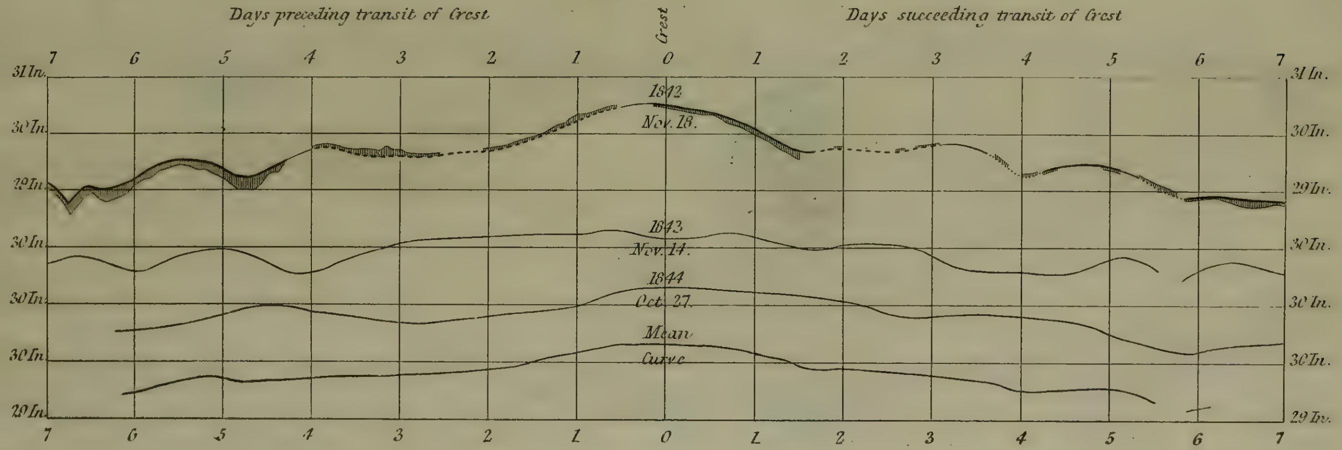


Fig. 2.



J.W. Lowry fc.

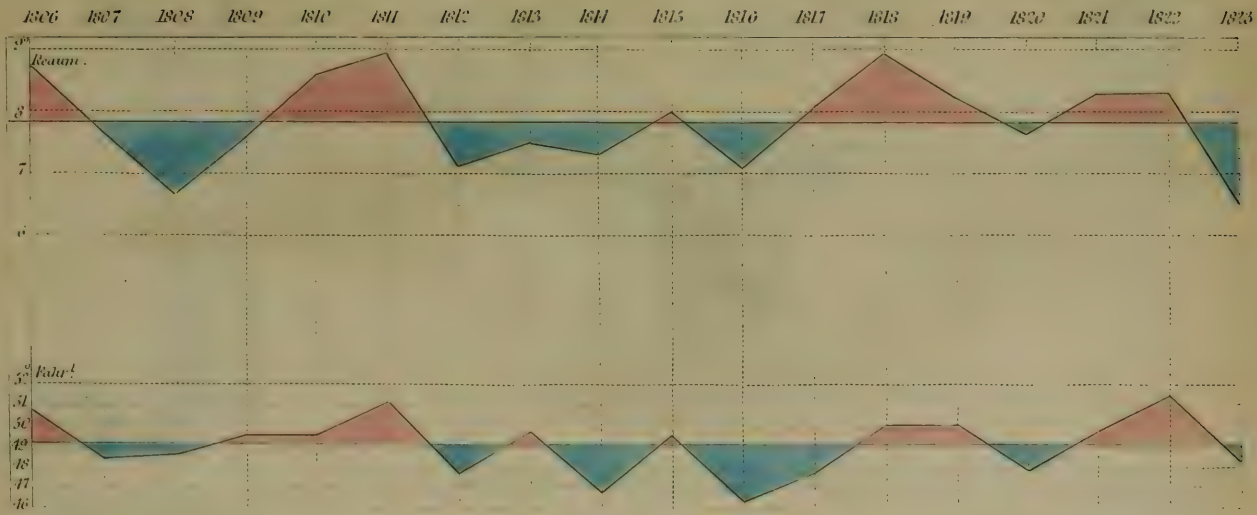
Great Symmetrical Barometric Wave as observed at London in 1842 1843 & 1844 by W. R. Birt.



Barometric Curve with Winds from S.W. Red
Barometric Curve with Winds from N.E. Blue
Barometric Curve with Winds from S.E. Green
Barometric Curve Calm

J. W. Lowry fc.

The extent of shading BELOW the Curve is intended to show the force of the S.W. winds, ABOVE that of the N.E. & S.E. winds.



Comparison of the Variation of the Annual Mean Temperature at London, with that at Geneva, thro' a Cycle of 18 Years. L.H. F.R.S. 1845.

Fig: IV.

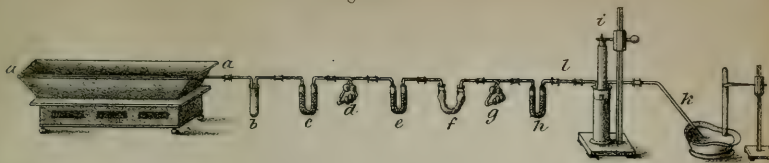


Fig: II.

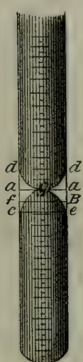
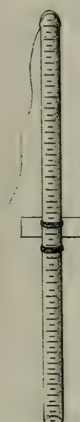


Fig: III.

Fig: I.



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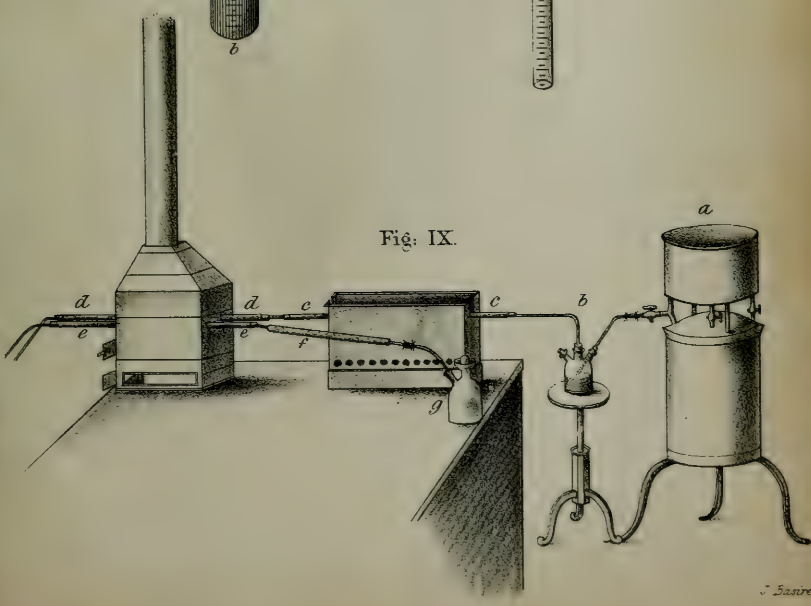
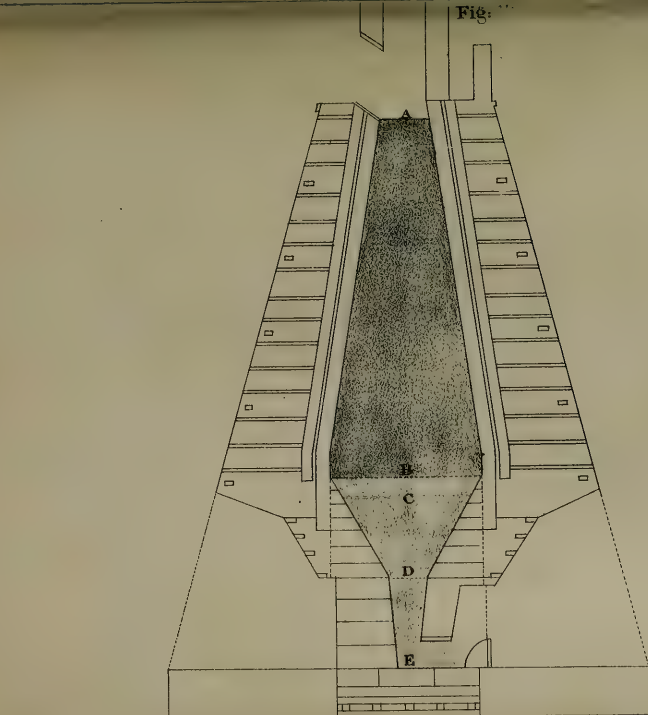


J. Basire,

Fig: ...

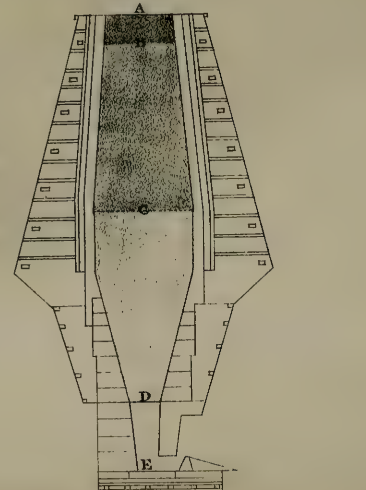


Scale of Feet.

0 1 2 3 4 5 10 15 20 25 30

IRON FURNACE OF BARUM, NORWAY.

Fig: VIII.



Scale of Feet.

0 3 6 9 12 15 18 21 24