REPORT

OF THE

TWENTY-SIXTH MEETING

OF THE

BRITISH ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE;

HELD AT CHELTENHAM IN AUGUST 1856.

LONDON:
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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 n-other, and with foreign philosophers,—to obtain a more general attention to the objects of Science, and a removal of any disadvantages of a public kind which impede its progress.

RULES.

ADMISSION OF MEMBERS AND ASSOCIATES.

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

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

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

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

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

COMPOSITIONS, SUBSCRIPTIONS, AND PRIVILEGES.

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

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

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

The Association consists of the following classes:—

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

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

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

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

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

6. Corresponding Members nominated by the Council.

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

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

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

   Annual Members who have not intermitted their Annual Subscription.

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

   Annual Members, who have intermitted their Annual Subscription.

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

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

Subscriptions shall be received by the Treasurer or Secretaries.

MEETINGS.

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

GENERAL COMMITTEE.

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

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

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

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

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

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

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

SECTIONAL COMMITTEES.

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

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

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

COMMITTEE OF RECOMMENDATIONS.

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

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

LOCAL COMMITTEES.

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

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

OFFICERS.

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

COUNCIL.

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

PAPERS AND COMMUNICATIONS.

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

ACCOUNTS.

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

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

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

The EARL OF ROSSE, F.R.S. CORK, August 17, 1843.	Earl of Listowel. Viscount Adare. Sir W. R. Hamilton, Pres.R.I.A. Rev. T. R. Robinson, D.D.	Professor John Stevelly, M.A. Rev. Jos. Carson, F.T.C. Dublin. William Keleher, Esq. Wm. Clear, Esq.
The REV. G. PEACOCK, D.D. (Dean of Ely), F.R.S. YORK, September 26, 1844.	Earl Fitzwilliam, F.R.S. Viscount Morpeth, F.G.S. The Hon. John Stuart Wortley, M.P. Sir David Brewster, K.H., F.R.S. Michael Faraday, Esq., D.C.L., F.R.S. Rev. W. V. Harcourt, F.R.S.	William Hatfeild, Esq., F.G.S. Thomas Meynell, Esq., F.L.S. Rev. W. Scoresby, LL.D., F.R.S. William West, Esq.
SIR JOHN F. W. HERSCHEL, Bart., F.R.S., &c. CAMBRIDGE, June 19, 1845.	The Earl of Hardwicke. The Bishop of Norwich Rev. J. Graham, D.D. Rev. G. Ainslie, D.D. G. B. Airy, Esq., M.A., D.C.L., F.R.S. The Rev. Professor Sedgwick, M.A., F.R.S.	William Hopkins, Esq., M.A., F.R.S. Professor Ansted, M.A., F.R.S.
SIR RODERICK IMPEY MURCHISON, G.C.St.S., F.R.S. SOUTHAMPTON, September 10, 1846.	The Marquis of Winchester. The Earl of Yarborough, D.C.L. Lord Ashburton, D.C.L. Viscount Palmerston, M.P. Right Hon. Charles Shaw Lefevre, M.P. Sir George T. Staunton, Bart., M.P., D.C.L., F.R.S. The Lord Bishop of Oxford, F.R.S. Professor Owen, M.D., F.R.S. Professor Powell, F.R.S.	Henry Clark, M.D. T. H. C. Moody, Esq.
SIR ROBERT HARRY INGLIS, Bart., D.C.L., F.R.S., M.P. for the University of Oxford OXFORD, June 23, 1847.	The Earl of Rosse, F.R.S. The Lord Bishop of Oxford, F.R.S. The Vice-Chancellor of the University Thomas G. Bucknall Estcourt, Esq., D.C.L., M.P. for the University of Oxford. Very Rev. the Dean of Westminster, D.D., F.R.S. Professor Daubeny, M.D., F.R.S. The Rev. Prof. Powell, M.A., F.R.S.	Rev. Robert Walker, M.A., F.R.S. H. Wentworth Acland, Esq., B.M.
The MARQUIS OF NORTHAMPTON, President of the Royal Society, &c. SWANSEA, August 9, 1848.	The Marquis of Bute, K.T. Viscount Adare, F.R.S. Sir H. T. DelaBeche, F.R.S., Pres. G.S. The Very Rev. the Dean of Llandaff, F.R.S. Lewis W. Dillwyn, Esq., F.R.S. W. R. Grove, Esq., F.R.S. J. H. Vivian, Esq., M.P., F.R.S. The Lord Bishop of St. David's.	Matthew Moggridge, Esq. D. Nicol, M.D.
The REV. T. R. ROBINSON, D.D., M.R.I.A., F.R.A.S. BIRMINGHAM, September 12, 1849.	The Earl of Harrowby. The Lord Wrottesley, F.R.S. Right Hon. Sir Robert Peel, Bart., M.P., D.C.L., F.R.S. Charles Darwin, Esq., M.A., F.R.S., Sec. G.S. Professor Faraday, D.C.L., F.R.S. Sir David Brewster, K.H., LL.D., F.R.S. Rev. Prof. Willis, M.A., F.R.S.	Captain Tindal, R.N. William Wills, Esq. Bell Fletcher, Esq., M.D. James Chance, Esq.
SIR DAVID BREWSTER, K.H., LL.D., F.R.S. L. & E., Principal of the United College of St. Salvator and St. Leonard, St. Andrews. EDINBURGH, July 31, 1850.	Right Hon. the Lord Provost of Edinburgh. The Earl of Cathcart, K.C.B., F.R.S.E. The Earl of Rosebery, K.T., D.C.L., F.R.S. Right Hon. David Boyle (Lord Justice-General), F.R.S.E. General Sir Thomas M. Brisbane, Bart., D.C.L., F.R.S., Pres. R.S.E. Very Rev. John Lee, D.D., V.P.R.S.E., Principal of the University of Edinburgh. Professor W. P. Alison, M.D., V.P.R.S.E. Professor J. D. Forbes, F.R.S., Sec. R.S.E.	Rev. Professor Kelland, M.A., F.R.S.L. & E. Professor Balfour, M.D., F.R.S.E., F.L.S. James Tod, Esq., F.R.S.E.

PRESIDENTS.	VICE-PRESIDENTS.	LOCAL SECRETARIES.
GEORGE BIDDELL AIRY, Esq., D.C.L., F.R.S., Astronomer Royal. IPSWICH, July 2, 1851.	The Lord Rendlesham, M.P. The Lord Bishop of Norwich. Rev. Professor Sedgwick, M.A., F.R.S. Rev. Professor Henslow, M.A., F.L.S. Sir John P. Boileau, Bart., F.R.S. Sir William F. F. Middleton, Bart. J. C. Cobbold, Esq., M.P. T. B. Western, Esq.	Charles May, Esq., F.R.A.S. Dillwyn Sims, Esq. George Arthur Biddell, Esq. George Ransome, Esq., F.L.S.
COLONEL EDWARD SABINE, Royal Artillery, Treas. & V.P. of the Royal Society. BELFAST, September 1, 1852.	The Earl of Enniskillen, D.C.L., F.R.S. The Earl of Rosse, M.R.I.A., Pres. R.S. Sir Henry T. DelaBeche, F.R.S. Rev. Edward Hincks, D.D., M.R.I.A. Rev. P. S. Henry, D.D., Pres. Queen's College, Belfast. Rev. T. R. Robinson, D.D., Pres. R.I.A., F.R.A.S. Professor G. G. Stokes, F.R.S. Professor Stevelly, LL.D.	W. J. C. Allen, Esq. William M'Gee, M.D. Professor W. P. Wilson.
WILLIAM HOPKINS, Esq., M.A., V.P.R.S., F.G.S., & Pres. Camb. Phil. Society. HULL, September 7, 1853.	The Earl of Carlisle, F.R.S. Lord Londesborough, F.R.S. Professor Faraday, D.C.L., F.R.S. Rev. Prof. Sedgwick, M.A., F.R.S. Charles Frost, Esq., F.S.A., Pres. of the Hull Lit. and Philos. Society. William Spence, Esq., F.R.S. Lieut.-Col. Sykes, F.R.S. Professor Wheatstone, F.R.S.	Henry Cooper, M.D., V.P. Hull Lit. & Phil. Society. Bethel Jacobs, Esq., Pres. Hull Mechanics' Inst.
The EARL OF HARROWBY, F.R.S. LIVERPOOL, September 20, 1854.	The Lord Wrottesley, M.A., F.R.S., F.R.A.S Sir Philip de Malpas Grey Egerton, Bart., M.P., F.R.S., F.G.S. Professor Owen, M.D., LL.D., F.R.S., F.L.S., F.G.S. Rev. Professor Whewell, D.D., F.R.S., Hon. M.R.I.A., F.G.S., Master of Trinity College, Cambridge. William Lassell, Esq., F.R.S. L. & E., F.R.A.S. Joseph Brooks Yates, Esq., F.S.A., F.R.G.S.	Joseph Dickinson, M.D., F.R.S. Thomas Inman, M.D.
The DUKE OF ARGYLL, F.R.S., F.G.S. GLASGOW, September 12, 1855.	The Very Rev. Principal Macfarlane, D.D. Sir William Jardine, Bart., F.R.S.E. Sir Charles Lyell, M.A., LL.D., F.R.S. James Smith, Esq., F.R.S. L. & E. Walter Crum, Esq., F.R.S. Thomas Graham, Esq., M.A., F.R.S., Master of the Royal Mint Professor William Thomson, M.A., F.R.S.	John Strang, LL.D. Prof. Thomas Anderson, M.D. William Gourlie, Esq.
CHARLES G. B. DAUBENY, M.D., F.R.S., Professor of Botany in the University of Oxford. CHELTENHAM, August 6, 1856.	The Earl of Ducie, F.R.S., F.G.S. The Lord Bishop of Gloucester and Bristol Sir Roderick I. Murchison, G.C.St.S., D.C.L., F.R.S. Thomas Barwick Lloyd Baker, Esq. The Rev. Francis Close, M.A.	Capt. Robinson, R.A. Richard Beamish, Esq., F.R.S. John West Hugall, Esq.
The REV. HUMPHREY LLOYD, D.D., D.C.L., F.R.S. L. & E., V.P.R.I.A. DUBLIN, August 26, 1857.	The Right Honourable the Lord Mayor of Dublin The Provost of Trinity College, Dublin. The Marquis of Kildare. The Lord Talbot de Malahide The Lord Chief Baron, Dublin Sir William R. Hamilton, LL.D., F.R.A.S., Astronomer Royal of Ireland Lieut.-Colonel Larcom, R.E., LL.D., F.R.S. Richard Griffith, Esq., LL.D., M.R.I.A., F.R.S.E., F.G.S.	Lundy E. Foote, Esq. Rev. Professor Jellett, F.T.C.D. W. Neilson Hancock, LL.D.

THE GENERAL TREASURER'S ACCOUNT from 12th September 1855 (at Glasgow) to 6th August 1856 (at Cheltenham).

RECEIPTS.

	£	s.	d.
To Balance brought from last Account	817	1	8
Life Compositions at Glasgow and since	359	0	0
Annual Subscriptions, ditto ditto	422	0	0
Associates' Tickets at ditto	1094	0	0
Ladies' Tickets at ditto	543	0	0
Composition for future Publications	5	0	0
Dividends on Stock, 12 months	161	11	0
Received proceeds of Sale of £769 10*s.* 3 per cent. Consols	732	13	5
From Sale of Publications, viz. Reports, Catalogue of Stars, &c.	141	15	9
	£4276	1	10

PAYMENTS.

	£	s.	d.	£	s.	d.
By paid Expenses of Glasgow Meeting, Sundry Printing, Advertising, and Incidental Payments by General Treasurer and Local Treasurers				349	6	7
Printing Report of the Twenty-fourth Meeting, Engraving, &c.				607	19	2
Engraving for Report of Twenty-fifth Meeting				26	0	0
Salaries, 12 months				350	0	0
Purchase £2269 10*s.* 3 per cent. Consols				2000	0	0
Maintaining the Establishment of Kew Observatory, viz. Balance of Grant, 1854	£75	0	0			
Grant, 1855	500	0	0			
				575	0	0
On Account of Grants, viz. for						
Ornithological Synonyms				100	0	0
Dredging and Dredging Forms				9	13	9
Chemical Action of Light				20	0	0
Strength of Iron Plates				10	0	0
Periodical Phænomena				10	0	0
Propagation of Salmon				10	0	0
Balance at Bankers	192	5	5			
Ditto in the hands of the General Treasurer and Local Treasurers	15	16	11			
				208	2	4
				£4276	1	10

EDWIN LANKESTER,
JAMES YATES, } *Auditors.*

N.B. Property now in the Funds £5000, 3 per cent. Consols.

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.,F.R.S.
Acland, Professor H. W., M.D., F.R.S.
Adams, J. Couch, M.A., F.R.S.
Adamson, John, Esq., F.L.S.
Ainslie, Rev. Gilbert, D.D., Master of Pembroke Hall, Cambridge.
Airy, G. B., D.C.L.,F.R.S., Astronomer Royal.
Alison, Professor W. P., M.D., F.R.S.E.
Ansted, Professor D. T., M.A., F.R.S.
Argyll, George Douglas, Duke of, F.R.S.
Arnott, Neil, M.D., F.R.S.
Ashburton, William Bingham, Lord, D.C.L.
Babbage, Charles, Esq., M.A., F.R.S.
Babington, C. C., Esq., M.A., F.R.S.
Baily, Francis, Esq., F.R.S. (deceased).
Baker, Thomas Barwick Lloyd, Esq.
Balfour, Professor John H., M.D., F.R.S.
Barker, George, Esq., F.R.S. (deceased).
Bell, Professor Thomas, Pres.L.S., F.R.S.
Beechey, Rear-Admiral, F.R.S. (deceased).
Bengough, George, Esq.
Bentham, George, Esq., F.L.S.
Bigge, Charles, Esq.
Blakiston, Peyton, M.D., F.R.S.
Boileau, Sir John P., Bart., F.R.S.
Boyle, Rt. Hon. D., Lord Justice-Gen[l]. (dec[d]).
Brand, William, Esq.
Breadalbane, John, Marquis of, K.T., F.R.S.
Brewster, Sir David, K.H., D.C.L., LL.D., F.R.S., Principal of the United College of St. Salvator and St. Leonard, St. Andrews.
Brisbane, General Sir Thomas M., Bart., K.C.B., G.C.H., D.C.L., F.R.S.
Brooke, Charles, B.A., F.R.S.
Brown, Robert, D.C.L., F.R.S.
Brunel, Sir M. I., F.R.S. (deceased.)
Buckland, Very Rev. William, D.D., F.R.S., Dean of Westminster. (deceased).
Burlington, William, Earl of, M.A., F.R.S.
Bute, John, Marquis of, K.T. (deceased).
Carlisle, George Will. Fred., Earl of, F.R.S.
Carson, Rev. Joseph, F.T.C.D.
Cathcart, Lt.-Gen., Earl of, K.C.B., F.R.S.E.
Chalmers, Rev. T., D.D., Professor of Divinity, Edinburgh. (deceased).
Chance, James, Esq.
Chester, John Graham, D.D., Lord Bishop of.
Christie, Professor S. H., M.A., F.R.S.
Clare, Peter, Esq., F.R.A.S. (deceased).
Clark, Rev. Prof., M.D., F.R.S. (Cambridge).
Clark, Henry, M.D.
Clark, G. T., Esq.
Clear, William, Esq. (deceased).
Clerke, Maj. S., K.H., R.E., F.R.S. (deceased).
Clift, William, Esq., F.R.S. (deceased).
Close, Very Rev. Francis, M.A., Dean of Carlisle.
Cobbold, John Chevalier, Esq., M.P.
Colquhoun, J. C., Esq., M.P. (deceased).
Conybeare, Very Rev. W. D., Dean of Llandaff.
Corrie, John, Esq., F.R.S. (deceased).
Crum, Walter, Esq., F.R.S.
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Report of the Council of the British Association as presented to the General Committee at Cheltenham, August 6th, 1856.

a. The Council have the satisfaction of reporting the continued efficiency and progress toward higher usefulness of the Observatory at Kew, which, while it fulfils the original object of its foundation, and readily takes up original research, is now a point of reference for Standard Instruments in meteorology, and auxiliary to the national service.

b. In conducting this establishment, the Council have in previous years had the great benefit of the cooperation of the Royal Society, and the Report of the Committee of the Observatory, which is now laid on the table, will show that this highly valued cooperation is continued. The Members will learn from the Report the final result of the Correspondence between the Committee of the Observatory and the Authorities of the Board of Public Works, concerning the repairs of the building and the laying-on of gas. The disadvantages which might have resulted from the unexpected issue of this correspondence have been removed by the prompt liberality of the Council of the Royal Society, who have advanced the necessary funds for immediately supplying the Observatory with gas.

c. The Council suggest to the General Committee to tender its cordial thanks to the Royal Society for the effective assistance thus given to an Institution in which both the Royal Society and the British Association recognize a powerful instrument of philosophical research.

d. The Council have the pleasure to forward another Report from the vigilant Committee which asserts the interests of Science in Parliament. By what means of a public nature the *Progress of Science* can be accelerated and assured;—*the Benefits of Science* applied and extended;—*the Position of the Cultivators of Science* amended;—these questions must strongly interest the Association, which, at the outset, declared its purpose to strive for the removal of all impediments of a public nature by which Science is retarded. Recommending this Report of the Parliamentary Committee to the approbation of the General Committee, and the important subjects which it opens to the serious deliberation of the Members, the Council beg to express their readiness to be instrumental in maturing and putting into action any measure which the Association may deem suitable, and in obtaining the cooperation of other scientific bodies to bring it to a good issue.

e. The Council may congratulate the Association on the progress made toward the fulfilment of the 7th Recommendation in the Report of their Parliamentary Committee for 1854–5—"That an appropriate building, in some central situation in London, should be provided, at the expense of the nation, in which the principal scientific societies may be located together:"—Burlington House is now devoted to the use of the Royal, Linnean, and Chemical Societies—a result due in a great degree to the prudent and persevering efforts of the Royal Society.

f. The General Committee will learn with satisfaction that, according to the Report of the General Treasurer, the Funds belonging to the Association, and invested in the names of the Trustees, amount to £5000. The Council suggest that it is desirable, for many reasons, to maintain a reserve of this kind, sufficient to meet unexpected contingencies, which may arise in consequence of efforts for the advancement of science.

g. The Council have added to the List of Corresponding Members the following Foreign men of Science:—

Dr. F. Cohn, Breslau.
Prof. E. Fremy, Paris.
Prof. A. Kölliker, Wurzburg.
Prof. F. Lanza, Spoleto.
M. Morren, Liège.
M. E. Peligot, Paris.
Prof. Retzius, Stockholm.

h. The Council have received Letters of Invitation to the Association to hold its next Meeting in Dublin; from

The Board of Trinity College, Dublin;
The Royal Dublin Society;
The Royal Irish Academy;
The King and Queen's College of Physicians in Ireland;
The Geological Society of Dublin;
The Lord Mayor and Municipal Council of Dublin.

i. The Council has this day received Letters of Invitation to the Association to hold its next Meeting in Manchester; from

The Manchester Geological Society;
The Statistical Society of Manchester;
The Manchester Athenæum;
The Town Clerk of Manchester.

k. It was resolved—

That the cordial thanks of the Council be tendered to the Lord Wrottesley and the Officers and Council of the Royal Society, for the promptitude with which they have responded to the request of the British Association, in granting the sum of £250 for the purpose of lighting the Kew Observatory with gas.

Report of the Kew Committee, presented to the Council of the British Association, August 6, 1856.

The Committee beg to submit the following Report of their proceedings since the meeting of the British Association at Glasgow:—

The instruments and apparatus sent by the Committee to the Paris Exhibition were returned to the Observatory in December last. The total expense incurred by the Committee in connexion with the Exhibition amounted to £202 : 7*s*. 11*d*., exceeding by £62 : 7*s*. 11*d*. the sum of £140 granted by the Board of Trade. This balance has since been repaid by the Board.

At the last Meeting of the Association, your Committee presented a Special Report relative to their application to Her Majesty's Government for the use of two acres of land contiguous to the Observatory, and the lighting of the building with gas,—such applications having been made in consequence of the recommendation of the General Committee at the Liverpool Meeting. The Association is still compelled to pay the high rent of ten guineas per acre for the land. The Committee fully expected that this year they should have been enabled to report that the expense of lighting the Observatory with gas would have been defrayed by the Government. The President of the Board of Works at first intimated to the Committee that the subject would receive consideration, and subsequently that he would consider the propriety of including the amount in the estimates for the present year. On further application, however, this has been refused. A copy of the correspondence is annexed to this Report.

Your Committee have, however, the gratification of reporting, that on a representation of the circumstances being submitted by the Council of the Association to the President and Council of the Royal Society, the sum of £250 from the Wollaston Fund was immediately placed at the disposal of the Committee, in order that no further delay from the want of funds should take place in effecting the long-desired object.

Much as the Committee may regret the refusal of the Board of Works to grant their request, they gladly avail themselves of this opportunity to express to Lord Wrottesley and the Council of the Royal Society their thanks for the prompt manner in which the intimation was made to them that the money had been voted. It affords another proof how ready the Royal Society has ever been to forward and assist scientific investigations.

Mr. De la Rue has made a preliminary examination of one of the Huygenian object-glasses, namely, that of 122 feet focal length, and, so far as he has hitherto been enabled to judge, it would appear that this object-glass defines with tolerable precision; but he is not yet able to say whether it will be desirable to go to the expense of erecting the tower for celestial observations.

A paper by Mr. Welsh, descriptive of the Kew Standard Barometer, and of the apparatus and processes employed in the verification of barometers, has been communicated to the Royal Society by the Chairman, and is now being printed in the Transactions of the Society.

The following statement shows the number of meteorological instruments which have been verified at Kew during the past year:—

	Thermometers.	Barometers.	Hydrometers.
For the Admiralty and Board of Trade	360	90	100
For the Portuguese Government		12	
For Opticians and others	170	35	
Total....................	530	137	100

On February 5, the Committee resolved,—"That, in consideration of the number of Barometers already verified at Kew having been sufficient to defray the preliminary expense of apparatus, the charge for verification shall in future be reduced to five shillings each instrument."

Arrangements have been made with Messrs. Adie, Casella, and Negretti and Zambra, to have on hand a constant supply of verified marine meteorological instruments, and the Public may be supplied through any respectable Optician in London or the country at the following prices:—

	£	s.	d.
For a Marine Barometer	£4	4	0
For a Set of Six Thermometers	2	2	0

Since the last Report, the Committee have disposed of 60 standard thermometers, graduated at the Observatory. Of these, 14 have been made for Mr. Hopkins, to be employed in his experiments on the effect of pressure upon the melting-points of solids. The charge on account of the graduation and distribution of these thermometers is arranged with the Government Grant Committee of the Royal Society, and consequently does not appear in the financial accounts of the Kew Committee.

A self-recording Anemometer, for measuring the velocity of the wind on the plan of Dr. Robinson, has been completed at the Observatory by Mr. Beckley: it is erected upon the dome, and has been in regular operation since the 1st of January. Its performance is most satisfactory, the delicacy of its indications being so great, that during the last six months the whole period of "calm," as shown by the registrations, has been only *four hours*. It has not yet been possible to erect an apparatus for registering the direction of the wind, on account of difficulties arising from the anticipated use of the dome for the solar photographic telescope. The direction of the wind has, however, been observed five times daily from an ordinary vane.

Mr. Beckley has since submitted to the Committee a model of a new arrangement for a self-recording Anemometer, in which the registration of both the direction and velocity of the wind (and also the fall of rain if desired) is obtained upon a single sheet of paper. This arrangement is much more compact in its design and less costly in construction than any other with which the Committee are acquainted. Mr. Beckley's model will be exhibited, and a description of it communicated to this Meeting.

A series of monthly determinations of the absolute horizontal force and of the magnetic dip was commenced in January, with instruments provided by General Sabine from his department at Woolwich. Some difficulties have been experienced by Mr. Welsh in the observations of the absolute horizontal force, owing to imperfections in the usual mode of suspension of the magnets during the observations of vibration. These difficulties he hopes soon to overcome by employing reversible collimator magnets, and by an improved mode of suspension.

A convenient apparatus has been constructed at the Observatory for the determination of the effect of temperature on magnets: with this apparatus the temperature coefficients of the magnets employed at the Toronto Observatory have been obtained. The scale of the unifilar, and the dimensions and weights of the *inertia* rings employed at the same Observatory, have been determined with reference to the Kew standards of length and weight.

Two dip circles, one for M. Hansteen of Christiania, and the other for Dr. Pegado of the Meteorological Observatory of Lisbon, have been examined and compared with the Kew instrument before being sent to those gentlemen. A 30-inch transit instrument, lent by General Sabine's department, has been erected in the south window of the old transit room. A clock by Shelton, the property of the Royal Society, is used with it.

Owing to alterations required in the dome in order to adapt it to the use of the solar photographic telescope, it has been necessary to remove the large electrical apparatus of Mr. Ronalds. An apparatus of smaller size, but on the same plan, has been erected on the side of the dome, by which atmospheric electrical phænomena can be determined in the same manner as heretofore. A new vane has also been constructed, having an indicating dial within the dome.

Dr. Halleur, who had for about six months assisted Mr. Welsh in the Observatory, having been appointed to a professorship in the New College of Engineering at Calcutta, left the Observatory in September last.

In February, the Committee, on the recommendation of Professor J. D. Forbes, engaged Mr. Balfour Stewart of the Edinburgh University, as Assistant Observer, at a yearly salary of £80, with residence in the Observatory. Mr. Stewart commenced his duties on March 1. The Committee regret having to report that the Observatory will shortly lose the services of this gentleman, who has recently been appointed an assistant to Professor Forbes: he will leave the Observatory on October 1, previous to which the Committee hope to be able to appoint a successor.

The Committee refer with pleasure to an ingenious thermometer devised by Mr. Stewart, in which advantage has been taken of the difference of capillary force and friction in two tubes of different capacity connected with the same bulb, to measure the sum of the fluctuations of temperature. The instrument has been made at the expense of the Committee; a description of it has been communicated by Mr. Stewart to the Royal Society, and is printed in its "Proceedings."

Mr. Welsh reports most favourably as to the general attention evinced by Mr. Beckley and Mr. Macgrath in the discharge of their respective duties. Mr. Beckley's talent as a mechanical engineer renders his services of great value in an establishment where instances constantly occur of work requiring the highest skill being promptly and correctly executed: the assiduity of Mr. Macgrath has been such as to merit the entire approbation of Mr. Welsh.

Your Committee cannot close this Report without again recording their high opinion of the unremitting care and attention, as well as of the ability which has ever been displayed by Mr. Welsh, as the Superintendent of the Observatory; during the past year he was compelled for upwards of six weeks to be in Paris, in order to arrange the delivery of the valuable scientific apparatus forwarded at the request of Her Majesty's Government by the Committee to the Paris Exhibition; but his arrangements were such, that the general business of the Observatory was not in any way suspended during his absence.

Your Committee have finally to report, that the total expenses of the Observatory during the past year amount to £557 : 1*s.* 9*d.* In consequence of the Committee having received during the year the sum of £221 : 7*s.* 8*d.* for the verification of meteorological instruments, they have in hand a balance amounting to £260 : 4*s*. 6*d*.; they do not consider it therefore necessary to apply to the Association for a larger sum than £350, to enable them to meet the expenses of the ensuing year.

By order of the Committee,

JOHN P. GASSIOT, *Chairman*.

22 July, 1856.

Correspondence.

"Clapham Common, December 18th, 1855.

"SIR,—In the interview with which you favoured the deputation from the British Association this day, you kindly explained that you had no power to order the Works such as we required to be executed for the Observatory in the Old Deer Park, Richmond, without the sanction of the Lords of the Treasury, and you suggested the advisability of my briefly explaining to you by letter the position in which the Association stands as regards the Building, as also of defining the exact object of our application previously to your submitting the same to their Lordships.

"The Building was placed at the disposition of the British Association by Her Majesty in 1842 for scientific purposes; it has ever since been used for those objects, the entire expense of the Establishment being paid by the Association, without receiving any assistance, pecuniary or otherwise, from Government.

"The Committee has obtained permission from the Hon. Charles Gore, Chief Commissioner of Woods and Forests and Land Revenues Department, to have gas-pipes laid along the pathway through the Park to the Observatory without any cost or indemnification being required by his department, provided the work is done in the winter months; and the more immediate object of the application of Colonel Sabine and myself was to request you would order at the present time the gas-pipes to be laid on to the Observatory in order that the Building may be properly lighted, such lighting being indispensable for the carrying out various scientific investigations, and thus enabling the Committee to fulfil with greater efficacy the purposes for which the Building was originally granted by Her Majesty to the Association.

"I may add, that the funds of the British Association consist of the contributions of its members; from these limited means the Council have most liberally expended of late years an annual sum of £500 for the Observatory, but it being unable to meet this increased expenditure, which would not exceed £250 (the estimate is £200), the Committee has been induced to make this application, which we hope will not be refused.

"In respect to the repairs alluded to by us, we merely desired to explain that some repairs were indispensable to preserve the Building, which, if promptly attended to, would probably save a much larger outlay at a future period.

"The Building could *perhaps* remain in its present state for a short period, but a trifling outlay, the extent of which could be easily ascertained by the Government Surveyor, would be all that at present is required. The Committee considered it their duty to point this out for your consideration.

"I have the honour to be, Sir,

"Your obedient Servant,

(Signed) "J. P. GASSIOT,

Chairman of the Kew Committee,

British Association."

"The Right Hon. Sir Benjamin Hall, Bart., M.P.,
Chief Commissioner of Works, Public Buildings, &c. &c."

"Office of Works, &c., Dec. 20, 1855.

"SIR,—I am directed by the Chief Commissioner of Her Majesty's Works, &c., to acknowledge the receipt of your letter, dated the 18th inst., relative to certain works considered to be necessary by the British Association at the Observatory at Kew, and to inform you that the subject will receive consideration. "I am, Sir,

"Your most obedient Servant,

(Signed) "ALFRED AUSTIN, *Secretary*."

"J. Gassiot, Esq."

"Office of Works, &c., Jan. 5, 1856.

"SIR,—With reference to your letter dated the 18th December last, requesting on behalf of the Kew Committee of the British Association that gas-pipes may be laid on to the Observatory at Kew, and that certain repairs may be also done to that Building at the expense of this Department, I am directed by the Chief Commissioner of Her Majesty's Works, &c., to acquaint you that he has caused an estimate to be made of the cost of the Works required by the Society, which amounts to a large sum, and that there are not any funds voted by Parliament out of which such cost can be defrayed.

"I am however directed to add, that the Chief Commissioner will consider the propriety of including the amount in the estimates of the ensuing year.

"I am, Sir,

"Your most obedient Servant,

(Signed) "ALFRED AUSTIN, *Secretary*."

"J. Gassiot, Esq."

"Clapham Common, May 19th, 1856.

"SIR,—I duly received the communication from your office, of 5th of last January, stating that you had caused an estimate to be made of the cost of the Works required at the Observatory in the Old Deer Park, Richmond, and that you would consider the propriety of including the amount in the annual estimates.

"I have been informed that the usual estimates have been voted by the House of Commons:—may I therefore beg the favour of your acquainting me, for the information of the Kew Committee of the British Association, whether it is arranged that the laying on of the gas to the Building, and effecting the necessary repairs should now be commenced?

"Permit me also to explain that it would be very advisable, in order to prevent additional outlay, that no further time should elapse as to the repairs of the Building. "I have the honour to remain, Sir,

"Your obedient Servant,

(Signed) "J. P. GASSIOT,

Chairman of the Kew Committee."

"The Right Hon. Sir Benjamin Hall, Bart., M.P.,
Chief Commissioner of Parks, Palaces, &c. &c."

"Office of Works, &c., May 27, 1856.

"SIR,—I am directed by the First Commissioner of Her Majesty's Works, &c., to acknowledge the receipt of your letter, dated the 19th inst., requesting that you may be informed whether it is arranged that the works for laying on gas at the Observatory at Kew, and for the necessary repairs, should now be commenced.

"In reply, I am directed to call your attention to a letter addressed to you by this Board on the 2nd of June last, to the effect that there would be no objection to the use of gas at the Observatory, but that the whole of the work connected therewith must be done by, and at the expense of, the Kew Committee of the British Association, and to the satisfaction of this Board's Officer in charge of the district.

"I am to add, that this communication was made to you before the First Commissioner came to this Office, and that he was not made aware of it when he gave directions for the letter of the 5th January last to be written to you, in which he informed you that he would consider the propriety of including the cost attending the laying on gas and performing the repairs therein referred to, in the Estimates of the ensuing year. His attention having now been directed to that communication of the 2nd June last, he is of opinion that the decision of the Board thereby conveyed must be adhered to, and that he is unable consequently to undertake the laying on gas at the Observatory, or to incur any portion of the expense attending it.

"With regard to the repairs referred to in your letter, the First Commissioner desires me to state that he will shortly communicate with you upon the subject. "I am, Sir,

"Your most obedient Servant,

"ALFRED AUSTIN, *Secretary.*"

"J. Gassiot, Esq."

"Clapham Common, June 3, 1856.

"MY LORD DUKE,—At the suggestion of Col. Sabine, I forward your Grace a copy of a correspondence I have recently had with the Board of Works relative to the lighting of Kew Observatory with gas.

"The letter alluded to of 2nd June 1855, and a copy of which I enclose, is printed in the Report of the Kew Committee. I may also state that in an interview with Sir B. Hall, on 18th last December, both Colonel Sabine and myself explained the particulars of my former correspondence with the Board of Works; this has possibly escaped Sir B. Hall's recollection, for we left him with the impression that he would grant our request; and this was further confirmed by a letter received from Mr. Austin, on January 5th, who in reference to our application says, 'the Chief Commissioner will consider the propriety of including the amount in the Estimates of the ensuing year.'

"I cannot therefore but feel much disappointed at the result, which, if confirmed, will prevent the Committee from carrying out those scientific researches they have in contemplation.

"Hoping your Grace may induce Sir B. Hall to reconsider the application, "I have the honour to be, My Lord Duke,

"Your obedient Servant,

"J. P. GASSIOT,

Chairman of the Kew Committee."

"His Grace the Duke of Argyll,
President of the British Association."

"Clapham Common, July 17, 1856.

"SIR,—I duly received your reply to my last letter of 19th May, and having communicated to the President and Council of the British Association your final determination not to incur any portion of the expense of laying on gas to the Observatory, I have now the pleasure of informing you that the Royal Society has, from a small fund bequeathed for scientific purposes, most liberally placed the sum of £250 at the disposal of the Kew Committee, in order that the work may be no longer delayed.

"I have respectfully to request you will be pleased to give the necessary directions to the Officer in charge of the district, referred to in Mr. Austin's letter of 27th May (but whose name, designation, or address I have no means of ascertaining), in order that the Committee may be informed by him in what manner the work must be done to his satisfaction.

"From what took place at the interview with which you favoured General Sabine, Mr. Welsh, and myself on 18th of last December, as well as from the tenor of the letter addressed to me by Mr. Austin on 5th last January, the Committee fully relied on the necessary amount for the proposed work being included in the Estimates; they regret that any circumstance should have arisen to prevent your carrying your intentions into effect, for although the amount may appear trifling, in comparison to many sums voted on such occasions, it is nevertheless a large item in the income of any scientific Society supported entirely by voluntary subscriptions; and considering that the British Association already devotes the large sum of £500 per annum for the support of the Observatory, the Committee could not anticipate that the cost of laying on gas to a building the property of the Crown, would have been refused by your Board.

"I have only to add, that, although nearly two months have elapsed since the date of Mr. Austin's last letter, and upwards of sixteen months since the subject was first communicated to your Board, I have not received any communication relative to the repairs, some of which are absolutely necessary for the preservation of the building.

"Regretting that you should have been troubled with so long a correspondence on this subject, "I have the honour to be, Sir,

"Your most obedient Servant,

"J. P. Gassiot,

Chairman of the Kew Committee,
British Association."

"The Right Hon. Sir Benjamin Hall, Bart., M.P.,
First Commissioner of Public Works, &c. &c."

"Office of Works, &c., 25th July, 1856.

"Sir,—I am directed by the First Commissioner of Her Majesty's Works, &c., to acknowledge the receipt of your letter of the 17th instant, stating that the British Association will, out of a grant of money made to them by the Royal Society, lay on gas to the Observatory at Kew, and requesting that the necessary orders may be given to the proper officer of this department on the subject, and also calling attention to the state of repair of the Building; and I am to inform you, in regard to the laying on of the gas, that the Board request that the Committee of the Association will, as soon as they shall be prepared to commence the works, communicate with Mr. Starie, the Officer of this Department, who has the charge of the Kew District, and who is instructed to attend from time to time to see that the works are performed to his satisfaction.

"With regard to the repairs I am directed to state that, upon further consideration, a question has arisen which renders it necessary for the First Commissioner to submit that subject to the Treasury, and that upon receiving their reply, the First Commissioner will communicate further with the Committee.

"I am, Sir,

"Your most obedient Servant,

"Alfred Austin, *Secretary.*"

"J. P. Gassiot, Esq."

Accounts of the Kew Committee of the British Association from Sept. 12, 1855, *till Aug.* 6, 1856.

RECEIPTS.

	£	s.	d.	£	s.	d.
Balance from last account				96	1	7
Received from the General Treasurer				500	0	0
" for the verification of Instruments—						
from the Board of Trade	113	10	0			
from the Admiralty	79	10	0			
from Opticians and others	28	7	8			
				221	7	8
" from Lord Wrottesley for thermometer-stand and three thermometers				14	15	0
				£832	4	3

PAYMENTS.

	£	s.	d.	£	s.	d.
Salaries, &c.:—						
To Mr. Welsh, one year, ending Aug. 27	175	0	0			
Ditto, allowed for petty travelling expenses	10	0	0			
Mr. J. V. Magrath, one year, ending Aug. 14	45	0	0			
Mr. B. Stewart, half-year, ending Sept. 1	40	0	0			
Mr. Beckley, 47 weeks, ending Aug. 4	82	5	0			
Ditto, Gratuity	10	0	0			
				362	5	0
Apparatus, Materials, Tools, &c.	80	15	3			
Ditto for Sundries furnished for Lord Wrottesley	14	15	0			
				95	10	3
House Expenses, Coals, Chandlery, &c.				41	19	0½
Mr. Ronalds for furniture supplied at his expense in 1852				8	0	0
Carpenter, Painter, and Smithwork				16	5	8½
Printing, Stationery, Books, Postage				21	3	10
Porterage and petty expenses				5	15	11
Rent of Land, one year ending Oct. 10, 1856				21	0	0
Balance in hand				260	4	6
				£832	4	3

I have examined the above account and compared it with the vouchers presented to me, and find the Balance to be Two Hundred and Sixty Pounds Four Shillings and Sixpence.

24th July, 1856.

R. HUTTON.

Report of the Parliamentary Committee of the British Association to the Meeting at Cheltenham in August 1856.

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

We have the pleasure of announcing that one very important subject to which our labours have been directed has been materially advanced since the date of our last Report; we allude to the juxtaposition of the Scientific Societies of London in a convenient and central locality.

The main building at Burlington House has been placed by the Government at the disposal of the Royal Society, on the understanding that they accommodate the Linnean and Chemical Societies with rooms therein; and the West Wing will be converted into a capacious Hall, which is to be occupied by the Royal Society at all times when it is not required for the examinations and public meetings of the University of London.

We trust that the period is not far distant in which permanent accommodation will be afforded to all the principal Scientific Societies in buildings to be erected near the same site, and in pursuance of some general plan.

Your Committee, however, anticipate most important advantages to Science from the present partial adoption by the Government of the principle of juxtaposition; and our Chairman has in his address to the Royal Society on the occasion of their last Anniversary, alluded to the benefits likely to accrue from this salutary measure.

In the same Address also will be found a Summary of our labours since our complete organization in 1851, a perusal of which will show to what extent the proceedings of our Committee have justified the anticipations of those who promoted its formation.

During the past year two subjects have been referred to us, viz.:—

1st. The question of the expenses incurred by Scientific Institutions not incorporated in appointing new trustees of their property, when vacancies occur. And, 2ndly. We were requested by your Council in January last to support an application to Parliament, in reference to lighting Kew Observatory with gas, when made by the Chief Commissioner of Woods.

The first subject above adverted to has been considered by us, and we shall resume its discussion when an opportunity offers for remedying the evil.

With respect to the second, we must refer to the Report of the Kew Committee for an explanation of the reasons which have made it impossible for us to render that species of assistance, which was contemplated at the time when the reference was made to us.

The most important subject of our last Report, viz. the question "whether any measures could be adopted by the Government or Parliament that would improve the position of Science or its Cultivators?" has since its discussion at Glasgow been again considered by us; and during the last Session of Parliament it was brought before the House of Commons by Mr. Heywood, as an individual Member of the House, and not as representing your Committee.

The discussion of our Report by the Committee of Recommendations at Glasgow in September last, the result of the debate which took place in the House of Commons on the occasion last referred to, and subsequent communications with Members of the Legislature, have combined to convince us—

1st. That men of science have as yet formed no definite opinion on the important question raised in the Report.

And 2ndly. That until such a result be attained, it is improbable that any important improvement will be effected in the position of Science or its Cultivators either through the agency of the Government or Parliament.

It is desirable therefore that some measures should be adopted, which may be instrumental in inducing scientific men generally to apply their minds to the consideration of these questions, and to agree upon some definite proposals:—We therefore recommend that the subject should be again brought before the Committee of Recommendations. Meanwhile the General Committee will be gratified on learning that the importance of the question has been recognized by the Council of the Royal Society, who have referred its consideration to the Government Grant Committee. That Committee have appointed a Sub-Committee, consisting of the President and Officers of the Royal Society and seven other Members, who will meet on the 7th of October for the purpose of discussing the subject prior to the reassembling of the Society after the recess.

Your Committee recommend for the consideration of the General Committee, whether it would be expedient to relax the rule by which vacancies in our Committee must be filled up exclusively from Members of the British Association, so far as to admit Members of either House of Parliament, who have advanced the interests of Science.

Your Committee also recommend that two vacancies in our body, caused by the non-attendance of the Earl Cathcart and Sir J. V. B. Johnstone, Bart., during two consecutive years, be filled by the election of the Earl of Burlington and Lord Stanley, Member of Parliament for King's Lynn.

25 July, 1856. WROTTESLEY, *Chairman.*

RECOMMENDATIONS ADOPTED BY THE GENERAL COMMITTEE AT THE CHELTENHAM MEETING IN AUGUST 1856.

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

Involving Grants of Money.

That the sum of £350 be placed at the disposal of the Council for maintaining the Establishment and providing for the continuance of Special Researches at Kew.

That Mr. F. Osler be requested to continue his reduction of Anemometrical Observations; with £20 at his disposal for the purpose.

That Mr. R. W. Fox be requested to make further Experiments on the Temperature of deep Mines in Cornwall; with £10 at his disposal for the purpose.

That Professor N. S. Maskelyne, T. F. Hardwich, and Mr. J. D. Llewellyn, be a Committee, with power to add to their number, for the purpose of drawing up a Report on the chemical nature of the image formed in photographic processes; with £10 at their disposal.

That Professor Anderson be requested to complete his Report on the compounds of Platinum and the allied metals with Ammonia; with £10 at his disposal for the purpose.

That Mr. Mallet be requested to continue his Investigations on Earthquake Waves; with £50 at his disposal for the purpose.

That Professor Phillips and Professor Ramsay be requested to construct a Vertical Column of British Strata, to accompany the Map which has been prepared for the Geological Section; with £15 at their disposal for the purpose.

That Mr. Patterson, Professor Dickie, and Mr. Hyndman, be a Committee, with power to add to their number, for the purpose of Dredging in the neighbourhood of Belfast; with £10 at their disposal.

That the Rev. C. P. Miles, Professor Balfour, Dr. Greville, and Mr. C. Eyton, be a Committee to report on the Dredging of the West Coast of Scotland; with £25 at their disposal for the purpose.

That Dr. Williams, Professor Bell, and Dr. Lankester, be a Committee for the purpose of completing a Report on the British Annelida, with £25 at their disposal.

That Mr. Archer and Dr. Dickinson be requested to report on the Vegetable Imports of Liverpool; with £10 at their disposal for the purpose.

That Mr. W. Keddie and Mr. Michael Connal be requested to report on the Vegetable Imports of Liverpool; with £10 at their disposal for the purpose.

That Professor Henslow, Professor Phillips, Sir W. Jardine, Mr. C. C. Babington, Professor Balfour, Professor Owen, Dr. Hooker, Mr. J. S. Bowerbank, Rev. M. J. Berkeley, Professor Huxley, and Dr. Lankester, be a Committee to report on the best manner of selecting and arranging a series of Typical Objects illustrative of the three Kingdoms of Nature, for Provincial Museums; with £10 at their disposal for the purpose.

That Sir W. Jardine, Bart., and Mr. Ashworth, be requested to continue their observations on the Growth of Salmon; with £10 at their disposal for the purpose.

That the Rev. P. Carpenter, Dr. Gray, and Mr. C. C. Babington, be a Committee to complete the Report on the Mollusca of California; with £10 at their disposal for the purpose.

That Madame Ida Pfeiffer be requested to report on the Natural History of Madagascar; with £20 at her disposal for the purpose.

That Mr. G. Rennie be requested to continue his experiments on the production of Heat by motion in fluids; with £20 at his disposal for the purpose.

That a Committee, consisting of Mr. A. Henderson, Mr. A. Anderson, Captain Sir E. Belcher, Mr. J. R. Napier, Mr. J. Thomson, C.E., Mr. W. Ramsay, C.E., Captain J. O. Owen, and Sir W. Jardine, Bart., be requested to continue the investigation as to the statistics and condition of Life-Boats and Fishing-Boats; as to the principles on which such boats should be constructed; the essential conditions of their successful use; and the manner of establishing them round the coasts; with £5 at their disposal for the purpose.

Not Involving Grants of Money.

Parliamentary Committee.

That copies of the two last Reports of the Parliamentary Committee be transmitted to each Member of the General Committee, with a request that opinions may be expressed as to the important subject "whether any measures could be adopted by the Government or Parliament that would improve the position of Science and its Cultivators," and that such opinion be forwarded for the consideration of the Council before the 20th of September.

That the Rule by which vacancies in the Parliamentary Committee must be filled up exclusively from Members of the British Association, be so far relaxed, as to admit Members of either House of Parliament who have advanced the interests of Science.

That two vacancies in the Parliamentary Committee, caused by the non-attendance of the Earl Cathcart and Sir J. V. B. Johnstone, Bart., during two consecutive years, be filled by the election of the Earl of Burlington, and Lord Stanley, M.P. for King's Lynn.

Title of Section F.

That the 'Section of Statistics' shall in future be entitled 'The Section of Economic Science and Statistics.'

Involving Applications to Government or Public Institutions.

That the application to Government for an Expedition to complete our knowledge of the Tides be renewed.

That the application which was made to the Government in September 1852, concerning the great Southern Telescope, be renewed.

That a deputation, consisting of Sir R. I. Murchison, Sir H. Rawlinson, General Sabine, Professor Owen, Professor Bell, Dr. Gray, Mr. Macgregor Laird, Dr. R. Latham, and Dr. N. Shaw, be requested to wait upon Her Majesty's Secretary for Foreign Affairs, to urge the desirableness of sending out an annual expedition to the Niger, at the period of the rising waters of that river (which has been proved to be the most healthy season), as proposed by Dr. Baikie, supported by the Royal Geographical Society, and advocated by persons deeply interested in establishing a regular commercial intercourse with the inhabitants of that portion of Africa.

That a Memorial be presented to the Admiralty, praying for the publication in a simple, uniform and complete shape, tabular and descriptive, of the results of the Trials of Her Majesty's Steam Ships.

That the Committee, consisting of Mr. Andrew Henderson, Mr. John Scott Russell, Mr. James R. Napier, and Mr. Charles Atherton, appointed to consider the question of the Measurement of Ships for Tonnage, be requested to continue their investigations; that the following names be added to the Committee, The Right Hon. the Earl of Hardwicke, Mr. Arthur Anderson, Rev. Dr. Woolley, Mr. Wm. Mann, Mr. George Frederic Young, Captain J. O. Owen, Professor Woodcroft, and Mr. James Perry; and that they be requested to inquire into the defects of the present methods, and to frame more perfect rules for the measurement and registration of ships; and also as to the adoption of a standard unit for estimating the working power of engines, instead of the present nominal horse-power, in order that a correct and uniform principle of estimating the actual carrying capacity and working power of steam-ships may be adopted in their future registration.

(N.B. In this Recommendation the Committees of Section F. and Section G. concurred.)

That the Earl of Harrowby, Lord Stanley, Mr. William Fairbairn, Mr. Thomas Graham (Master of the Mint), Mr. James Heywood, Mr. Commissioner Hill, General Sabine, and Mr. Thomas Webster, be a Committee for the purpose of taking such steps as may be necessary to render the Patent system of this country, and the funds derived from inventors, more efficient and available for the reward of meritorious inventors, and the advancement of practical science.

Applications for Reports and Researches.

That Mr. Cayley be requested to complete his Report on the Progress of Theoretical Dynamics.

That a Committee, consisting of General Sabine, Professor Phillips, Sir James C. Ross, Mr. Robert W. Fox, and Rev. Dr. Lloyd, be requested to undertake the repetition of the Magnetic Survey of the British Islands.

That Dr. Miller be requested to complete his Report on Electro-chemistry.

That Dr. Price be requested to complete his Report on Commercial Varieties of Iron.

That Professor Buckman and Professor Voelcker be requested to continue their researches into the Effects of External Agents in the Growth of Plants.

That Mr. Rennie be requested to prosecute his experiments on the Velocity of the Screw-propeller, and report on them next year.

That Mr. Wm. Fairbairn, C.E., be requested to continue his Report on Boiler Explosions.

That a Committee, consisting of Mr. James Thomson, C.E., and Mr. William Fairbairn, C.E., F.R.S., be requested to continue their investigations on the Friction of Discs in water and on Centrifugal Pumps.

That Mr. James Thomson, C.E., be requested to report further on the Measurement of Water by Weir Boards.

Communications to be printed entire among the Reports.

That Dr. Booth's Memoir on the Geometrical origin of Logarithms be printed entire in the Reports of the Association.

That Mr. Etheridge's List of the Fossils from the Lias Bone Bed be printed entire in the Report of the Association's Proceedings.

That the Communication of Dr. Wright, on the Echinodermata of the Oolite, be printed entire in the Reports of the British Association.

That Professor Goodsir's Paper on the Morphological Constitution of the Skeleton of the Vertebrate Head be printed entire in the Reports of the Association, with such Illustrations as may be necessary.

Synopsis of Grants of Money appropriated to Scientific Objects by the General Committee at the Cheltenham Meeting in Aug. 1856, *with the name of the Member, who alone, or as the First of a Committee, is entitled to draw for the Money.*

	£	s.	d.
Kew Observatory.			
At the disposal of the Council for defraying expenses	350	0	0
Mathematics and Physics.			
Osler, F.—Reduction of Anemometrical Observations......	20	0	0
Fox, R. W.—Observations on Subterranean Temperature....	10	0	0
Chemical Science.			
Maskelyne, Prof.—Chemical Nature of Photographic Image	10	0	0
Anderson, Prof.—Compounds of Platinum and other metals with Ammonia	10	0	0
Geology.			
Mallet, R.—Earthquake Wave Experiments	50	0	0
Phillips, Prof.—Section of British Strata	15	0	0
Zoology and Botany.			
Patterson, R.—Dredging near Belfast	10	0	0
Miles, Rev. C. P.—Dredging on the West Coast of Scotland.	25	0	0
Williams, Dr.—British Annelida	25	0	0
Archer, T. C.—Natural Products imported into Liverpool ..	10	0	0
Keddie, W.—Natural Products imported into Glasgow......	10	0	0
Henslow, Prof.—Typical Forms for Museums	10	0	0
Jardine, Sir W.—Propagation of Salmon	10	0	0
Carpenter, Rev. P.—Mollusca of California	10	0	0
Pfeiffer, Madame Ida.—Natural History of Madagascar ..	20	0	0
Mechanics.			
Rennie, G.—Production of Heat in Fluids	20	0	0
Henderson, Andrew.—Life-Boats	5	0	0
Grants....	£620	0	0

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

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

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

1842.

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

1843.

	£	s.	d.
Revision of the Nomenclature of Stars	2	0	0
Reduction of Stars, British Association Catalogue	25	0	0
Anomalous Tides, Frith of Forth	120	0	0
Hourly Meteorological Observations at Kingussie and Inverness	77	12	8
Meteorological Observations at Plymouth	55	0	0
Whewell's Meteorological Anemometer at Plymouth	10	0	0
Meteorological Observations, Osler's Anemometer at Plymouth	20	0	0
Reduction of Meteorological Observations	30	0	0
Meteorological Instruments and Gratuities	39	6	0
Construction of Anemometer at Inverness	56	12	2
Magnetic 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
Uncovering Lower Red Sandstone near Manchester	4	4	6
Vegetative Power of Seeds	5	3	8
Marine Testacea (Habits of)	10	0	0
Marine Zoology	10	0	0
Marine Zoology	2	14	11
Preparation of Report on British Fossil Mammalia	100	0	0
Physiological Operations of Medicinal Agents	20	0	0
Vital Statistics	36	5	8
Additional Experiments on the Forms of Vessels	70	0	0
Additional Experiments on the Forms of Vessels	100	0	0
Reduction of Experiments on the Forms of Vessels	100	0	0
Morin's Instrument and Constant Indicator	69	14	10
Experiments on the Strength of Materials	60	0	0
	£1565	10	2

1844.

	£	s.	d.
Meteorological Observations at Kingussie and Inverness	12	0	0
Completing Observations at Plymouth	35	0	0
Magnetic and Meteorological 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

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

1845.

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

1846.

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

1847.

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

1848.

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

1849.

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

1850.

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

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

1851.

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

1852.

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

1853.

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

1854.

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

1855.

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

1856.

	£	s.	d.
Maintaining the Establishment at Kew Observatory:— 1854......£ 75 0 0; 1855......£500 0 0	575	0	0
Strickland's Ornithological Synonyms	100	0	0
Dredging and Dredging Forms	9	13	9
Chemical Action of Light	20	0	0
Strength of Iron Plates	10	0	0
Registration of Periodical Phænomena	10	0	0
Propagation of Salmon	10	0	0
	£734	13	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., 6 Queen Street Place, Upper Thames Street, London, for such portion of the sum granted as may from time to time be required.

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

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

General Meetings.

On Wednesday, Aug. 6th, at 8 P.M., in the College, the Duke of Argyll resigned the office of President to C. G. B. Daubeny, M.D., F.R.S., Professor of Botany in the University of Oxford, who took the Chair at the General Meeting, and delivered an Address, for which see p. xlviii.

On Thursday Evening, Aug. 7th, a Conversazione and Musical Promenade took place at the Pittville Spa.

On Friday, Aug. 8th, at 8½ P.M., in the College, Col. Sir H. Rawlinson, F.R.S., delivered a Discourse on Recent Discovéries in Assyria and Babylonia, with the results of Cuneiform Research up to the present time.

On Saturday Evening, Aug. 9th, a Conversazione was held in the College.

On Monday, Aug. 11th, at 8½ P.M., in the College, W. R. Grove, Esq., M.A., F.R.S., delivered a Discourse on the Correlation of Physical Forces.

On Tuesday, Aug. 12th, at 5½ P.M., the Members dined together in the Music Hall of the Royal Old Well, the President, Prof. Daubeny, in the Chair.

On Wednesday, Aug. 13th, at 3 P.M., the concluding General Meeting took place in the College, when the Proceedings of the General Committee, and the Grants of Money for scientific purposes, were explained to the Members.

The Meeting was then adjourned to Dublin*.

* The Meeting is appointed to take place on Wednesday, the 26th of August, 1857.

ADDRESS

BY

CHARLES DAUBENY, M.D., F.R.S.,

Professor of Botany in the University of Oxford.

Gentlemen of the British Association,

Exactly twenty years have elapsed since the time when, as one of the Local Secretaries of this Institution, at the Meeting held in Bristol, it became my province to lay before the Members present a Report on the progress of Physical Science, more especially with reference to the subjects that had been treated of in the last volume of our Transactions.

And it was with no assumed feeling of humility that I expressed on that occasion my lively sense of the responsibility of the task imposed upon me, and of my own feeble qualifications for its execution.

It is, however, with a much more pervading consciousness of my deficiencies that I appear at the present time, when, addressing you as the President of this great Body, I see before me similar duties committed to me to discharge.

On the former occasion, indeed, I was at least encouraged by the reflection, that however eminent those who had preceded me in the drawing up of such reports might have been,—and doubtless there were amongst them some of our most valued associates,—still, as the task had up to that time been confided to the Local Secretaries, it was one to which persons of humbler pretensions might aspire; nor was the general Body likely itself to be compromised by any remarks that emanated from one of its subordinate Officers.

But I now stand before you in quite a different capacity, following as I do in the wake of a long train of distinguished individuals, several of whom, indeed, as was the case with my own immediate predecessor, added to the recommendation of extensive scientific and literary attainments, the *prestige* of exalted rank and eminent social position; whilst of the remainder many had been peculiarly marked out for such a post, either on the ground of their own contributions to Science, or on that of the depth and range of their information in some of its highest departments.

In my own case, on the contrary, I cannot but feel, that this important office has been imposed upon me, chiefly on account of my position as the Senior amongst the Professors of Physical Science in a neighbouring University, which doubtless deserves the gratitude of this Association, for the support rendered to it, when such fostering care was most needed, in the infancy of its existence.

And if other reasons for the selection are sought for, I would refer it also to the accident of my birth, and to the partiality of my friends in the County where we are now assembled, to whom I flatter myself it may be a matter of satisfaction, to see thus distinguished, an individual whom they regard as one of themselves, and one too who owes his position in life, and his capability of indulging in those studies which here engage us, mainly to the good fortune of attaining, in the University alluded to, a Gloucestershire Fellowship.

With respect indeed to any personal claims I have to prefer for occupying so distinguished a post, the most that could be alleged in my behalf is the having from the commencement of this Association done what I could to promote its success, and to enlist others in its service; persuaded, as I have ever been, that it could not fail to prove a most efficient instrument for the furtherance of scientific objects, not only through the direct influence of its Meetings in promoting a friendly intercourse and a free interchange of opinions amongst those devoted to kindred pursuits, but also indirectly, by engaging the Public in various useful undertakings, which Science indeed might have suggested, but which the Nation alone was capable of carrying into effect.

And that these anticipations have been borne out by the result, would now seem to be generally admitted from the fact, that other Societies, since organized in this country with a view to similar objects, have been uniformly framed after its model, and conducted upon principles which they have borrowed from this Institution.

It is indeed rather remarkable, that the first idea of an Association of such a kind should have suggested itself only a year after death had deprived us of our three most distinguished philosophers,—for who had we then left to compare, with Davy for the brilliancy and importance of his discoveries; with Young for the singular union of almost universal acquirements with admirable powers of invention; and with Wollaston for an acuteness of mental vision, which gave him the same advantage in the pursuits of science, which the Naturalist armed with a microscope has over the unassisted observer? Just as in the animal œconomy the *vis medicatrix naturæ* sometimes makes an extraordinary effort to repair the damage inflicted by injury or disease; so it would seem, as if Science, conscious of the loss she had sustained in the almost simultaneous extinction of her three brightest luminaries, endeavoured to make good the deficiency, by concentrating into one *focus* those that yet remained, to light her onwards on her path.

At any rate, the progress which the Natural Sciences have made since that period, although doubtless attributable to several concurrent causes, is a fact which must not be overlooked in estimating the services rendered by this Association to the cause of human advancement; nor can I in any better manner point out its value, than by bringing before your notice some of the additions to our knowledge which have been made since I last addressed you, especially considering, that not a few of the discoveries to which I shall allude were either first announced, or have been made the subjects of discussion, at our several Meetings.

Beginning then with Chemistry, as the subject with which I am most familiar, let me remind you, that at a period not much more remote than the one alluded to, all of it that could be quoted as really worthy the name of a Science was comprehended within the limits of the mineral kingdom.

Here at least the outline had been traced out with sufficient precision—the general laws established on a firm basis—the nomenclature framed with logical exactness—the facts consistent with each other, and presented in a scientific and luminous form. Thus a philosopher, like Sir Humphry Davy, who had contributed in so eminent a degree to bring the science into this satisfactory condition, might, at the close of his career, have despaired of adding anything worthy of his name to the domain of chemistry, and have sighed for other worlds to subdue.

But there was a World almost as little known to the chemists of that period as was the Western Hemisphere to the Macedonian Conqueror,—one comprising an infinite variety of important products, called into existence by the mysterious operation of the vital principle, and therefore placed, as was imagined, almost beyond the reach of experimental research.

This is the new World of Chemistry, which the continental philosophers in the first instance, and subsequently those of our own country, have during the last twenty years been busy in exploring, and by so doing have not only bridged over the gulf which had before separated by an impassable barrier the kingdoms of inorganic and of organic nature, but also have added provinces as extensive and as fertile as those we were in possession of before, to the patrimony of Science.

It is indeed singular, that whilst the supposed elements of mineral bodies are very numerous, the combinations between them should be comparatively few; whereas amongst those of vegetable and animal origin, where the ultimate elements are so limited in point of number, the combinations which they form appear almost infinite. Carbon and hydrogen, for instance, constitute, as it were, the keystone of every organic fabric; whilst oxygen, nitrogen, and less frequently sulphur and phosphorus, serve almost alone to build up their superstructure.

And yet what an infinity of products is brought about by ringing the changes upon this scanty alphabet! Even one series of bodies alone, that known by the name of the Fatty Acids, comprises several hundred well-ascertained combinations, founded however upon a single class of hydro-carbons or compound radicals, in which the carbon and hydrogen stand to each other in equal atomic proportions, and are in each case acidified by the same number of equivalents of oxygen.

These acids are all monobasic, or combine with only one proportion of base; but add to any one of them two equivalents of carbonic acid, and you obtain a member of a second series, which is bibasic, or is capable of forming two classes of salts.

The above therefore constitute a double series, as it were, of organic acids, the members of which are mutually related in the manner pointed out, and differ from each other in their mode of combining according to the relation between their respective elements. But already, by the labours of Hofmann and of other chemists, two other double series of acids, the one monobasic the other bibasic, mutually related exactly in the same manner as those above, have been brought to light; each series no doubt characterized by an equally numerous appendage of alcohols, of æthers, and of aldehydes, to say nothing of the secondary compounds resulting from the union of each of these bodies with others.

Hence the more insight we obtain into the chemistry of organic substances, the more we become bewildered with their complexity, and in investigating these phænomena, find ourselves in the condition of the explorer of a new continent, who, although he might see the same sun over his head, the same ocean rolling at his feet, the same geological structure in the rocks that were piled around him, and was thus assured that he still continued a denizen of his own planet, and subject to those physical laws to which he had been before amenable, yet at every step he took was met by some novel object, and startled with some strange and portentous production of Nature's fecundity.

Even so the chemist of the present day, whilst he recognizes in the world of organic life the same general laws which prevail throughout the mineral kingdom, is nevertheless astonished and perplexed by the multiplicity of new bodies that present themselves, the wondrous changes in them resulting from slight differences in molecular arrangement, and the simple nature of the machinery by which such complicated effects are brought about.

And as the New World might never have been discovered, or, at all events, would not have been brought under our subjection, without those improvements in naval architecture which had taken place prior to the age of Columbus, so the secrets of organic chemistry would have long remained unelicited, but for the facilities in the methods of analysis which were introduced by Liebig.

Before his time the determination of the component elements of an organic substance was a task of so much skill as well as labour, that only the most accomplished analysts—such men, for instance, as my lamented friend Dr. Prout in this country, or as the great Berzelius in Sweden—could be depended upon for such a work; and hence the data upon which we could rely for deducing any general conclusions went on accumulating with extreme slowness.

But the new methods of analysis invented by Liebig have so simplified and so facilitated the processes, that a student, after a few months' practical instruction in a laboratory, can, in many instances, arrive at results sufficiently precise to be made the basis of calculation, and thus to enable the master mind, which is capable of availing itself of the facts before it, to breathe life into these dry numerical details,—just as the sculptor, by a few finishing strokes, brings out the expression of the statue, which has been prepared for him by the laborious chiseling of a number of subordinate workmen.

And as the established laws and institutions of the Old World have been modified—may I not say in some instances rectified?—by the insensible influence of those of the New, so have the principles that had been deduced from the phænomena of the mineral kingdom undergone in many instances a correction from the new discoveries made in the chemistry of the animal and vegetable creation.

It was a great step indeed in the progress of the Science, when Lavoisier set the example of an appeal to the balance in all our experimental researches, and the Atomic Theory of Dalton may be regarded as the necessary, although somewhat tardy, result of the greater numerical precision thus introduced.

But no less important was the advance achieved, when structure and polarity were recognized as influencing the condition of matter, and when the nature of a body was felt to be determined, not only by the proportions of its component elements, but also by their mutual arrangement and collocation—a principle, which, first illustrated amongst the products of organic life, has since been found to extend alike to all chemical substances whatsoever.

Formerly it had been the rule to set down the bodies which form the constituents of the substances we analysed, and which had never yet under our hands undergone decomposition, as elementary; but the discovery of cyanogen in the first instance, and the recognition of several other compound radicals in organic chemistry more lately, naturally suggest the idea, that many of the so-called elements of inorganic matter may likewise be compounds, differing from the organic radicals above mentioned merely in their constituents being bound together by a closer affinity.

And this conjecture is confirmed by the curious numerical relations subsisting between the atomic weights of several of these supposed elements; as, for example, between chlorine, bromine and iodine; an extension of the grand generalization of Dalton, which, although it was unforeseen by the Founder of the system, and therefore, like Gay-Lussac's theory of volumes, might very possibly have been repudiated by him, had it been proposed for his acceptance, will be regarded by others as establishing, in a manner more conclusive than before, the soundness of his antecedent deductions.

What, indeed, can be a greater triumph for the theorist, than to find that a law of nature which he has had the glory of establishing by a long and painful process of induction, not only accommodates itself to all the new facts which the progress of discovery has since brought to light, but is itself the consequence of a still more general and comprehensive principle, which philosophers, even at this distance of time, are still engaged in unfolding?

It is also curious to reflect, that whilst the bold speculations of Democritus have been realized by the Manchester philosopher, the reveries of the alchemists derive something like solid support from the minute investigations of his successors.

We may remark indeed as not a little remarkable, how frequently the discoveries of modern days have served to redeem the fancies of medieval times from the charge of absurdity.

If the direction of a bit of steel suspended near the earth can, as General Sabine has proved, be influenced by the position of a body like the moon, situated at a distance from it of more than 200,000 miles, who shall say that there was anything preposterously extravagant in the conception, however little support it may derive from experience, that the stars might exert an influence over the destinies of man? and when we observe a series of bodies, exhibiting, as it would seem, a gradation of properties, and, although as yet undecompounded, possessing a common numerical relation one to the other, who will deny the probability, that they are composed of the same constituents, however little approach we may have as yet made towards the art of resolving them into their elements, or of forming them anew?

Organic chemistry has also considerably modified our views with respect to chemical affinity.

According to one view, indeed, which has been supported of late with considerable talent and ingenuity, the law of elective attraction, to which we have been in the habit of referring all the changes that are brought about by chemical means, is a mere figment of the imagination; and decomposition may be accounted for, without the interference of any such force, by regarding it simply as the result of that constant interchange which is supposed to be going on between the particles of matter,—the atoms even of a solid body being, according to this hypothesis, in a state of incessant motion.

But passing over these and other speculations which have not as yet received the general assent of chemists, let me advert to others of an older date, possessing, as I conceive, the strongest internal evidence in their favour, which the case admits, from the harmony they tend to introduce into the chaos of facts which the late discoveries in organic chemistry have brought to light.

Amongst these, one of the most generally received, and at the same time one of the most universal application, is that which represents the several combinations resulting from organic forces, as being put together according to a particular model or type, which impresses upon the aggregate formed certain common properties, and also causes it to undergo change most readily, through the substitution of some other element in the place of one of those which already enters into its constitution.

And this principle, having been established with regard to one class of bodies, has since been extended to the rest; for it now begins to be maintained, that in every case of chemical decomposition a new element is introduced in the place of one of those which constituted a part of the original compound, so that the addition of a fresh ingredient is necessarily accompanied by the elimination of an old one.

The same doctrine, too, has even been extended to the case of combination with a body regarded as elementary, for here also the particles are considered as being in a state of binary combination one with the other, owing perhaps to their existing in opposite electrical conditions, and therefore possessing for each other a certain degree of chemical affinity.

Thus, when we unite hydrogen with oxygen, we substitute an atom of the latter for one of the former, previously combined with the same element. The type therefore remains, although the constituents are different.

When, in the formation of alcohol, we combine the oxide of the compound radical æthyle with water, there is still only a substitution of the former for one of the atoms of water previously united together, two and two; and when we form æther, we eliminate the second atom of water, and replace it by another atom of the same compound radical. Thus the type of water still remains, although none of the materials of the original fabric continue; or, if I may adopt the metaphor of a building, although the original bricks which composed the structure may have been all replaced by other materials, the latter, however differing in their nature, always correspond, in point of shape, dimensions, and number, with the parts of the edifice which have been removed to make way for them.

It is on this principle that Professor Williamson has propounded a new theory of ætherification, regarding the process as resulting from the alternate replacement of hydrogen by æthyle, and of æthyle by hydrogen, in the sulphuric acid concerned,—a view, which best harmonises with the composition of the new æther he hit upon in the course of his investigations.

The same principle may even be extended to bodies of the same type as ammonia; for inasmuch as this body is made up of a union of an atom of nitrogen with three of hydrogen, it is easy to conceive that a variety of different compounds might be formed by the substitution of one, two, or three atoms of other radicals for the same number of atoms of the original hydrogen. How beautifully this idea has been carried out in the recent researches of Hofmann, and how happily it serves to elucidate the formation of the various vegetable alkaloids, which, from their energetic action upon the animal œconomy, have of late excited so much interest in the public mind, is sufficiently known to those who are chemists, and could not be rendered intelligible to those who are not, without entering into details which would be out of place on the present occasion.

I must not, however, pass over this part of the subject without remarking, that the adoption of Professor Williamson's othyle theory would establish a still nearer analogy between the constitution of organic and of mineral compounds than is at present recognized, since in that case alcohol and æther would stand in the same relation one to the other, and belong to the same class or series, as the acids and their salts.

These views, however, and others having reference to the same subject, are now under discussion, and I hope in progress of being worked out by the able chemist above alluded to, whose promised Report on this subject, had it been ready for this Meeting, would have superseded the necessity of the above Remarks. They have also engaged the attention of my distinguished successor in the chair of Chemistry at Oxford, who has published some elaborate researches bearing upon the questions here mooted, whilst on the Continent they have been taken up by several of the most eminent chemists of the day, such as Gerhardt, Wurtz, and Cahours.

Should they ultimately win their way to general reception, they must tend to bring about an entire remodeling of our views, both with respect to organic and inorganic compounds, and render that reform in our nomenclature which I pressed upon the attention of the Chemical Section at our meeting in Ipswich, more than ever a matter of urgent necessity.

Many, however, perhaps of my present audience may not have advanced beyond that initial stage of all speculation, which contemplates external objects solely as they affect themselves, and not abstractedly in their relations to each other; and to such it may be more interesting to consider those practical results bearing upon the arts of life, which have either been actually deduced, or may be anticipated as likely to accrue, from the discoveries in question.

Of these perhaps the most important is the possibility of forming by art those compounds, which had been formerly supposed to be only producible by natural processes, under the influence of the vital principle. The last two years have added materially to the catalogue of such bodies artificially produced, as in the formation of several species of alcohol from coal gas by Berthelot, that of oil of mustard by the same chemist, and the generation of taurine, a principle elaborated in the liver, by Strecker.

And if the above discoveries should strike you at first sight rather as curious than practically useful, I would remark, that they afford reasonable ground for hope, that the production of some of those principles of high medicinal or œconomical value, which nature has sparingly provided, or at least limited to certain districts or climates, may lie within the compass of the chemist's skill.

If Quinine, for instance, to which the Peruvian bark owes its efficacy, be, as would appear from recent researches, a modified condition of ammonia, why may not a Hofmann be able to produce it for us from its elements, as he has already done so many other alkaloids of similar constitution?

And thus, whilst the progress of civilization, and the development of the chemical arts, are accelerating the consumption of those articles, which kind Nature has either been storing up for the uses of man during a vast succession of antecedent ages, or else is at present elaborating for us in that limited area, within which alone the conditions would seem to be such as to admit of their production, we are encouraged to hope that Science may make good the loss she has contributed to create, by herself inventing artificial modes of obtaining these necessary materials.

In this case we need not so much regard the exhaustion of our collieries, although Nature appears to have provided no means for replenishing them; nor even be concerned at the rapid destruction of the trees which yield the Peruvian bark, limited though they be to a very narrow zone, and to a certain definite elevation on either side of the equator.

Already, indeed, chemistry has given token of her powers, by threatening to alter the course of commerce, and to reverse the tide of human industry.

Thus she has discovered, it is said, a substitute for the cochineal insect, in a beautiful dye producible from guano.

She has shown, that our supply of animal food might be obtained at a cheaper rate from the Antipodes, by simply boiling down the juices of the flesh of cattle now wasted and thrown aside in those countries, and importing the extract in a state of concentration.

She has pointed out, that one of the earths which constitute the principal material of our globe contains a metal, as light as glass, as malleable and ductile as copper, and as little liable to rust as silver; thus possessing properties so valuable, that when means have been found of separating it œconomically from its ore, it will be capable of superseding the metals in common use, and thus of rendering metallurgy an employment, not of certain districts only, but of every part of the earth to which Science and Civilization have penetrated.

And may I not also say, that she has contributed materially towards the advancement of those arts in which an agricultural county like this is especially interested?

Who has not heard of the work of Baron Liebig, which, at the time of its first appearance, made such a sensation throughout the country; and stirred up the dormant energies of the agricultural public, not less thoroughly, than the subsoil plough, of which he explained the advantages, elicited the latent treasures of the land?

It is not often that the same individual has reaped a high reputation, at once by establishing general principles in Science, and by rendering popular their application to practice.

Oersted, the father of the science of Electro-chemistry, and our own Faraday, who has done so much to develope its principles, left to Wheatstone the invention of the telegraph; Dalton, the propounder of the Atomic Theory, did nothing to improve the manufactures of the city in which he resided; and the contrivances which have rendered the steam-engine generally applicable to practice required a combination of the distinct talents of a Black and a Watt, the one to explain the theory of latent heat, the other to apply it to the œconomical generation of steam.

But Baron Liebig stands equally distinguished for his ingenuity in devising new methods of analysis, for his originality in propounding great theoretical principles in Science, and for his happy talent in applying these principles to purposes of practical utility.

Like his countryman Göethe, his mind seems to have passed through three phases; for his ingenious methods of analysis were appreciated, before his views on the relation between organic substances, his doctrine of compound radicals, and the consequences flowing from his researches in vegetable chemistry, came to be generally admitted; and the latter had already taken root in the minds of chemists, and had established for him a very high reputation among his fellow-labourers in Science, before his attempts to apply his principles to agriculture and to physiology made his name so celebrated, as it has since been, amongst the public in general.

It is well known, that a controversy has been going on for some time past between this distinguished foreigner, and certain experimental agriculturists of our own country, with regard to the principles upon which the manuring of our land ought to be regulated. In this dispute, however, you will not expect me to take part; for it would be obviously improper on the present occasion, that I should avail myself of a little brief authority to influence the public on either side of a much-debated question; and, indeed, on any other, it might be deemed an act of presumption in an individual, who can prefer no claim either to the extensive practical experience of the one, or to the high scientific eminence of the other, to take upon himself to adjudicate between two such conflicting parties.

But I may be permitted to remark, that whilst some points of difference between them still remain open for further investigation, a much nearer correspondence of opinion exists with respect to others, than the public in general, or even perhaps the disputants themselves, are inclined to allow.

In so far, indeed, as concerns the relative advantages of mineral and ammoniacal manures, I presume there is little room for controversy; for although most soils may contain a sufficiency of the inorganic constituents required by the crop, it by no means follows that the latter are always in an available condition; and hence it may well happen that in most cases in which land has been long under cultivation, the former class of manures becomes, as Baron Liebig asserts, a matter of paramount necessity. Now that the same necessity exists for the addition of ammoniacal manures can hardly be contended, when we reflect, that at the first commencement of vegetable life, every existing species of plant must have obtained its nourishment, solely from the gaseous constituents of the atmosphere, and from the mineral contents of the rock in which it vegetated.

The only divergence of opinion therefore that can arise, relates to the degree of their respective utility in the existing state of our agriculture, and to the soundness of Baron Liebig's position, that a plant rooted in a soil well-charged with all the requisite mineral ingredients, and in all other respects in a condition calculated to allow of healthy vegetation, may sooner or later be able to draw from the atmosphere whatever else is required for its full development.

And does not, I would ask, this latter position derive some support from the luxuriant vegetation of the tropics, where art certainly contributes nothing towards the result? and is it not also favoured by such experiments as those carried on at Lois Weedon in Northamptonshire, where the most luxuriant wheat crops have been obtained for a number of consecutive years without manure of any kind, simply by following out the Tullian system of stirring up and pulverizing the soil?

How, too, are we to explain that capacity of subsisting without any artificial supply of ammonia, which Mr. Lawes is led by his experiments to attribute to turnips, and other plants of similar organization, unless we assume that the power residing in the leaves of absorbing ammonia from the air may render plants, in some cases at least, independent of any extraneous aid?

Be this, however, as it may, there is at least a wide distinction between this opinion, and the one attributed to Baron Liebig by many, who would seem to imagine, that according to his views, ammonia, if derived from artificial sources, was in a manner useless to vegetation.

As if it could be a matter of any moment, whether the substance which in both cases afforded the supply of nitrogen, and which in both cases also was primarily derived from the decomposition of organic substances, had been assimilated by plants directly upon its being thus generated, or had been received into their system at a later period, after having been diffused through the atmosphere! To suppose that Baron Liebig should have attached any moment to this distinction seems inconsistent with many passages in his work, in which, although the paramount importance of mineral manures may be insisted upon, and the success which had in certain cases attended the use of one compounded only of mineral ingredients may be put forward as a motive for further trials, the utility of ammoniacal substances in all their several forms is at the same time distinctly admitted.

Still the practical question remains, whether, admitting the theoretical truth of Baron Liebig's position, a larger expenditure of capital will not be required for bringing a given farm into a condition to dispense with ammoniacal manures, than for procuring those materials which contain that ingredient ready for use. And here experimental researches, such as those conducted on so extended and liberal a scale by Mr. Lawes and Dr. Gilbert, come in aid of theory. They stand, as it were, midway between the abstract principles which Science points out to the farmer, and the traditional usages with respect to his art, which have been handed down to him from one generation to another. They bear the same relation to the farmer, which the records of the clinical practice in a large infirmary do, to the general principles of medicine expounded by the modern physiologist.

It is true, that the experience of a particular hospital may not at all times coincide with the anticipations which science holds out; but this discrepancy only suggests to us the imperfection of our present knowledge, and is not allowed to disturb the confidence of the physician in principles already established on incontrovertible evidence. On the contrary, whilst he modifies his practice from time to time by the experience he has gained by actual observation, he feels at the same time the fullest conviction, that these results will be found eventually reconcileable with the general principles, which a still more extended series of induction may have established.

I need not occupy your time by applying the same method of proceeding to the recent researches alluded to, but I will carry the analogy between the science of Agriculture and of Therapeutics one step further. You may recollect, that in a Report on the progress of husbandry, drawn up some years ago by one of the most enlightened and zealous promoters of the agricultural interest in Great Britain, now, alas! deceased, it was asserted, that chemistry had done nothing for the farmer, except in teaching him to use sulphuric acid with his bones, and to take advantage of the refuse flax liquor, formerly thrown away and wasted.

Now a statement of this kind, although it might be literally true in the narrow sense in which the author doubtless intended it, namely, as referring merely to the introduction of new specifics or recipes into farming, was calculated, when put forth on such high authority, to foster that tendency in the human mind to which we are all more or less prone, that of sparing ourselves the trouble of thought and reflection in shaping the course of our conduct, by leaning blindly upon certain rigid and unvarying rules already chalked out to us by others.

It was this propensity exercised upon moral subjects which has encumbered our libraries with those vast tomes on casuistry, in which the conduct to be pursued in each imaginable case of conscience was attempted to be prescribed; it was this which has driven many a patient to fly from the regular practitioner into the arms of the homœopathist, who professes to have a *globule* ready to meet every possible symptom.

Grant that Science has as yet supplied us with only two infallible receipts for the improvement of our land, the agricultural chemist may derive courage from the reflection, that medicine too, since the days of Hippocrates, has lighted only upon two or three specifics for the cure of disease; and that the most enlightened physicians of the present day, in the spirit which we would fain see actuating the leaders of the agricultural body, depend not upon the efficacy of *nostrums*, but upon their sagacity in referring the varying conditions of each case which comes before them to those principles of physiology which modern Science has established.

And has not Science also unfolded principles which may be called in to aid and direct the practical labours of the agriculturist?

I need not go further than the works of Baron Liebig for an answer to this question. I may appeal, for instance, to the extensive employment of guano at the present time, first introduced in England in consequence of his suggestions: I may refer to the substitution of mineral phosphates for bones, founded upon his explanation of the sources from which the latter substance derives its efficacy as a manure: and I may allude more especially to his refutation of the humus theory, to which even the great Saussure gave his adhesion, and the reception of which was calculated to vitiate, not a few processes only, but the entire system of our husbandry.

But whilst we do justice to those comprehensive views on agricultural science which have shed a new lustre upon the name of Liebig, let us not forget the practical researches which have been carried on in our own country; and especially those conducted under the auspices of the Highland Society by Dr. Anderson; at our own Agricultural College by Prof. Voelcker; and, through the aid of the Royal Agricultural Society, by their consulting chemist, Mr. Way. And, although in alluding to the labours of the latter, we may be bound to confess, that in one of the latest and probably the most important investigations undertaken by him, that namely on the absorptive qualities of clay with reference to ammoniacal salts, he had been anticipated, so far as the principle goes, by the German Professor, who announced the fact many years before in his work 'On Chemistry applied to Agriculture*,' yet experience has often shown that a principle may lie dormant long after it was enunciated, until its truth is rendered palpable to the senses by a series of practical researches expressly directed with a view to demonstrate its general applicability.

Baron Liebig has himself remarked, that as a plant, in order to thrive, must receive its food, not in a concentrated form, but reduced to a certain state of tenuity by being diffused through water; so an abstract truth only makes an impression upon the mind and feelings, when presented to it properly diluted, turned, as it were, inside out, examined under every aspect, and decked out with all the accompaniments of dress, ornament, and colour.

Then, indeed, as the seed, when implanted in the ground and taken root, is able to cleave asunder the hardest rocks, and that, as the old proverb says, all without noise; so likewise the truth will at length in its own good time begin to germinate, and gradually conquering all obstacles, establish for itself a footing in the mind of the public. Let us not therefore withhold our meed of approbation from those who have worked out for us any useful scientific principle, even though the germ may be traceable to some other quarter; conscious that it is to its being brought thus prominently forward, and, as it were, forced upon the attention of the public, that we owe its general reception and its reduction to practice.

But it is time to hasten on to certain other departments of Natural Science.

In Botany and Vegetable Physiology it cannot perhaps be said, that whole provinces have been added to the domain of the Science since the period alluded to, as we have seen to be the case in our review of the progress of chemistry.

Even so long ago as the year 1832, the elder DeCandolle, who, if not the most original or the most profound of the botanists of his day, was at least the most conspicuous for the wide range of his information, and for his happy talent of imparting it to others, published that admirable work on vegetable physiology, which even at the present time is capable of serving as a most useful guide in many branches of the subject.

And yet what a mass of important information has been brought together since that period!

* P. 57, Eng. Trans.

The improvements in the microscope which have since taken place, render us familiar with particulars relating to the structure and functions of the vegetable creation, which the ruder methods of investigation before resorted to would never have revealed to us.

We owe to them the interesting discoveries of Brown and Adolphe Brongniart, as to the mode in which the pollen is brought into immediate contact with the ovules, by means of the tubes which it protrudes by a prolongation of the innermost of its two investing membranes. Thus much at least appears to be fully ascertained; but in alluding to the observations of others who have endeavoured to push their scrutiny still further, it becomes me to speak with more diffidence, inasmuch as the office which the pollen discharges in the act of fecundation is still a matter of dispute, between such men as Schleiden and Schacht on the one side, and Hofmeister, Moll, &c. on the other.

Whilst, however, this controversy continues, it is something at least to know, that the vivifying principle, whatever it may be, is actually transmitted to the part where its influence is to be exerted, and not kept apart from it, as we were formerly compelled to assume, by that long intervening plexus of fibres or tubes which constitutes the style.

To the microscope also we owe all that is as yet known with respect to the reproductive process in cryptogamous plants, which are now shown to possess a structure analogous to that of flowering ones in respect to their organs of reproduction; not, indeed, as Hedwig supposed, that parts corresponding to stamens and pistils in appearance and structure can be discovered in them, but that, as the primary distinction of sexes seems to run throughout the vegetable kingdom, new parts are superadded to a structure common to all as we ascend in the scale of creation, until from the simple cell, which, in consequence of some differences of structure to our eyes inappreciable, appears to exercise in one case the function of the male, in another of the female, as is found the case in certain of the Confervæ, we arrive at length at the complicated machinery exhibited in flowering plants, in which the cell containing the fecundating principle is first matured in the stamen, and afterwards transmitted through an elaborate apparatus to the cells of the ovule, which is in like manner enveloped in its matrix, and protected by the series of investing membranes which constitutes the seed-vessel. Thus, as Goethe long ago observed, and as modern Physiologists have since shown to be the case, the more imperfect a being is, the more its individual parts resemble each other —the progress of development, both in the animal and vegetable kingdom, always proceeding from the like to the unlike, from the general to the particular.

But whilst the researches of Brown and others have proved, that there is no abrupt line of division in the vegetable kingdom, and that one common structure pervades the whole; the later inquiries of Suminski, Hofmeister, Unger, Griffith, and Henfrey, have pointed out several curious and unlooked-for analogies between plants and animals.

I may mention, in the first place, as an instance of this analogy, the existence of moving molecules or phytosperms in the antheridia of Ferns and other Cryptogams, borne out, as it has been in so remarkable a manner, by the almost simultaneous observations of Bischoff and Meissner on the egg, confirmatory of those formerly announced by Barry and Newport; and by the researches of Suminski, Thuret, and Pringsheim, with respect to the ovule of plants. I may refer you also to a paper read at the last Meeting of the Association, by Dr. Cohn of Breslau, who, in bringing this subject before the Natural History Section, adduced instances of a distinction of sexes which had come under his observation in the lower Algæ.

In like manner a curious correspondence has been traced between the lower tribes of animals and plants, in the circumstance of both being subject to the law of what is called alternate generation. This consists in a sort of cycle of changes from one kind of being to another, which was first detected in some of the lower tribes of animals, a pair of insects, for example, producing a progeny differing from themselves in outward appearance and internal structure, and these reproducing their kind without any renewed sexual union, the progeny in these cases consisting of females only. At length, after a succession of such generations, the offspring reverts to its primæval type, and pairs of male and female insects of the original form are reproduced, which complete the cycle, by giving rise in their turn to a breed presenting the same characters as those which belong to their own progenitors.

An ingenious comparison had been instituted by Owen and others between this alternation of generations in the animal, and the alternate production of leaves and blossoms in the plant; but the researches to which I especially allude have rendered this no longer a matter of mere speculation or inference, inasmuch as they have shown the same thing to occur in Ferns, in Lycopodia, in Mosses, nay, even in the Confervæ.

We are indebted to Professor Henfrey for a valuable contribution to our Transactions in 1851 on these subjects, given in the form of a Report on the Higher Cryptogamous Plants; from which it at least appears, that the proofs of sexuality in the Cryptogamia rank in the same scale as to completeness, as those regarding flowering plants did before the access of the pollen tubes to the ovule had been demonstrated. Indeed, if the observations of Pringsheim with respect to certain of the Algæ are to be relied upon, the analogy between the reproductive process in plants and animals is even more clearly made out in these lower tribes, than it is in those of higher organization.

It also appears, that the production in Ferns and other Acrogens of what has been called a *pro-embryo*; the evolution of antheridia and archegonia, or of male and female organs, from the former; and the generation from the archegonia of a frond bearing spores upon its under surface, is analogous to what takes place in flowering plants in general; where the seed, when it germinates, produces stem, roots and leaves; the stem for many generations gives rise to nothing but shoots like itself; until at length a flower springs from it, which contains within itself for the most part the organs of both sexes united, and therefore occasions the reproduction of the same seed with which the chain of phænomena commenced. This is the principle which a learned Professor at Berlin has rather obscurely shadowed out in his Treatise on the Rejuvenescence of Plants, and which may perhaps be regarded as one at least of the means, by which Nature provides for the stability of the forms of organic life she has created, by imparting to each plant a tendency to revert to the primæval type.

To the elder DeCandolle we are also indebted for some of our most philosophical views with respect to the laws which regulate the distribution of plants over the globe,—views which have been developed and extended, but by no means subverted, by the investigations of subsequent writers; amongst whom Sir Charles Lyell, in his 'Principles of Geology,' and the younger DeCandolle, a worthy inheritor of his father's reputation, in his recently published work on Botanical Geography, have especially signalized themselves. But it is to the late Professor Edward Forbes, and to Dr. Joseph Hooker, that we have principally to attribute the removal of those anomalies, which threw a certain degree of doubt upon the principles laid down by

DeCandolle in 1820, in his celebrated article on the Geography of Plants, contained in the 'Dictionnaire des Sciences Naturelles,' where the derivation of each species from an individual, or a pair of individuals, created in one particular locality, was made the starting-point of all our inquiries.

These anomalies were of two different kinds, and pointed in two opposite directions: for we had in some cases to explain the occurrence of a peculiar flora in islands cut off from the rest of the world, except through the medium of a wide intervening ocean; and in other cases to reconcile the fact of the same or of allied species being diffused over vast areas, the several portions of which are at the present time separated from each other in such a manner, as to prevent the possibility of the migration of plants from one to the other. Indeed, after making due allowances for those curious contrivances by which Nature has in many instances provided for the transmission of species over different parts of the same continent, and even across the ocean, and which are so well pointed out in DeCandolle's original essay, we are compelled to admit the apparent inefficiency of existing causes to account for the distribution of the larger number of species; and must confess that the explanation fails us often where it is most needed; for the Compositæ, in spite of those feathery appendages they possess, which are so favourable to the wide dissemination of their seeds, might be inferred, by their general absence from the fossil flora, to have diffused themselves in a less degree than many other families have done. And on the other hand, it is found, that under existing circumstances, those Compositæ, which are disseminated throughout the area of the Great Pacific, belong in many cases to species destitute of these auxiliaries to transmission.

But here Geology comes to our aid; for by pointing out the probability of the submergence of continents on the one hand, and the elevation of tracts of land on the other, it enables us to explain, the occurrence of the same plants in some islands or continents now wholly unconnected, and the existence of a distinct flora in others too isolated to obtain it under present circumstances from without. In the one case we may suppose the plants to have been distributed over the whole area before its several parts became disunited by the catastrophes which supervened; in the other, we may regard the peculiar flora now existing as merely the wreck, as it were, of one which once overspread a large tract of land, of which all but the little patch upon which it is now found had since been submerged.

Upon this subject, however, our opinions may in some measure be swayed by the nature of the conclusions we arrive at with respect to the length of time during which seeds are capable of maintaining their vitality; for if after remaining for an indefinite period in the earth they were capable of germinating, it would doubtless be easier to understand the revival, under favourable circumstances, of plants which had existed before the severance of a tract of land from the continent in which they are indigenous. An inquiry has accordingly been carried on for the last fifteen years under the auspices of, and with the aid of funds supplied by, this Association, the results of which, it is but fair to say, by no means corroborate the reports that had been from time to time given us with respect to the extreme longevity of certain seeds, exemplified, as it was said, in the case of the mummy-wheat and other somewhat dubious instances; inasmuch as they tend to show, that none of the seeds which were tested, although they had been placed under the most favourable artificial conditions that could be devised, vegetated beyond a period of forty-nine years; that only twenty out of 288 species did so after twenty years; whilst by far the larger number had lost their germinating power in the course of ten.

These results, indeed, being merely negative, ought not to outweigh such positive statements on the contrary side as come before us recommended by respectable authority, such, for instance, as that respecting a Nelumbium seed, which germinated after having been preserved in Sir Hans Sloane's Herbarium for 150 years; still, however, they throw suspicion as to the existence in seeds of that capacity of preserving their vitality almost indefinitely, which alone would warrant us in calling to our aid this principle in explaining the wide geographical range which certain species of plants affect.

Let us then be content to appeal to those ingenious views which were first put forth at one of our meetings by the late Professor Forbes, and which have since been promulgated in a more detailed and systematic form by the same distinguished naturalist. By the aid of the principles therein laid down, he was enabled to trace the flora of Great Britain principally to four distinct sources, owing to the geological connexion of these islands at one period or other with Scandinavia, with Germany, with France, and with Spain! And it was by a similar assumption that Dr. Joseph Hooker explained the distribution of the same species throughout the islands of the Great Pacific, and the contiguous continents, tracts which, as Darwin had shown, were formerly united. Nor is this mode of explanation limited to the case of the above regions; for in the 'Flora Indica,' which important work I regret to find has been suspended after the appearance of the first volume, Dr. Hooker, in conjunction with his fellow traveller, Dr. Thomson, has discussed the same problem with regard to the whole of India, extending from Affghanistan to the Malayan peninsula.

And amongst the many services rendered to the Natural Sciences by these indefatigable botanists, one of the greatest I conceive to be, that they have not only protested against that undue multiplication of species, which had taken place by exalting minute points of difference into grounds of radical and primary distinction, but that they have also practically illustrated their views with respect to the natural families which have been described by them in the volume alluded to. They have thus contributed materially to remove another difficulty which stood in the way of the adoption of the theory of specific centres,—I mean the replacement of forms of vegetation in adjoining countries by others, not identical, but only as it should seem allied; for it follows from the principles laid down by these authors, that such apparently distinct species may after all have been only varieties, produced by the operation of external causes acting upon the same species during long periods of time.

But if this be allowed, what limits, it may be asked, are we to assign to the changes which a plant is capable of undergoing, and in what way can we oppose the principle of the transmutation of species, which has of late excited so much attention, and the admission of which is considered to involve such startling consequences?

I must refer you to the writings of modern physiologists for a full discussion of this question, and may appeal in particular to the lecture delivered before this Association by Dr. Carpenter at our last meeting. All that I shall venture to remark on the subject is, that had not Nature herself assigned certain boundaries to the changes which plants are capable of undergoing, there would seem no reason why any species at all should be restricted within a definite area, since the unlimited power of adaptation to external conditions which it would then possess might enable it to diffuse itself throughout the world, as easily as it has done over that portion of space within which it is actually circumscribed.

Dr. Hooker instances certain species of *Coprosma*, of *Celmisia*, and a kind of Australian Fern, the *Lomaria procera*, which have undergone such striking changes in their passage from one portion of the Great Pacific to another, that they are scarcely recognizable as the same, and have actually been regarded by preceding botanists as distinct species. But he does not state that any of these plants have ever been seen beyond the above-mentioned precincts; and yet if Nature had not imposed some limits to their susceptibility of change, one does not see why they might not have spread over a much larger portion of the earth, in a form more or less modified by external circumstances.

The younger DeCandolle, in his late admirable treatise already referred to, has enumerated about 117 species of plants which have been thus diffused over at least a third of the surface of the globe; but these apparently owed their power of transmigration to their insusceptibility of change, for it does not appear that they have been much modified by the effect of climate or locality, notwithstanding the extreme difference in the external conditions to which they were subjected.

On the other hand, it seems to be a general law, that plants, whose organization is more easily affected by external agencies, become, from that very cause, more circumscribed in their range of distribution; simply because a greater difference in the circumstances under which they would be placed brought with it an amount of change in their structure, which exceeded the limits prescribed to it by Nature.

In short, without pretending to do more than to divine the character of those impediments, which appear ever to prevent the changes of which a plant is susceptible from proceeding beyond a certain limit, we seem to catch a glimpse of a general law of Nature, not limited to one of her kingdoms, but extending everywhere throughout her jurisdiction,—a law, the aim of which may be inferred to be, that of maintaining the existing order of the universe, without any material or permanent alteration, throughout all time, until the *fiat* of Omnipotence has gone forth for its destruction.

The will, which confines the variations in the vegetable structure within a certain range, lest the order of creation should be disturbed by the introduction of an indefinite number of intermediate forms, is apparently the same in its motive, as that which brings back the celestial Luminaries to their original orbits, after the completion of a cycle of changes induced by their mutual perturbations; it is the same which says to the Ocean, Thus far shalt thou go, and no further; and to the Winds, Your violence, however apparently capricious and abnormal, shall nevertheless be constrained within certain prescribed limits—

> Ni faciat, maria et terras cœlumque profundum,
> Quippe ferant rapidi secum, verrantque per auras.

The whole indeed resolves itself into, or at least is intimately connected with, that law of symmetry to which Nature seems ever striving to confirm, and which possesses the same significance in the organic world, which the law of definite proportions does in the inorganic.

It is the principle which the prophetic genius of Goethe had divined, long before it had been proved by the labours of physiologists to be a reality, and to which the poet attached such importance, that the celebrated discussion as to its merits which took place in 1830 between Cuvier and Geoffroy St. Hilaire so engrossed his mind, as to deprive him, as his biographer informs us*, of all interest in one of the most portentous political events of modern days

* Lewes' Life of Goethe, vol. ii.

which was enacting at the very same epoch,—I mean the subversion of the Bourbon dynasty.

It is indeed not less calculated to subserve to the gratification of our sense of the beautiful, than to provide against too wide a departure from that order of creation which its great Author has from the beginning instituted; and, as two learned Professors of a sister kingdom have pointed out in memoirs laid before this Association, and have since embodied in a distinct treatise*, manifests itself not less in the geometrical adjustment of the branches of a plant, and of the scales of a fir-apple—nay even, as they have wished to prove, in the correspondence between the form of the fruit and that of the tree on which it grows—than in the frequent juxtaposition of the complementary rays of the spectrum, by which that harmony of colour is produced in Nature, which we are always striving, however unsuccessfully, to imitate in Art.

The law, indeed, seems to be nothing else than a direct consequence of that unity of design pervading the universe, which so bespeaks a common Creator—of the existence in the mind of the Deity of a sort of archetype, to which His various works have all to a certain extent been accommodated; so that the earlier forms of life may be regarded as types of those of later creation, and the more complex ones but as developments of rudimentary parts existing in the more simple. Here too we may perhaps trace an analogy with His dealings with mankind, as unfolded in His Revealed Word; from which we find, that the earlier events recorded are often typical of those more modern, and that Christianity itself is in some sense a development of the Jewish dispensation which preceded it.

I should apologize for dwelling so long upon the two departments of natural knowledge to which I have hitherto confined myself, were it not that other sciences of a still higher rank than those treated of had been discussed so fully in the Discourses of former Presidents.

Whilst indeed this is the first occasion, save one, in which a Chemist has had the honour of occupying the Chair of the British Association, it has on no former occasion fallen to the lot of a professed Botanist to be thus distinguished. I have therefore consulted alike my own ease, and what was due to the Sciences themselves, in making Chemistry and Botany the principal themes of my discourse. Leaving, then, to the gifted friend who will discourse before you next Monday evening "On the Correlation of Physical Forces," the task of connecting with those Powers of Nature that manifest themselves in the phænomena of chemical attraction or of cell-development, the imponderable agents which form the proper subjects of branches of Physics not here dwelt upon, and thus establishing the existence of that common brotherhood among the Sciences, which furnishes the best plea for such Meetings as the present, I will only further detain you by noticing one other field of inquiry, in which I have ever felt a lively interest, although it has only been in my power to bestow on it a casual attention, or to cultivate one limited portion of the wide range which it embraces.

Indeed Geology, the Science to which I now allude, has, during the last twenty years, made such rapid strides, that those who endeavoured from an early period of life to follow at a humble distance the footsteps of the great leaders in that Science, obeying the impulse of such zealous and ardent spirits, as the one—now, alas! by the inscrutable decrees of Providence, lost to his friends and to Science,—who constituted the Head of what was once

* Typical Forms, by M'Cosh and Dickie.

called, I hope not too grandiloquently, the Oxford School of Geology,—have, if I may judge of others by myself, been often distanced in the race, and when they endeavoured to make good their lost ground, found themselves transported into a new, and to them an almost unknown region.

Thus the thorough exploration which has taken place of the Silurian and Cambrian systems, through the exertions of two of our oldest and most valued Associates, has added a new province—ought I not rather to say, a new kingdom?—to the domain of Geology, and has carried back the records of the creation to a period previously as much unknown to us as were the annals of the Assyrian dynasties before the discoveries of Sir Henry Rawlinson.

I might also be disposed to claim for the recent investigations of Botanists some share in fixing the relative antiquity of particular portions of the globe, for, from the floras they have given us of different islands in the Great Pacific, it would appear, that the families of plants which characterize some groups are of a more complicated organization than those of another. Thus whilst Otaheite chiefly contains Orchids, Apocyneæ, Asclepiadeæ and Urticeæ; the Sandwich Islands possess Lobeliaceæ and Goodenoviæ; and the Galapagos Islands, New Zealand and Juan Fernandez, Compositæ, the highest form perhaps of dicotyledonous plants.

In deducing this consequence, however, I am proceeding upon a principle which has lately met with opposition, although it was formerly regarded as one of the axioms in geology.

Amongst these, indeed, there was none which a few years ago seemed so little likely to be disputed, as that the classes of animals and vegetables which possessed the most complicated structure were preceded by others of a more simple one; and that when we traced back the succession of beings to the lowest and the earliest of the sedimentary formations, we arrived at length at a class of rocks, the deposition of which must be inferred, from the almost entire absence of organic remains, to have followed very soon after the first dawn of creation. But the recognition of the footsteps and remains of reptiles in beds of an earlier date than was before assigned to them, tended to corroborate the inferences which had been previously deduced from the discovery, in a few rare instances, in rocks of the secondary age, of mammalian remains; and thus has induced certain eminent geologists boldly to dispute, whether from the earliest to the latest period of the earth's history any gradation of beings can in reality be detected.

Into this controversy I shall only enter at present, so far as to point out an easy method of determining the fact, that organic remains never can have existed in a particular rock, even although it may have been subjected to such metamorphic action as would have obliterated all traces of their presence. This is simply to ascertain, that the material in question is utterly destitute of phosphoric acid; for inasmuch as every form of life appears to be essentially associated with this principle, and as no amount of heat would be sufficient to dissipate it when in a state of combination, whatever quantity of phosphoric acid had in this manner been introduced into the rock, must have continued there till the end of time, notwithstanding any igneous operations which the materials might have afterwards undergone. But as the discovery of very minute traces of phosphoric acid, when mixed with the other ingredients of a rock, is a problem of no small difficulty, an indirect method of ascertaining its presence suggested itself to me in some experiments of the kind which I have instituted, namely, that of sowing some kind of seed, such for instance as barley, in a sample of the pulverized rock, and determining whether the crop obtained yielded more phosphoric acid than was present in the grain, it being evident that any excess must have been derived from the rock from which it drew its nourishment.

Should it appear by an extensive induction of particulars, that none of the rocks lying at the base of the Silurian formation, which have come before us, contain more phosphoric acid than the minute quantity I detected in the slates of Bangor and Llanberris, which were tested in the above manner, it might perhaps be warrantable hereafter to infer, that we had really touched upon those formations that had been deposited at a time when organic beings were only just beginning to start into existence, and to which, therefore, the term Azoic, assigned to these rocks by some of the most eminent of our geologists, might not be inappropriate.

The proofs of the former extension of glaciers in the northern hemisphere, far beyond their actual limits, tend also to complicate the question which has at all times so much engaged the attention of cosmogonists with respect to the ancient temperature of the earth's surface; compelling us to admit, that at least during the later of its epochs, oscillations of heat and cold must have occurred, to interfere with the progress of refrigeration which was taking place in the crust.

On the other hand, facts of an opposite tendency, such as the discovery announced at our last Meeting by Captain Belcher, of the skeleton of an Ichthyosaurus in lat. 77°, have been multiplying upon us within the same period; inasmuch as they appear to imply, that a much higher temperature in former times pervaded the Arctic regions than can be referred to local causes, and therefore force upon us the admission, that the internal heat of the nucleus of our globe must at one time have influenced in a more marked manner than at present the temperature of its crust.

On the causes of this increased temperature, whether local or cosmical, much elaborate research has been brought to bear, by Sir Charles Lyell in his celebrated 'Principles of Geology,' and by Mr. Hopkins in his Address to the Geological Society.

The most extensive collection of facts, however, having reference to this subject, is contained in the Reports on Earthquake Phænomena, published by Mr. Mallet in our Transactions, supplying, as they do, data of the highest importance to the full elucidation of the subject. For although the evidence I have myself brought together in my work on Volcanos might be sufficient to establish in a general way the connexion of earthquakes with that deep-seated cause which gives rise to the eruptions of a volcano, yet our interest is thereby only the more awakened in the phænomena they present,—just as Dr. Whewell's inquiries into the local variations of the Tides were valued all the more in consequence of the persuasion already felt, that lunar attraction was their principal cause.

But if earthquakes bring under our notice chiefly the dynamical effects of this hidden cause of movement and of change, those of volcanos serve to reveal to us more especially their chemical ones; and it is only by combining the information obtained from these two sources, together with those from hot springs, especially as regards the gaseous products of each, that we can ever hope to penetrate the veil which shrouds the operations of this mysterious agent; so as to pronounce, with any confidence, whether the effects we witness are due, simply to that incandescent state in which our planet was first launched into space, or to the exertion of those elective attractions which operate between its component elements,—attractions which might be supposed to have given rise, in the first instance, to a more energetic action and consequently to a greater evolution of heat, than is taking place at present, when their mutual affinities are in a greater measure assuaged.

Within the last twenty years much has been done towards the elucidation of this problem, through the united investigations of Boussingault, of Déville, and above all of Bunsen, with respect to the gases and other bodies evolved from volcanos in their various phases of activity; the results of which, however, do not appear to me to present anything irreconcileable with that view of their causes which was put forth many years ago in the work I published.

Whilst, however, the latter is offered as nothing more than as a conjectural explanation of the phænomena in question, I may remind those, who prefer the contrary hypothesis on the ground that the oblate figure of the earth is in itself a sufficient proof of its primæval fluidity, that this condition of things could only have been brought about in such materials by heat of an intensity, sufficient, whilst it lasted, to annul all those combinations amongst the elements which chemical affinity would have a tendency to induce, and thus to render those actions to which I have ascribed the phænomena, not only conceivable, but even necessary consequences, of the cooling down of our planet from its original melted condition.

In the nearly allied Science of Geography, several important undertakings have been set on foot, and some interesting discoveries made since the period of our last Meeting.

1. Dr. Kane has extended Arctic discovery, through Smith Strait, at the head of Baffin Bay, to about 3 degrees nearer the Pole.

2. Mr. Kelley has announced the result of several independent surveying expeditions despatched by him to the Valley of the Atrato, with a view to the formation of a great navigable channel through Central America, between the Atlantic and Pacific Oceans. When Humboldt directed attention to this region fifty years since, he had only uncertain reports to guide his anticipations; and these surveys have been the first to throw actual light upon this region.

3. An expedition has been despatched to North Australia, for the purpose of exploring the interior and tracing the extent of the northern watershed. Its arrival at the mouth of the Victoria River has already been announced.

4. It is proposed, by the Geographical Society, to despatch an expedition to Eastern Africa, to explore the extent of the inland waters known to exist there, and if possible to discover the long-sought sources of the Nile.

5. Explorations have been undertaken in the Rocky Mountains, by several parties in South America, in the Pacific, and elsewhere: these, however, are far too numerous to be particularly alluded to.

Such are a few of the additions to our knowledge which have been made in the course of the last twenty years in those sciences with which I am most familiar.

Whilst, however, the actual progress which has taken place in them is in itself so satisfactory, the change which the sentiments of the public have undergone, with respect to their claims to respect, affords no less room for congratulation.

If our attention is turned to the metropolis, we see rising up around us establishments for the advancement of Physical Science, of which our ancestors would scarcely have dreamed the possibility.

I may instance the School of Mines, first placed under the management of our late Associate, Sir Henry De la Beche, and now presided over by Sir Roderick Murchison, as a convincing proof of the improved feeling on such subjects entertained by the Government of this country.

I may mention also another proof of a greater appreciation of the claims of Science, in their having departed from the practice which had prevailed ever since the death of Sir Isaac Newton, of regarding the Mastership of Her Majesty's Mint a purely political appointment, and in conferring it, as they have done on the two last occasions, as a reward for scientific eminence.

It is also gratifying to find, that the attention of the Legislature has at length been seriously called to consider what measures of a public nature might be adopted for improving the position of Science and its cultivators, and that the Royal Society has appointed a Body of its Members to receive suggestions on that subject, and to report upon it, in order that a matured plan may be presented to Parliament to meet this object at its next Session.

Nor, if we extend our glance to the Provinces, need I go further than the neighbourhood of our present place of meeting, in order to point out as many as four active clubs of naturalists, who sustain as well as diffuse an interest in our pursuits, by frequent meetings, and by investigating, in common, the physical peculiarities of their respective neighbourhoods.

In this very county, too, we have lately witnessed the first example of an Institution founded for the express purpose of communicating to the rising generation of farmers, that scientific as well as practical instruction, the union of which is admitted by every enlightened agriculturist to be essential, for the purpose of deriving the fullest advantage from the natural resources of our soil. Nor can I help feeling an honest pride when I reflect, that this Establishment, which has since risen to such importance, and is celebrated throughout the land as the best training school for youths destined to husbandry which England affords, should have emanated from the members of a little club existing in a neighbouring county-town, endeared to me by long associations, from its near proximity to the place of my birth, and the home of my earliest years.

Turning, too, to the University to which I belong, in which a few years ago our pursuits were hardly regarded as integral parts of academical instruction, we now find in it at least a recognition of their importance to have taken place, and Classical Literature no longer disdaining to own as her Sisters, the Studies which engross so large a part of the attention of the public in general.

Nay, the Academic Body has lately devoted no small portion of its revenues towards the erection of a Museum, intended to comprehend under one roof all the appliances for research, as well as all the means of instruction which can be required in the several branches of Natural Philosophy.

The extension, indeed, which is now given to the name in the language of naturalists, and even by the public at large, is in itself an indication of correcter views than were formerly entertained with regard to the uses of such Establishments.

Few, for instance, have such a notion of a Museum as Horace Walpole gave utterance to at the close of the last century*, when he defined it "a "hospital for everything that is singular—whether the thing has acquired "singularity from having escaped the rage of time—from any natural oddness, "—or from being so insignificant that nobody thought it worth while to pro-"duce any more of the same."

Nor will it be possible to ridicule these Institutions, as an eminent member of my own University, even within my recollection, was tempted to do, in alluding to the little Institutions of the kind set up in some of our provincial towns†.

"The stuffed ducks, the skeleton in the mahogany case, the starved cat and

* Fugitive Pieces. † Sewell's Letter to a Dissenter, 1834.

"rat which were found behind a wainscot, the broken potsherd from an old "barrow, the tattooed head of the New Zealand chief, the very unpleasant-"looking lizards and snakes coiled up in the spirits of wine, the flint-stones "and cockle shells," &c., will no longer be seen jumbled together in heterogeneous confusion, as might have been the case at the period alluded to.

The Ipswich Museum has set an example, which I have no doubt will be generally followed, of selecting for such Institutions a series of types illustrative of the mineral, vegetable, and animal kingdoms; and a Committee of this Association is now employed in the useful undertaking of preparing a list of objects calculated to illustrate the different forms in nature, and thus rendering our provincial Museums no longer mere rareeshows, but places where the masses may receive instruction in all branches of Natural History.

But the Oxford Museum aims at much more than is usually understood by that title. Its central area, indeed, may be regarded as the Sanctuary of the Temple of Science, intended to include all those wonderful contrivances by which the Author of the Universe manifests himself to His creatures; whilst the apartments which surround it, dedicated as they will be to lectures and researches connected with all branches of Physical Science, may represent the chambers of the ministering Priests, engaged in worshiping at her altar, and in expounding her mysteries.

In turning too to this Association, the reception with which it is now greeted in the course of its migrations through the various portions of the United Kingdom, is not less encouraging as an augury of the future prospects of Science.

Our Body, indeed, may now be said to have passed unscathed through that ordeal to which all infant undertakings are exposed, and which even its great prototype, the Royal Society of London, at its commencement, did not altogether escape. And the best proof that such is the case, will be found in the different manner in which it is received by the public in general.

Twenty years ago the invitations sent us proceeded, either from places like the Universities expressly dedicated to learning, and therefore peculiarly called upon to lend a helping hand to Science; or else from Cities, in which the predominant occupations brought the mass of the population into immediate and constant connexion with scientific processes.

Now, on the contrary, we have seen the two principal Centres of fashionable resort—the favourite retreats of the wealthy and noble of the land—vieing with each other in their eagerness to receive us; and an almost purely agricultural County greeting us with the same hearty welcome as that which we had heretofore received from the commercial and manufacturing Communities.

Twenty years ago it was thought necessary to explain at our meetings the character and objects of this Association, and to vindicate it from the denunciations fulminated against it by individuals, and even by parties of men, who held it up as dangerous to religion, and subversive of sound principles in theology.

Now, so marked is the change in public feeling, that we are solicited by the clergy, no less than by the laity, to hold our meetings within their precincts; and have never received a heartier welcome than in the city in which we are now assembled, which values itself so especially, and with such good reason, on the extent and excellence of its educational establishments.

It begins, indeed, to be generally felt, that amongst the faculties of mind, upon the development of which in youth success in after life mainly depends, there are some which are best improved through the cultivation of the Physical Sciences, and that the rudiments of those Sciences are most easily acquired at an early period of life.

That power of minute observation—those habits of method and arrangement—that aptitude for patient and laborious inquiry—that tact and sagacity in deducing inferences from evidence short of demonstration, which the Natural Sciences more particularly promote, are the fruits of early education, and acquired with difficulty at a later period.

It is during childhood, also, that the memory is most fresh and retentive; and that the nomenclature of the sciences, which, from its crabbedness and technicality, often repels us at a more advanced age, is acquired almost without an effort.

Although, therefore, it can hardly be expected, that the great schools in the country will assign to the Natural Sciences any important place in their systems of instruction, until the Universities for which they are the seminaries set them the example, yet I cannot doubt, but that the signal once given, both masters and scholars will eagerly embrace a change so congenial to the tastes of youth, and so favourable to the development of their intellectual faculties.

And has not, it may be asked, the signal been given by the admission of the Physical Sciences into the curriculum of our academical education?

I trust that this question may be answered in the affirmative, if we are entitled to assume, that the recognition of them which has already taken place will be consistently followed up, by according to them some such substantial encouragement, as that which has been afforded hitherto almost exclusively to classical literature.

Our ability to accomplish this, with the means and appliances at our command, does not, I think, admit of dispute.

Happily for this country, the conservative feeling which has ever prevailed amongst us, and the immunity we have enjoyed from such political convulsions as have affected most other European nations, maintain in their integrity those Academical Establishments, which, as Monsieur Montalembert has remarked, are, like our Government and our other Institutions, a magnificent specimen of the social condition of the middle ages, as it at one time existed throughout the whole of Western Europe.

They are Institutions, indeed, which foreigners may well look upon with envy, but which when once destroyed, it is hopeless to expect that Governments, engrossed as they are with the interests and politics of the day, will ever think of restoring.

Thanks to their existence, it rarely happens, that a student, in Oxford at least, who has distinguished himself in his classical examinations, fails to obtain some reward for his past exertions, and, if he require it, some assistance to enable him to continue them in future.

And this, too, be it observed, has been the case, even whilst the natural, although perhaps mistaken partiality of our founders, for their native counties, for the parishes in which their estates lay, or for their own collateral descendants, greatly curtailed the number of fellowships which could be bestowed on merit.

All, therefore, that seems wanted, now that local preferences seem on the point of being removed, is, on the one hand, a more equal distribution of the existing emoluments between the several professions, and, on the other, the admission of the claims of the sciences received into our educational system, to share in the emoluments which, up to this time, have been monopolized by the Classics.

And as it is far from my wish to curtail the older studies of the University of their proper share of support—for who that has passed through a course of them can be insensible of the advantages he has derived from that early discipline of the mind which flows from their cultivation?—I rejoice to think, that when the Legislature shall have completed the removal of those restrictions which have hitherto prevented us in many instances from consulting the claims of merit in the distribution of our emoluments, there will be ample means afforded for giving all needful encouragement to the newly recognized studies, without trenching unduly upon that amount of pecuniary aid which has been hitherto accorded to the Classics.

In anticipation of which change, I look forward with confidence to the day, when the requirements at Oxford, in the department of Physical Science, will become so general and so pressing, that no Institution which professes to prepare the youth it instructs for academical competition will venture to risk its reputation by declining to admit these branches of study into its educational courses.

Indeed the example has already been set in many, as I understand to be the case with the noble Seminary within whose walls we are now assembled, as well as with that older Establishment, which, under the energetic management of its present head master, has become its worthy rival as a training school for the Universities.

At any rate, I trust the time has now passed away, when studies such as those we recommend lie under the imputation of fostering sentiments inimical to religion.

In countries, and in an age in which men of Letters were generally tinctured with infidelity, it is not to be supposed that Natural Philosophy would altogether escape the contagion; but the contemplation of the works of creation is surely in itself far more calculated to induce the humility that paves the way to belief, than the presumption which disdains to lean upon the supernatural.

It is not, indeed, without an excusable feeling of exultation that in surveying the triumphs of modern science, we see

> "An intellectual mastery exercised
> O'er the blind elements; a purpose given;
> A perseverance fed; almost a soul
> Imparted to brute matter;"

or that we repeat to ourselves the words in which the poet apostrophizes the philosopher,—

> "Go, wondrous creature! mount where Science guides,—
> Go, measure earth, weigh air, and state the tides;
> Instruct the planets in what orbs to run,
> Correct old Time, and regulate the Sun."

Nevertheless, if we pursue the line of thought in which the same author indulges, we shall be compelled to ask ourselves, not without a deep sentiment of humiliation, even whilst contemplating the highest order of intellect which the human race has ever exhibited,—

> "Could he, whose rules the rapid Comet bind,
> Describe or fix one movement of the mind?
> Who saw its fires here rise, and there descend,
> Explain his own beginning, or his end?"

When indeed we reflect within what a narrow area our researches are of necessity circumscribed, when we perceive that we are bounded in space almost to the surface of the planet in which we reside,—itself merely a speck in the universe, one of innumerable worlds invisible from the nearest of the fixed stars—when we recollect, too, that we are limited in point of time to a few short years of life and activity—that our records of the past history of the globe and of its inhabitants are comprised within a minute portion of the latest of the many epochs which the earth has gone through—and that with regard to the future, the most durable monuments we can raise to hand down our names to posterity are liable at any time to be overthrown by an earthquake, and would be obliterated, as if they had never been, by any of those processes of metamorphic action which geology tells us form a part of the cycle of changes which the globe is destined to undergo,—the more lost in wonder we may be at the vast fecundity of Nature, which within so narrow a sphere can crowd together phænomena so various and so imposing, the more sensible shall we become of the small proportion, which our highest powers and their happiest results bear, not only to the Cause of all causation, but even to other created beings, higher in the scale than ourselves, which we may conceive to exist.

"Think thou this world of hopes and fears
Could find no statelier than his peers
In yonder hundred million spheres?"

It is believed, that every one of the molecules which make up the mass of a compound body is an aggregate of a number of atoms, which, by their arrangement and mutual relation, impart to the whole its peculiar properties; and, according to another speculation which has been already alluded to, these atoms are not absolutely motionless, but are ever shifting their position within certain limits, so as to induce corresponding changes in the properties of the mass.

Indeed it has been imagined, that the production of different compounds from the same elements united in the same proportions, may be one of the consequences resulting from the different arrangement of particles thereby induced.

If this hypothesis have any foundation in fact, what an example does it set before us of great effects brought about by movements which, to our senses, are too minute to be appreciable; and what an illustration does it afford us of the limited powers inherent in the human race, which are nevertheless capable of bringing about effects so varied, and to us so important; although, as compared with the universe, so insignificant!

We also are atoms, chained down to the little globe in which our lot is cast; allowed a small field of action, and confined within definite limits, both as to space and as to time.

We, too, can only bring about such changes in nature, as are the resultants of those few laws which it lies within the compass of our powers to investigate and to take advantage of.

We, too, can only run through a certain round of operations, as limited in their extent, in comparison with those which lie within the bounds of our conception, as the movements of the atoms, which serve to make up a compound molecule of any of the substances around us, are to the revolutions of the heavenly Luminaries.

And as, according to Professor Owen, the conceivable modifications of the vertebral archetype are very far from being exhausted by any of the forms which now inhabit the earth, or that are known to have existed here at any former period; so likewise the properties of matter with which we are permitted to become cognizant, may form but a small portion of those of which it is susceptible, or with which the Creator may have endowed it in other portions of the Universe.

We are told, that in a future and a higher state of existence, the chief occupation of the blessed is that of praising and worshiping the Almighty. But is not the contemplation of the works of the Creator, and the study of the ordinances of the Great Lawgiver of the universe, in itself an act of praise and adoration; and, if so, may not one at least of the sources of happiness which we are promised in a future state of existence, one of the rewards for a single-minded and reverential pursuit after truth in our present state of trial, consist in a development of our faculties, and in the power of comprehending those laws and provisions of Nature with which our finite reason prevents us at present from becoming cognizant?

Such are a few of the reflections which the study of Physical Science, cultivated in a right spirit, naturally suggests; and I ask you, whether they are not more calculated to inspire humility than to induce conceit; to render us more deeply conscious how much of the vast field of knowledge must ever lie concealed from our view—how small a portion of the veil of Isis it is given us to lift up—and therefore to dispose us to accept, with a more unhesitating faith, the knowledge vouchsafed from on high, on subjects which our own unassisted reason is incapable of fathoming.

"Let us not, therefore," to use the language of a living prelate, "think scorn of the pleasant land. That land is the field of antient and modern Literature—of Philosophy in almost all its Departments—of the Arts of Reasoning and Persuasion. Every part of it may be cultivated with advantage, as the Land of Canaan when bestowed upon God's peculiar people. They were not commanded to let it lie waste, as incurably polluted by the abominations of its first inhabitants; but to cultivate it and to dwell in it, living in obedience to the Divine laws, and dedicating its choicest fruits to the Lord their God."

REPORTS

ON

THE STATE OF SCIENCE.

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Report from the Committee appointed by the British Association for the Advancement of Science, at the Meeting in Liverpool, in September 1854, *to investigate and report upon the effects produced upon the Channels of the Mersey by the alterations which within the last fifty years have been made in its Banks.*

YOUR Committee have to report, that for the purpose of securing a satisfactory solution of the questions submitted to their investigation, they deemed it expedient to refer different portions of the inquiry to individual members of their body, in the following manner:—

1. Mr. George Rennie, to trace historically the important projections into the river, and reclamation of large areas of land which would exclude the entry of water.

2. Mr. Joseph Boult, to show important changes in the bottom, including the channels and outlets of the river, so dividing the work that it may illustrate the effects of the above-named encroachments.

3. Mr. Henderson, to compare the tides of the present period with the tides registered by Mr. Rendell.

It has been thought desirable to present the reports of these gentlemen to the Association unabridged, as affording the best solution of the subject which has yet been prepared, and your Committee will therefore only refer to the more salient points of the inquiry, and to the conclusions to be drawn from the information laid before them.

Mr. Rennie's report is accompanied by copies of the following valuable documents:—

1. Report of Messrs. Wilkin relative to the navigation and conservancy of the River Mersey, 28th April 1840.

2. Area and content of water in the River Mersey, from Blackrock to Woolston Weir, above Warrington, at certain tides, below and above Liverpool Old Dock sill, by George Rennie, 18th May 1838.

3. Index of the engineers' and surveyors' reports who have reported on the estuary and River Mersey.

4. First and second Memorial of the Mayor, Aldermen and Burgesses of the Borough of Liverpool, April and September 1839.

5. Letter from H. M. Denham, R.N., to the Corporation of Liverpool, 27th September 1836.

6. Statement of the Town-clerk as to the rights of the Mayor, Aldermen, and Burgesses of Liverpool to the lordship of Liverpool, comprising the River Mersey up to the bridges and strand at Liverpool, Toxteth Park, Birkenhead, and Wallasey.

7. Letter from William Lord, R.N., to the Chairman of the Conservancy Committee, 23rd March 1840.

8. Letter from William Lord, R.N., to R. Radcliffe, Esq., 3rd April 1840.

The history of the Mersey is well detailed by Messrs. Wilkin down to the date of their inquiry. From their report it appears that until 1818 there was no check or control exercised by any authority over encroachments upon the tidal area of the river. In that year the Corporation of Liverpool, whose jurisdiction extended from Hoylake to Hesketh Bank on the Ribble, and all over the River Mersey to Warrington and Frodsham Bridges, and who had authority to remove any obstructions to the navigation, "be it the ground or soil of the King's most excellent Majesty, or any other person or persons, bodies politic or corporate whatsoever," called in Mr. Whidbey, of Plymouth Breakwater, to examine the encroachments which had been made on the estuary at different parts, and to lay down some general principles as to its future preservation. Subsequently Mr. Rennie, Sen., and Messrs. Chapman, Giles, Walker, Mylne, Stevenson, and George and John Rennie, reported in confirmation of the general principles laid down by Mr. Whidbey. They may be briefly stated as follows:—"That tide harbours are deep or otherwise in proportion to the quantity of water which flows and ebbs through their channels, and that to embank portions of the tidal area is to diminish that quantity of water and consequently to injure the harbour." So completely had these principles been contravened in former days, that it appears from Mr. Rennie's calculation of the area and content of water in the River Mersey (No. 2), that the original tidal area was 36,500 acres, of which 13,440 acres were then (1838) lost to the tideway, being enclosed marshes.

The very elaborate survey of the Mersey, from the Blackrock to Woolston Weir, which was prepared about thirty years since by the late Mr. Giles, C.E., for the Corporation of Liverpool, is an invaluable and unique document. As it is plotted to an adequate scale, and furnishes data for determining the extent of any changes, either in the area or depth of the river, since that date. As, however, the survey has not yet been repeated, your Committee have been unable to investigate the changes in that part of the Mersey: there is reason to believe that some of them have important relations to the well-being of the river, and the great interests in either shore. Amongst others, the mutations in the Devil and Pluckington Banks, and the waste of various portions of the shore are the most remarkable.

Unfortunately, Mr. Giles's survey did not include the outer estuary or Liverpool Bay; of this frequent and excellent surveys have been made during the last twenty-three years by Capt. Denham, and his successor Lieut. Lord, who, as marine surveyors to the port, exercised unceasing vigilance on the changes within the sphere of their observations. Mr. Boult's attention has been especially directed to the alterations recorded by these surveys, and to the influence which may have been exercised upon those alterations by the dock-works of Liverpool and Birkenhead, and by meteorological phænomena. The changes in the areas and positions of the several banks have been laid down in coloured outlines, upon the accompanying charts* A, B, and C, and the alterations in their cubical contents and in the average areas of the sea channels, as far as they can be approximately ascertained from the surveys, are recorded in the tables D, E, F, and G.

From these it appears that there has been a progressive, though irregular,

* Of these charts it has been found desirable to publish Chart A. only; as the scale to which the illustrations are necessarily restricted is too small to permit distinctness in the several contours.

increase in the sizes of the banks, the growth having been both lateral and vertical; some of the fluctuations are very remarkable; that the average area of the northern channel remains very stationary, though in places the mutations have been considerable; and that there has been a diminution of average area in the Rock Channel, arising from a deposit of silt at the eastern end. This channel is the oldest known entrance into the Mersey; it is laid down by Captain Collins in his survey of 1689, who says of the northern channel (by way of Crosby and Formby) that it is not buoyed or beaconed, and so not known. There appear to be grounds for serious apprehensions that the Rock Channel may be irrecoverably lost, if due precautions are not adopted in good time.

There have been extraordinary fluctuations in the seaward entrance of the northern channel within the period embraced in this inquiry, and at this present time another great change is being accomplished, namely, the substitution of the Queen's Channel for the Victoria Channel, intermediate between the latter and the Zebra Channel.

There is reason to believe that the growth of the banks and the silting up of part of the Rock Channel have been much promoted by the abstraction of area which has taken place for dock purposes; nor is this surprising when we find the extent of this abstraction, and the important part of the river, especially in relation to the Rock Channel, where it has been made.

Between 1846 and 1852, or in six years, it seems that as much as 500 acres have been enclosed for the dock-works of Liverpool and Birkenhead, and the result apparently confirms the correctness of the principle laid down by Mr. Whidbey and other eminent engineers who have reported upon the river, as indicating the consequence of diminishing the scouring power of the last of the flood and the first of the ebb, the situations of the abstractions referred to being in parts of the river which are occupied by those portions of the tidal waters.

It appears from Mr. Boult's researches, that the change of direction in the channels is not so much the result of the direction of the dock walls as of alterations in the size and position of the sand-banks; alterations which seem to be due to the permanent loss of scouring power, by abstraction of tidal area; to the temporary increase of that loss from drought; to the temporary accession of scouring power from freshes; and to the drifts of sand by the winds to which the bay is peculiarly exposed, and which are the prevailing winds on this part of the coast. The extent of this sand-drift is so great, that, since Collins's survey, the eastern shore of the estuary appears to have advanced westward as much as one-half the width of the northern channel, or about 1000 yards.

It is *possible* that the deterioration of the Rock Channel is to be ascribed, in part, to the erection of the new north wall at Liverpool. It is built on the Bootle shore, almost immediately opposite the junction of that channel with the northern channel, and directly across the direction of the tidal stream in the Rock Channel. Therefore, the flood-stream entering the river by that channel is suddenly checked by this upright wall, and is deprived of the space formerly allowed by the sloping Bootle shore for gradually changing its direction into that of the main course of the river and the northern channel.

It was observed by Messrs. Whidbey, Chapman, and Rennie, in their Report to the Corporation of Liverpool in 1822, that "all channels through which water flows must be of a magnitude proportionate to the quantity which passes them, and any increase or diminution of that quantity will enlarge or diminish the channel, unless when formed of materials so hard that the strength of the current is not able to remove them." The truth of this observation is strikingly confirmed by the remarkable waste of the clay cliffs of the Cheshire shore of the river at Seacombe and Egremont. This has been observed for many years past; but, according to the evidence which accompanies the report of Mr. Walker, C.E., printed by order of the House of Commons, 23rd June 1856, it has greatly increased within the last ten years, or since so much of the tideway on the opposite shore has been abstracted for the north dock-works.

The result of the inquiry, so far as your Committee have been able to prosecute it, shows the vital importance of a strict conservancy of the River Mersey in all its tidal area, in order that it may be preserved for the vast commerce centered on its shores. There is no doubt that injury—to a great extent irremediable—has been already inflicted, not only upon some of the owners of property on its margin, but also upon the river itself, more especially upon its approaches. Your Committee conceive that the nature and extent of this injury should be determined as accurately and as speedily as possible; that the trade on this river is vastly too important in its relation to the national prosperity, for the subject of this inquiry to be left to a committee, however zealous, which is unendowed with pecuniary resources, and dependent for information upon the researches of gentlemen actively engaged in official and professional occupations; and that the result of such an investigation would be highly beneficial to the science of harbour engineering. The scientific value of the information so acquired would be greatly enhanced were the phænomena of all our tidal harbours subjected to similar research. It is not unreasonable to expect that the ultimate result would give greater certainty as to the influence of projected works upon the well-being of the harbours with which they are associated; and relieve the Legislature from the responsibility of sanctioning undertakings the destructive or conservative effects of which, at present, are often very speculative.

HARROWBY, *Chairman*.
P. M. GREY EGERTON.
R. I. MURCHISON.
F. W. BEECHEY.
GEORGE RENNIE.
ANDREW HENDERSON.
JOSEPH BOULT, *Secretary*.

Report on the past and present state of the Estuary of the Mersey within the last seventy years, as derived from historical records, and according to the maps, charts, and reports of different Engineers, and which have been laid before the Committee appointed by the British Association at its meeting at Liverpool, September 1854, *to investigate and report upon the same. By* GEORGE RENNIE, *F.R.S.*

The early history of the Mersey, previous to the beginning of the present century, is confined to the uncertain statements of topographical writers such as Leland, Gough, King, Ormerod, Mortimer, and others; and the charts of Captain Collins in 1689, and by M'Kenzie in 1760.

According to the original constitution of the charters and grants made from time to time to the borough of Liverpool, the boundaries of that port were adopted by a commission issued 19th July, 32 Charles II., which recited an Act passed in the 14th year of the then king's reign, for "preventing frauds and regulating abuses in the Customs;" and also an Act of the 1st of Elizabeth. It was settled in November 1680, that the boundaries of the port of Liverpool should be "from the Red Stones on the point of Wirrall southerly, to the foot of the Ribble water in a direct line northerly, and so upon the south side of the said river to Hesketh Bank easterly." These limits were adopted in the Dock Act of Anne, and subsequent dock acts, as the limits of the crown revenues, and have been adhered to down to the present time. The limits of the old borough and parish of Liverpool bordering on the Mersey are thus defined, viz.—"The western boundary commences at low-water mark of the River Mersey, where a brook, called Beacon's Gutter, enters the river, and continues thence southward along the low-water mark of the said river, to the centre of a certain slip or basin called Etna Slip. The southern boundary commences from the centre of Etna Slip, and runs from thence to the eastward, across the southernmost end of the Queen's Dock. The northern boundary returns along the Beacon's Gutter, to the beforementioned low-water mark of the river." The 8th of Anne, 1709, defined the limits of the port of Liverpool to extend as far as "a certain place in Hoylake called the Red Stones, and from thence all over the River Mersey to Warrington and Frodsham Bridges." These boundaries and rights of the Mayor, Aldermen, and Burgesses to the lordships of Liverpool, comprising the River Mersey up to the bridges and to the strand at Liverpool, Toxteth Park, Birkenhead, and Wallasey, are fully explained in the accompanying statement, No. 6, as also in the second memorial of the Liverpool Corporation to the Admiralty, No. 4. According to a statement made by Mr. Rollet, surveyor of Wallasey embankment, at the fifth meeting of the Architectural and Archæological Society of Liverpool, in 1854, the sea had formerly effected a direct entrance into the valley of the Mersey through its present channel, from which, he believed, it had been separated previously by a diluvial deposit of clay, boulders, and sand, and that after it had so effected its entrance, its progress, in forming a deep channel, would be gradual. In proof of which he cited the authority of Captain Collins, "That great ships belonging to Liverpool put out at Hyle, or Hoylake, part of their lading until they are light enough to sail over the flats of Liverpool."

The charts of Collins and M'Kenzie, although valuable as records, can scarcely be depended upon. The first authentic survey of the port of Liverpool, by Captain George Thomas, in 1813, and published in 1815, and the subsequent and more accurate surveys of Denham, in 1833 and 1837, and of Lord, in 1840, 1841 and 1852, are proofs of the anxiety evinced by the Corporation of Liverpool to employ officers of the Admiralty in recording accurately the actual state of the banks and channels, and the changes which have taken place between those periods. These are very fully detailed in the accompanying report of Mr. Boult, who has taken more than usual pains to compare the different plans with one another and with Captain Thomas's, and has shown in contour and coloured lines the remarkable changes which have taken place in the sea banks and channels at the entrance of the Mersey. These changes show the necessity of causing annual surveys to be made, as set forth in the report of Messrs. Mylne and Rennie, in 1837.

The history of the Mersey is also well detailed in the accompanying report of Messrs. John and George Wilkin. Those gentlemen show that, in 1818, Mr. Whidbey, of Plymouth, was the first whose assistance was called in by the Mayor and Corporation to examine the encroachments which had been made on the estuary in different parts, and to lay down some general principles as to its future preservation. Subsequently, Mr. Rennie, sen., Messrs. Chapman, Giles, Walker, Mylne, Stevenson, and George and John Rennie, reported in confirmation. Extracts from the reports of some of these engineers will show how their predictions have been corroborated, and how necessary it was to frame and constitute a Commission of Conservancy. This was done upon the principles laid down by Messrs. W. C. Mylne and George Rennie, in their report of 1837, as also from the assistance of the marine surveyor, Lieutenant Lord.

The general principles laid down by Messrs. Whidbey, Chapman and Rennie, in their report of 1822, to the Corporation of Liverpool, were—

"That all channels through which water flows must be of a magnitude proportional to the quantity which passes them; and any increase or diminution of that quantity will enlarge or diminish the channel, unless where formed of material so hard that the strength of the current is not able to remove them."

Mr. Whidbey says, in his report of 1818, "Tide harbours are deep or otherwise, in proportion to the quantity of water that flows into them from the esa, and the fresh water that comes down from the interior. The greater the quantity of water, the greater will be the depth, from the effect which the increased body of water will have in scouring the bottom at the time of the ebb tide, and carrying out the sullage."

Again, with reference to embankments, Mr. Whidbey says,—

"It is evident that if a certain portion of either side of a river or harbour be embanked, and the tide be prevented from flowing over it in its usual way, a diminished quantity of water will flow in from the sea equal to the cubic contents of what has been embanked, and consequently there will be a less quantity to ebb out; and the scouring effect being thereby lessened, it will be rendered incapable of carrying out to sea the sullage and alluvious matter washed down from the country, with the same force as before the embankment was made."

The same principle was advocated by Messrs. Chapman, Rennie, Walker, Giles and Stevenson, in all their subsequent reports relative to encroachments, and to obstructions made to the free flow of the tide by piers and jetties.

The very accurate survey and maps of the estuary made by Mr. Giles for the Corporation, by the recommendation of the late Mr. Rennie, is one of the most valuable records of any harbour in existence. It forms, in fact, the standard for all future surveys, with reference to any changes which may take place.

The annexed is a catalogue of the reports which have been made by the engineers and surveyors of the Mersey. The calculation of the area and contents of the estuary of the Mersey between the Blackrock at entrance, and Woolston Weir above Warrington, as shown by the annexed tables, No. 2, are taken from Mr. G. Rennie's report of 1838.

Captain Denham, the surveyor to the port, in his report of 1836, gives his opinions on the causes of variations of the Devil and Pluckington Banks, and expresses considerable doubt how far their removal could be effected by jetties projected from the Cheshire shore.

Lieutenant Lord, who succeeded him as surveyor, in his report of 3rd April, 1840, proposed a similar remedy. The question had been previously discussed, and remedies proposed, by former engineers. Lieutenant Lord's report of the 23rd March, 1840, entirely coincides with the opinion of former engineers in the necessity of preserving the whole of the estuary and its tributary streams from encroachments, and the necessity of guarding the shores from the action of the winds and waves by defences of stone, and that the limits of high-water margin should be accurately defined.

As regards the tides, these have been accurately defined for a long period by Mr. Giles, in his great survey; and the very valuable observations on the rise and fall of the tides in the Mersey, from Formby Point to Warrington Bridge, taken during the years 1840, 1841, 1842, and 1843, by Mr. Rendell—as shown by the diagrams in the first and second volumes of Mr. Thomas Webster's work, 1848, 1853—leave nothing to be desired in point of excellence.

With such records, the Commissioners of Conservancy have only to impress upon their surveyors the necessity of making frequent inspections of the whole of the estuary, and annual surveys of its banks and channels, so that this invaluable port shall be maintained, in future, in its full integrity.

Mr. Boult's report, which accompanies this, enters most fully into the details of the changes which have taken place in the direction and depths of the sea channels. The increase or diminution of the sand-banks, from the first publication of Captain George Thomas's map, in 1815, down to 1854, accompanied by an elaborate table, showing the average cubical contents of the Great Burbo, Brazil, and North Bank, and the banks of Formby, Taylor, Jordan, Mud-wharf, Middle, Little Burbo, and Outlying, and East Hoyle, from which it will be seen that in 1840 there is a slight decrease from 1837; for the years 1846 and 1852 a considerable increase; and a slight diminution in 1854. These tables are analysed with great minuteness by Mr. Boult; and the accompanying charts, in colours, illustrate distinctly the variations*. The valuable meteorological and historical information which Mr. Boult has brought forward, entitle him to the best thanks of the Committee.

London, July 18, 1856. GEORGE RENNIE.

No. 1.—Report of the Messrs. Wilkin relative to the Navigation and Conservancy of the River Mersey.

Spring Gardens, 28th April, 1840.

SIR,—We have the honour of referring to our letter of the 18th April, 1839, in which we observed, that much more information than we at that time possessed would be wanting to enable us to make a final report on the state of the River Mersey, and for recommending such measures for the improvement of the navigation, and for preventing further encroachments on its shores.

This inquiry has caused much labour and attention on our parts, Mr. George Wilkin having been almost entirely occupied in this business from the beginning of the month of March 1839, and having spent nearly three months in Liverpool for the purpose of communicating with those most competent to render us assistance. We were unable to proceed without a regular survey, and for that purpose, at our recommendation, the Corporation employed Mr. Eyes to make an accurate report and survey of the shore within the port of Liverpool (No. 1†), which contains the description and customs in each township, showing whether the same is a manor, or reputed manor, and whether courts are held, and whether any, and what, claims are made to the shore, or any privileges exercised therein. The names of the proprietors of land adjoining the beach, the encroachments made thereon, and the enclosures of marshes over which the tide formerly flowed in the upper part of the river, which exceed 13,000 acres.

We beg leave to represent, that the obstructions to the navigation of the

* See note, page 2.

† The figures in Messrs. Whidbey's report refer to documents which are not printed with it.

Mersey having of late years been the subject of much complaint, attracted the attention of the Corporation of Liverpool, who have, from the year 1818 to the present time, in their anxiety to improve the navigation of the river, expended large sums of money in consulting the most eminent engineers, and in obtaining their reports, opinions and surveys on the state of the river; viz. in the year 1818, the late Mr. Whidbey, the contractor of the Breakwater at Plymouth; in 1832, a second report from him, in conjunction with Messrs. Chapman and John Rennie; in 1823, by Mr. Chapman; in 1826, by Mr. Whidbey, and Messrs. George Rennie and Giles; in 1826, a second report from Mr. Giles; in 1827, by Mr. Robert Stevenson, also by Messrs. Walker and Mylne; in 1826, by Captain Denham, R.N., and in 1837, by Messrs. Mylne and G. Rennie. The late Mr. Telford, Messrs. Nimmo and Fowls have also been consulted by the Corporation and reported thereon (No. 2).

It appears from the evidence (No. 3) taken before a committee of the House of Commons in the session of 1838, on a bill of the Grand Junction Railway Company, in which they proposed to erect a bridge over the Mersey at Runcorn, and to take a branch of the railway over it (which was rejected), that the area of the Mersey from Black Rock at the Mouth to Woolston Weir above Warrington Bridge (where the tide ceases), is 23,062 acres, over which, at a 22-feet tide, 736,945,215 tons of water flow, and that no less than 13,440 acres of marshes have been abstracted from the tideway, equal to about 25 millions of tons of water, calculated at the same tide.

For the purpose of more clearly showing the want of a proper authority to control and improve the navigation of the Mersey, we have thought it desirable to make extracts from the Reports of the engineers; all of whom are of opinion that the principal causes for obstructing the navigation of the river are the embankments made for enclosing large tracts of marsh lands over which the tide formerly flowed; the numerous piers, jetties and chevrons which impede the flux and reflux of the tide, and decrease the water space. They observe, that all the channels through which water flows must be of a magnitude proportional to the quantity passing through them; that if a certain portion of either side of a river or harbour be embanked, and the tide be prevented from flowing over it in its usual way, a diminished quantity of water will flow in from the sea equal to the cubic contents of what has been embanked, consequently there will be a less quantity to ebb out, thereby decreasing the scouring effect, and preventing the sullage and alluvial matter being washed down with sufficient force to prevent the old channels becoming choked up.

They further state, that the preservation and improvement of navigable channels depend entirely upon the flux and reflux of the tide and the discharge of fresh waters, which cause an effectual scour. That in no case can there be too much backwater, it being well known that a number of rivers and harbours have been ruined from the want of preserving the backwater. Two harbours are noticed by Mr. Whidbey, viz. Portsmouth, as having been seriously injured, and Rye, as having been entirely ruined by encroachments on the mud land.

Report dated 17th July, 1818 (No. 2).—Mr. Whidbey says, the Mersey is an inlet of the sea, rather than a river, being kept open entirely by the quantity of water that flows into it, and not by the trifling streams which it receives at Warrington and Frodsham Bridges; that tidal harbours are deep or otherwise in proportion to the quantity of water that flows into them from the sea, and the fresh water that comes down from the interior; the greater the quantity of water, the greater will be the depth from the effect which the increased body of water will have in scouring the bottom at the time of the ebb tide in carrying out the sullage.

He observes, that if all the mud lands above and below Ince, and above and below Runcorn, were embanked, leaving a channel only for the waters that come from the country to discharge themselves, the total ruin of Liverpool would be the consequence. The backwater would be so much diminished that the scouring effect would be destroyed, and the sand driven in towards the entrance of the Mersey by the violence of the north-west and western gales, would in time accumulate beyond the possibility of removal.

He alludes to an Act passed in the 46 Geo. III. cap. 153, for protecting harbours and navigable rivers, but considers it does not go far enough, and thinks the Corporation should lose no time in obtaining an Act giving them the necessary powers for the preservation of the harbour of Liverpool, reserving to the Mersey and Irwell Company all powers granted to them under their Acts.

He further observes, that it is a prevailing opinion, that if water-courses be narrowed, the channels through which the water has to run will become deeper; which would be the case if the water always ran one way, being produced from springs in the country; it must be discharged into the sea somewhere, therefore the more it is confined the deeper will be the channel through which it runs, but the contrary will be the case where the tide runs in and out every twelve hours.

Report dated 25th May, 1822 (No. 2).—Messrs. Whidbey, Chapman and John Rennie state, that on a careful examination between Runcorn and Fidler's Ferry at high and low water they found large tracts of marsh land without the present line of banks, and serving as important receptacles for backwater. On the banks and shores they observed numerous jetties, erected for the protection of the land against the violence of the current, extending in many instances much further than necessary, and for the most part operating as injurious impediments to the tideway, which, by obstructing its course, diminish its velocity, and allow time for the alluvial matter with which it is impregnated to be deposited and form banks and shoals highly injurious to the navigation, particularly mentioning one at Halton, and another near the old Quay Canal entrance. The Ince Ferry Quay has also an injurious effect, but they do not recommend its removal, on account of its absolute necessity for the purposes of commerce, but that openings should be made through it in various places, and arching them over. Several other jetties are detrimental, and should be removed.

They also recommend that no time should be lost in obtaining sufficient powers to enable the Corporation to have the complete conservatorship or control of the river Mersey and all its branches, to the end that when any encroachments are making by jetties, embankments or otherwise, they may have full power to cause them to be removed.

In obtaining the powers here recommended, they conceive there can be little or no difficulty, for all the leading interests of the country are combined in the necessity of maintaining and improving the navigation of the port of Liverpool, and none more so than the adjacent landholders, the value of whose estates must necessarily rise and fall with the population of this great commercial emporium, which is certainly of far greater importance to them than any advantage that can be derived from the acquisition of any land over which the tide flows.

Report dated 26th June, 1826 (No. 2).—Messrs. Whidbey, G. Rennie and Giles make strong observations on the jetties, piers and chevrons from Fidler's Ferry to Halton Point, which they think should be removed. They also notice the land embanked by Sir R. Brooke, and the encroachments made by the Mersey and Irwell Company, also at Ince Quay, Tranmere Bay, Wallasey Pool, and Seacombe.

They recommend that a quay or other boundary-line along the whole of the shores of the river Mersey and its inlets within the influence of the tide, should be accurately defined upon plans confirmed by Parliament. In order also that this important object may be effected in the most conciliatory and equitable manner, it should as far as possible be concerted with the landowners upon the principle of compensation for such lands as may be required for that purpose.

Report dated 4th October, 1826 (No. 2).—Mr. Giles is of opinion, that by the means of a shore and river-wall such a uniformity of flood and ebb current will be established up and down the river as to produce the best scouring effect of the tide and land waters, and particularly upon the ebb tide, which will be directed more forcibly upon the south-east end of the Liverpool shore than at present, so as not only to prevent a further accumulation of bank, but most probably to lessen the present extent and height of it. That the further result of forming such uniform lines of shore and river-wall will equalize and distribute the currents more over the river above Liverpool in particular, so as to prevent in a great degree the accumulation of mud and other sediment under the river-walls, and at the entrance to the docks generally, and at the same time render the navigation of vessels more direct and easy than can be the case through the various partial forces of currents and eddies of the present tideway.

Report dated December 1826 (No. 2).—Messrs. Rennie and Giles have given particular consideration to the sea channels, and to the river from Black Rock to Runcorn, and from thence to Woolston Weir, where the tide ceases. They say it is admitted by all intelligent and impartial men, that the preservation and improvement of the navigable channels of a river depend entirely upon the flux and reflux of the tidal waters, and the discharge of fresh waters, and that these have the most powerful effect during high spring tides and rainy seasons in scouring and deepening the channels through which such waters must flow. It is scarcely possible that a case can exist where a port or river can have too much backwater. There is a material tendency of the flood tide to drive in from the sea portions of sand, and a similar tendency of the inland waters to bring down sand and alluvial matter, and these find upon some parts of the shore of a river places and eddies where certain depositions of them will take place, and thus diminish the capacity of the river to that degree as will nearly balance or bring into equilibrium the content of water in the river with the power or force of currents which that content will produce both in its flowing into and ebbing out of the river. Taking it therefore as an axiom that no such thing can occur as a harbour having too much backwater, except what may be produced occasionally by mountain torrents, but not by the reflow of tidal waters, the general principle that the tide of a river, particularly in the upper parts of it, should be carefully protected by all possible means, is applicable in its fullest extent in the case of the Mersey, the fact of there being no excess of backwater in the Mersey having been fully ascertained.

It is too obvious to need argument, that water ebbing from the higher parts of the Mersey is infinitely more valuable than from the lower parts for the purpose of effecting a scour; the water from the highest parts having to run through the greatest length of the navigable channels in its passage to Liverpool, and afterwards through the sea channels at a period when the tidal waters have considerably ebbed, and when those channels are narrowed within the banks that enclose them.

The centre of Liverpool is about three and a half miles above the mouth of the river, while Runcorn is nearly twenty miles; the value, therefore, of the tide at Runcorn compared with that at Liverpool (taking it only at the relative distance between those places), is nearly as 5 to 1; but it is also beneficial in a manifold degree in consequence of its operating so much more powerfully to scour the bed of the channels at Liverpool and the sea channels than any water can do which is discharged from situations nearer the mouth of the river in the early parts of the ebb tide. Another circumstance may be cited in favour of preserving the tidal waters at Runcorn, and particularly upon the flat stones near to the level of high water. The fact has been proved by Mr. Giles, that the spring tides actually rise one foot and a half higher at Runcorn than at Liverpool, consequently any enclosure of such shores at Runcorn must be exceedingly injurious.

Too much vigilance therefore cannot be exercised in preserving the tidal waters at Runcorn, and also in having it discharged by the natural ebb of the tide.

Report dated 30*th January*, 1827 (No. 2).—Mr. R. Stevenson states, as a principle which ought to regulate all operations upon the banks of rivers, that backwaters are essential to the preservation of such rivers in a navigable state; and with regard to the Mersey, he is of opinion that the great influx and reflux of tides into this estuary every twelve hours is what alone preserves the Horse and Formby Channels in their present navigable state. To the preservation of these channels all the arguments relating to the backwater resolve themselves. An alteration in the depth or direction of these channels might be attended with consequences most serious to Liverpool, encumbered as its entrance is with sand-banks of a great extent.

He also recommends that the jurisdiction of the conservators should follow the high-water mark in all its gambols, though trenching sometimes upon one side of the estuary and sometimes upon the other, and that they should take the most prompt cognizance of all works undertaken upon the ebb, or between the points of high and low water. He conceives that a distinction should be made between works intended for the legitimate purpose of navigation, and those which have for their object the acquirement of firm ground at the expense of the backwaters of the river.

Report dated 31*st January*, 1827 (No. 2).—Messrs. Walker and Mylne state that the Mersey is only deeper at Liverpool than at Warrington, because the greater quantity of water at Liverpool requires a greater area to pass it. If the tide was excluded, the Mersey at Liverpool would by the deposit of matter brought down from the interior soon diminish to the same size as at Warrington, and the entrance from the sea would soon sand up, leaving space sufficient only to pass the water of the river in this diminished state.

Report dated 27*th September*, 1836 (No. 2*).—Captain Denham says, the progress of Pluckington Bank, since 1828, has been a horizontal increase of 210 yards abreast of Brunswick Basin, abreast of King's Dock 123 yards, and abreast of Duke's Dock only 40 yards. Its respective elevations he cannot quote between these dates, but since 1834 he finds it grown up one foot off Brunswick Dock, two feet off Brunswick Basin, three feet off Duke's

* Reprinted at length in No. 5 herewith.

Dock, and one foot off Canning Dock, during which its low-water margin has yielded 50 yards directly off Brunswick Basin. Simultaneous with this two years' fluctuation, the Devil's Bank has warped 143 yards towards the eastern shore, lowered in altitude four feet, but elongated towards Pluckington Shelf 250 yards, so that the spit of the Devil's Bank and Pluckington Shelf is within one-fourth of a mile of uniting with each other,—an event to be feared, seeing that the Devil's Spit has elongated two-thirds of a mile in eight years, but which should be averted with all anxiety, for in the space between them being shoaled up to a bar of six feet instead of fifteen, the Garston branch of the Mersey will scour its way through the Swatchway just above Otter's Pool, dividing the Devil's Bank from Eastham Sands, and join the main column of ebb stream down the Cheshire side of the river.

Report dated March 1837 (No. 2).—Messrs. Mylne and G. Rennie state, that from a rough estimate of the quantity of land which has been embanked out of the river above Runcorn, and which is still under the level of ordinary spring tides (or 22 feet on the Old Dock Sill), the present water surface only amounts to one-fifth of the whole. Below Runcorn the marshes of Widness, Ditton, Frodsham, Stanlow, and Wallasey, amount to nearly one-half the whole; or in other words, the total quantity of land embanked out of the Mersey exceeds the total quantity of water surface. In laying down quay lines in the Mersey, the following principles should be adhered to:—

1st. To preserve to the fullest extent the receptacles for the tide water.

2nd. To designate the boundaries by mere stones placed at intervals.

3rd. To have power to excavate and improve the bed of the river.

4th. To prevent encroachments, whether by embanking lands or accumulating matter by means of jetties.

5th. To prevent jetties, or other open or solid works of any kind, from being projected into the river without the consent of the Conservators.

6th. To prevent ballast or other solid matter from being thrown into the river.

7th. To raise and remove wrecks or other obstructions.

8th. To cut off or remove projecting points of rocks, without prejudice to existing interests, buildings or jetties which may tend to obstruct the free effect of the current of the tides; and to erect quay walls or other works which may assist the operation or diversion of the tide for the general benefit of the port.

They conclude by recommending a Commission of Conservancy, not only for the benefit of the port, but the public in general.

For the remedy of the evils mentioned in their reports, the engineers all recommend that the conservancy should be vested in the Corporation of Liverpool by Act of Parliament, with powers to remedy these evils, and to render the navigation as perfect as circumstances will admit.

We have been induced to make these copious extracts from the reports, as they so clearly point out the difficulties attending the navigation of the river, and the probability of the most serious consequences following, if powers are not given to the Corporation by Act of Parliament, to improve the navigation. We have personally inspected the state of the river, and are perfectly satisfied with the correctness of their reports and observations thereon, and are convinced that the navigation is yearly becoming more difficult, and that the obstructions will continue to increase if Parliamentary provision is not made for its improvement, perhaps to the ultimate ruin of the port.

The Corporation of Liverpool brought the state of the river under the special consideration of the late Mr. Huskisson in the year 1828; that eminent statesman gave the subject his most serious consideration: he viewed with alarm the numerous encroachments making, which he considered would, if allowed to go on, at no very remote period in all probability prove highly prejudicial to the navigation, and was persuaded that a Commission of Conservancy should be without delay appointed, consisting of not more than three Commissioners, including the Mayor of Liverpool, to be constituted by Act of Parliament, or by the Crown, reserving to His Majesty the power of appointing additional Commissioners if it should hereafter be found necessary. That his suggestions were fully approved by Lord Lowther, then Chief Commissioner of Woods and Forests, and by Mr. Arbuthnot, the Chancellor of the Duchy of Lancaster, appears from the Correspondence (No. 4). His melancholy death occurred before the business was finally arranged. And by the reform of corporate bodies, and from other causes, no effectual measure was taken till the session of the year 1837, when a bill was brought into Parliament by the Corporation of Liverpool, which was objected to by Government in consequence of the extensive powers sought for, and was consequently withdrawn on the understanding that the subject should be hereafter taken up by the Board of Trade.

The public bodies most materially interested in the navigation of the Mersey, are the Mersey and Irwell Navigation, the Duke of Bridgewater's Canal, the River Weaver Navigation, the Ellesmere Canal, and the Sankey Canal Companies. We have understood that objections have been raised by some of these companies to the Corporation of Liverpool having a prevailing interest in the conservancy. For the purpose of meeting the wishes of these most important and highly respectable bodies, and also those of the influential, commercial, and agricultural interests connected with the Port of Liverpool, or the River Mersey, we have personally waited on the Mayor of Manchester and the town authorities of Warrington, and the gentlemen taking the most prominent part in the management of the Canal and Navigation Companies. We have also seen the Earl of Sefton, the auditor of the Earl of Derby's estates (both of these noble lords having considerable estates adjoining the river), Mr. Potts of Chester, on the part of several landowners on the Cheshire shore, as well as for the Ellesmere Canal Company, for whom he acts, and other landed proprietors having property adjoining the Mersey. We think it proper to annex notes of the observations made (No. 5), from which it will appear that they all concur in the propriety of an effective Conservancy being appointed, but some of them express a strong feeling against the Corporation of Liverpool being invested with more power than what is given to other public bodies, and the Mersey and Irwell Company only seemed inclined to contribute to the expense of the Conservancy.

It is our desire to pay every respect to the opinions of these highly respectable and important companies, and to meet their wishes if possible; but we cannot lose sight of the correct view taken by the late Mr. Huskisson, that if the Conservancy was too numerous it would probably be ineffective; and we cannot therefore recommend that the Commission should, in the first instance, exceed four, though we should much prefer its being limited to three only, viz. the Mayor of Liverpool for the time being, with power to nominate one of the Aldermen to act for him in case his public duties should engage too much of his time; one of the Dock Trustees, and one on the part of the public conversant with the state of the river;

to communicate with the Board of Trade on all points affecting the navigation.

If it should be considered advisable, a fourth Commissioner may be appointed,—the Canal and Navigation Companies to make this appointment from one of their body.

The Corporation of Liverpool propose to bear two-thirds of the expense, and the Dock Trustees the other third. The Conservancy can, in our opinion, only be efficiently formed by a public Act, in which powers may be given to the Board of Trade for increasing the number of Commissioners, if hereafter found necessary;—or to commence by a Commission from the Crown, as suggested by Lord Lowther to Mr. Huskisson, obtaining when necessary increased powers from Parliament.

The Conservancy of the River Thames appears to have been first appointed by charter in the third year of the reign of James I., and afterwards extended by several Acts of Parliament from the reign of George III. We would take the liberty of recommending that the powers of the Conservators of the Mersey should assimilate, as nearly as circumstances will admit, to those of the Thames; and that the shore of the river or of the sea within the Port of Liverpool should not be vested in them, but should remain in the Crown, or in other persons legally holding the same, and should not be taken or used by the Conservators without permission or purchase. Nor should the Conservators be authorized to interfere with the extensive enclosures of the marshes above Runcorn, or in the River Weaver, which are of a very ancient date; nor with the numerous jetties, chevrons (unless they are longer than necessary, and obstruct the navigation of the river), or other encroachments; but that their operations should, in the first instance, be confined entirely to the bed of the river, in scouring the same with proper machinery, and in making new channels and removing obstructions.

It is not for Liverpool alone that a Conservancy is wanting, nor for the Navigation Companies connected with the Mersey: it is of equal importance to Manchester, and all the other manufacturing towns in Lancashire, Cheshire, Yorkshire and Staffordshire, and to the general commercial and shipping interests of the kingdom. If the measure is properly carried into effect, it will be beneficial to the interests of the community at large.

We have thought it advisable to request the Corporation of Liverpool to state their views as to the plan of operations in the event of Conservancy being granted.

The Town Clerk has favoured us with two letters from Lieutenant Lord, R.N. (No. 2)*, the marine surveyor of the port, to the chairman of the Conservancy Committee. He recommends that the lines of high water should be accurately marked and defined, and that no future encroachments should be allowed without authority. That the edges of the banks, which in the upper part of the river are composed of earthy sward, should be protected by a facing of stone or other suitable material, to prevent any part from being carried away by the tide. This, he says, would render permanent a scouring force of water, which would maintain the sea-approaches in an effective state, and it would then remain to watch the changes that might arise in the sand-banks in the river and its approaches, and to adopt such timely remedies as might be necessary. He refers particularly to the dredging operations which were so successfully carried on for a period of ten months during the last year, by which means a most valuable channel was

* Nos. 7 and 8 herewith.

opened at a small expense;—that its success depended entirely on the column of water running out of the Mersey on the ebb tide, and to a minute attention to what was taking place in that region.

He considers the natural formation of the Mersey admirably adapted for scouring and keeping open the sea-channels, if encroachments are not allowed to be made on its banks; but he doubts the propriety of scarping or removing rocks.

We cannot venture to give an opinion as to the most practicable mode of improving the navigation. The Conservators will (if appointed), as a matter of course, consult the most eminent engineers as to the best means of proceeding; but we think the navigation would be much improved if the plan of dredging with machinery, so successfully adopted in the Victoria Channel, was followed up in the river. It is most desirable to make it apparent to the Navigation Companies, to the landowners, and to all other parties interested, that in appointing a Conservancy the public good only is looked to, and that there is no intention whatever to interfere with private interests, which will be duly preserved and protected.

If the President and Lords of the Board of Trade be pleased to approve of a Conservancy being established by Act of Parliament, we will prepare a bill founded on the practice in the River Thames for their Lordships' approval, making special provisions for preserving the rights of the Mersey and Irwell Company, and those of all other Companies connected with the River Mersey.

We also beg to send a statement delivered to us by the Town Clerk of Liverpool, with a map of the river (Nos. 6 and 7), showing the rights of the Mayor, Aldermen, and Burgesses to the Lordship of Liverpool, comprising the River Mersey up to Warrington and Frodsham Bridges, and the Strand at Liverpool, Toxteth Park, Birkenhead, and Wallasey, which the Corporation wish to be noticed in our Report; from which it appears that the 18th Section of the Act of the 2nd George III. cap. 86, authorizes them as Trustees of the Docks, by authority from twenty-five of their body, to remove such nuisances as may be necessary for improving, scouring, and keeping open the navigation from the sea as far southwards as the Lordship extends; and by the Dock Acts of the 39th George III. cap. 59. sec. 29, and 57 George III. cap. 143. sec. 80, their water-bailiff and harbour-master have special powers over vessels, wrecks, and obstructions. It would therefore seem that Parliament intended to give powers to the Corporation which are not considered sufficient to constitute an efficient Conservancy.

We have the honour to be, Sir,
Your most obedient Servants,
(Signed) JOHN WILKIN.
Dennis Le Marchant, Esq. GEORGE WILKIN.

No. 2.—Area and Content of Water in the River Mersey, from Black Rock to Woolston Weir, above Warrington, at certain Tides below and above Liverpool Old Dock Sill.

	Low water, neap tide, 1 ft. 9 in. below Liverpool Old Dock Sill.		Low water, spring tide, 8 ft. 9 in. below Liverpool Old Dock Sill.		At an average high water mark at neap tides, or 11 ft. 3 in. above Liverpool Old Dock Sill.		At an average high water mark of spring tides, or 18 ft. 3 in. above Liverpool Old Dock Sill.		At 20-feet tide.		At 22-feet tide.		At 23 ft. 3 in., April 3, 1821, or an average of 24-feet tide.	
	Acres.	Tons of Water.	Acres.	Tons of Water.	Acres.	Tons of Water.	Acres.	Tons of Water.	Acres.	Tons of Water.	Acres.	Tons of Water.	Acres.	Tons of Water.
From Black Rock to the extent of flow of low water lines.	..	211,099,722	6,225	138,874,737										
From Black Rock to Runcorn Gap.	..	.. ..	..	.. ..	20,000	444,450,138	21,600	621,009,125	21,600	666,872,373	21,600	719,239,898	21,600	771,587,973
From Runcorn Gap to Warrington Bridge.	..	.. ..	..	.. ..	910	2,222,222	1,307	10,370,299	1,340	13,207,749	1,340	16,450,549	1,340	19,693,349
Sundry Marshes	..	.. ..	..	.. ..	..	.. ..	122	701,195	122	959,528	122	1,254,768	122	1,550,008
Total		211,099,722	6,225	138,874,737	20,910	446,672,360	23,029	632,080,619	23,062	681,039,650	23,062	736,945,215	23,062	792,831,330

Inland Marshes.

	Acres.
Wallasey Marsh	3,609
Trafford Marsh..........................	2,237
Frodsham Marshes	3,745
Frodsham Valley above Bridge	433
Ditton and Widnes	560
Runcorn to Warrington	2,856
	13,440

Salt Marshes.

	Acres.
Wallasey, Tranmere and Brombro	398
Frodsham and Weaver........................	759
Sundry Marshes	76
Ditton and Widnes	230
between Runcorn and Warrington	434
	1,897

There are 23,062 acres in the River Mersey from Black Rock to Woolston Weir, and 13,440 acres enclosed marshes lost to the tideway.

Or about 25 millions of tons of water at 22-feet tide, and 50 millions at 24-feet tide.

Given in by Geo. Rennie, 18th of May, 1838.

No. 3.—Index of the Engineers' and Surveyors' Reports who have reported on the Estuary and River Mersey.

Extract of Mr. Rennie's report as to any one dock, 1809.
Mr. Whidbey, ditto, 1818.
Late Mr. Rennie's ditto, on Ditton Embankment, 11th October, 1819.
Ditto, Messrs. Whidbey, Chapman and Rennie, upon the lines of wharf walls at the south and north ends of the docks upon Pluckington Bank, 1822.
Mr. Telford on Mersey and Irwell Works, 29th January, 1823.
Messrs. Telford and Nimmo on same subject, 1823.
Ditto, on Mersey and Irwell Navigation, June 1823.
Mr. John Rennie, jun., in reply to above Report, July 26, 1823.
Mr. Whidbey on ditto, July 14, 1823.
Mr. Chapman on ditto, July 18, 1823.
Messrs. Whidbey, Rennie and Giles, 1826.
Mr. Giles proposed Conservancy line, 1826.
Messrs. Rennie and Giles on Conservancy of River generally, 1826.
Messrs. Whidbey and Giles, afterwards J. Walker, on Embankments, 14th August, 1826.
Messrs. Stevenson, ditto, ditto, 1827.
Messrs. Walker and Mylne, ditto, 1827.
Messrs. G. Rennie, James Walker, R. Stevenson, F. Giles, and W. C. Mylne on Viner's Embankment and Ince's Quay, 1827.
Messrs. Telford, Stevenson and Nimmo, on new sea-ports in Rivers Dee and Mersey, with a ship channel, 1828.
Mr. Chapman's Report on the effect on the navigation of River likely to result from works, 1823.
Mr. George Rennie on the effect of New Brighton Pier, 8th December, 1834.
Captain Denham on Mr. Lace's projection, and Pluckington Bank and Devil's projection, and proposing a river wall, 1836.
Report of Messrs. Mylne and Rennie on Mersey, 1837.
Letter from Lieut. Lord, recommending mode in which the Conservancy should be effected, 1840.
Second letter ditto, 1840.
Captain Evans on River Mersey, May 29, 1844.
Mr. George Rennie on Seacombe Pier and Pluckington Bank, 17th November, 1844.

No. 4.—*Conservancy. First and Second Memorial.*

To the Right Honourable the Lords Commissioners of the Admiralty, and to the Right Honourable the Lords Commissioners for the Affairs of Trade.

The Memorial of the Mayor, Aldermen, and Burgesses of the Borough of Liverpool,

Sheweth,—That your Memorialists, as representing the town and being the owners of the Lordship of Liverpool, comprising the Port, are most materially interested in the maintenance, preservation, and improvement of navigation of the River Mersey.

That the entrance to the River Mersey is by three principal channels, formed in the midst of numerous sand-banks and shoals, frequently shifting and increasing.

That in other parts of the river there are dangerous banks and shoals, and that in particular extensive banks have formed opposite the entrance of the docks, threatening the most dangerous consequences.

That for years past the general state of the river has been most critical and alarming.

That the principal causes of this state of the river are, as your Memorialists believe, the impediments offered to the flux and reflux of the tidal waters and the diminution of water space above the town, by the enclosure from the river of large tracts of land.

That your Memorialists have for many years vainly endeavoured to obtain some efficient protection for their own and the public interests in the vesting of the conservancy of the river in commissioners with adequate powers, your Memorialists fearing that unless vigorous measures were adopted, the Mersey would become, like the Dee, the Lune, the Exe, and many other rivers, no longer navigable for vessels of burden.

That your Memorialists, from the year 1818 to the present time, have, at a very heavy expense, caused frequent surveys and reports upon the state of the river to be made, namely, in 1818 by the late Mr. Whidbey, the constructor of the breakwater at Plymouth (whose Report contains a concise and clear view of the then state of the river, and of the deterioration to be anticipated from the causes before mentioned); in 1822 by the same gentleman in conjunction with the late Messrs. Chapman and John Rennie; in 1823 by Messrs. Telford, Nimmo, Whidbey, Chapman, Rennie, and Fowler; in 1826 by Mr. Whidbey and Messrs. George Rennie and Giles; in 1827 by Messrs. George Rennie and Giles, and afterwards by Messrs. James Walker and W. C. Mylne; in 1828 by Messrs. Telford, Stevenson, and Nimmo; in 1835 by Mr. George Rennie; in 1836 by Commander Denham, R.N.; and in 1837 by Messrs. Mylne and George Rennie and Walker.

That these Reports prove in the most unquestionable manner the absolute necessity for active and incessant superintendence, and they also incontestably prove the changeable character of the river and its approaches.

That in the beginning of the Session of last year a Bill was brought into the House of Commons to empower the proprietors of the Grand Junction Railway to amend their present line, by forming a new line of railway by crossing the River Mersey three to four miles below the town of Warrington, by a bridge at a place called Fidler's Ferry.

That your Memorialists, fully sensible of the importance of the proposed measure, were with great reluctance compelled to offer to it all the opposition in their power, inasmuch as the proposed bridge would have been injurious to the trade and navigation on the river, and would have interfered with the flux and reflux of the tide.

That this Bill was rejected in committee so far as related to the intended bridge.

That your Memorialists on this occasion offered evidence as to the past and present state of the river.

That from the evidence thus given, your Memorialists have extracted portions comprising part of the Reports already referred to, which they lay before your Lordships, and to which they earnestly and respectfully solicit your attention.

That one statement in particular proved before the committee was as follows:—

"The present area of the River Mersey, from the Black Rock at the mouth to Woolston Weir above Warrington Bridge, is 23,062 acres, over which, at a 22-feet tide, 736,945,215 tons of water flow, and that no less than 13,440 acres of marshes have been abstracted from the tideway, equal to about 25,000,000 tons of water, calculated at the same tide. That the remaining salt marshes were, about the year 1822, only 1897 acres, from which further abstractions have since been made."

That in further corroboration of your Memorialists' representation, they lay before your Lordships the following Report of Lieutenant Lord, R.N., the Marine Surveyor of the Dock Trustees:—

"Marine Surveyor's Office, February 1839.

"My attention having been called to the fluctuations going on from time to time on the banks and shores of the Mersey and its embouchure, I beg to state that all those conversant with the navigable channels of the river are aware that frequent and sometimes very sudden changes take place in the sand-banks and navigable waters of the same. That such fluctuations are going on continually is strongly evidenced by the Marine Surveyor's Report in 1836, by which it appears that between the years 1828 and 1836 the horizontal increase of Pluckington Bank was 210 yards abreast of Brunswick Basin, 123 abreast of King's Dock, and 40 abreast of Duke's Dock; and that between the years 1834 and 1836 it had grown up one foot at Brunswick Dock, two feet off Brunswick Basin, three feet off King's Dock, three feet off Duke's Dock, and one foot off Canning Dock; whilst its lower water margin yielded 50 yards during the same period. Thus threatening to become a serious obstruction to the entrance of Brunswick, King's, and Duke's Dock.

"It also appears from the same statements, that the Devil's Bank and Spit had considerably elongated during the above period.

"In a remoter region, namely, the sand-banks at the entrance of the port, such as the Great and Little Burbo, Jordan Flats, &c., the changes have been still greater, as was fully evinced in the survey carried on last summer, as compared with that of 1835.

"In no part is this more strongly exemplified than in the Half-tide Swashway and the New Channel.

"In the former the Old Channel has filled, leaving a dry bank at low water, and another channel has scoured itself where we had formerly a dry bank; whilst in the New Channel there has been a gradual warping and filling up for the last four years, leaving now a navigable channel of only 130 fathoms wide, with 11 feet at low water, where we formerly had a channel half a mile wide with 12 and 13 feet.

"Taylor's Bank has also considerably spread to the north-west during the above interval, and various other alterations have taken place in the contour and altitude of the banks.

"In conclusion, I would state it to be my conviction that the encroachment on the bed of the river, by the reclaiming of land, &c. at its upper part, cannot be too strongly deprecated, as it must evidently diminish the backwater, on the scouring effects of which the very vitality of the entrances to the port depends, besides altering and diverting the stream of the river into new and often injurious channels.

"I have the honour, &c., "W. Lord."

That your Memorialists, in the language of their late lamented representative the Right Honourable William Huskisson, "feel convinced, from facts and personal observation, that if the system of encroachment and nuisance which has prevailed for many years in the Mersey is not effectually checked, so as to give full scope for the natural flux and reflux of the tidal waters, the Port of Liverpool will, in the course of no very long time, be as much choked up as those of Chester and Lancaster now are."

Your Memorialists therefore, in conclusion, earnestly urge on the attention of your Lordships the necessity for immediate measures for the future protection of the navigation of the River Mersey, an object of increasing and anxious interest to your Memorialists, and one in which the country at large is deeply concerned.

And your Memorialists will ever pray, &c.

Liverpool, April 1839.

Second Memorial, September 1839.

To the Honourable the Lords Commissioners of the Admiralty, and to the Right Honourable the Lords Commissioners for the Affairs of Trade.

The Memorial of the Mayor, Aldermen, and Burgesses of the Borough of Liverpool,

Sheweth,—That your Memorialists presented in May last, through the members of the borough, a Memorial to your Lordships, setting forth the dangerous state of the River Mersey, from the numerous and shifting banks and shoals, the causes for this state, the endeavours hitherto ineffectually made to obtain efficient protection, the necessity for incessant superintendence, the immense area already abstracted from the tideway, and other grounds, as inducements for the interference of your Lordships, in order to the establishment of a Commission of Conservancy; which Memorial was accompanied by extracts of evidence taken before a Committee of the House of Commons in the session of 1838, in the Grand Junction Railway Bill, as to the past and present state of the river.

That your Memorialists are anxious to receive the opinion of your Lordships upon the prayer of their Memorial, and (venturing to assume that a Bill to be brought into Parliament in the ensuing session will be directed or sanctioned by your Lordships) more particularly as to the preliminary question, whether such Bill ought to be public or private, inasmuch as in case the latter be deemed by your Lordships to be preferable, the necessary notices must be forthwith given, and other parliamentary proceedings be taken in conformity to the standing orders; and, as whatever course of proceeding your Lordships may recommend, immediate meetings with parties concerned, proprietors along the banks of the river, ought to be held, in order as much as possible to remove misunderstanding and consequent hostility on their parts.

That your Memorialists would respectfully urge on your Lordships' consideration, that the plan of a public bill would be the preferable course; for even the notice of a private bill, and the deposit of maps showing a line of causeway along, or, as many would suppose, over estates on the banks of the Mersey, creates such alarm in the minds of the proprietors interested, as to make it exceedingly difficult and almost impossible afterwards to explain that the proposed measure is one for the public good, and for the benefit rather than to the injury of individuals.

That your Memorialists have, through their officers, lately had the advantage of conferences with Mr. Wilkin, one of the officers of the Woods and Forests, and with Mr. Wilkin, junior, both lately dispatched by that Board to Liverpool, at the instance of your Lordships, to take preliminary steps on the subject of the Conservancy; and your Memorialists believe that these gentlemen, who have given considerable attention to the subject, and have taken great interest therein, concur in opinion with your Memorialists and their officers, that a public bill is the proper measure to be recommended, but that, however that point may be determined, another session ought not to pass over without a bill, public or private, being brought into Parliament.

Your Memorialists therefore pray the immediate consideration and direction of your Lordships on the matters submitted.

(Copy.)

No. 5.—Letter from H. M. Denham, R.N., to the Corporation of Liverpool, 27th September, 1836.

Marine Surveyor's Office, Liverpool, Sept. 27, 1836.

SIR,—Pursuant to a request to the following effect,—"That I would furnish a plan of that part of the river opposite the property of Mr. Lace and others, and a report and statement of the variation in Pluckington Bank and the adjacent parts,"—I took every opportunity afforded by the tides and weather to produce the results set forth in this report and the accompanying plans, which will evidence how necessarily the question involved an actual re-survey of the whole region between the Rock Lighthouse and where the river ceases to be navigable at low water, viz. Garston and Eastham; for on no less datum than the most *recent* tests as to the causes and effects of the river's deflection could I presume to give an opinion, which, on the one hand, might involve capital already embarked in projections, or, on the other, incite the sanction of its conservators as respects those projections. I can, however, now assert, that so distant is the primary cause and impetus of the river's deflection (on its eastern margin) from those projections between Knott's Hole or Dingle Point and the southern extremity of the Dock Estate, as to entirely absolve the works of Messrs. Lace and others from any ill effects.

Provided, that it be a *sine quâ non* such jetties shall be subject to a boundary-line on the strand, laterally with the low-water margin as delineated on the Plan, such line to constitute the *face* of all projections, and (until connected with the shelving rocks at Dingle Point) to have 100 yards of face wall always at right angles to the southward of the southernmost offset.

In this stipulation it will appear that I admit the deflecting effect of any offsets upon the ebb stream, *although north* of Dingle Point. So I do; but it is so slight, in comparison with the position and continuous diversion of that point, that if we abstain from interrupting the downset of the recovering water-level (feeble as it is) after rounding Dingle Point, by direct offsets, then we shall direct that feeble portion of stream *fairly* and *beneficially* down the face of the docks.

Thus much, Sir, applies to the question of Mr. Lace's projection, or any others in the limits quoted.

I now beg to report on the nature of Pluckington and Devil's Banks; to elucidate which, I submit a plan of the features of the river between the Rock Lighthouse and Garston, upon four inches to the mile, whereon the course and velocity of the flood and ebb stream are portrayed, the former in red and the latter in blue ink, showing that Pluckington owes nothing to the flood-tide deposit, but that on the course of the eastern column of the ebb does that deposit depend, and that course depends on Dingle Point; for by practical tests on each half-hour of ebb from high to low water, we perceive its inclination to follow the trend of shore until within 100 yards of Dingle Point, which becomes so decidedly the point of deflection, as to hurry it into the deep-water column with such impetus as to blend with it, and divert the whole obliquely towards Birkenhead, whereby the tidal stream off the southern portion of docks, especially King's, Queen's, and Brunswick Docks, becomes so weakened as to permit the sand held in solution to deposit thereat, besides being too weak to bear away the silt driven forth from the several dock sluices. The first effect of this diversion manifests itself in the formation of a shelf of sand varying from three to ten feet under water, that springs from abreast of the rocks under Mr. Lawrence's wall one-third of a mile southward of the Potteries, trending obliquely towards Birkenhead until abreast of the southern extremity of the Dock Estate, where it forms an elbow one-third of a mile towards the centre of the river, and then trends to St. George's Dock. This shelf, therefore, narrows the river capacity at low water to nearly one-half what it appears to be at Rock Ferry and Brunswick Dock, and then the *visible* Pluckington springing obliquely from the southern extremity of the Dock Estate, and forming an entrance off Brunswick off-tide entrance at an offset of 270 yards into the river, whence it trends into St. George's Dock, lateral to and within thirty yards of the margin of the shelf.

This bank outlays King's Dock Basin also 270 yards, varying from six feet to one foot in height above low-water level. Its highest part is off Duke's Dock, where it outlays fifty yards less, but drives up ten feet; off Canning Dock it outlays above 120 yards, and drives up to six feet four inches, then gradually narrows at an elevation of two feet, until uniting with the base of George's Pier-head.

Taking the progress of this bank since 1828, which is marked by a green shade on Plan, we have a horizontal increase of 210 yards abreast of Brunswick Basin, abreast of King's Dock 123 yards, and abreast of Duke's Dock only 40 yards. Its respective elevations I cannot quote between those dates, but since 1834, I find it grown up one foot off Brunswick Dock, two feet off Brunswick Basin, three feet off King's Dock, three feet off Duke's Dock, and one foot off Canning Dock, during which its low-water margin has yielded fifty yards directly off Brunswick Basin. Simultaneous with this two years' fluctuation, I find the Devil's Bank to have warped 143 yards towards the eastern shore, lowered in altitude four feet, but elongated towards Pluckington Shelf 250 yards, so that the spit of Devil's Bank and Pluckington Shelf are within a quarter of a mile of uniting with each other,—an event to be feared, seeing that the Devil's Spit has elongated two-thirds of a mile in eight years, but which should be *averted* with all anxiety; for on the space between them being shoaled up to a bar of six feet instead of fifteen, the Garston branch of the Mersey will scour its way through the Swatchway just above Otterspool, dividing the Devil's Bank from Eastham Sands, and join the main column of ebb stream down the Cheshire side of the river. I therefore earnestly propose, that, with reference to the curvilineal boundary set forth for the future projections between the Dock Estate and Dingle Point, a river-wall should be extended in connexion from forty yards within the low-water edge of the Knott's Hole rocks, scraping the edge of those rocks, and preserving a gentle concave along the low-water margin of the shore. This wall would produce a most sensible effect on the first 400 yards' advance, by presenting a cutwater edge to the down stream, instead of allowing the whole body of water to drive against the north cliffs and rocks of Dingle Point, and then jerked off with an impoverished impetus at nearly right angles to its wonted and natural course.

Its further extension might be subject of convenience of funds, &c., understanding that as it progressed south-eastward, more decided guidance and impetus on the ebb stream would be afforded, the destructive undermining of the cliffs and consequent dissemination thereof on the banks obviated, and much valuable frontage redeemed; for, supposing it carried up to Otterspool, an area of 616 acres would be produced; and if up to Garston, 1590 acres.

The *filling up* would not concern our tidal object; on the contrary, the circulation of water within would avoid the displacement of 2,702,018 cubic yards of tidal water in first enclosure to Otterspool, and 72,000,000 in the whole enclosure. The contemplated enclosure between the Dock Estate and Dingle Point will embrace 346 acres area, and 11,024,444 cubic yards of water, for the total of which displacement I should not be tenacious of permitting of a *close* wall and filling up the strand within it, notwithstanding the assumed obvious advantage to property.

I will conclude this Report, Sir, by begging it may go hand in hand with the local and general Plans herewith submitted for elucidation to the mind's eye of those gentlemen concerned in the conservation of the Mersey and Dock approaches. Of the latter it need only be said, that, whilst placing dock sills between four and nine feet of low-water level, a bank should be contemplated with much jealousy that not only precludes taking up early anchorage near the Southern Docks, but that threatens to elevate itself above the level of those sills, except in the guttering course of the gate sluices.

I ought to add, that we need not wait the connexion of a boundary wall from the Docks to Dingle Point before striking out the *cutwater* wall *southward*, but act independently and effectively by Dingle Point, by first projecting on the rocks 100 yards in a south-west direction, and then vigorously working towards Otterspool.

I have the honour to be, Sir,
Your obedient Servant,
H. M. DENHAM, R.N.,
Marine Surveyor to the Dock Trustees

To the Worshipful the Mayor of Liverpool.

No. 6.—Statement of the Town Clerk as to the Rights of the Mayor, Aldermen, and Burgesses of Liverpool to the Lordship of Liverpool, comprising the River Mersey up to the Bridges and to the Strand at Liverpool, Toxteth Park, Birkenhead, and Wallasey.

1. *The title of the Corporation to the Lordship of Liverpool, comprising the River Mersey up to the Bridges.*

The Corporation, as purchasers from the grantees of King Charles the First, are seized in fee of the town and lordship of Liverpool, and all the customs, anchorage, and key or keel towl of the water of the Mersey, of which over the whole of the river up to the Warrington and Frodsham Bridges the Corporation are, and ever since their purchase have been, in the receipt and enjoyment. The lordship comprises the river up to the bridges.

By the Liverpool Dock Act, 2 Geo. III. c. 86. s. 18, the Corporation, as "the Trustees of the Liverpool Docks," have the following express powers:—

"And be it further enacted by the authority aforesaid, that it shall and may be lawful to and for the said trustees, their agents, servants or workmen, when and as often as occasion shall require, well and sufficiently to cleanse, scour, open, deepen, widen or straighten, rake up or cut through any banks, shoals, flats, shallows, dock sluices or guts in the said harbour of Liverpool, or leading into the same from the sea, as the same trustees, or any twenty-five or more of them, shall think proper and necessary for the better securing, maintaining, and preserving a free, open and perfect navigation into and through the said harbour of Liverpool, and to dig, cut, remove and take away any sand, gravel, rocks, stones, anchors, cables, timber and other things, wrecks of ships, or other vessels, or any other obstructions or impediments to the navigation leading into and being within the said harbour of Liverpool from the sea or mouth of the said harbour, and so far southwards as the liberties or lordship of the Corporation of Liverpool extend, be it the ground or soil of the King's Most Excellent Majesty or any other person or persons, bodies politic or corporate, whatsoever."

2. *The property of the Corporation in the Strand at Liverpool and part of Toxteth Park.*

The Corporation of Liverpool are the owners of the freehold of the whole of the strand, forming the river front of the ancient borough, such ownership so far as respects the docks now standing vested in them in their capacity of "the Trustees of the Liverpool Docks," by virtue of appropriations under the Dock Acts. As to the small dock of the Trustees of the late Duke of Bridgewater, that property, with certain limited privileges over the strand, is leasehold for lives, with a right of perpetual renewal on payment of a small fixed fine, the Corporation still owning the freehold in reversion. Of the title of the Corporation there is, from 1670 downwards, the strongest proofs, by grants, leases, and various other acts of ownership, as in 1828 was fully admitted by the Duchy of Lancaster, Mr. Wyndham then being the Duchy Solicitor. Upon this occasion extracts from the Corporation Records, with three explanatory maps, were laid before the Duchy.

Of the strand in Toxteth Park, so far as the Liverpool Docks extend into that township or extra-parochial place, the Corporation, principally in their capacity of "the Trustees of the Liverpool Docks," are also the owners of the freehold by purchases from Lord Sefton and others under the Dock Acts.

The docks of the trustees and the river-walls were all made under acts of Parliament.

3. *The property of the Corporation in Birkenhead and Wallasey.*

The Corporation by purchases are entitled to their land at Birkenhead and Wallasey in fee, with the rights of the lords of the manors to the shore of the Mersey. The only erections (called by Mr. Eyes encroachments) made since the purchases of the Corporation are parts of the public road, viz. where that road crosses Gill Brook, and where it crosses Bridge End, and one other erection, the unauthorized act of a tenant. All the other erections on the shore were made by prior owners.

(Copy.)

No. 7.—Letter from Lieut. Wm. Lord to the Chairman of the Conservancy Committee.

Marine Surveyor's Office, Liverpool,
March 23rd, 1840.

Sir,—Referring to those points to which it is most desirable the attention of the Conservative Commissioners of the River Mersey should be primarily directed in the event of conservative powers being obtained from Parliament, I would premise, that the existence and maintenance of the sea channels leading to the port, vitally depend on the preservation of the backwater which the Mersey and its tributary streams afford; that this body of water is liable to daily diminution by various encroachments, and, if not protected, will be materially lessened, the effect of which would undoubtedly be, the sanding and filling up of the sea channels, leading ultimately to the ruin of the port.

The first object therefore worthy the attention of the conservators, would, in my opinion, be the preservation of the backwater as it at present exists, and to take care that for the future it was not trenched on or diminished.

To effect this object, it would, I think, be desirable that the limits of the high-water margin of the river should be accurately marked and defined, and that no subsequent encroachment should be allowed on the bed of the river, either in the shape of reclaiming land from its banks, or by allowing any projections into the stream of the river without the sanction of the Commissioners.

It is a well-known fact, that considerable encroachments have in former times been made on the bed of the Mersey by the reclaiming of land in the upper part of the river, and such operations cannot, in my opinion, be too strongly deprecated; and I may here add, that it is to this very cause, viz. the enclosure of land in its upper part, that the filling up of the channels in the estuary of the Dee is very generally attributed.

Having defined the high-water limits, it would, I think, be very desirable that the edges of the banks (which in the upper part of the river are composed of an earthy sward) should be protected by a facing of stone or other suitable material; the destructive fretting away and undermining of their margins and consequent dissemination thereof on the banks in the river, and its embouchure, would thus be obviated.

Having thus secured and rendered permanent a scouring force of water equal to that we now possess, and which there is every reason to believe is capable of maintaining the sea-approaches of the port in as effective a state as they now exist, it would only remain to carefully and vigilantly watch the changes that might arise from time to time in the sand-banks in the river and its approaches, and should circumstances render it necessary, adopt such timely remedial measures as the urgency of the case or the operations of nature might suggest. I may here remark, that the dredging operations which were so successfully carried on during a period of ten months last year in the Victoria Channel, and by means of which a most valuable channel was opened to the port, depended for their success entirely on the column of water running out of the Mersey on the ebb tide, and a minute attention to the changes which were naturally taking place in that region; and should any future fluctuations take place in that or other quarters, it may again become requisite to adopt artificial measures to improve or preserve the approaches to the port.

The natural formation of the River Mersey is, I think, admirably adapted for the purpose of scouring and keeping open the sea channels, provided that formation is not altered and distorted by encroachments on its banks. The upper part of the river, between the Dingle Point and Weston Point, forms as it were an immense inland lake of eleven miles long by two and a half broad, the latter being the average width between Eastham and Garston, and Dungeon Point and the Cheshire shore. At the Dingle Point the river contracts, and between the Cheshire shore and Liverpool, from the south to the north end of the docks, it constitutes a narrow gorge of only half a mile width and considerable depth, through which the calculated waters of the upper lake are disgorged with a velocity of as much as seven miles per hour on the ebb tide; and though it is true that this impetus is materially diminished by the time it reaches the sea at the outer bars of the shallows, still if we can preserve the same column of water and strength of current which we now possess, I see no reason to apprehend the outer approaches of the port sanding or filling up.

The scarping, or removal of rocks, in the river should not, I think, be undertaken without due consideration of the effects likely to be produced by so doing, and should, in my opinion, be avoided as much as possible.

In conclusion, I would beg to remark, that I think the new dock proposed to be formed to the westward of the Salthouse Dock, and the carrying out of the river-wall in that quarter, so as to form a continuous line with the other docks, will be a great and decided improvement to the navigation of the river.

I am, Sir, your obedient Servant,
(Signed) WM. LORD,
Marine Surveyor to the Port.

To the Chairman of the Conservancy Committee.

(Copy.)

No. 8.—Letter from Lieut. Wm. Lord to R. Radcliffe, Esq.

Marine Surveyor's Office, April 3, 1840.

DEAR SIR,—Since I last wrote to you on the Conservancy affairs, it has occurred to me that two or three piers judiciously run out between Garston and the Dingle Point, might produce a good effect in preventing the great offset of the tide from the Dingle Point, and conducting it along the line of the docks, by which some portion of Pluckington Bank would doubtless be got rid of.

Having had some conversation with the Dock Surveyor on the subject, I may add that he fully concurs with me on this matter, which may be worthy the attention of the Conservancy Commissioners, should such be appointed.

The expense of the erection of such piers would not, I apprehend, be very great.

I am, dear Sir,
Yours very truly,
(Signed) WM. LORD.

R. Radcliffe, Esq., Town Hall.

Report upon the changes in the Sea Channels of the Mersey, as recorded by the Surveys taken and published within the last fifty years; and which surveys have been laid before the Committee appointed to investigate and report upon the same, by the British Association for the Advancement of Science, at its meeting in Liverpool, September 1854. *By* JOSEPH BOULT.

The charts of the Mersey having been usually prepared when important changes had taken place in the channels, the investigations of those changes could not be arranged by epochs of time, and therefore the periods which the charts themselves prescribe have been adopted.

For the purpose of this inquiry it may be conveniently assumed that the true mouths of the river are at the outward extremities of the sea channels. The streams of tide running inland through these sea channels unite into one great stream between the north dock-works of Liverpool and New Brighton. After passing the towns of Liverpool and Birkenhead, through a narrow gorge—which in places is as much as 10 or 12 fathoms deep, at low water of ordinary spring tides—the river rapidly widens into a very extensive reach or reservoir, sometimes called the upper estuary; from which the tide, after sending an offshoot into the Weaver, passes into the upper reaches of the river through the smaller gorge of Runcorn-gap. After traversing a series of reaches and gorges of less and less importance, and surmounting a low weir at Howley-locks (Warrington), its further progress is finally barred by the Woolston-weir of the Mersey and Irwell navigation. This weir is about four miles above Warrington; twenty-two miles above the Rock Point, New Brighton; and thirty-four miles above the bar of the Victoria Channel.

In the first instance, the phænomena of the upper estuary, and those of the outer estuary or Liverpool Bay, may be most conveniently considered apart; the results of their investigation can afterwards be combined.

Liverpool Bay.—The earliest authentic survey of Liverpool Bay, published within the period assigned to this inquiry, is that of Captain George Thomas, R.N., which was taken in 1813, and published in May 1815. The next authentic survey is that of Captain H. M. Denham, R.N., in 1833. Both these surveys were made by order of the Admiralty, in consequence of the great anxiety and alarm experienced by the local authorities, arising from the important changes which took place in the channels prior to each of the above dates.

The changes of the later period continuing,—they were in fact the precursors of the substitution of new outlets for the old ones,—the surveys were repeated by Captain Denham, in 1835 and 1837.

North Channel.—On comparing the charts of 1813 and 1833, it appears that at the former date the Northern Channel, which was previously divided into two portions, called the Crosby and the Formby Channels, maintained an even course until it had passed Crosby Point, where it separated into two outlets; one over a bar, with from one to eight feet of water, into the old Formby Channel, in which were from one and three-quarters to six fathoms; and thence over another bar seaward with from one to eight feet of water. The other outlet, called the South Channel, was to the southward and westward, and passed between the Jordan and Great Burbo Banks, having from two to six fathoms, diminishing on a seaward bar to 7 feet. In this survey Formby Bank is insulated and covered at four hours' flood.

Formby Bank.—In 1833, twenty years later, Formby Bank had attached itself to the main shore; and the old Formby Channel was almost land-locked, and had no communication with the Crosby Channel, except over a 6-foot bar, between Jordan and Formby Banks. The depth of water on the seaward bar of this channel had increased in places to 13 feet.

New Channel.—The South Channel of Thomas's survey appears to have shifted upwards of a mile to the southward, and acquired nearly a true east and west bearing; and had a bar with 10 or 11 feet of water. It was called by Denham the New Channel.

Zebra Channel.—Between the Formby Channel and the New Channel another outlet was opened, having a minimum depth of 2 feet, and called the Half-tide Swatchway, or Zebra Channel.

Mad Wharf.—Mad Wharf, a large bank adjoining Formby Point to the northward, had elongated upwards of 2200 yards in that direction, and its area considerably enlarged.

Many changes took place in the position and magnitude of the minor banks adjoining the seaward entrance of the Northern Channel; some of which, as the "middle patch," nearly disappeared; whilst others enlarged their area, or sprang altogether into existence.

Victoria Channel.—Between the survey of 1833 and those of 1835 and

1837, the differences chiefly consist of the changes which accompanied the partly natural and partly artificial formation or readjustment of the new channels; they found their issue in the formation of that which is known as the Victoria Channel.

West Channel.—A similar examination of the Western Channel, divided into two portions called the Rock and the Horse Channels, will show the following changes.

Rock Channel.—In the above-named period of twenty years the banks north of the Rock Channel were enlarged and consolidated; the Brazil Bank and Burbo Sand were united to the Great Burbo Bank, and the patch, which at the earlier date divided the Rock Channel at its junction with the river into two portions, was itself divided, and one piece added to Burbo Sand, the other to the main shore.

At the western extremity of the Rock Channel, near its junction with the Horse Channel, its width has been contracted about 400 yards; the accretions are partially on Dove Spit, but chiefly on the western point of Great Burbo, now called the North Spit. At the bar of the Rock Channel, Thomas gives soundings of one-third fathom (or 2 feet) seaward, and of one and two-third fathom (or 10 feet) on the Liverpool side. In 1833 Denham gives 2 feet on the bar, and 3 feet on the Liverpool side, showing a diminution of 7 feet in the latter.

Denham's soundings are unaltered in 1837.

Hoylake.—In 1689, the date of Captain Collins's survey, the big ships put out part of their lading in Hoylake, that they might sail over the flats into Liverpool; at that time the depth of water in the lake ranged from two and a half fathoms to seven fathoms, and William III. was able to embark his army for Ireland. 124 years afterwards, Thomas records the range as reduced from one fathom to four fathoms; and twenty years later it appears upon Denham's first chart as closed by a bar, the pools on either side of the bar having been reduced in width to about one-half of that of the lake in 1813.

Hoylake joined the Western Channel at the junction of the Horse and Rock Channels.

Horse Channel.—Whilst these changes have taken place, the direction of the Horse Channel has been slightly varied by additions to the north-eastern extremity of East Hoyle Bank.

Dock Extensions. 1803 *to* 1836.—According to information obligingly furnished by Mr. J. B. Hartley, one of the engineers to the Committee of the Liverpool Docks, the works constructed between 1803 and 1836 comprised the Prince's Dock and Basin; the Waterloo, Victoria, and Trafalgar Docks; the Clarence Dock; the Clarence Graving Dock and Clarence Half-tide Dock, and the Salisbury Dock, northwardly; the widening of the George's and King's Piers, and the construction of the Manchester Basin, Canning Half-tide Dock, and Albert Dock, centrally; and the widening of the Queen's Pier and the construction of the Eagle Basin and river craft dock, the Union, Coburg, and Brunswick Docks, the Brunswick Graving Docks, the Brunswick Half-tide Dock, and the Dockyard, southwardly; and the space abstracted from the river by these works comprised an area of about 156 acres.

These works have been almost entirely constructed since 1813.

Meteorological Phænomena.—There are no reliable meteorological observations of the period 1813 to 1837. The following notices of storms of wind and rain are compiled from the annals appended to Gore's Directory of Liverpool:—

1802.—A dreadful hurricane; considerable damage done by sea and land;

the tide rose 6 feet higher than the calculation in the time-table. Sefton Church lost about 5 feet of its spire. January 21.

There appears to be a lapse in this portion of the chronicle, as the next record is in

1818.—A continuance of stormy and boisterous weather during February and March.

1821.—A most dreadful storm experienced in the town. November 30.

1822.—The pilot-boat No. 4 lost on Salisbury Bank (in the Dee estuary), in a dreadful storm. December 5.

1823.—A very violent hurricane; several chimneys blown down; several vessels blown on shore in Bootle Bay and other parts of the river. December 3rd. More serious accidents happened from this storm than from any other since the memorable one in the year 1560.

1824.—The equinoctial gales set in with such violence that many of the steam-boats from the opposite ferries, which usually cross in six or seven minutes, were more than two hours on their passage. March 4.

A dreadful storm; much damage done in the Prince's Dock by the vessels driving against each other. October 26.

1829.—A dreadful storm of thunder and lightning and rain; continue from 3 p.m. to 8 p.m. July 24.

A very violent storm of wind and rain, which flooded Whitechapel and the neighbourhood (the site of the old pool) to a much greater extent than had been experienced for many years. The sewer in the Old Dock burst, and carried several yards of wall into the dock. August.

1830.—Alarming thunder-storm, with heavy rain; much damage in Whitechapel, &c.; many houses in the higher parts of the town flooded. July 30.

1831.—Liverpool visited with one of the most tremendous falls of rain recorded in its annals. The consequences were very disastrous.

1832.—Tremendous storm of wind; several vessels were wrecked, and many lives lost. October 8.

1833.—Dreadful storm of wind and rain for two days, which produced great mischief on shore, and a very melancholy loss of life at sea. November 29.

A storm more severe than that of November 29th, much more property being destroyed. The tide rose from the proper height of 17 feet 5 inches to 26 feet; the piers and wharves were overflowed, and much damage was done to the public works, north and south. December 31.

1834.—Violent gale on the night of Sunday, December 7.

1835.—A very violent storm, in which many vessels were driven on shore and wrecked. February 22.

1836.—The 'John Welsh,' Captain Woodhouse, from Savanilla, lost in a hurricane, on West Hoyle, July 29.

During a severe gale, the 'Heyes,' for Barbadoes, and the 'Febo,' for Palermo, were lost; and the 'Sandbach' and several other vessels got on shore; several pilots were taken to sea. December 22nd and 23rd.

Since 1837 the surveys of Liverpool Bay have been conducted by Lieutenant Lord, R.N., lately marine surveyor to the Dock Committee; they were published in the years 1840, 1846, 1849, 1852, 1853, and 1854.

Northern Channel. 1840.—On comparing the survey of 1840 with that of its immediate predecessor of 1837, it will be seen that the Northern Channel had undergone important changes. They were as follows:—

Crosby Channel.—The length and direction of that portion of the Crosby Channel which lies between the Rock Lighthouse and the Crosby Light-vessel had been very slightly altered; and its area had remained very much the same as in 1837; but the average depth had been reduced from 31 feet to 30 feet.

Between the Crosby and Formby Light-vessels the direction of the channel had undergone considerable alteration, the Formby vessel, in 1840, having been moved nearly 600 yards westward; the area and depth increased, the former from 15,600 yards to 17,500 yards, and the latter from 26½ feet to 27 feet. The average of the whole channel from the Rock Lighthouse to Formby Light-vessel being an area slightly increased, and a depth stationary.

Victoria Channel.—The change in the direction of this channel had been very great; the Bell Buoy, which indicates its entrance from the sea, having been moved, in 1840, nearly 2000 yards to the north of its position in 1837. The depth of water on the bar had been reduced from 12 feet and 13 feet to 10 feet and 11 feet.

Zebra Channel.—This channel had been advanced to the westward of its former position, and had increased its minimum depth from 2 feet to 3 feet on the fairway track.

Formby Bank.—This bank had been slightly moved to the eastward, and considerably elongated to the northward, the elevation of its surface much more varied, some portions having been considerably higher and others lower than they were in 1837; the elongated portion may be specially noted as having been entirely "wash." On the whole, however, the volume of the bank appears to have been diminished nearly one-third; the cubic contents of the bank, in 1837, having been nearly 10,000,000 yards, and in 1840 rather more than 6,500,000 yards.

Mad Wharf.—In this bank there had been little change.

Great Burbo.—The area of this bank had been enlarged, and its volume increased from about 58,500,000 yards to about 62,000,000 yards.

Western Channel.—The eastern portion of this channel, called the Rock Channel, had been reduced in length about 500 yards, and in average depth 1 foot; its area had been reduced about 580 yards, making the average loss on the three years equal to 6 per cent. per annum.

The depth of water on the bar reduced from 2 feet to 1 foot; and the first sounding on the Liverpool side of the bar from 3 feet to 2 feet.

The sailing direction of the Horse Channel remained unaltered; but the North-west Light-vessel at the seaward entrance of the channel had been removed in 1840 about 250 yards north of its position in 1837.

East Hoyle.—The bar in Hoylake, forming part of this bank, had increased in area, and grown up to 2 feet and 3 feet above low-water level; but, notwithstanding this accession, the area and altitude of this bank had been diminished; and its volume reduced from nearly 81,250,000 yards to rather more than 73,500,000 yards.

Dock Extension.—No works of importance were constructed during the period under investigation.

Meteorological Phænomena.—In the continued absence of recorded scientific observations, reference is again made to the precarious information in 'Gore's Annals,' from which the following notices are compiled:—

1838.—The British ship 'Athabaska,' bound to Quebec, totally lost on West Hoyle during a gale; all on board perished. April 17.

1839.—A terrific and most destructive hurricane visited Liverpool on the evening of January 6, and continued with little intermission till the following afternoon. The destruction of life and property was very great; and there was scarcely a part of the town in which some fatal accident did not occur. The loss of life amongst the shipping was awful. The North-west Lightship was driven from her moorings and brought into port. Two New York packets, outward bound, were lost upon the North Bank (part of the Great Burbo, in the Rock Channel). The 'Brighton,' from Bombay, was wrecked near the Middle Patch Buoy, in the same channel. The 'Harvest Home,' from St. Thomas, was lost on Mad Wharf.

Northern Channel. 1846.—Between the years 1840 and 1846 considerable changes had occurred, though, on the whole, less remarkable than those which took place between the years 1837 and 1840.

Crosby Channel.—That portion between the Rock Lighthouse and the Crosby Light-vessel had not undergone much change; its direction had been altered by removing the light-vessel nearly 200 yards to the eastward; the average depth had remained nearly stationary at 30 feet. The average area had slightly increased from 18,000 yards in 1840 to 18,840 yards in 1846.

That portion between the light-vessels had undergone greater change. Its length had been increased about 400 yards, the average depth reduced to 26 feet; the average area increased about 1000 yards.

Notwithstanding the change in the position of the Crosby Light-vessel above-mentioned, and the removal of the Formby Light-vessel nearly 400 yards to the northward, the direction of the channel in 1846 was parallel to its direction in 1840.

The average of the whole channel from the Rock Lighthouse to Formby Light-vessel is a depth diminished from 29 feet to $28\frac{1}{2}$ feet, and an area increased nearly 700 yards.

Victoria Channel.—The direction of this channel had been altered by the change in the position of the Formby Light-vessel above-mentioned, and by removing the Bell Buoy about 500 yards westward. The average depth of water on the bar had slightly increased, the various soundings having been 10 feet, 11 feet, and 12 feet.

Zebra Channel.—The minimum depth on the fairway track through this channel had been increased from 3 feet to 6 feet.

Formby Bank.—The area of this bank had been slightly enlarged, and the elevation very considerably increased, the volume having been nearly 13,000,000 yards in 1846, against rather more than 6,500,000 yards in 1840. The position had been nearly stationary; there had been a slight elongation northwards and a slight movement eastwards.

Mad Wharf.—This bank had sustained considerable loss of area by abrasion on the north-western margin; but this loss had been partially compensated by increase of elevation, the change in which had been very great. The volume in 1846 had been nearly 5,750,000 yards, against 6,500,000 yards in 1840.

Great Burbo.—The area of this bank appears to have been unaltered, taken as a whole, though there had been considerable local changes. The elevation had been a good deal reduced, and, consequently, the volume; the difference is represented by 59,750,000 yards in 1846, instead of 62,000,000 yards in 1840.

Western Channel.—The eastern portion, or Rock Channel, had recovered 300 yards of its length in 1837; the average depth had been stationary, and the average area slightly increased. The soundings at the bar had been unaltered. In the Horse Channel East Hoyle Bank had advanced towards the north-east, and the North-west Light-vessel had been moored about 300 yards to the westward.

East Hoyle.—In area this bank had remained pretty stationary, but the loss in elevation had reduced the volume from upwards of 73,500,000 yards to under 72,000,000 yards.

Liverpool Dock Extension.—These dock-works comprehended the Nelson, Bramley-Moore, and Wellington Docks; the Wellington Half-tide Dock, the Sandon Dock, the Sandon Graving Dock, and the Sandon Basin; altogether a tidal area of about 117 acres.

Meteorological Phænomena.—From observations recorded in the Warrington Museum and Library, for the use of which the Committee is indebted to Mr. Glazebrook Rylands of that town, it appears that the fall of rain in 1844 (the earliest year perfectly recorded) was 23·73 inches; in 1845, 30·12 inches; and in 1846, the year of the survey, 30·29 inches.

In 'Gore's Annals' the following facts are noted:—

1841.—Terrific thunder-storm. The spires of the churches of St. Michael's and St. Martin's-in-the-Fields struck. August 24.

1843.—A great storm during the night of January 13. Houses and buildings were unroofed. The damage done to the shipping in the river and outside the harbour was very great, and many lives were lost.

1844.—The dock receipts for the last week were much greater than were ever received in any one week, and considerably more than double the receipts of the corresponding week of last year. The long prevalence of easterly winds in some measure contributed to produce so large an item. June 13.

Northern Channel. 1849.—The survey of 1849 does not exhibit any marked changes beyond the consolidation of some of the outlying banks near the junction of the Victoria and Zebra Channels; as, for example, that of the Taylor's Bank and Jordan Flats. It appears to have been prepared to show an alteration in the fairway track through the Victoria Channel, in consequence of a shift westward of Little Burbo Bank. The positions of the Bell Buoy and of the Formby and Crosby Light-vessels remained unaltered.

The average depth of water on the Victoria Bar had been slightly reduced.

Dock Extension.—The Huskisson Dock, the most northernly of the Liverpool Docks, and the Birkenhead Docks, had made considerable progress since the survey of 1846.

Meteorological Phænomena.—The Warrington tables record the rain-fall during the interval between the two surveys, as follows:—In 1846, 30·29 inches; in 1847, 36·71 inches; in 1848, 33·75 inches; and in 1849, 33·98 inches.

In Swineshaw Brook, a feeder of the Tame, which is a branch of the Mersey, the rain-fall recorded by Messrs. Peter Clark, F.R.A.S., and J. F. Bateman, F.G.S., Mem. Inst. C.E. (Memoirs of the Literary and Philosophical Society of Manchester, page 17, vol. ix. second series), was as follows:—1845, 59·8 inches, "possibly registered too high; in other places the fall just an average;" 1846, 42·6 inches, "and this year was considerably below the average;" 1847, 49·35 inches, "this year was about the average, in some places above."

Survey, 1852.—The chart of 1852 shows that considerable and important changes had taken place since the survey of 1846, with which that of 1849 may be considered in the main identical. The re-survey of the bay at the latter period, as before observed, seems to have been confined to the immediate vicinity of the Victoria Channel.

The following comparison, therefore, is instituted between the surveys of 1846 and 1852, a period of six years.

Northern Channel—Crosby Channel.—The principal changes which had taken place in that portion of the Crosby Channel between the Rock Lighthouse and the Crosby Light-vessel, were its elongation, and the consequent removal of the Light-vessel about 2000 yards north-westwardly of its position in 1846; the diminution of its average depth from 30 feet to 29 feet; and the diminution of its average area from 18,840 yards to 17,500 yards.

The direction of this portion of the channel had been slightly altered, as indicated by the change in the position of the Light-vessel.

In that portion of this channel between the two Light-vessels, the changes had consisted of the removal of the Formby Light-vessel about 750 yards north-westwardly; an increase of the average depth from 26 feet, in 1846, to 28 feet in 1852; and a diminution of the average area from 18,600 yards, in 1845, to 16,450 yards in 1852.

In its whole length, the Crosby Channel during this period had been elongated about 500 yards; its average area diminished from 18,443 yards to 17,126 yards; and its average depth nearly stationary, but slightly increased.

The change in the position of the Crosby Light-vessel appears to have been occasioned by the growth of a large elbow upon Great Burbo. The Formby vessel appears to have been moved partly for the same reason, and partly from a change in the position of Little Burbo, on the northern side of the Victoria Channel.

Victoria Channel.—The position of this channel had again undergone very great change, the Bell Buoy having been removed about 1000 yards to the southward, or nearly midway between its positions in 1840 and 1837. The average depth of water on the bar had been very much the same in 1852 as in 1849, that is, rather less than in 1846.

Zebra Channel.—The minimum depth of water in this channel had increased from 6 feet, in 1846, to 7 feet in 1852; in other respects it had remained without material alteration.

Formby Bank.—This bank had been enlarged by the accession of the Jordan Bank, and by its own increased elevation: in 1846 the volume of Formby Bank was nearly 13,000,000 yards; and that of Jordan Bank 1,500,000 yards, making a total of 14,500,000 yards; in 1852 these quantities were respectively 11,000,000 yards and 4,750,000 yards, or a total of 15,750,000 yards. Its position had been stationary.

Mad Wharf.—This bank had sustained a slight loss of elevation; but this had been compensated in volume by an extension westward, the entire contents having been nearly 6,500,000 yards in 1852, against nearly 5,750,000 yards in 1846, the former quantity being very nearly identical with that of the same bank in 1840.

Taylor Bank.—Taylor Bank and Jordan Flats, the former of which in 1833 had no existence, and the latter at that date of very minor importance, had not only united in 1849, but in 1852 had largely increased in volume; and in the same period had moved into close proximity with the united Formby and Jordan Banks. During the period since 1833, Little Burbo, the Middle, the West Middle, and other outlying banks had either been depressed below low-water level, or had disappeared altogether.

Great Burbo.—This bank had undergone material alterations since 1846, one of which was the extraordinary growth of the north-east angle in Crosby Channel before-mentioned; other important changes of outline may be noticed on inspection of the charts; perhaps the most remarkable alteration is the increase of bulk, arising partially from enlarged area, but principally from increased elevation; and it is to be observed that this additional elevation is generally diffused over the whole bank. In 1846 the volume of this bank had been calculated to be about 59,750,000 yards; in 1852 it had increased to 69,500,000 yards.

Western Channel.—In 1852 the Rock Channel had again undergone a slight elongation; the average depth had been reduced to 13 feet instead of 14 feet, as in 1846; but the average area had been nearly stationary. The entrance from the Horse Channel had been slightly contracted. The sailing direction for the Horse Channel had been altered a quarter of a point, in consequence of a movement of East Hoyle Bank towards the north-east.

East Hoyle.—This bank had also acquired a considerable increase of bulk, arising from additional elevation. Its volume in 1846 had been nearly 72,000,000 yards, in 1852 about 84,500,000 yards.

Dock Extension.—Since 1846 the Huskisson Dock, Liverpool, had been completed, and the north wall so far advanced as practically to exclude the tidal water; by these combined works about 355 acres have been abstracted from the river.

In the same period the works at Birkenhead had made great progress; and the stank or dam across the Great Float, and the walls of the north and south reserves constructed; by these an additional area of 150 acres had been taken from the tidal area of the river,—making a total abstraction of upwards of 500 acres.

Waste of River Margin.—On the Cheshire side of the river, between Seacombe Point and Sea Bank (Liscard), the waters of the river within eight years have encroached upon the land to an extent, estimated by Mr. Macpherson, the late surveyor to the Wallasey Board of Health, now of Edinburgh, at 11,350,810 cubic feet; which, at an average height of 40 feet, represent 6½ acres.

Meteorological Phænomena.—From the Warrington tables, it appears that the rain-fall, between 1846 and 1852, was as follows:—

1846=30·29 inches.	1850=27·79 inches.
1847=36·71 ,,	1851=31·48 ,,
1848=33·75 ,,	1852=41·46 ,,
1849=33·98 ,,	

In 'Gore's Annals' the following only are recorded:—

1846.—Dreadful storm in the town and neighbourhood, great damage done. November 20.

1850.—Ship 'Providence,' bound for Africa, lost in the channel during a severe gale of wind. October 7.

Survey, 1853.—This survey appears to have been confined to the immediate vicinity of the Victoria Channel, to show the alterations in the fairway track, occasioned by changes intermediate between the surveys of 1852 and 1854.

Survey, 1854.—*Northern Channel.*—The survey of 1854, like those of 1849 and 1853, appears to have been very partial, and has been confined to the vicinities of the Victoria Channel and of the Rock Channel; the leading line through the former had become more tortuous, though the position of the Bell Buoy and the Formby Light-vessel had been unaltered. The depths of water on the bar had slightly increased, the soundings being 11 feet, 12 feet, and 13 feet.

The average area and average depth of the Crosby and Formby Channels had not undergone any important change.

Zebra Channel.—The direction of the Zebra Channel had been slightly altered, having acquired a more westwardly bearing, and the average depth of water considerably reduced; the minimum sounding was 6 feet in 1854, against 7 feet in 1852.

New Channel.—A new swatchway, now known as the Queen's Channel, had been opened through the shoals, intermediate between the Zebra and Victoria Channels, having a minimum depth of 9 feet.

The Banks.—No material change had taken place in any of the banks, except that Little Burbo had been sunk below low-water level, with soundings of from 2 feet to 5 feet, and that the bulk of Taylor's Bank and Jordan Flats had been slightly reduced.

Western Channel.—The eastern portion of the Rock Channel had been a good deal contracted, principally by enlargement of the foreshore at New Brighton. The average area in 1854 had been reduced 200 yards, or about four per cent. per annum. The average depth had remained pretty stationary.

Meteorological Phænomena.—From the Warrington tables, it appears that the rain-fall at Warrington had been—

In 1852=41·46 inches.
1853=28·25 „
1854=27·18 „

From the tables printed with Mr. Osler's paper "On the Self-registering Anemometer and Rain-Gauge in the Liverpool Observatory," published in the Reports of the Association for 1855, p. 128, it appears that the rain-fall at Liverpool had been—

In 1852=31·53 inches.
1853=22·42 „
1853=22·11 „

It will be observed that there is a very great difference between the records for Liverpool and Warrington, the proportionate difference for each year being very similar; and it is to be noted that it is the fall in the up-country which is most likely to produce changes in the channels of the river, through the agency of freshes.

The Liverpool tables for the first time furnish definite information upon the phænomena of wind. From them it appears that the point out of the whole sixteen from which the wind blows for the greatest number of days throughout the year is S.S.E., and therefore it has been said by Mr. Osler that in Liverpool the prevailing winds are from that point. In the absence of explanation, or without very careful explanation of the tables, this statement is likely to convey an erroneous impression: if, instead of comparing point with point, we take the five points from N. to W. both included, we find that in 1854 the winds from this quadrant blew for as much as half the year, or for as many days as the winds from all the other points taken together. In the other years there is a preponderance of the same points, though not to the same extent. The relative hourly velocity for the winds from this quadrant is also greater than for those from other points.

If reference be made to the table (p. 142, vol. 1855) which exhibits the extreme pressure of the wind in pounds per square foot, and the greatest horizontal motion of the air between any one hour and the next following hour, for all the gales during the four years of which observations are recorded, in which the pressure has reached 15 pounds per square foot, it will be observed that in thirteen cases in which the velocity has exceeded fifty miles per hour, four of them were from S. of W., attaining velocities respectively of 71, 70, 53, and 51 miles per hour; the remainder being from W. to N.W., having velocities varying from 51 to 56 miles per hour. It may also be observed that of eighteen cases in which the pressure exceeded twenty pounds on the square foot, four of them were from the S. of W., the pressure being respectively 42 lbs., 42 lbs., 23 lbs., and 22 lbs.; the remainder ranged from W. to N.W., and had pressures varying from 21 lbs. to 43 lbs.

On reference to 'Gore's Annals,' we find in 1852 the town and neighbourhood visited by a severe storm. December 25th.

1854.—Violent hurricane visited Liverpool Feb. 7th and 8th. On referring to the last-mentioned table we find that the "severe storm," December 25th, 1852, was from W.S.W., the greatest velocity seventy miles per hour, and the extreme pressure 42 lbs. per square foot; and that it was repeated on the 27th of the same month, blowing from S.W., the greatest velocity seventy-one miles, and the extreme pressure 42 lbs. We also find that the "violent hurricane," Feb. 17th and 18th, 1854, was, on the first day, from N.W., the velocity fifty-six miles, the pressure 27 lbs.; on the 18th, from W.N.W., the velocity also fifty-six miles, the pressure 31 lbs. The same table shows that during the years 1852 to 1854 there were several other storms, of which 'Gore's Annals' have no mention; as, for example, Feb. 26th, 1853, from N.N.W., the velocity sixty miles, the pressure 33 lbs.; and Jan. 26th, 1854, from W., the velocity fifty-three miles, the pressure 43 lbs.

In estimating the influence of the wind in producing changes in the sea channels, it must be recollected that Liverpool Bay is peculiarly exposed to winds ranging from W. to N., and sheltered from all other winds.

It is not intended in this Report to lay down any precise theory for the solution of all the observed phænomena of Liverpool Bay; the collection of the facts recorded in the preceding portion of this Report, and in the charts and tables by which it is accompanied, has been so recently completed as entirely to preclude their satisfactory digest into any such hypothesis. Indeed these researches, so far from furnishing a complete analysis of the data upon which any trustworthy theory can be founded, give occasion to regret that the various changes which the estuary has undergone were not more fully recorded than they have been prior to 1833; and it is especially to be regretted that the phænomena of meteorology should have been so much neglected in this district. The valuable records of the Liverpool Observatory, as well as those of the Warrington Museum and Library, it is to be hoped, will supply the requisite information to future inquirers.

In recording the previous observations on the changes in the bay, the earliest survey within the period of inquiry has been assumed as the starting-point, and succeeding phænomena are noted in chronological sequence; it is now proposed to retrace the inquiry, in order, as far as practicable, to reduce effects to their proximate causes, important facilities being derived from the less imperfect data of the more recent periods.

On comparing the surveys of 1854 and 1852, it was observed that the changes were almost entirely confined to the increased tortuousness of the Victoria Channel, the continued silting up of the Zebra Channel, the opening of the Queen's Channel, intermediate between the Zebra and the Victoria, and the contraction of the eastern portion of the Rock Channel with a consequent diminution of its average area. During this period there was no abstraction of tidal water space for dock purposes, and consequently no reduction from *that* cause of the scour. In 1852 the rain-fall was about 50 per cent. above the average. In 1853 and 1854 the fall was about an average in each year. In the latter year, 1854, the wind was more than usually in the range from W. to N.

It may be observed that as the influence of freshes in a tidal river is greatest when the ebb tide is low, their effects in the Mersey will be more apparent in the northern channel and its branches than in the western channel, because the direction of the latter is almost at right angles to the course of the river, whilst that of the former is continuous; the bar which crosses the western channel at its junction with the river will also tend to weaken the scour of the water when the tide is low.

It appears then that the freshes of 1852, in passing down the northern channel, were deflected by the bank called Taylor's Bank and Jordan Flats, on to the N.E. elbow of Great Burbo, itself of recent formation; after passing that elbow the ebb took the direction due to the impetus down Crosby Channel, modified by the influence of Taylor-Jordan Bank combined with Great Burbo, passed over the shoals between the Zebra and Victoria Channels, and opened up the swatchway now known as the Queen's Channel. The channel thus initiated by the freshes of 1852 was deepened by the continued action of the ebb tide throughout that year and the following, until in 1854 we find the Queen's Channel formed, the Zebra silting up from the loss of the water which then passed by the new channel. On the Victoria Bar, again, these freshes had won a slightly increased depth of water.

The contraction of the Rock Channel may be due to the drift of sand promoted by the N.W. wind.

The most remarkable gales of the period 1852 and 1854 are those of December 25 and 27, 1852, from the W.S.W. and S.W., from denudation by which the Cheshire land would protect the sand-banks; February 26, 1853, from N.N.W.; January 26, 1854, from W.; and February 17 and 18 of the same year, from N.W. and W.N.W.

Very important changes have been recorded as having taken place between the years 1846 and 1852. They may be briefly described as consisting of the enlargement and consolidation of all the banks, with the bare exception of Mad Wharf, the increased size being in great measure due to increased elevation; the elongation of the Crosby Channel, chiefly in that part between the Rock Light and the Crosby Light-vessel; and the diminution of the average depth and area of this portion of the channel, accompanied by a slight alteration in its direction; in that part of this channel, between the Crosby and Formby Light-vessels, the depth was considerably increased, but the area diminished; the changes in the channel were occasioned by the growth of the north-east elbow of Great Burbo, and an accretion on the western side of the Taylor-Jordan Bank, both of which had taken place principally after the 1849 survey.

On reference to the Warrington tables, we find that, in 1846, the rain-fall was slightly, but very slightly, below the average of twelve years; in the three following years it was above the same average, particularly in 1847, when the excess was about 16 per cent.; in 1850 the fall was 10 per cent. below the average, and in 1851 slightly above. It appears then, that during the years 1848 and 1849, and particularly in 1850, the banks had grown in directions to produce, in 1851, those changes which rendered necessary the survey of 1852. The increased depth of the channel between the lightships above mentioned, seems due to the contracted width of that part, consequent upon the enlargement of the banks.

We have no record of the phænomena of wind during this period, and therefore can only conjecture that the horizontal and vertical growth of the banks are effects to which the prevailing winds *may* have been accessory, assisted by the loss of scour caused by the extensive dock-works of Liverpool and Birkenhead.

The change in the positions of the light-vessels and of the Bell Buoy was made after 1849. The depth of water on the Victoria Bar remained stationary.

In the Zebra Channel the depth of water had increased between 1846 and 1849, when the rain-fall was rather above the average; and between 1849 and 1852 the depth had diminished again.

In the Rock Channel the average depth had been diminished, and the average area stationary.

As it was during this period that the greatest amount of tidal area taken between two surveys was abstracted, the occasion is favourable for considering the influence of works of that kind upon the sea channels. According to the evidence of Mr. Rendel, C.E., House of Commons, 1844 (see 'Ports and Docks of Birkenhead,' by Thomas Webster, M.A., F.R.S., Barrister-at-Law, 1848, p. 77), high water of an 18-foot tide is $1^h\ 25^m$ later at Warrington Bridge than it is at the Prince's Pier, Liverpool, where it is 35^m later than at the Formby Light-vessel. And from Mr. Joseph Boult's observations at Woolston Weir, four miles above Warrington, that on 8th March last, in a 21-foot tide, high water was $1^h\ 50^m$ later than was recorded by the tide-gauge at George's Pier, Liverpool. It follows, therefore, that the water which formerly covered the space now enclosed must have passed out to sea on the top of the ebb tide, whilst the flood tide was yet rising in the upper reaches of the river.

The loss of depth in the Rock Channel appears to indicate that the abstraction of the tidal area has been prejudicial. The surveys since 1833 indicate a progressive, though irregular, tendency towards the silting up of this channel; and there are facts which render it probable that the effects of diminished scour should first be manifested here.

The tidal establishment is earlier at the North-west Lightship, or entrance of the western channel, than it is at the Bell Buoy, or entrance of the northern channel; though the difference is very slight, it is sufficient to give a bias to the stream of tide, as is shown by the experience of bathers on the shore just above the junction of the Rock Channel with the river, who find that with a young flood there is a current out again to sea by the northern channel.

The same also appears from the experiments of Mr. Enfield Fletcher, C.E., and others with floats. These were liberated at Wallasey Pool, on the ebb tide, for the purpose of ascertaining in what time the water from the pool would reach the Victoria Bar; but all the floats, without exception, went down the Rock Channel and grounded upon Dove Spit.

This result may, in part, be due to the attraction of the Cheshire shore. The bias with the ebb would, however, be confined to the upper stratum of the water; the impetus of the current to sea naturally giving to the main bulk the more direct course by the northern channel, in preference to the almost right-angled deflection down the western channel.

Whilst the Rock Channel has been losing depth, the depth of water in the northern channel, considered in its whole length from the Rock Lighthouse to the Bell Buoy, is almost undiminished since 1833. The loss on the Victoria Bar may be due to the diversion to the part of the stream formerly by the Zebra, now by the Queen's Channel. But for the elevation of the banks and of the bottom of the Rock Channel, and of the south part of the Crosby Channel, it is difficult to assign any other cause than the loss of scour at the first of the ebb, and the influence of the prevailing winds in drifting sand from the coast.

As respects the Rock Channel, the influence of the new north wall in Bootle Bay is very likely to aggravate the tendency to silt up, as it tends to impede the advance of the flood tide through that channel by substituting for a shelving shore a nearly perpendicular face almost at right angles to the course of the flood.

The influence which the direction of the enclosure walls may have upon the course of tide has yet to be considered.

It appears that between 1846 and 1849, during which these works were in progress, there was no alteration in the direction of any of the channels;

and that between 1849 and 1852, these works being still in progress, the direction of the Victoria Channel was so altered that the Bell Buoy was removed about 1000 yards westward of its position in 1846; and that in the upper or southern portion of the northern channel there had been no changes in the fairway track beyond those consequent upon the elongation of the part between the Rock Lighthouse and Crosby Light-vessel.

The change in the Victoria Channel is probably due to the lengthening of the Crosby Channel, which has been attributed to the growth of the sandbanks; and it does not appear that the extension of the dock walls had yet been productive of much effect on the direction of the sea channels.

Between 1840 and 1846 the most remarkable of the recorded changes are, a large increase in the size of the Formby Bank; a slight diminution in those of Great Burbo and East Hoyle, principally in elevation; and a slight diminution in the depth of the Crosby Channel, principally in its northern part.

There was a remarkable drought in 1844, the rain-fall at Warrington having been about 33 per cent. below the average of twelve years. There was also an extraordinary continuance of easterly winds in this year. No remarkable meteorological phænomena are recorded for the preceding year. The large increase in the size of Formby Bank, and the loss of elevation in East Hoyle and Great Burbo, are possibly to be ascribed to the influence of the wind.

In 1840 to 1846 the Liverpool dock-works abstracted about 117 acres of tidal area in northern works.

Between 1837 and 1840 the most remarkable change in the northern channel is in the direction of the Victoria Channel, as indicated by the removal of the Bell Buoy about 2000 yards northwards, accompanied by a loss of 2 feet of water on the bar. According to a letter of Lieut. Lord's of October 8th, 1839*, the dredging operations had deepened the water on the Victoria Bar to 15 feet. On the survey of 1840, that depth was reduced to 10 feet and 11 feet. In the period of 1837 to 1840 there had been a loss of depth in the southern portion of the Crosby Channel, and a similar gain in the northern part of the same; a considerable reduction in the size of Formby Bank, equal to 30 per cent.; an increase in the Great Burbo; a loss of half the depth on the bar of the Rock Channel, and a loss of average area in the same channel equal to 6 per cent. per annum; and a diminution in the area and elevation of East Hoyle.

There were no important dock-works during this period.

There are no meteorological observations which throw light upon the cause of these changes beyond,—1st, the fact that there were great floods in 1839 in various parts of Great Britain, by which much injury was occasioned to the hay and other crops; and though the local 'Mercury' of the date has no record of floods in the Mersey, there may have been freshets; and, 2nd, the vivid recollection of the terrific and destructive hurricane from the S.W., which visited the town and port on the 6th and 7th of January, 1839, during which the North-west Lightship and many of the buoys in the channel were washed from their moorings, and several vessels were wrecked.

The following curious sequence is deduced from the foregoing observations:—

	Phænomena and date thereof.	Productive interval.	Date of survey.
Gale, January	1839	1839	1840
Drought	1844	1845	1846
Freshes	1847	1848	1849
Drought	1850	1851	1852
Freshes	1852	1853	1854

* In the 'Liverpool Mercury' of that month.

Between 1833 and 1837 was perfected that remarkable change in the northern outlet of the Mersey, of which Capt. Denham has recorded so many important particulars in his 'Sailing Directions,' and in communications to the Association. But there is such a complete dearth of observations upon the changes which preceded the opening of this new outlet in 1833, and upon the meteorological phænomena by which they were preceded, or accompanied, that the result of any detailed inquiry must necessarily be extremely precarious. The same observations apply to periods immediately subsequent and precedent to Capt. Thomas's survey in 1813. The general features of the consolidation and enlargement of the principal sand-banks, and also of the eastern shore of the estuary, may be observed upon this survey, and also upon all the authentic surveys since that of Capt. Collins in 1689. It is also remarkable that the low-water margin of the eastern shore appears to have advanced westward to an extent fully equal to one-half the width of the northern channel as laid down by Collins, or 1000 yards.

From a report of Mr. George Rennie, C.E., to the Corporation of Liverpool, in 1838, it appears that at that time upwards of 13,000 acres had been abstracted from the tidal area of the river, the original extent of which is estimated at about 35,000 acres, and these abstractions were principally in the upper part of the river. Since then no important abstractions have been made without the sanction of Parliament.

The tidal area appropriated to the dock purposes of Liverpool alone since 1650 amounts to 784 acres, exclusive of the open basins; of these, 470 acres have been appropriated within the last fifteen years.

From the foregoing remarks it appears that the changes in Liverpool Bay are to be attributed principally to the influence of freshes, droughts, wind, and the reduction of tidal area; and that remedial measures adopted for the maintenance or improvement of the approaches should be specially designed to cooperate with these forces.

It may perhaps be thought that sufficient consideration has not been given to the very large amount of silt, which, according to Capt. Denham, in his paper in the 'Reports' of the Association (1837), is being constantly washed down by the river and deposited in the bay.

The attention of the Committee has so far been confined principally to the phænomena of the bay. Captain Denham supposed the silt to be derived from the shores of the upper part of the river, where there is no doubt that the tidal water continues to encroach upon the land. From the geological formation of this land, a large proportion of the silt must consist of clay and mud, with but a very small proportion of sand. The former, from its levity, is mostly conveyed away by the ebb tide, a thin deposit being only temporarily left upon the sandy shores and banks of the upper and lower estuaries, which is either dried up and dissipated by the wind, or removed by those neap tides which are too low to be able to continue the encroachments of the spring tides.

Two local changes seem to require special notice before concluding this Report:—

1st. The waste of the clay cliffs in Cheshire, from Seacombe Point to North Egremont, which has now been going on to a considerable extent and for some years. This, there can be little doubt, is a consequence of the North Dock-works of Liverpool, by which the river has had its channel much contracted, and has naturally sought its equivalent from the opposite and weaker side.

2nd. The waste on the Cheshire shore, adjacent to Leasowe Castle, westwardly. According to Mr. Rollett, the acting-surveyor of the Wallasey Embankment, under the surveyor to the Corporation of Liverpool, this waste has averaged 6 yards per annum for nearly thirty years past. It is, however, confined to a small lineal extent of the coast, about two miles. The situation is one that is now very much exposed to the flood tide through the Horse Channel, especially in N.W. winds. The geological formation is entirely alluvial, consisting of sand, peat, and clay. It is, in fact, the site of part of the so-called submarine forest of Wirral.

When Hoyle Lake was in existence, the flood tide advancing in two streams—one through the lake, the other through the Horse Channel—met at this place, and their united stream ran up the Rock Channel. It may be assumed that the influence on the beach of the stream through the Horse Channel was mitigated by the stream through Hoyle Lake, by which it was deflected into the Rock Channel. As the lake was silted up the influence of the stream was gradually weakened, until it was entirely lost by the closing up of the lake. The enlargement of the west spit of Great Burbo has also assisted to give to the stream through the Horse Channel, a more direct set upon the beach. About thirty years ago the late Mr. Giles, C.E., constructed an embankment upwards of 100 yards above high water spring tides. The seaward slope is now submerged every tide; and as it was not designed for such a situation, it has been occasionally broken through, almost entirely reconstructed and considerably raised.

Great watchfulness is exercised by those who have charge of the embankment; for if the sea were to make good its entrance through any breach, a large tract of meadow country, nearly 3000 statute acres, would be submerged in their whole extent to the docks at Birkenhead.

These meadows are part of the tidal area which had been reclaimed, and was formerly submerged through Wallasey Pool.

Liverpool, August 1856. JOSEPH BOULT.

[With respect to the tables D, E, F, and G, by which this Report is accompanied, it should, perhaps, be observed that they are to be regarded as only approximations to the truth, and not as representing the absolute areas of the channels, or volumes of the banks; and they are merely intended as gauges for comparing the growth or decline of the various features included in them. The truth of the observation would be apparent to all who had inspected the surveys; it is recorded here for those who have not had the opportunity of doing so.]

The Report was illustrated by the following charts and tables:—

A.—Plate I. Admiralty Chart of Liverpool Bay, corrected to 1847, with Contours from Surveys by Collins, 1689; Eyes and Fearon, 1756; Thomas, 1813.

B.—A Chart of the Approaches to Liverpool, by Lieut. Lord, R.N., 1852, with Contours from Denham, 1837; Lord, 1840; and Lord, 1846.

C.—A Chart of the Approaches to Liverpool, by Lieut. Lord, R.N., 1854; with Contours from Lord, 1852.

D, E, F.—Tables, showing the average depth below low water of ordinary Spring Tides, and the average sectional Area of the Crosby and Rock Channels, computed from the Surveys of 1837, 1840, 1846, 1852, and 1854.

G.—A Table, showing the average Volume of the Banks above Low Water of ordinary Spring Tides, computed from the Surveys of 1837, 1840, 1846, 1852, and 1854.

H.—A Plan exhibiting the space abstracted by the Corporation of Liverpool from the Tidal Water of the River Mersey during five successive Periods, comprised between the years 1650 and 1843, compiled from authentic Documents and actual Survey.

J.—Sections of Part of Great Burbo Bank, on Planes parallel to a Plane passing through the Leasowe and Formby Lighthouses.

Table D.—Crosby Channel—Rock Lighthouse to Crosby Light Vessel.

Date of Survey.	Surveyor's Name.	Length of Channel.	No. 1. Depth.	No. 1. Average area.	No. 2. Depth.	No. 2. Average area.	No. 3. Depth.	No. 3. Average area.	No. 4. Depth.	No. 4. Average area.	No. 5. Depth.	No. 5. Average area.	No. 6. Depth.	No. 6. Average area.	No. 7. Depth.	No. 7. Average area.	No. 8. Depth.	No. 8. Average area.	No. 9. Depth.	No. 9. Average area.	Average depth.	Average area of the whole.	Remarks.	
		yds.	ft.	yards.	ft.	yards.	ft.	yards.	ft.	yards.	ft.	yards.	ft.	yards.	ft.	yards.	ft.	yards.	ft.	yards.	ft.	yards.		
1837.	Capt. Denham	6500	37	15,460	35	19,252	33	22,778	32	21,233	29	19,333	24	19,077	31	14,885					31	18,860	or the average of the first seven columns.	
1840.	Lieut. Lord ...	6700	38	18,221	31	17,450	31	17,300	30	19,218	28	20,000	28	18,584	28	15,360					30	18,019		
1846.	Lieut. Lord ...	6750	33	17,225	31	17,665	34	20,163	32	20,790	27	18,973	25	19,968	27	17,147					30	18,839	ft.	yards.
1852.	Lieut. Lord ...	8700	36	17,213	31	17,087	31	19,673	30	16,387	26	17,628	23	17,952	26	16,600	28	16,817	31	18,160	29	17,502	29	17,506
1854.	Lieut. Lord ...	8700	35	16,543	33	16,750	33	19,067	30	15,405	27	17,567	22	20,788	24	18,470	28	18,387	28	18,332	29	16,923	+29	17,779

Table E.—Crosby Channel—Crosby Light Vessel to Formby Light Vessel.

Date of Survey.	Surveyor's Name.	Length of Channel.	Depth.	Average area.	No. 1. Depth.	No. 1. Average area.	No. 2. Depth.	No. 2. Average area.	No. 3. Depth.	No. 3. Average area.	No. 4. Depth.	No. 4. Average area.	No. 5. Depth.	No. 5. Average area.	No. 6. Depth.	No. 6. Average area.	No. 7. Depth.	No. 7. Average area.	Average depth.	Average area of the whole.	Remarks.	
		yds.	feet.	yards.	ft.	yards.	ft.	yards.	ft.	yards.	ft.	years.	ft.	yards.	ft.	yards.	ft.	yards.	ft.	yards.		
1837.	Capt. Denham	5860	+29	17,356	31	17,300	29	15,650	26	15,770	26	17,273	24	14,783	23	12,832			27	15,601	or adding columns 8 and 9, Table D.	
1840.	Lieut. Lord ...	5800	−29	17,796	30	17,598	27	17,837	29	17,020	29	19,028	23	17,756	24	15,981			27	17,537		
1846.	Lieut. Lord ...	6200	+28·5	18,443	29	19,960	33	18,167	30	17,916	28	19,660	24	21,237	23	17,350	24	16,900	26	18,599	ft.	yards.
1852.	Lieut. Lord ...	4800	+28·6	17,126					29	16,850	31	17,662	27	19,100	24	15,200	28	13,440	28	16,451	+28	16,748
1854.	Lieut. Lord ...	4800	28·7	17,302					29	18,647	35	16,900	29	17,852	23	17,217	26	9,800	28	16,083	+28	16,733

The two columns in brackets show the average from Rock Light to Formby Vessel.

Table F.—Rock Channel—Rock Light-house to Dove Spit.

Date of Survey.	Surveyor's Name.	Length of Channel.	No. 1.	No. 2.		No. 3.		No. 4.		No. 5.		No. 6.		No. 7.		No. 8.		No. 9.		No. 10.		Aver. depth.	Aver. of the whole nine columns.
				Depth.	Average area.	Depth.	Average area.	Depth.	Average area.	Depth.	Average area.	Depth.	Average area.	Depth.	Average area.	Depth.	Average area.	Depth.	Average area.	Depth.	Average area.		
		yards.		ft.	yards.	feet.	yards.	feet.	yards.	feet.	yards.	feet.	yards.	feet.	yards.	feet.	yards.	feet.	yards.	feet.	yards.	feet.	yards.
1837.	Capt. Denham	10,000	Nihil.	2	193	3	650	14	1500	14	1660	18	3100	14	5243	17	6517	13	5950	18	6067	12·5	3431
1840.	Lieut. Lord ...	9,500	......	1	42	2	367	16	1740	18	2227	12	2762	11	3802	11	5033	15	5070	18	4583	11·5	2847
1846.	Lieut. Lord ...	9,800	......	1	110	2·5	521	14	1749	13	2840	13	3893	13	4233	12	5360	13	4917	19	2600	+11	2914
1852.	Lieut. Lord ...	10,000	......	1	47	2	367	15	1650	11	1950	12	3570	12	3890	12	4567	15	4735	17	4467	−11	2805
1854.	Lieut. Lord ...	10,000	......	1	42	2	222	15	1223	13	1717	11	2730	11	3800	12	4258	15	4875	17	4475	−11	2594

Remarks.—In making an average of the whole channel, the first column, which represents a cross-section where the channel is dry, has been omitted.

The above Tables represent cross-sections in the respective channels, in the right angles to the Fairway Track, and at intervals of 1000 yards, commencing in Tables D. and F. on a plane passing through the Rock Light, and in Table E. on a plane through Crosby Vessel; length of channels in *yards*; depth in *feet*; average area in *yards*. The signs + and − indicate respectively rather more and rather less than the quantity to which they are annexed.

Datum.—Low water of ordinary spring tides.

Table G.—Average Volume of the Banks.

Date of Survey.	Surveyor's Name.	Great Burbo, Brazil, and North Banks.	Formby.	Taylor's.	Jordan's.	Mad wharf.	Middle.	Little Burbo.	Outlying.	Total.	East Hoyle.
1837.	Capt. Denham...	58,543,257	9,929,400	....	238,333	6,510,000	97,750	859,333	360,367	76,268,740	81,219,333
1840.	Lieut. Lord......	62,010,225	6,668,417	91,667	231,667	6,510,000	From a wash to 9 ft. below low water.	A wash 2 feet below low water.	....	75,511,976	73,623,283
1846.	Lieut. Lord......	59,795,536	12,993,750	390,250	1,512,833	5,720,250	3 ft. to 12 ft. below low water.	Say, a wash to 9 ft. below low water.	....	80,412,619	71,943,259
1852.	Lieut. Lord......	69,578,770	11,079,600	4,404,800	4,720,000	6,350,067	A wash 3 feet below low water.	Say, a wash to 7 ft. below low water.	....	96,133,237	84,579,450
1854.	Lieut. Lord......	99,396,034	11,079,600	4,502,400	4,121,025	6,350,067	A wash 3 feet below low water.	2 ft. to 6 ft. below low water.	....	95,449,128	84,579,450

This Table represents the *comparative* growth of the several banks above LOW WATER OF SPRING TIDES, and represents only approximately their *absolute* size.

Datum.—Low water of ordinary spring tides.

Report upon the effects produced upon the Channels of the Mersey by the alterations which, during the last fifty years, have been made in its Banks, on the Tides of the present period compared with the Tides registered by Mr. Rendel in June 1844. *By* ANDREW HENDERSON.

It may be premised that the discussion on the subject, in June 1844, was with reference to the proposed bill for establishing docks at Birkenhead; it was urged by Liverpool authorities that this would reduce the level of the river by abstracting so large an area as 150 acres. The state of the river, then, may be based on the tidal observations of Mr. Rendel at six stations, giving diagrams of height of tide from Victoria Bar to Warrington Bridge, as follows:—

TIME AND HEIGHT OF HIGH WATER.

Datum, Prince's Dock Sill (six feet below the Old Dock Sill), taken from Mr. Rendel's Diagrams.

	Spring Tide, June 3, 1846. Time. h m	Height. ft. in.	June 10, 1844, Neap Tide. Time. h m	Height. ft. in.	No.
1. Formby Point	12 20	23 4	6 50	17 9	1.
2. New Brighton	12 30	23 0	7 0	17 7	2.
3. Prince's Dock	12 50	23 8	7 10	18 2	3.
4. Ellesmere Point	1 10	24 7	7 40	18 7	4.
5. Runcorn	1 25	25 4	8 0	19 0	5.
6. Fidler's Ferry	1 50	25 2	8 55	18 10	6.
7. Warrington Bridge	2 30	25 10	9 40	18 8	7.

These observations were taken simultaneously; and it may be seen that, at the Prince's Pier, which is in the narrowest gorge of the estuary, the tide heaps up 8 inches and 7 inches in the two miles from New Brighton. The velocity of the flood tide at Seacombe is recorded as 7211 feet per second, the width of the Mersey being there reduced to 3060 feet, and the sectional area 184,622 feet, it being altogether a gorge at that point defined by the Prince's Dock wall on the one side, and the natural rock of Seacombe on the other.

This has been aptly designated the neck of the bottle, extending one mile from Egremont Ferry to Seacombe Ferry, where the Mersey is half a mile broad to Prince's Pier, extending about one mile to the old fort before the Stanley Dock was begun in 1844, at which time the mouth of the Mersey bottle was between Egremont and the old fort, from whence a curved wall half a mile east to Beacon's Gutter was built in 1833, the north shore to Rimrose Brook (some three and a half miles) forming with the shore from Seacombe to New Brighton what may be termed the funnel for filling the bottle of the Mersey.

These positions are exhibited on the map appended to the Report of Mr. James Walker, C.E., to the conservators of the River Mersey, on the effects of the new north river-line of the Liverpool docks on the Cheshire shore, published June 1856, pp. 306, with abstract notes of evidence.

As these documents contain much valuable information bearing on the effects produced on the channels of the Mersey by the alteration made in its banks, the following extracts are given, premising that the complaint was the waste of the Cheshire shore about Egremont. The Report states, there is no reason to doubt that an increase of damage has taken place and is continuing, and that the Liverpool dock walls are the principal cause.

"One thing is certain, that the Liverpool dock trustees have acquired since 1844 an area of not less than 500 acres of land from the river; upon this they have made splendid docks, and are now proceeding to add to them for the benefit of the country, on a greater scale than they have hitherto done.

"That the proper remedy for the prevention of further waste is a river wall or other similar protection, from Seacombe to New Brighton; and that the dock trustees, in consideration of the damage done and of their having already occupied 500 acres of the Mersey, and proposing to occupy in a few years 150 acres more, which will increase the waste on the Cheshire shore, may be reasonably expected to take the protection into their consideration.

"That the effect which dock walls on the Liverpool side have had, or are likely to have, in deepening the navigation of the Mersey or its entrance channels, does not amount to much more than a tendency."

The evidence of Capt. Cook, Superintendent of Pilots, states, "There are now four channels, viz. the Rock or Horse, Victoria, Queen's, Zebra or Eastern Channels. Large vessels enter by the Victoria Channel. The Queen's improves, but not yet log-lined. Not very important to have very deep entrances into Liverpool, as the heavy ships enter the docks.

	ft.	in.
Depth on Victoria Bar at lowest tide	10	0
Lift of tide	31	0
High water, spring tide	41	0
Depth of water upon Bar, neap tide	18	6
Of tide	15	0
Depth on the Bar, high water neaps	33	6

West wind raises the tide 5 or 6 feet, east wind cuts the tide as much. As regards the effects of the dock walls already built upon the navigation of the river, Mr. J. Hartley, Lieut. Lord, and the dock-masters assert that there has been no perceptible difference in the height of the tides for many years, the old tables of depth upon the sills of the docks being still found to be the correct guide, and the velocity, so far as they can observe, being unaltered."

Some witnesses considered that the tides rose vertically 2 feet higher at Seacombe, but no gauge having been kept, the impression may have arisen from the greater effect, or in "consequence of the lash of the waves upon the Cheshire side being heavier," since the last built portion of the "dock wall is placed so as to meet the waves that are brought by the westerly gales through the Rock Channel."

This is shown on the Plan attached to the Report; and the Report states, "It is also to be expected that the rebound will be increased when the gap which at present leaves a portion of Bootle Bay open to receive the seas, shall be filled up by a wall, as I presume is intended."

A reference to the Plan will show that the filling up of this gap would not only greatly increase the evils complained of at Seacombe, but cause the Rock Channel to silt up in a few years, as Hoylake has done; and should the wall be extended to Rimrose Brook, as proposed in 1858, enclosing 150 acres, it will greatly reduce the flow of water into the Mersey by contracting the entrance between the fort on the Rock Point and high water at Bootle Bay, distant $1\frac{1}{2}$ mile or 2700 yards. The map shows the present end of wall to extend 900 yards across the entrance to a river wall of 250 yards towards a gap of 700 yards, thus reducing the entrance between the river wall and the Fort on Rock Point to 1800 yards, with a bulb between Seacombe and New Brighton, where the sea and tide through the Rock Channel deflected from the Liverpool wall are wasting the shore. The only remedy for this being, as stated in the Report, "the construction of a wall 4000 yards long from Seacombe to New Brighton."

From opposite Seacombe the Liverpool dock wall extends 4000 yards to the gap in Bootle Bay; by ending it there, only a curved line, similar to that in 1833, shown in the Plan, with a sloping sea-wall, would allow the sea to expend itself in Bootle Bay as heretofore, and act as the eastern side of the funnel of the Mersey, the Rock Channel forming the western.

The effects these alterations may have had on the levels of the tides in the Mersey, since they were recorded by Mr. Rendel in 1844, we have no means of comparing, as it will be seen by the before-mentioned table; they only relate to two tides of that year, which are so much affected by the wind as to form no criterion, it requiring the average of a long period to establish any change in the mean height and flow of the tide.

We are indebted to Lieut. Lord for the only reliable results derived from the observations of the self-registering tide-gauge at George's Pier, Liverpool. The discussion of two years of these tidal observations, 1854–55, by Mr. Burdwood, of the Hydrographer's Office, Admiralty, gives the following mean :—

Datum, Old Dock Sill. Establishment (High Water, full and change) $11^h\ 35^m$ Greenwich time.

	ft.	in.
High water :—		
Springs.—Average height *above* the sill	18	0
Neaps	12	2
Low water :—		
Springs.—Average height *below* the sill	8	0
Neaps	2	4

Admiralty, 2nd June 1856. J. BURDWOOD.

Lieut. Lord's diagrams furnish the levels of high and low water, direction and force of the wind, and height of the barometer every day in the year, as well as an intermediate line indicating the ordinary sea-level as averaging 6 feet above the old dock sill.

As these observations are to be continued at several stations on the Mersey, we may look upon them as the basis of future observations on the changes in the level and flow of the tides in that river.

Mr. Rendel's diagrams are very useful, as recording the tidal wave in 1844 as well as the relative time of high water at the Bar, New Brighton, Prince's Dock, Runcorn, Fidler's Ferry, and Warrington Bridge.

From information obligingly furnished to the Committee by Mr. Fereday Smith, Mr. R. Skay, and Mr. Edward Johnes and other sources, we may confidently contemplate the establishment of a record of the tides of the Mersey, both at Ellesmere and other points, with reliable data and information on the important subject.

Cheltenham, 12th August 1856. ANDREW HENDERSON.

Interim Report to the British Association, on Progress in Researches on the Measurement of Water by Weir Boards. By JAMES THOMSON, *C.E.*

Belfast, August 6, 1856.

HAVING at last year's meeting of the Association read in the Mechanical Section a short paper on the Measurement of Water by Weir Boards, and having been requested by the General Committee to prepare a Report on the same subject, I beg now to state that I have in the meantime been collecting information for the purposes of that Report. My professional engagements have occupied me necessarily so much as to oblige me to defer for this year the detailed prosecution of the subject and the preparation of the Report in full. I have, however, the gratification of stating, that, with special reference to the researches entrusted to me by the Association, the President of the Athenæum of Boston, United States, Mr. Thomas G. Cary, has generously sent to me, with the request that it be presented to the British Association on his behalf, a valuable book, containing accounts of experiments recently carried out on a very grand scale in America on the measurement of large bodies of flowing water by means of Weir boards and by other methods.

The work is entitled 'Lowell Hydraulic Experiments,' by James B. Francis. In reference to the experiments, Mr. Cary, the donor of the book, states in his letter to me, "These experiments, made under the direction and at the expense of the associated companies of Lowell, near Boston, who employ Mr. Francis as the engineer for their cotton and woollen factories, have cost about £4000 sterling; and they make part in a series of investigations which have cost those companies £15,000."

In the Report which I hope to submit to the British Association, I shall have much occasion for reference to these important experiments, and for this purpose I think it right to retain the book in my hands at present.

As the expenses incurred in reference to the researches have been but small, and chiefly for the procuring of books, I do not desire to draw for them on the fund of £10 liberally placed at my disposal by the Association; and as my intention is, not to conduct experiments on the subject myself, but chiefly to give a review of the most important experiments and deductions which have been made by others, I do not think it necessary to ask for a renewal of the grant.

Dredging Report.—Frith of Clyde. 1856.

At the last meeting of the British Association for the Advancement of Science, held in Glasgow, the following resolution was adopted:—

> "That a Committee, consisting of the Rev. C. P. Miles, M.D., Professor Balfour, Dr. Greville, and Mr. Eyton, be requested to report on the dredging of the West coast of Scotland, and that the sum of £10 be placed at their disposal for the purpose."

Of the Committee only two members have been able to devote any time to the object contemplated, viz. Dr. Greville, and the Rev. C. P. Miles. The latter, having engaged a residence on Holy Island, Lamlash Bay, was joined by the former on June 9th, when both were prepared to commence a systematic course of dredging, and to give up their whole time, for several weeks, to the work. They had provided themselves with the Government charts, and with such books on the different departments of marine zoology as were likely to be of service; they had also everything requisite for the preservation of specimens; and they had at their command a small yacht*, and a stout four-oared cutter†. So far, therefore, as *material* was concerned, the Committee had armed themselves for a vigorous campaign.

In the arrangement for their plan of proceeding, the Committee took into

* This vessel was lent to the Rev. Mr. Miles (on the condition of his paying the expenses of fitting her out) by Alexander Melville, Esq., Glasgow.

† The property of Dr. Carpenter, Holy Island, Arran.

consideration the terms of their instructions; and they came to the conclusion that it would be impossible to draw up a satisfactory Report in the course of a single season. They do not regard a mere enumeration of the forms of animal life, as observed from time to time by different individuals, as the object contemplated by the Association, but rather some account of the distribution of those forms in the estuary and Lochs of the Clyde, coupled with some efforts to render our knowledge of the Fauna more complete. It appeared to them that the most proper course would be for the Committee, not to aim too suddenly at issuing a general Report, but rather to present, for some time to come, an annual statement of their labours. By a judicious change of head-quarters, they would be enabled, in successive seasons, to pursue their investigations in a way best calculated to promote the ultimate views of the Association.

The naturalist's dredge has been used in the Clyde for some years by various persons, but, as far as is ascertained, without any special plan; and although in many instances notes have been preserved, the existing materials for a full Report are utterly insufficient. Of the different localities, Lamlash Bay has, perhaps, acquired the greatest reputation. It occurred therefore to the Committee that it would be peculiarly desirable to ascertain, with some precision, the extent and distribution of the forms existing in this section of the Clyde—stating whether they are rare or frequent in these parts. They hoped to accomplish this end with comparatively little trouble, as they had repeatedly dredged over portions of the same ground on former occasions; and, further, they had the experience of Major Martin and of the late Rev. Dr. Landsborough to assist them. Other places in the vicinity of Lamlash Bay were marked out for examination, with special reference to Kilbrennan Sound, on the west side of Arran, which, it is believed, has been unexplored by the scientific dredger.

To their exceeding regret the Committee have to state that they had scarcely made their arrangements before the weather became adverse. Rain and wind—the latter often rising to a gale—set in, and continued, with a few exceptional days, throughout the months of June and July, that is, from the moment they were prepared to commence operations until the last day at their disposal previous to the Meeting of the Association. The precarious position of the dredger could not be more forcibly illustrated. During the first month scarcely more than one day in each week would admit of the dredge being used, and, altogether, there were only *fifteen* days available for the prosecution of the work, which was sometimes attempted when the severity of the weather made it all but impracticable to sail the yacht, and when the employment of the four-oared cutter would have been impossible. The intended visit to the west of Arran has consequently been postponed; and, under these disastrous circumstances, the unfortunate Committee found occupation, in spite of rain and wind, in searching the pools and coast at low tide, and in collecting the littoral nudibranchs, echinoderms, crustaceans, &c.

The ground explored by the dredge embraces, as marked in the accompanying map* (Plate II.), the following well-defined localities:—The south side of Brodick Bay, from Invercloy to Corriegills, in depths varying from 7 to 25 fathoms; the entire area of Lamlash Bay, from Clachland Point to the north end of Holy Island, and from the south end of Holy Island to Kingscross Point; the eastern, or outer side of Holy Island, from Hamilton's Rock, near Clachland Point, to the most southern point of the island, in from 30 to 6 fathoms; and from Fullarton's Rock to Whiting Bay.

The subjoined Tables give the results of the labours of the Committee:—

* The map is an exact copy of the Government Chart.

TABLE I.—Mollusca.

Species.	*Station.*	*Remarks.*
Acmæa testudinalis	Littoral—Holy Island, &c.	Abundant.
—— virginea	Laminarian zone.	
Anomia ephippium	Generally diffused.	
Aplysia hybrida	Rock-pools, Holy Island, &c.	Not uncommon.
Aporrhais pes-pelecani	Generally diffused—Deep water.	Only dead shells obtained.
Artemis exoleta	Ditto.	
—— lincta	Ditto.	
Astarte sulcata	Ditto.	
Buccinum undatum	Ditto.	
Cardium edule	Lamlash sands.	
—— echinatum	Lamlash Bay.	
—— Norvegicum	Deep water between Holy Island and Clachland Point.	Adult specimens rare.
Cerithium reticulatum	Generally diffused.	
Chiton asellus	Ditto.	
—— ruber	Ditto.	
Circe minima	Between Holy Island and Clachland Point.	
Corbula nucleus	Ditto.	
Crania anomala	Ditto	Not uncommon.
Cylichna cylindracea	Ditto.	
Cypræa Europæa	Ditto.	
Cyprina Islandica	Lamlash Bay	Only dead shells.
Dentalium entalis	Between Holy Island and Clachland Point.	Common.
Emarginula reticulata	Ditto }	{ Near the north end of Holy Island in from 10 to 30 fathoms.
Eulima polita	Ditto }	
—— distorta	Ditto }	
Fissurella reticulata	Ditto.	
Fusus antiquus }	{ Near Fullarton's Rock, in about 20 fathoms.	
—— Islandicus }		
Kellia rubra	Littoral	Attached to *Lichina pygmæa.*
—— suborbicularis	Lamlash Bay	Found inside dead shells of *Artemis exoleta.*
Lamellaria —— ?	Littoral—Holy Island.	
Lima hians }	{ North end of Holy Island in about 10 and 15 fathoms.	The nests of *L. hians* in this locality are very abundant.
—— Loscombii }		
—— subauriculata	Near Fullarton's Rock	Only single valves found.
Littorina Neritoides }	Holy Island, &c.	
—— littoralis }		
—— littorea }		
Lyonsia Norvegica	Between Holy Island and Clachland Point.	
Mactra solida }	{ Lamlash Bay and off Holy Island.	
—— subtruncata }		
Mangelia Leufroyi }	{ Between Holy Island and Clachland Point.	Scarce.
—— linearis }		
—— rufa, var. Ulideana	Between Fullarton's Rock and King's Cross Point.	Only one specimen obtained.
—— teres	Between Holy Island and Clachland Point.	Three specimens obtained in from 15 to 25 fathoms.
Modiola Modiolus	Lamlash Bay.	
Montacuta substriata	North end of Holy Island	On the spines of *Spatangus purpureus.*
Mytilus edulis	Round the coast	Immature and scarce.
Nassa incrassata.		
—— reticulata	Generally diffused.	
Natica Alderi }	{ Between Holy Island and Clachland Point.	*N. monilifera* scarce.
—— monilifera }		
—— Montagui }		
Ostrea edulis	Lamlash Bay by Holy Island.	
Patella athletica }	Holy Island, &c.	
—— pellucida }		
—— vulgata }		

TABLE I. (*continued.*)

Species.	*Station.*	*Remarks.*
Pecten maximus	North end of Holy Island; also near Fullarton's Rock.	Scarce.
—— opercularis	Throughout the district	Abundant in certain localities.
—— striatus —— tigrinus	Between Holy Island and Clachland Point.	Scarce; dead shells of *P. tigrinus* not uncommon.
Pectunculus glycimeris	North end of Holy Island.	
Philine aperta	Throughout Lamlash Bay	Not uncommon in any part.
Pholas crispata	Near Lamlash Pier.	
Pileopsis Hungarica	North end of Holy Island.	
Pleurobranchus ——?	Holy Island at low water	Found four individuals under stones: probably they are *P. membranaceus.*
Pilidium fulvum Psammobia Ferroensis Puncturella Noachina	North end of Holy Island.	
Purpura lapillus	Littoral. Holy Island, &c.	
Rissoa striata	Generally diffused.	
Scaphander lignarius	North end of Holy Island.	
Tapes decussata	Holy Island, &c.	
Tellina donacina	North end of Holy Island.	
Terebratula caput-serpentis	Ditto.	
Teredo Norvegica	Holy Island	Fine specimens of the tubes obtained from the wreck of the old pier.
Thracia phaseolina	North end of Holy Island.	
Trichotropis borealis	Between Holy Island and Clachland Point.	
Trochus alabastrum	Lamlash Bay	Dredged by Mr. Eyton.
—— cinerarius	North end of Holy Island.	
—— Magus	Near the pier, Holy Island.	
—— millegranus	North end of Holy Island.	
—— tumidus	Ditto.	
—— umbilicatus	Holy Island, &c., littoral	*T. umbilicatus* is the common shell of these shores.
—— zizyphinus	North end of Holy Island	*T. zizyphinus* is scarce.
Turritella communis	Ditto.	
Venus casina	Ditto.	
—— fasciata	Ditto.	
—— ovata	Ditto.	
—— striatula	Ditto.	

TABLE II.—Nudibranchiate Mollusca.

Species.	*Remarks.*
Doris bilamellata —— tuberculata	Found under stones at low water on Holy Island, &c. Common.
Eolis Drummondi	Ditto. Not uncommon.
Goniodoris nodosa	Ditto. One example found on Holy Island.
Lomanotus ——?	Dredged (probably a new species) in about 15 fathoms between Macdonald's Hotel, Invercloy, and Corriegills.
Polycera quadrilineata Triopa claviger	Lamlash shore.

TABLE III.—Crustacea.

Species.	*Station.*	*Remarks.*
Carcinus Mænas	Holy Island, &c.	Abundant round these shores.
Cancer Pagurus	Ditto	Ditto.
Ebalia Pennantii	North end of Holy Island	Not very uncommon.
Eurynome aspera	Ditto	3 or 4 specimens obtained.
Galathea ——	Generally diffused	All immature examples.
Hippolyte varians	Lamlash Bay.	
Homarus vulgaris	Everywhere round shore	Tolerably abundant.
Hyas araneus	Generally diffused.	
Inachus Dorsettensis	Ditto.	
Pagurus Bernhardus	Ditto.	
—— Prideauxii	Ditto	Always accompanied by *Adamsia palliata.*
Palæmon Squilla	Rock Pools	Common round the coast.
Pandalus annulicornis	Lamlash Bay.	

Table II. (*continued.*)

Species.	*Station.*	*Remarks.*
Porcellana longicornis	North end of Holy Island.	
—— platycheles	Littoral. Holy Island, &c.	Abundant round the coast.
Stenorhynchus Phalangium	Generally diffused	Not common.

Table IV.—Echinodermata.

Amphidotus cordatus	Generally diffused	Common.
Asterias aurantiaca	Near Fullarton's Rock	Only two specimens obtained.
Asterina gibbosa	Littoral. North end of Holy Island.	Under stones in a pool.
Chirodota digitata	Near the Pier (south side), Holy Island.	In from 15 to about 6 fathoms.
Comatula rosacea	Pier, Holy Island, and Fullarton's Rock.	Abundant in about 8 to 15 fms.
Cribella oculata	North end, Holy Island.	
—— rosea	Ditto	Rare.
Echinocyamus pusillus	Generally diffused.	
Echinus miliaris	Ditto.	
—— sphæra	Ditto.	
Goniaster Templetoni	Ditto.	
Luidia fragillissima	Ditto.	
Ophiocoma bellis	Ditto.	
—— granulata	Ditto.	
—— rosula	Ditto.	
Ophiura texturata	Ditto.	
Palmipes membranaceus	Between Holy Island and Clachland Point in 25 fms.	Rare.
Sipunculus ——?	Lamlash Bay.	
Spatangus purpureus, Solaster papposa	North end, Holy Island.	
Uraster glacialis, —— rubens	Generally diffused.	

Table V.—Zoophyta.

Species.	*Remarks.*
Actinia bellis, (Gærtner), —— coriacea	Common in the pools and round the whole coast.
—— crassicornis	Dredged in about 25 fathoms north of Holy Island.
—— mesembryanthemum	Common everywhere.
Adamsia palliata	Frequent—always with *Pagurus Prideauxii.*
Anthea cereus	On *Zostera marina*, Lamlash Bay.
Antennularia antennina	Near Fullarton's Rock.
Cellepora pumicosa, —— ramulosa, —— Skenei	The corals are generally diffused in deep water (from about 20 fathoms) outside of Lamlash Bay.
Campanularia dumosa.	
Flustra foliacea.	
Halecium halecinum.	
Laomedea geniculata	On stones and dead shells.
Lepralia annulata	Ditto.
—— hyalina	Ditto.
—— Malusii	Ditto.
—— Peachii	Ditto.
—— trispinosa	Ditto.
—— violacea, var. cruenta	On stones and dead shells in deep water, between Holy Island and Clachland Point. Also between the south end of Holy Island and Fullarton's Rock: several specimens.
Plumularia pinnata	Lamlash Bay.
Salicornaria farciminoides	Common, outside of Lamlash Bay.
Sertularia tamarisca.	

The Committee have deemed it advisable, for the present, to omit the following classes—Cirripedia, Annelida, Acalepha, and Poriphora; also the Sessile-eyed Crustaceans; nor have they even attempted to search for the microscopic forms included in the Infusoria and Rhizopoda.

Among the Nudibranchiata, a species of rare beauty was obtained when dredging in Brodick Bay, between Invercloy and Corriegills, in from 10 to 15 fathoms. As it could not be identified by the Committee, a sketch taken by Dr. Greville was forwarded to Mr. Alder, who replied,—"The beautiful Nudibranch you have found is a Lomanotus, and probably new; but of this we could not be certain without a careful examination, and I shall therefore be glad to avail myself of your kind offer to send the animal alive. I dredged a minute Lomanotus (only quarter of an inch long) in Lamlash Bay in 1846, which is figured in the 6th Part of our Monograph, under the name of *L. flavidus*. I think it can scarcely be the young of this large species*. Since the completion of our work, we have received from Mr. Thompson of Weymouth, a somewhat similar Lomanotus, white, with orange processes, and about an inch long. Yours differs from them in the length of the vela-filaments and the expansion at the posterior extremity, and also from the latter in the large size of the tentacular sheaths. The only British specimens of this new genus we have yet seen have been in a sickly state, and only one of each kind, so that any additional information concerning them is desirable. Perhaps if you should be dredging again in Lamlash Bay after the receipt of this you will be so good as to keep a look out for the small *L. flavidus*. It was dredged in shallow water among scallops, very near to the Holy Island. The only specimen of *Doris planata* yet found I also got there."

The Committee have to add, with deep regret, that this apparently new form of Lomanotus, having been placed *for safety* in the vivarium, has disappeared, and, although the tank was emptied for a thorough search, no trace whatever could be found. Two unsuccessful attempts have since been made to secure another specimen by dredging in Brodick Bay.

To conclude:—The result, in a general point of view, of the Committee's present and previous researches, added to those of other parties, as far as they are known, is, that although Lamlash Bay contains many interesting forms, most of the rarer ones are so exceedingly scarce as to cause considerable disappointment to the collector. The naturalist who wishes to secure a series of cabinet specimens, especially of shells, and to obtain a store of duplicates in return for his expenditure of time and money, must seek other localities. For example, with regard to the more interesting Mollusca inhabiting the Laminarian zone and deeper water, *Lima hians*, with its curious nests, can alone be pronounced abundant. It may be obtained in any quantity. *Pecten tigrinus* comes next in order, but an entire day's dredging, in the most favourable ground, would scarcely produce more than half-a-dozen good full-sized specimens. In the course of several days' dredging this season, single specimens only of *Lyonsia Norvegica* and *Pilidium fulvum* were secured; of the Eulimæ, only two of *Eulima polita* and a solitary specimen of *E. distorta*; of *Chemnitzia* none; of *Trichotropis borealis* one; of *Odostomiæ* none; of *Rissoæ* only the common species; of *Mangeliæ*, one of *M. Leufroyi*, three of the rare *M. teres*, a few of the common *M. linearis*, and one of *M. rufa*, var. *Ulideana*; of *Cylichnæ* none, except two or three poor specimens of *C. cylindracea*; of *Philine* none, except *P. aperta*. It is remarkable that species, which usually are not accounted at all scarce, are represented sparingly in this part of the Clyde district. Mr. Barlee, well known as one of the most practical conchologists and indefatigable dredgers in Great Britain, visited the Committee, and, having dredged over the best ground† for two days, came to the conclusion that Lamlash Bay is remarkably deficient both in Molluscan forms generally and in the number of indi-

* The species dredged by the Committee was 2 inches in length.

† That is, from Hamilton's Rock, near Clachland Point, to the North and N.E. end of Holy Island, in from 35 to 15 fathoms. Also in the vicinity of Fullarton's Rock.

viduals which actually exist there. Among the Echinodermata, the only species of any interest that is really abundant, in certain defined localities, is *Comatula rosacea.* Nor is *Goniaster Templetoni* unfrequent, that is, half-a-dozen examples may be procured in a successful day's dredging. The same may be said of *Uraster glacialis.* More rarely brought up is *Luidia fragillissima,* especially of full size. Professor Allman and his party did not succeed in finding more than one adult individual during two days' dredging with the Committee. At the same time specimens measuring from 4 to 6 inches across are often seen at low water both at Lamlash and in Holy Island. Only one specimen of *Palmipes membranaceus* (immature) has been taken this season. And of the Holothuriadæ not one has occurred except *Chirodota digitata,* of which two examples came up in the dredge, in from 15 to 6 fathoms, near the house on Holy Island. With respect to the Crustaceans, the rarer forms of Podophthalma are poorly represented. Nor is there much to report of Zoophytes, for both Anthozoa and Polyzoa are remarkably deficient with the exception of a few of the commonest kinds, and even some of those most generally distributed appear to be wanting altogether.

In closing this necessarily meagre Report, the Committee take the opportunity to make some observations on the expenditure connected with dredging operations. Boats must of course be hired, with crews, according to circumstances. In some localities, a stout boat, with a couple of men, may get through some work in fine weather, and with a depth of water not exceeding 10 or 12 fathoms. But if the dredge be constantly down the labour is severe, and the occasional assistance of the gentlemen, whose time ought to be otherwise employed, will be required. Four men are not too many, and, in some states of the weather, they are necessary. The charge for a boat and two men cannot be set down at less than from *5s.* to *6s.* a day. At Lamlash the usual charge is *7s. 6d.* For deep-sea dredging, and indeed for the examination generally of the more exposed parts of the Clyde, whether in shore or at a distance, a small sailing craft is indispensable—such as a common herring boat—with a crew of four men, the cost of which would be about £4 a week. This, Mr. Barlee—the Committee could not quote higher authority—has found to be quite efficient. With such a vessel having a boat in tow, dredging may be carried on when oars would be useless. From the above statement of the absolute outlay inseparable from dredging operations when conducted on a useful scale (omitting altogether the cost of *material,* its wear and tear, and various contingent expenses), it will be evident that a grant of £10 will go but a short way in the hands of an active Committee.

On behalf of the Committee,

Charles Popham Miles
(Incumbent of St. Jude's English Church, Glasgow).

Holy Island, Lamlash Bay. Arran, N.B.
August 1st, 1856.

Report on Observations of Luminous Meteors, 1855–56. *By the* Rev. Baden Powell, *M.A., F.R.S. &c., Savilian Professor of Geometry in the University of Oxford.*

Since my last report to the British Association I have received but a very small number of communications of meteor observations, but among these will be found one or two of remarkable interest as presenting very peculiar features.

I am chiefly indebted, as hitherto, to Mr. E. J. Lowe.

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity of duration.
1853. Sept. 30	h m 11 15 ...... (G.M.T.)	Round, = *1st mag., magnitude diminished and disappeared as if merely from distance.	White	....	Continued about 1 sec. (not observed at commencement).
	11 15	Pear-shaped, $=\frac{2}{3}$ of moon. Afterwards burst at the lower part into a number of fragments which disappeared.	Lustre like quicksilver.	....	2 or 3 secs. ....
1855. Feb. 21	10 15 p.m. (G.M.T.)	About double of ♂. Form doubtful.	White	None observed	About $1\frac{1}{2}$ second...
Aug. 11	11 30 p.m.	A bright light behind the hills preceded the rising of a bright body like the full moon. Gradually diminished to a small star.	Rays proceeding from it on all sides, not shooting out but stationary. More red than ♀. Brightness obscured the stars, " like a crimson moon."	....	Continued till 1 a.m., rising slowly.
Dec. 11	8 10 p.m. (Commencement not observed: only noticed by reflexion on snow which covered the ground.)	Round, well-defined, diam. = 30′.	Intensely bright, pale violet.	Tail of red sparks	Disappeared very suddenly after 2 secs.
1856. Jan. 7	4 55 p.m.	Clear round disk, somewhat less than the moon.	....	Left behind a " column of vapour."	....
	4 55 p.m.	....	....	A bright vertical line emitting sparks brighter than ♃.	After 5 minutes, curved and waving for 10 minutes, then horizontal and vanished.
	4 55 p.m.	....	....	Exploded at the end of a long slanting fiery train, which remained, length 5^s.	....
	4 55 p.m.	A ball of fire, burst without noise.	With a flash like lightning.	A small white cloud, remained about $\frac{1}{2}$ hour, then vanished.	....

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
Moving rapidly upwards towards zenith.	Atmosphere clear, daytime.	Balgrummo, near Leven, Fifeshire.	W. Swan, Esq. ..	Proceedings of the Royal Society of Edinburgh, Mar. 5, 1854.
From N.E. to S.W. Altitude azimuth determined afterwards.	No sound or explosion.	Ditto .... lat. 56° 13′ 5″ N., long. $12^m 2^s{\cdot}6$ W.	Mr. D. Wallace .	Ibid.
At middle of course azimuth S. Alt. 45° (estimated by eye). Course E. to W., nearly horizontal, wavering about 15°.	Atmosphere heavy, so as to conceal stars, and give the meteors a nebulous aspect.	Near Bellahouston, 2½ miles S.S.W from Observatory, Glasgow.	W. J. Macquorn Rankine.	MS. communication.
Low altitude, nearly S.W.	Many shooting stars during the time.	Tillington, near Petworth.	Mrs. Ayling, and friends.	MS. letter to Lord Wrottesley.
N. 20°. W. alt. 30°. Moving almost horizontally from E. to W., slightly descending inclination about 7°, for about 15°.	Air calm. Below the clouds. See App. No. 1.	1 mile S. of Edinburgh.	Professor C. Piazzi Smyth.	MS. communication. See Appendix, No. 1.
From 25° to 30°, 5° W. of S....	....	Redhill, Reigate	Mr. Carrington and Mr. Good.	Letter from Mr. Carrington.
Immediately under h	Sky very clear......	St. Thomas's Hill near Canterbury.	Mr. Masters ...	Kentish Gazette. See Appendix, No. 2.
About 30°	Ditto	Stone near Aylesbury.	Mrs. Smyth......	MS. See Appendix, No. 4.
....	....	Bonchurch	Miss Sewell......	MS.

Meteor	Apparent zenith distance.	Azimuth.
Appeared ...	70° 37′ N.	20° 59′ E.
Burst	57° 40′	7° 48′
Disappeared	47° 30′	10° 49′

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or duration.
1856. Jan. 7	h m 4 55 p.m.	A ball of fire darted down and suddenly disappeared.	Extremely brilliant.	Leaving a brilliant fiery train, gradually became faint, and expanded in 5 minutes; appeared like a thin fleecy white cloud	
	4 55 p.m.	Shot downward a little obliquely and exploded.		Left a band of light changed through various forms (see diagram, Appendix, No. 3.) for 10 minutes. Also a progressive motion through about 4° towards E.	Through about 8° of space.

Luminous Meteors observed in 1855–56,

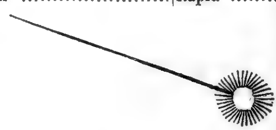
Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or duration.
1855. Sept. 4	8 30 p.m.	=1st mag.*	Red	Train	Rapid, duration 0s·2
	8 32	=3rd mag.*	Colourless	Streak	Instantaneous
	8 50	=1st mag.*	Colourless	Train	Instantaneous
7	9 13	For first half path = 3rd mag.*, then gradually increased till =2nd mag.*	Red	Tail	Slowly, duration 1 sec.
Oct. 7	7 55	2nd mag.*	Yellow	Train	Rapid
14	8 27	About four times apparent size of ♃, oval in form.	Bluish	Narrow streak, visible after meteor vanished. The streak was visible both sides, the break at the same time.	Motion rather slow, duration 3 secs.
Nov. 8	8 53	2nd mag.*	Yellow	Train	Rapid
30	6 56	Very large, somewhat like a flash of lightning.	As light as day, long shadows cast.		Lingered 2 secs.
Dec. 6	5 35 p.m.	=♃	Colourless, increased in brightness as it progressed.	Leaving a long streak of light.	Very rapid, duration 0·5 sec.
19	6 13 a.m.	=☾	Light as noonday.	Streak left for a considerable time.	Duration fully 10 minutes.
21	4 50	4 times size of ♃	Blue	A single ball with well-defined edges, no streamers.	Slow, duration 4 secs.

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
....	In daylight, sky clear.	Hartley Rectory, Hants.	Rev. J. T. Plummer.	MS. letter to Mrs. Bell.
little W. of S., point of explosion about 22° alt.	....	Oxford	A friend of Mr. G. A. Rowell.	Letter from Mr. Rowell. See Appendix, No. 3.

y E. J. Lowe, Esq., F.R.A.S., F.G.S.

om Polaris perpendic. down .	....	Obser^y^, Beeston	E. J. Lowe, Esq.	Mr. Lowe's MS.
arted on W. edge of Galaxy, falling perpendic. down from 5° below the altitude of Atair.	....	Ibid................	Id.	Ibid.
ll perpendic. down from centre of Ursa Major.	....	Ibid................	Id.	Ibid.
arted S. of Galaxy, 15° below Atair, moved downwards.	....	Ibid................	Id.	Ibid.
own through the Pleiades ...	....	Obser^y^, Beeston	E. J. Lowe, Esq.	Ibid.
arted at altitude of 80°, falling perpendic. down to within 10° of W.S.W. horizon.	Star-like on the edges, when it passed over half its track, it suddenly disappeared, and almost immediately reappeared 0½° lower. This break was devoid of the streak, which remained after the meteor had vanished.	Nottingham Forest.	F. E. Swann, Esq.	Ibid.
om below Polaris towards the East, downwards at an angle of 50°.	....	Ibid................	Id.	Ibid.
ll downwards, bursting due S.E. at an altitude of 45°.	....	Ibid................	An assistant to E. J. Lowe.	Ibid.
om β Andromedæ, passing 1° below γ Pegasi, vanished instantaneously.	....	Obser^y^, Beeston	Id.	Ibid.
....	....	Highfield House Observatory.	E. J. Lowe, Esq.	Ibid. See Appendix, No. 5.
ll down in N.W. from an altitude of 40°.	Very bright	Bulwell	G. Allcock, Jun., Esq.	Ibid.

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or duration.
1855.	h m				
Dec. 5	A large meteor seen.				
6	5 40 p.m.	=2nd mag.*	Bluish	Streak	Rapid
	11 p.m. till 11 30	Several small with	Colourless	Train	Rapid
12	Many meteors				
	11 22 p.m.	=2nd mag.*	Colourless	Long streak	Rapid
13	12 40 a.m.	=2nd mag.*	Colourless	Long streak	Rapid
	12 45 a.m.	=2nd mag.*	Colourless	Long streak	Rapid
1856.					
Jan. 2	10 10 a.m.				
7	A large meteor seen at Chelmsford, cloudy here.				
11	7 15 p.m.	Small	Colourless		Rapid
12	11 16 p.m.	=2nd mag.*	Red	Streak	Slowly, duration secs.
27	7 p.m. till 9 p.m.				
	12 3 a.m.	=1st mag.*	Rich scarlet	Train	2 secs., slowly
Feb. 2	7 45 p.m.	=2nd mag.*	Colourless =3rd mag.*	Train	Rapid
3	7 55 p.m.	A splendid meteor			
	7 55 p.m.	½ size of moon	Green, orange and red, very brilliant.		Duration 2 secs rapid.
13	1 7 30 a.m.	=2nd mag.*	Blue	Streak	Instantaneous
Mar. 8	12 60 a.m.	=3rd mag.*	Colourless	Streak	Rapid
April 3	1 23 a.m.	=1st mag.*	Yellow	Streak	Duration 1 sec.
	1 27 a.m.	=2nd mag.*	Blue	Streak	Duration 1 sec.
May 30	12 51 a.m.	=3rd mag.*	Bluish	No train	Rapid, duration 0 sec.



Direction or altitude.	General remarks.	Place.	Observer.	Reference.
m π Herculis to μ Herculis.	....	Obser^y, Beeston	E. J. Lowe, Esq.	Mr. Lowe's MS.
out Polaris	....	....	Id.	Ibid.
....	....	Ibid...............	Id.	Ibid.
m Castor down towards E. .	....	Ibid...............	Id.	Ibid.
pendic. down from β Cygni	....	Ibid...............	Id.	Ibid.
pendic. down from Dragon's head.	....	Ibid...............	Id.	Ibid.
....	A loud report in S. lasting 3 secs., somewhat different to thunder: could it be the bursting of a meteor?	Ibid...............	Id.	Ibid.
....	....	Ibid...............	Id.	Ibid.
pendic. down to 1° above Saturn.	....	Ibid...............	Id.	Ibid.
m γ Andromedæ to within 2°, and to N. of β Arietis.	....	Ibid...............	Id.	Ibid.
....	Many small meteors	Ibid...............	Id.	Ibid.
om No. 28 to No. 5 in Monoceros.	....	Ibid...............	Id.	Ibid.
oved through Pegasus towards the zodiacal light (which was brilliant), near γ Pegasi, fading near the edge of zodiacal light; on bursting suddenly increased considerably in size but not in brightness.	....	Ibid...............	Id.	Ibid.
....	....	Ibid...............	Id.	Ibid.
ownwards at an angle of 45°, passed 5° S. of Orion's belt. This meteor, when first seen, was *green*, then changed to orange, and then to red. These changes took place suddenly without altering the size of the meteor.	....	Ibid...............	Id.	Ibid.
ssed through Saturn, fell down at an angle of 50° towards W.	....	Ibid...............	Id.	Ibid.
rpendic. down in Cassiopeia.	....	Ibid...............	Id.	Ibid.
orizontally towards N., passed through α Cygni.	....	Ibid...............	Id.	Ibid.
own towards N.W., passed through Gemini.	....	Ibid...............	Id.	Ibid.
om α Coronæ, passing 5° below Arcturus. Like a spark. Apparently very low.	....	Ibid...............	Id.	Ibid.

APPENDIX.

No. 1.—Extract from Prof. C. P. Smyth's communication. (Meteor, Dec. 11, 1855.)

"It was apparently below the clouds, for they were thick and compact cirrostrati in all that part of the sky, shutting out all the stars and reflecting the glare of distant iron-works; and the meteor showed no symptoms of shining through the cloudy medium, for it was well-defined. The clouds were such as have an altitude of four to five miles attributed to them, and have a very scattering effect on rays of light passing through them, and must have been composed of frozen particles; one or two stars were hazily seen through the clouds in the S. and S.W."

No. 2.—Meteor, Jan. 7, 1856.

"*To the Editor of the Kentish Gazette.*

"SIR,—This evening, at a quarter before five o'clock, being at St. Thomas's Hill, near Canterbury, I was struck by what appeared a rocket in brilliancy, but with sparks more compacted than usual. I ran to a position where no trees intercepted my sight, and was astonished to find a bright vertical line—[to appearance about 6 ft. long and 2 in. wide] *—in the south, immediately under Saturn.

"There was no cloud near it, or indeed, on the whole hemisphere at the time. Its brilliancy exceeded that of the planet, and it seemed to emit light in the manner of a gilded snake.

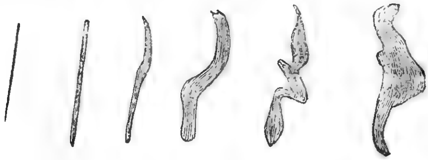
"It continued about five minutes with this aspect, when its form began to change, and showed a bold curve in its centre, with a deflection at each extremity; at this time, a bright, waving, thread-like tail became visible, and very soon after a similar vermiform appearance in the opposite direction was to be seen at the top. As the body, so to speak, curved, so it appeared to become broader, and in about 10 minutes the general direction was changed, for it had lost its vertical direction, and was just acquiring a horizontal one.

"It was not till this time that its nature could be defined; but now it showed that it was a thin cloud, and it finally passed away without leaving a trace behind.

"I am, Sir, yours truly,

7th January, 1856. "WILLIAM MASTERS."

No. 3.—Diagram of meteor, January 7, 1855, accompanying Mr. Rowell's letter.



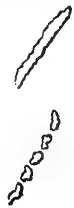
No. 4.—Extract of a letter from Mrs. Smyth.

"January 1855.

"On Monday the 7th instant, as I was returning homeward from the northward with a friend about a quarter before five o'clock P.M., my friend suddenly exclaimed, 'There is a rocket!' pointing to the southward in the direction of the Chiltern Hills. She saw it explode at the lower end of a long and rather slanting fiery train.

* The part in brackets is given as communicated.

"The sky being very clear, it was still bright day-light. Supposing it only a rocket, although a gigantic one, we resumed our conversation, but the stationary character of the train again attracted our attention, though we ascribed it chiefly to the stillness of the air, or not quite so oblique. After upwards of five minutes it gradually became less dense, as if the fiery flakes or atoms receded from each other. Then it gradually assumed the appearance of a series of very bright small clouds at sun-set, only the brightest side was turned to the eastward. Elevation of the phænomenon above the horizon at first about 35°. Length of the train about 5°. When the train became dismembered it seemed to have risen higher in the atmosphere, by some 10°.

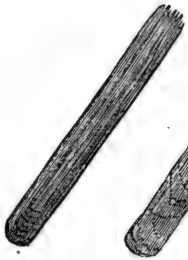


I regret much from the wrong impression, that I did not take more accurate notes of this very bright *meteor*, as it proved to be.

No. 5.—Extract of a note from Mr. Lowe.

"I beg to enclose you sketches and description of the remarkable meteor (No. 10 of the foregoing Catalogue) which was seen here on the 19th of December 1855, at 6^h 13^m A.M.

Fig. 1.



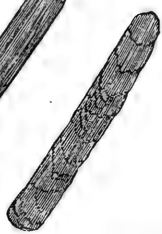


Fig. 2.

"The meteor was first seen in N.N.W., moving towards the W. Fig. 1 represents the appearance when at the brightest, at which time it more closely resembled a brilliant flash of lightning than a meteor; the light, for the moment it lasted, equaling that of day. When first seen it was not far distant from the position of H 17 Camelopardi, and moving downwards to midway between Capella and μ Persei. The size was about that of the apparent diameter of the moon. There was no noise of explosion heard. After the meteor itself had vanished, a belt of light, similar to that of a comet's tail, was visible along the whole path of the meteor; this gradually became less bright, and after a short time the lower portion was curved towards the east. Fig. 2 shows its first appearance, and fig. 3 when curved; later it assumed the form of fig. 4, and afterwards of fig. 5; when it nearly approached that of a circular band; the upper portion never moved its position in the heavens. Finally, on breaking up the base of the circle disappeared first. It was visible fully ten minutes. A falling star of about the 1st magnitude crossed over the band horizontally from W. to E., starting near Capella and moving towards ϵ Cassiopeiæ.

"The night was cloudless with a cutting E.S.E. wind.

"E. J. Lowe."

No. 6.—Extract of a note from Mr. Lowe.

"Observatory, Beeston near Nottingham,
July 25, 1856.

"From the appearances presented in the several large meteors seen at the end of last and at the beginning of this year, it appears evident to me that these bodies are not *self-luminous*. The light seems to be *owing* to the meteor, instead of the light *of the meteor*; probably the great speed causes a peculiar property of the upper regions to ignite, at the instant of ignition being an intense blaze, and then subsiding into a phosphorescent flame, which may linger for a length of time and be wafted along by currents of air, as was the case in several instances. In the case of the meteor of Dec. 19, 1855, it moved over $18\frac{1}{2}°$ in less than a second of time; it cannot therefore be supposed that the meteor itself could be within 5° of this path 10 minutes afterwards. Now if we suppose the meteor burst at this point (which to me seems improbable), it must have burst in a medium where *light could shine*, and if so it is as easy to suppose some substance should be ignited, as the meteor itself should blaze. The intense brightness is too great for *reflected light*. "E. J. Lowe."

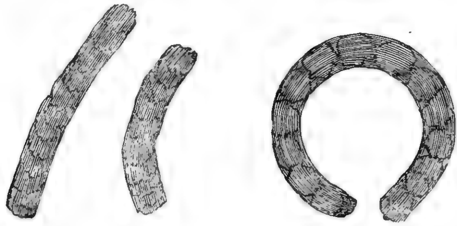


Fig. 3. Fig. 4. Fig. 5.

Photochemical Researches. By Professor Bunsen, *of Heidelberg, and* Dr. Henry E. Roscoe, *of London.*

We had the honour of laying before the Chemical Section of the British Association at the Glasgow Meeting, a short account of a series of experiments which we had undertaken with the view of becoming more nearly acquainted with the laws which regulate the chemical action of light, and of obtaining, if possible, a measure for this action.

These experiments, the continuation of which has been assisted by a grant from the Association, have been extended during the present summer months, and we beg to lay before the meeting, in a short report, the chief results as yet obtained.

The method employed by us for measuring the chemical action of light is founded upon the well-known fact that chlorine and hydrogen combine when exposed to light. The employment of this reaction as a measure of the chemical action of light was proposed and practically carried out by Dr. Draper of New York in 1844, to whom belongs the great credit of first having attempted to obtain a measure for this action. A number of experiments instituted for the purpose of testing the accuracy of the instrument proposed by Draper, assured us, however, that not only for observations extending over a considerable period of time, but even for those of short duration the indications of the instrument were not reliable. The possibility of obtaining exact photometrical results with a mixture of chlorine and hydrogen, depends upon the fulfilment of various conditions which in Draper's tithonometer have not been regarded. Of these conditions the two most essential are—

1. The constant composition and purity of the gaseous mixture.
2. Constant pressure exerted upon the gas.

It is easy to show from the laws of gas absorption that the method employed by Draper for evolving the sensitive gas never could have furnished it of constant composition.

Draper's instrument consists of a siphon tube, of which one limb is short and closed, and the other longer, narrow and open at top. The long limb is furnished with a scale, the shorter one has two platinum wires melted into the glass near the bend. The whole of the short, and part of the long limb, is filled with hydrochloric acid saturated with chlorine, and by means of an electric current the acid can be decomposed and the gases collected in the short limb. According to Draper no gaseous chlorine is evolved during the electrolysis of hydrochloric acid; the hydrogen, however, set free at the negative pole passing through the liquid displaces some of the chlorine held in solution, and thus a sensitive gas is obtained and collected in the shorter siphon limb. The composition of this gas cannot, however, be constant, for according to the law of gas absorption, when a mixture of gases is collected over water, the free gas cannot possess a fixed composition before a certain relation between the volumes of the dissolved gases has been attained. Until this equilibrium has ensued, a continuous interchange between the volumes of free and dissolved gases must take place, and in the case of the tithonometer this equilibrium is not even approached. Another more considerable source of error in Draper's instrument lies in the difference of pressure to which the gas is subjected during the experiments, arising from the gradual fall of the liquid in the longer limb in proportion as the sensitive gas is acted upon by the light.

Having assured ourselves that the indications of the tithonometer cannot be relied on, the necessity of obtaining an instrument in which the foregoing and many other essential conditions are fulfilled, became apparent. The first object therefore was to obtain a gas consisting of equal volumes of chlorine and hydrogen of constant composition. This object we attained (contrary to Draper's express statement) by the electrolysis of aqueous hydrochloric acid. Exact volumetric analysis convinced us that as soon as the acid is saturated with the two gases, in accordance with the laws of absorption, the evolved gas consists exactly of equal volumes of chlorine and hydrogen, unaccompanied by oxides of chlorine, or hydrogen or other impurities. After many fruitless attempts, we have at length constructed an apparatus in which the second, and all other required conditions are satisfied, and by means of which we have been enabled not only to obtain a relative, but even an absolute measure for the chemical action of light.

This apparatus, represented in Pl. III., is constructed entirely of glass, and consists essentially of four parts: firstly, a tube (*a*) containing carbon or platinum poles fastened on platinum wires melted through the glass, serving for the electrolytic decomposition of the aqueous hydrochloric acid; secondly, a set of bulbs for washing the gas, furnished with a glass stopcock for shutting off the supply of gas; thirdly, a small flattened glass bulb (*c*) containing water, in which the gas is exposed to the action of the light; and fourthly, a capillary tube (*d*) furnished with a millimetre scale, on which the diminution of volume caused by the absorption of the hydrochloric acid is accurately observed by the advancing column of water. Each of these pieces is fitted air-tight into its place by ground-glass joints, so that no caoutchouc or other organic substance comes in contact with the sensitive gas.

In this arrangement the pressure is rendered constant throughout the whole apparatus by raising or depressing the exit tube dipping into the bottle (*e*) filled with water, and by means of the horizontal absorption tube (*d*) the pressures before and after the experiment do not differ by two millimetres of water.

A series of experiments conducted with lamp-light for the purpose of testing the accuracy of the instrument, gave the following results:—

As soon as the atmospheric air has been completely expelled from the apparatus by the electrolytic gas, and the equilibrium between the amounts of gas absorbed by the water, and the free gas established, an action is observed on exposing the gas to the light. This action, however, does not commence immediately on exposure to the light; a short time elapses before the absorption of the water in the tube (*d*) begins, but this soon takes place, showing that the combination effected by the light in the vessel (*c*) has commenced. This absorption becomes gradually quicker until a certain rapidity is attained, after which the action continues regular as long as the source of light remains constant. This peculiar phænomenon, to which we have given the name of *Photochemical Induction*, is one of great interest and importance, and as the study of this branch of the subject has occupied our particular attention, the results obtained will be subsequently detailed.

On passing more gas through the apparatus and again isolating the mixture, the same phænomenon is observed, with the difference, that the constant action is larger than in the former case, that is, the gaseous mixture has become more sensitive. In this way, by continuing to lead the gas evolved from successive portions of hydrochloric acid through the apparatus, the action brought about by a gas flame of the same dimensions increases regularly, until, after having continued the operation for several (from 12 to 18) hours, the amount of action effected by the flame remains constant. The apparatus has then attained its maximum degree of sensibility, and, as we shall show, always gives comparable results. Before this maximum action is attained, upwards of 5000 cub. cent. of gas must be passed through the apparatus, which contains only about 2 cub. cent. of water requiring saturation. Observations made with the apparatus thus prepared, showed that the light from a gas lamp concentrated by a lens produced always exactly the same amount of action on various days and with fresh gaseous mixtures evolved from different portions of acid. These experiments sufficed to show that our apparatus was capable of producing reliable and accurate results. We next determined the limits of concentration between which the hydrochloric acid can be used, and experiment showed that the amount of anhydrous acid contained in solution must not diminish to 20 per cent., as the gas evolved from an acid of that concentration no longer gives the maximum action.

Having assured ourselves that the apparatus gave, under these circumstances, comparable results, it became necessary to examine whether the heat evolved from the combination of the gases, and more especially the heat radiated from the source of light, had any appreciable effect upon the indications. By comparing the relative volumes of the vessel, in which the insolation takes place, and the absorption tube, it was found that a rise of less than 0°·04 Cent. in the mass of the gas would cause an expansion of 1 millimetre on the absorption tube. Hence the apparatus is not only a photometer, but also a very delicate air-thermometer. In order to prevent any of the rays of radiant heat from expanding the gas, the insolation-vessel was placed behind a double metallic screen furnished with a metallic cap fitting over the vessel. The rays of light fell on the gas through an opening in the screen filled by a layer of water contained between two plate-glass surfaces. By filling the apparatus with atmospheric air, it was proved that with this arrangement the source of light may be placed within a few inches of the gaseous mixture, without the radiant heat interfering in the least with the indications. The sources of exterior error arising from radiant heat having been thus removed, it only remained to determine whether the heat evolved from the slow combustion of the chlorine and hydrogen exerted any perceptible action upon the instrument.

On suddenly cutting off the light from the sensitive gas, the action is found not to cease immediately. This absorption, after the exclusion of the light, may be owing to three causes.

1. The combination of the gases may continue for a short time after the removal of the light.

2. The hydrochloric acid formed may not be instantaneously removed by solution in the water.

3. The decrease of volume may be produced from the whole gas cooling down, owing to the heat of combustion no longer being added to it.

Experiments undertaken to determine which of these three suppositions was true, showed that this contraction could be almost completely accounted for, from the decrease of temperature of the gas, proving therefore that the first two assumptions were groundless. This contraction is so small that it does not in the least degree interfere with the accuracy of the observation.

In order still more fully to test our apparatus, an arrangement was made by means of which a small jet of coal-gas could be brought within different measured distances of the sensitive mixture, and the amount of the decomposition effected measured. The results thus obtained showed most exactly that the chemical action varied *inversely* as the square of the distance from the source of light, proving that the chemical rays obey the same general law as the visible rays, and affording another evidence of the accuracy of the results obtained by this instrument. Observations made with this arrangement also showed that exactly the same action was effected by the flame, placed at the same distance, at different times extending over a period of one month. The amounts of action effected by the same flame on various days from the 12th to the 26th of June, were 13·99, 13·83, 13·76, 13·84.

Photochemical Induction.

Chemical affinity, or the force which causes different bodies to unite and form chemical compounds, is in every particular case a certain definitive, unalterable quantity, which like all other forces (and matter itself) can neither be created nor destroyed. Hence it is incorrect to say that, under certain circumstances, a body attains an affinity which under other circumstances it loses. All that can be said in such a case is, that the body at one time follows the chemical attraction, and at another time is retarded by forces acting in an opposite direction. This opposite action may be conceived to be a resistance similar to that occurring in friction, or in the passage of electricity through conductors. This resistance is overcome when we facilitate the formation of a precipitate by agitation, or when chemical action is brought about by increase of temperature, catalytic action, or insolation. The existence of such a resistance presupposes a certain combining power, which may be measured by the amount of combination caused by the unit of force in the unit space of time.

The act by which this resistance is overcome, and the state reached in which combination takes place, we have called *Chemical Induction.* The laws which regulate the action of chemical affinity, when this resistance is fully eliminated, are as yet entirely unknown to us; and although the solution of this, the most important problem in our science, appears at present so far removed, it is at least desirable that facts should be found which may form starting-points in this new field of research. The interesting relations in which the phænomena of photochemical induction stand to these questions, have induced us to examine this part of the subject with particular attention.

The circumstance that the combination of chlorine and hydrogen does not take place immediately on exposure to the light, was observed by Draper in 1844. This was explained by him on the supposition that the chlorine, by exposure to the light, was transformed into a permanent allotropic modification which differed from ordinary chlorine by possessing greater combining power. We have convinced ourselves that this explanation of the phænomenon is incorrect, and have proved that it is connected with actions of a very peculiar nature which may be classed together under the term of Chemical Induction.

A number of experiments made with both diffuse solar and lamp-light, with different mixtures and various masses of sensitive gas for the purpose of determining the inductive action, showed that the times which elapse until the action begins, and until the maximum action is attained, are very different. We therefore next proceeded to examine the various causes which might influence the amount of the induction. First, the relation between the inductive action and the mass of the gas; secondly, the effect produced on the inductive action by variation of the amount of light, with a constant volume of gas; thirdly, the effect produced on the inductive action by allowing the gas to remain in the dark; and fourthly, the action of small quantities of foreign gases upon the induction.

Experiments carried on with the view of answering the first of these questions, showed that the inductive action, or the transition of the gas from the inactive to the active state, was retarded by increase of the mass of gas. A larger volume of gas had to be insolated for a longer time than a smaller volume before the maximum action ensued.

The influence of the amount of light on the rate of the inductive action was proved to be very great. The time required for induction diminished with increase of the amount of light, and in a quicker proportion than the increase of light.

On allowing a sensitive mixture, which had already been insolated, and had attained its maximum action, to stand for some time in the dark, it was found that upon readmission of light the action did not begin again immediately, but a new induction was necessary before the maximum action was attained. Hence the change effected upon the gas by the light is not a permanent one, for after the light is withdrawn, the gas returns to its original inactive state, and requires as long an insolation before the maximum action is again reached as in the case with the original gas. This fact is of itself sufficient to disprove Draper's statement that this active condition of the gas when once brought about by the action of light is permanent. We have also convinced ourselves by experiment, that the supposition of a non-permanent allotropic modification of either gas as an explanation of this phænomenon is untenable. The gases evolved by the electrolysis of hydrochloric acid were collected separately, and after each gas had separately traversed a tube which could be exposed to direct solar rays, the gases were allowed to mix, and were then passed into the apparatus. On examining the action of lamp-light on the mixture, no difference in the rapidity of the action could be perceived between the sensitive gas, the constituents of which had been separately exposed to direct sunlight, and that which had not been previously insolated. From these experiments it is seen that the explanation of the phænomenon of photochemical induction is not to be sought in any allotropic modification of either gas.

The effect produced by the presence of small traces of foreign gases upon the induction is very remarkable. We have found that the sensibility of the gaseous mixture depends entirely upon the absence of every trace of foreign gas. The retarding action of oxygen upon the mixture is the most marked; the addition of one per cent. of this gas to the chlorine and hydrogen mixture reduced the amount of action to $\frac{1}{50}$th; and the presence of a mere trace of this gas (probably not more than $\frac{1}{1000}$th per cent.) diminished the action to one half of the normal amount. Excess of either chlorine or hydrogen was found to act in the same manner, but not to such a remarkable extent. This retarding action of oxygen accounts for the very great length of time which it is necessary to lead the gas through the apparatus before the maximum action is attained.

The diminution of the sensibility of the chlorine and hydrogen mixture when foreign gases are present, gives a very accurate measure of the catalytic action effected by such gases.

The simple relations which exist between the amount of hydrochloric acid formed by the action of the light and the time of exposure, and amount of light, were first observed by Draper. We have confirmed his results in this respect, and have proved that both laws hold good for diffuse solar as well as for lamp-light. The relations are the following:—

1. The amount of chemical action effected by a constant source of light is directly proportional to the time of exposure.

2. The amount of chemical action effected by the light in equal times, is directly proportional to the amount of light.

(These laws are of course only applicable when the phænomena of induction have been fully eliminated.) A third relation which we have established is, that the amount of chemical action varies inversely as the square of the distance between the source of light and the sensitive mixture.

The experimental difficulties which accompany the examination of the relations existing between the amount of action and the mass of the gas, are of so peculiar and considerable a nature, that although we have been occupied for more than a month upon this branch of the subject, we have not as yet succeeded in arriving at the law which regulates the action. We have, however, already proved that after the light has passed through a certain depth of the gas, it is no longer capable of causing a combination to take place; and we have further proved that the depth at which the light ceases to act upon the mixture is very different for light from various sources. Differences in this respect have not only been found in light from different sources, but the diffuse solar light reflected from a perfectly cloudless sky is found to differ, not only in the quantity, but also in the *quality* of the chemical rays according to the sun's altitude. These interesting observations are not complete, but the results as yet obtained give promise of further important relations being established between the nature and amount of the chemical rays falling upon the earth's surface at various periods of the day.

Reduction of the Chemical Action of Light to an Absolute Measure.

The difficulty of obtaining any constant terrestrial source of light threw great obstacles in the way of reducing the chemical action of light to an absolute measure. The normal source of light which we have chosen for the calibration of our instrument (fig. 1), is a flame of pure carbonic oxide gas streaming from a large (3 millims in diameter) platinum burner, and issuing under a constant pressure of half a millimetre of water. By measuring the volumes of gas burned by different-sized flames and observing the chemical action produced, it was found that even with the homogenous flame of carbonic oxide, the chemical action increases in a greater ratio than the volume of gas burned. This relation between the action produced and the volume of gas burned, we have determined by accurate experiment, so that between certain limits we can calculate the amount of action produced by burning the unit volume of gas issuing at a given rate. We call *the unit amount of action for any instrument that produced by burning a cubic millimetre of carbonic oxide at the distance of one millimetre from the sensitive gas, issuing under the above-mentioned circumstances.*

The interesting relations of the reflexion, absorption, and polarization of the chemical rays, we hope to have the honour of laying before the Section on a future occasion.

Heidelberg, August 5th, 1856.

On the Trigonometry of the Parabola, and the Geometrical Origin of Logarithms. By the Rev. James Booth, *LL.D., F.R.S. &c.*

[A Communication ordered to be printed among the Reports.]

When engaged, some years ago, in researches on the geometrical properties of elliptic integrals, the results of which appeared in two memoirs printed in the Philosophical Transactions for 1852 and 1854, I was led to discuss a particular case of a cardinal theorem in the theory of elliptic integrals. Certainly no discovery was anticipated in matters so long known and thoroughly investigated as the theory of logarithms and the properties of the parabola. The propositions I now bring before the Section are, I believe, entirely new; and as they open a field of research in a department of geometrical science studied by every mathematician in the course of his reading, I thought the discussion of them might not prove unacceptable to the Mathematical Section of the British Association.

Section I.

I. Let the angles ω, ϕ, and χ, which we shall call *conjugate amplitudes,* be connected by the equation

$$\tan\omega=\tan\phi\sec\chi+\tan\chi\sec\phi. \quad \ldots \ldots \quad (1)$$

Hence ω is such a function of ϕ and χ as will render

$$\tan[\phi,\chi]=\tan\phi\sec\chi+\tan\chi\sec\phi.$$

We must adopt some appropriate notation to represent this function. Let the function $[\phi,\chi]$ be written $\phi\perp\chi$, so that

$$\tan(\phi\perp\chi)=\tan\phi\sec\chi+\tan\chi\sec\phi.$$

This equation must be taken as the *definition* of the function $\phi\perp\chi$.

In like manner we may represent by $\tan(\phi\top\chi)$ the expression

$$\tan\phi\sec\chi-\tan\chi\sec\phi.$$

From (1) we obtain

$$\sec\omega=\sec(\phi\perp\chi)=\sec\phi\sec\chi+\tan\phi\tan\chi. \quad \ldots \ldots \quad (2)$$

If we now differentiate the equation

$$\tan\omega=\tan\phi\sec\chi+\tan\chi\sec\phi,$$

we shall have

$$\left.\begin{aligned}\frac{d\omega}{\cos\omega}\cdot\sec\omega=\frac{d\phi}{\cos\phi}\cdot\sec\phi\sec\chi+\frac{d\chi}{\cos\chi}\tan\phi\tan\chi\\ +\frac{d\phi}{\cos\phi}\tan\phi\tan\chi+\frac{d\chi}{\cos\chi}\sec\phi\sec\chi\end{aligned}\right\}\ldots \quad (3)$$

Adding these expressions together, and introducing the relation established in (2), we find

$$\frac{d\omega}{\cos\omega}=\frac{d\phi}{\cos\phi}+\frac{d\chi}{\cos\chi}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

This is the differential equation which connects the amplitudes ω, ϕ, and χ.

As ω, ϕ, and χ are supposed to vanish together, we shall have by integration,

$$\int\frac{d\omega}{\cos\omega}=\int\frac{d\phi}{\cos\phi}+\int\frac{d\chi}{\cos\chi}; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

or in the more compact notation,

$$\int\sec\omega\, d\omega=\int\sec\phi\, d\phi+\int\sec\chi\, d\chi. \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)^*$$

Hence if ω, ϕ, and χ are connected by the relation assumed in (1), we shall have the simple relation between the integrals expressed in (5).

II. If in (1) we make the following imaginary substitutions, that is to say, put $\sqrt{-1}\sin\alpha$ for $\tan\phi$, $\sqrt{-1}\sin\beta$ for $\tan\chi$, $\sqrt{-1}\sin\gamma$ for $\tan\omega$, $\cos\alpha$ for $\sec\phi$, $\cos\beta$ for $\sec\chi$, $\cos\gamma$ for $\sec\omega$, and change $\perp$ into $+$ and $\top$ into $-$, we shall have $\sin\gamma=\sin(\alpha+\beta)=\sin\alpha\cos\beta+\sin\beta\cos\alpha$, the well-known expression for the sine of the sum of two arcs of a circle.

We shall show presently that an arc of a parabola measured from the vertex may be expressed by the integral $\int\sec\theta\, d\theta$, θ being the angle which the normal to the arc at its other extremity makes with the axis, or the angle between the normals drawn to the arc at its extremities.

$\perp$ and $\top$ may be called logarithmic plus and minus. As examples of the analogy which exists between the trigonometry of the parabola and that of the circle, the following expressions in parallel columns are given; premising that the formulæ marked by corresponding letters may be derived singly, one from the other, by the help of the preceding imaginary transformations.

In applying the imaginary transformations, or while $\tan\phi$ is changed into $\sqrt{-1}\sin\phi$, $\sec\phi$ into $\cos\phi$, and $\cot\phi$ into $-\sqrt{-1}\operatorname{cosec}\phi$, $\perp$ must be changed into $+$, and $\top$ into $-$; as also $\int\sec\phi d\phi$ into $\phi\sqrt{-1}$†.

The reader who has not proceeded beyond the elements of trigonometry may assume the fundamental formula as proved. He will find little else that requires more than a knowledge of plane trigonometry.

* The relation between the conjugate amplitudes ω, ϕ, and χ, was originally obtained in this way. In the theory of elliptic integrals, any three conjugate amplitudes are connected by the equation

$$\cos\omega=\cos\phi\cos\chi-\sin\phi\sin\chi\sqrt{1-i^2\sin^2\omega} \quad . \quad . \quad . \quad . \quad .$$

i is called the modulus. When we make $i=0$, we get

$\cos\omega=\cos\phi\cos\chi-\sin\phi\sin\chi$ or $\omega=\phi+\chi$ in the trigonometry of the circle. When we take the complement of 0, or make $i=1$, we get

$$\sec\omega=\sec\phi\sec\chi+\tan\phi\tan\chi \text{ or } \omega=\phi\perp\chi$$

in the trigonometry of the parabola. Whence, as above,

$$\tan\omega=\tan\phi\sec\chi+\tan\chi\sec\phi.$$

† I hardly need to remind the advanced reader, that this is the imaginary transformation by which we are enabled, in elliptic functions of the third order, to pass from the *circular* form to the *logarithmic* form, or to pass from the properties of a curve described on the surface of a sphere to its analogue described on the surface of a paraboloid of revolution. See the author's paper "On the Geometrical Properties of Elliptic Integrals," in the Philosophical Transactions for 1852, pp. 362, 368, and for 1854, p. 53.

III.

Trigonometry of the Parabola.

$$\tan(\phi \perp \chi) = \tan\phi \sec\chi + \tan\chi \sec\phi. \quad (\alpha)$$

$$\tan(\phi \top \chi) = \tan\phi \sec\chi - \tan\chi \sec\phi. \quad (\beta)$$

$$\sec(\phi \pm \chi) = \sec\phi \sec\chi \pm \tan\phi \tan\chi. \quad (\gamma)$$

$$\sin(\phi \perp \chi) = \frac{\sin\phi + \sin\chi}{1 + \sin\phi \sin\chi}. \quad (\delta)$$

$$\sin(\phi \top \chi) = \frac{\sin\phi - \sin\chi}{1 - \sin\phi \sin\chi}. \quad (\epsilon)$$

Let $\phi = \chi$.

$$\tan(\phi \perp \phi) = 2\tan\phi \sec\phi. \quad (\eta)$$

$$\sec(\phi \perp \phi) = \sec^2\phi + \tan^2\phi. \quad (\theta)$$

$$\sin(\phi \perp \phi) = \frac{2\sin\phi}{1 \dotplus \sin^2\phi}. \quad (\iota)$$

$$\sec\phi = \frac{e^{\int \sec\phi\, d\phi} + e^{-\int \sec\phi\, d\phi}}{2}, \tan\phi = \frac{e^{\int \sec\phi\, d\phi} - e^{-\int \sec\phi\, d\phi}}{2} \quad (\kappa)$$

$$1 + \sqrt{-1}\tan(\phi \perp \phi) = \{\sec\phi + \sqrt{-1}\tan\phi\}^2. \quad (\lambda)$$

$$\left.\begin{aligned} 2\tan^2\phi &= \sec(\phi \perp \phi) - 1 \\ 2\sec^2\phi &= \sec(\phi \perp \phi) + 1 \end{aligned}\right\}. \quad (\mu)$$

Let the amplitudes be $\phi \perp \chi$ and $\phi \top \chi$.

$$\tan(\phi \perp \chi)\tan(\phi \top \chi) = \tan^2\phi - \tan^2\chi. \quad (\nu)$$

Trigonometry of the Circle.

$$\sin(\phi + \chi) = \sin\phi \cos\chi + \sin\chi \cos\phi. \quad (a)$$

$$\sin(\phi - \chi) = \sin\phi \cos\chi - \sin\chi \cos\phi. \quad (b)$$

$$\cos(\phi \pm \chi) = \cos\phi \cos\chi \mp \sin\phi \sin\chi. \quad (c)$$

$$\tan(\phi + \chi) = \frac{\tan\phi + \tan\chi}{1 - \tan\phi \tan\chi}. \quad (d)$$

$$\tan(\phi - \chi) = \frac{\tan\phi - \tan\chi}{1 + \tan\phi \tan\chi}. \quad (e)$$

Let $\phi = \chi$.

$$\sin 2\phi = 2\sin\phi \cos\phi. \quad (\bar{e})$$

$$\cos 2\phi = \cos^2\phi - \sin^2\phi. \quad (th)$$

$$\tan 2\phi = \frac{2\tan\phi}{1 - \tan^2\phi}. \quad (i)$$

$$\cos\phi = \frac{e^{\phi\sqrt{-1}} + e^{-\phi\sqrt{-1}}}{2}, \quad \sin\phi = \frac{e^{\phi\sqrt{-1}} - e^{-\phi\sqrt{-1}}}{2\sqrt{(-1)}}. \quad (k)$$

$$1 + \sin 2\phi = (\cos\phi + \sin\phi)^2. \quad (l)$$

$$\left.\begin{aligned} 2\sin^2\phi &= 1 - \cos 2\phi \\ 2\cos^2\phi &= 1 + \cos 2\phi \end{aligned}\right\} \quad (m)$$

Let the amplitudes be $\phi + \chi$ and $\phi - \chi$.

$$\sin(\phi + \chi)\sin(\phi - \chi) = \sin^2\phi - \sin^2\chi. \quad (n)$$

Since $\sec(\phi\perp\phi)=\sec^2\phi+\tan^2\phi$, and $\tan(\phi\perp\phi)=2\tan\phi\sec\phi$,

$$\sec(\phi\perp\phi)+\tan(\phi\perp\phi)=(\sec\phi+\tan\phi)^2.$$

Again, as

$$\sec(\phi\perp\phi\perp\phi)=\sec(\phi\perp\phi)\sec\phi+\tan(\phi\perp\phi)\tan\phi,$$

and

$$\tan(\phi\perp\phi\perp\phi)=\tan(\phi\perp\phi)\sec\phi+\sec(\phi\perp\phi)\tan\phi,$$

it follows that

$$\sec(\phi\perp\phi\perp\phi)+\tan(\phi\perp\phi\perp\phi)=(\sec\phi+\tan\phi)^3,$$

and so on to any number of angles. Hence

$$\sec(\phi\perp\phi\perp\phi\ldots\text{ to }n\phi)+\tan(\phi\perp\phi\perp\phi\ldots\text{ to }n\phi)=(\sec\phi+\tan\phi)^n. \quad (6)$$

Introduce into the last expression the imaginary transformation

$$\tan\phi=\sqrt{-1}\sin\phi,$$

and we get Demoivre's imaginary theorem for the circle,

$$\cos n\phi+\sqrt{-1}\sin n\phi=\{\cos\phi+\sqrt{-1}\sin\phi\}^n.$$

This is a particular case of the more general theorem

$$\sec(\alpha\perp\beta\perp\gamma\perp\delta\perp\&c.)+\tan(\alpha\perp\beta\perp\gamma\perp\delta\perp\&c.)$$
$$=(\sec\alpha+\tan\alpha)(\sec\beta+\tan\beta)(\sec\gamma+\tan\gamma)(\sec\delta+\tan\delta)\ \&c.*$$

In the circle,

$$\frac{1+\tan\phi}{1-\tan\phi}=\sqrt{\frac{1+\sin 2\phi}{1-\sin 2\phi}}. \quad \text{(aa)}$$

Accordingly, in the parabola,

$$\frac{1+\sqrt{-1}\sin\phi}{1-\sqrt{-1}\sin\phi}=\sqrt{\frac{1+\sqrt{-1}\tan(\phi\perp\phi)}{1-\sqrt{-1}\tan(\phi\perp\phi)}}. \quad (\alpha\alpha)$$

In the circle,

$$\tan^2\phi=\frac{2\sin 2\phi-\sin 4\phi}{2\sin 2\phi+\sin 4\phi}; \quad \text{(bb)}$$

hence in the parabola,

$$\sin^2\phi=\frac{2\tan(\phi\perp\phi)-\tan(\phi\perp\phi\perp\phi\perp\phi)}{2\tan(\phi\perp\phi)+\tan(\phi\perp\phi\perp\phi\perp\phi)}. \quad (\beta\beta)$$

In the circle,

$$\cos 2\phi=\cos^4\phi-\sin^4\phi, \quad \text{(cc)}$$

hence in the parabola,

$$\sec(\phi\perp\phi)=\sec^4\phi-\tan^4\phi. \quad (\gamma\gamma)$$

In the circle,

$$\tan^2\phi-\tan^2\chi=\frac{\sin(\phi+\chi)\sin(\phi-\chi)}{\cos^2\phi\cos^2\chi}; \quad \text{(dd)}$$

therefore in parabolic trigonometry,

$$\sin^2\phi-\sin^2\chi=\frac{\tan(\phi\perp\chi)\tan(\phi\top\chi)}{\sec^2\phi\sec^2\chi}. \quad (\delta\delta)$$

In the circle,

$$\tan\phi=\sqrt{\frac{1-\cos 2\phi}{1+\cos 2\phi}}. \quad \text{(ee)}$$

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* Hence $\cos(\alpha+\beta+\gamma+\delta+\&c.)+\sqrt{-1}\sin(\alpha+\beta+\gamma+\delta+\&c.)$
$=(\cos\alpha+\sqrt{-1}\sin\alpha)(\cos\beta+\sqrt{-1}\sin\beta)(\cos\gamma+\sqrt{-1}\sin\gamma)(\cos\delta+\sqrt{-1}\sin\delta)\ \&c.$

Accordingly, in the trigonometry of the parabola,

$$\sin\phi=\sqrt{\frac{\sec(\phi\perp\phi)-1}{\sec(\phi\perp\phi)+1}}. \quad \text{(εε)}$$

If

$$\frac{\sin\phi}{\tan\psi}=\frac{\sin(\phi-\chi)}{\sin(\chi-\psi)}, \quad \text{(kk)}$$

it is easily shown that $\tan\phi$, $\tan\chi$, and $\tan\psi$ are in harmonic progression.

Hence it follows in parabolic trigonometry, that if

$$\frac{\tan\phi}{\tan\psi}=\frac{\tan(\phi\top\chi)}{\tan(\chi\top\psi)}, \quad (\kappa\kappa)$$

$\sin\phi$, $\sin\chi$, and $\sin\psi$ are in harmonic progression.

Let $\bar{\omega}$ be conjugate to ψ and ω, while ω, as before, is conjugate to ϕ and χ. Then we shall have

$$\tan\bar{\omega}=\tan(\phi\perp\chi\perp\psi),$$

or

$$\tan(\phi\perp\chi\perp\psi)=\tan\phi\sec\chi\sec\psi+\tan\chi\sec\psi\sec\phi$$
$$+\tan\psi\sec\phi\sec\chi+\tan\phi\tan\chi\tan\psi \quad (\varpi)$$

$$\sec(\phi\perp\chi\perp\psi)=\sec\phi\sec\chi\sec\psi+\sec\phi\tan\chi\tan\psi$$
$$+\sec\chi\tan\psi\tan\phi+\sec\psi\tan\phi\tan\chi. \quad (\rho)$$

and

$$\sin(\phi\perp\chi\perp\psi)=\frac{\sin\phi+\sin\chi+\sin\psi+\sin\phi\sin\chi\sin\psi}{1+\sin\chi\sin\psi+\sin\psi\sin\phi+\sin\phi\sin\chi}, \quad (\sigma)$$

whence in the trigonometry of the circle,

$$\sin(\phi+\chi+\psi)=\sin\phi\cos\chi\cos\psi+\sin\chi\cos\psi\cos\phi$$
$$+\sin\psi\cos\phi\cos\chi-\sin\phi\sin\chi\sin\psi. \quad \text{(p)}$$

$$\cos(\phi+\chi+\psi)=\cos\phi\cos\chi\cos\psi-\cos\phi\sin\chi\sin\psi$$
$$-\cos\chi\sin\psi\sin\phi-\cos\psi\sin\phi\sin\chi. \quad \text{(r)}$$

$$\tan(\phi+\chi+\psi)=\frac{\tan\phi+\tan\chi+\tan\psi-\tan\phi\tan\chi\tan\psi}{1-\tan\chi\tan\psi-\tan\psi\tan\phi-\tan\phi\tan\chi}. \quad \text{(s)}$$

We have here a remarkable illustration of that fertile principle of *duality* which may be developed to such an extent in every department of pure mathematical science.

The angle $\phi\perp\phi$ may be called the *duplicate* of the angle ϕ, the angle $\phi\perp\phi\perp\phi$ the *triplicate*, and the angle ($\phi\perp\phi$ to n terms) the *n-plicate* of the angle ϕ.

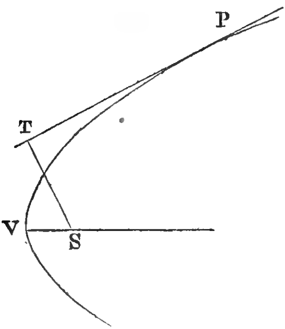
The reader will observe that in this paper the signs $\perp$ and $\top$ connect the angular magnitudes of the parabola, while numerical quantities are connected by + and —. Thus in the circle, we have $\phi+\chi$ and $a+b$ indifferently, while in the parabola we must use the notation $\phi\perp\chi$ or $\phi\top\chi$, but $a+b$ or $a-b$, as in the circle.

Section II.

IV. An expression for the length of a curve in terms of a perpendicular p let fall from a fixed point on a tangent to it, and making the angle θ with a line passing through the given point or pole, is found in most elementary works, namely $s=\int p d\theta+t$. In the following figure,

$$p=\text{ST}, \quad \theta=\text{VST}, \quad t=\text{PT}.$$

Fig. 1.



Let $\Pi(m.\theta)$ denote the length of the arc of a parabola whose parameter is $4m$, measured from the vertex to a point at which the tangent to the arc is inclined to the ordinate of that point to the axis by the angle θ. When $m=1$, the symbol becomes $\Pi(\theta)$.

In the parabola whose equation is $y^2=4mx$, the focus S is taken as the pole, and therefore $p=m\sec\theta$: while PT, or $t=m\sec\theta\tan\theta$.

The arc of a parabola, measured from the vertex, may therefore be expressed by the formula

$$\Pi(m.\theta)=m\sec\theta\tan\theta+m\int\sec\theta\,d\theta.$$

The difference between the arc and its subtangent t may be called the *tangential difference.*

For brevity, and for a reason which will presently be shown, the distance between the focus and the vertex of a parabola will be called its *modulus.* Hence the parameter of a parabola is equal to four times its modulus.

V. Let $\Pi(m.\omega)$, $\Pi(m.\phi)$, $\Pi(m.\chi)$ denote three parabolic arcs VD, VB VC, measured from the vertex V of the parabola. Let, moreover, ω, ϕ, and χ be *conjugate amplitudes.* Then

$$\left.\begin{aligned}\Pi(m.\omega)&=m\tan\omega\sec\omega+m\int\sec\omega\,d\omega\\ \Pi(m.\phi)&=m\tan\phi\sec\phi+m\int\sec\phi\,d\phi\\ \Pi(m.\chi)&=m\tan\chi\sec\chi+m\int\sec\chi\,d\chi\end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (7)$$

Whence, since $\int\sec\omega\,d\omega=\int\sec\phi\,d\phi+\int\sec\chi\,d\chi$, because ω, ϕ, and χ are conjugate amplitudes, we get, after some reductions,

$$\Pi(m.\omega)-\Pi(m.\phi)-\Pi(m.\chi)=2m\tan\omega\tan\phi\tan\chi. \quad . \quad . \quad (8)$$

It is not difficult to show that

$$\tan\omega\sec\omega-\tan\phi\sec\phi-\tan\chi\sec\chi=2\tan\omega\tan\phi\tan\chi.$$

Substitute for $\tan\omega$, $\sec\omega$, their values given in (1) and (2). Write $(\sec^2\phi-\tan^2\phi)$ and $(\sec^2\chi-\tan^2\chi)$ for 1, the coefficient of $\tan\phi\sec\phi$ and $\tan\chi\sec\chi$ in the preceding expression, and we shall obtain the foregoing result.

VI. Let y, y', y'' be the ordinates on the axis of the parabola of the extremities of the arcs $\Pi(m.\omega)$, $\Pi(m.\phi)$, and $\Pi(m.\chi)$. Then $y=2m\tan\omega$, $y'=2m\tan\phi$, $y''=2m\tan\chi$. Therefore $2m\tan\omega\tan\phi\tan\chi=\frac{yy'y''}{4m^2}$.

We have therefore the following theorem:—

The algebraic sum of the three conjugate arcs of a parabola, measured from the vertex, is equal to the product of the ordinates of their extremities divided by the square of the semiparameter.

To exemplify the preceding theorem. Let

$$\tan\omega=2,\qquad \tan\phi=\frac{1}{2},\qquad \tan\chi=\frac{\sqrt{5}}{2},$$

then

$$\sec\omega=\sqrt{5},\quad \sec\phi=\frac{\sqrt{5}}{2},\quad \sec\chi=\frac{3}{2};$$

and these values satisfy the fundamental equation of condition,

$$\tan\omega=\tan\phi\sec\chi+\tan\chi\sec\phi.$$

Now

$$\Pi(m.\omega)=m2\sqrt{5}+m\log(2+\sqrt{5})$$

$$\Pi(m.\phi)=m\frac{\sqrt{5}}{4}+m\log\left(\frac{1+\sqrt{5}}{2}\right)$$

$$\Pi(m.\chi)=m\frac{3\sqrt{5}}{4}+m\log\left(\frac{3+\sqrt{5}}{2}\right).$$

Hence, since $\log(2+\sqrt{5})=\log\left(\frac{1+\sqrt{5}}{2}\right)+\log\left(\frac{3+\sqrt{5}}{2}\right)$, we shall have

$$\Pi(m.\omega)-\Pi(m.\phi)-\Pi(m.\chi)=m\sqrt{5};\quad\ldots\quad(9)$$

and $m\sqrt{5}=2m\tan\omega\tan\phi\tan\chi$.

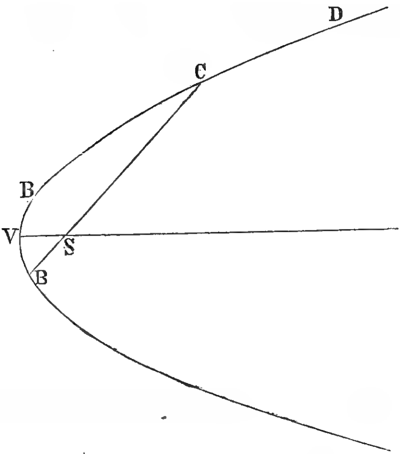
VII. If we call an arc measured from the vertex of a parabola an *apsidal* arc, to distinguish it from an arc taken anywhere along the parabola, the preceding theorem will enable us to express an arc of a parabola, taken anywhere along the curve, as the sum or difference of an apsidal arc and a right line.

Thus, let VCD be a parabola, S its focus, and V its vertex. Let $VB=\Pi(m.\phi)$, $VC=\Pi(m.\chi)$, $VD=\Pi(m.\omega)$, and let $\frac{yy'y''}{4m^2}=h$. Then (8) shows that the parabolic arc $(VC+VB)=\text{arc } VD-h$; and the parabolic arc $VD-VB=BD=VC+h$.

VIII. When the arcs $\Pi(m.\phi)$ and $\Pi(m.\chi)$ together constitute a focal arc, or an arc whose chord passes through the focus, $\phi+\chi=\frac{\pi}{2}$, and h is the ordinate of the arc VD. Accordingly we derive the following theorem:—

Any focal arc of a parabola is equal to the difference between the conjugate apsidal arc and its ordinate.

Fig. 2.



The relation between the amplitudes $\phi=\left(\frac{\pi}{2}-\chi\right)$ and ω in this case is given by the equation $\sin 2\phi=\frac{2\cos\omega}{1-\cos\omega}$. Thus when the focal chord makes an angle of 30° with the axis, we get $\cos\omega=\frac{1}{5}$, or $y=10m$. Here, therefore, the ordinate of the conjugate arc is ten times the modulus.

IX. When $\phi=\chi$, (8) is changed into

$$\Pi(m\,.\,\omega)-2\Pi(m\,.\,\phi)=2m\tan\omega\tan^2\phi\,; \quad . \quad . \quad . \quad . \quad (10)$$

or as $\tan\omega=2\tan\phi\sec\phi$, see (η) of III.,

$$\Pi(m\,.\,\omega)-2\Pi(m\,.\,\phi)=4m\tan^3\phi\sec\phi. \quad . \quad . \quad . \quad . \quad (11)$$

Let $\phi=45$, then $\Pi\left(m.\frac{\pi}{4}\right)$ is the arc of the parabola intercepted between the vertex and the focal ordinate; and as $\sec\omega=\sec(\phi+\phi)=\sec^2\phi+\tan^2\phi$, we shall have, since $\tan\phi=1$ and $\sec\phi=\sqrt{2}$, $\sec\omega=3$; therefore

$$\Pi(m\,.\sec^{-1}.3)-2\Pi\left(m.\frac{\pi}{4}\right)=4m\sqrt{2}.$$

Now as $\sec\omega=3$, $\tan\omega=2\sqrt{2}$, and the ordinate $Y=4m\sqrt{2}$, we may therefore conclude that *the parabolic arc, whose ordinate is $4m\sqrt{2}$, diminished by this ordinate, is equal to the arcs of the parabola between the focal ordinate produced both ways, and the vertex.*

X. It is easy to give an independent proof of this particular case without the help of the preceding theory.

The length of the parabolic arc whose amplitude is 45° will be found by the usual formula to be

$$\Pi\left(m.\frac{\pi}{4}\right)=m\sqrt{2}+m\log(1+\sqrt{2})\,;$$

and twice this arc is

$$2\Pi\left(m.\frac{\pi}{4}\right)=m2\sqrt{2}+m\log(3+2\sqrt{2});\text{ since }(1+\sqrt{2})^2=3+2\sqrt{2}.$$

The parabolic arc whose amplitude is $\sec^{-1}3$, is found in like manner to be

$$\Pi(m.\sec^{-1}3)=m3.2\sqrt{2}+m\log(3+\sqrt{2}).$$

Subtracting the former equation from the latter,

$$\Pi(m.\sec^{-1}3)-2\Pi\left(m.\frac{\pi}{2}\right)=4m\sqrt{2}.$$

Now the ordinate Y of the parabolic arc whose amplitude is $\sec^{-1}3$ is equal to

$$2m.2\sqrt{2}=4m\sqrt{2},$$

therefore

$$\Pi(m.\sec^{-1}3)-2\Pi\left(m.\frac{\pi}{4}\right)=\text{Y}.$$

It is easily shown that $4m\sqrt{2}$ is the radius of curvature of the extremity of the arc whose amplitude is 45°.

XI. To find a parabolic arc which shall differ from twice another parabolic arc by an algebraic quantity, may be thus exemplified.

Let

$$\tan\phi=2,\qquad \tan\omega=4\sqrt{5},$$
$$\sec\phi=\sqrt{5},\quad \sec\omega=9,$$

then

$$\Pi(m.\sec^{-1}9)=m36\sqrt{5}+m\log(9+4\sqrt{5})$$
$$2\Pi(m\tan^{-1}2)=2m\,2\sqrt{5}+m\log(2+\sqrt{5})^2.$$

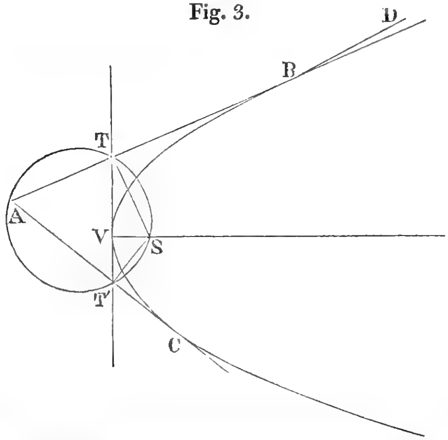
Consequently, since $(2+\sqrt{5})^2=9+4\sqrt{5}$,

$$\Pi(m.\sec^{-1}9)-2\Pi(m.\tan^{-1}2)=m32\sqrt{5}=2m\tan\omega\tan^2\phi. \quad (12)$$

XII. We may in all cases represent by a simple geometrical construction the ordinates of the conjugate parabolic arcs, whose amplitudes are ϕ, χ, and ω.

Let BC be a parabola whose focus is S and whose vertex is V. Let

Fig. 3.



VS=m; moreover, let VB be the arc whose amplitude is ϕ, and VC the arc whose amplitude is χ. At the points V, B, C draw tangents to the parabola; they will form a triangle circumscribing the parabola, whose sides represent the semi-ordinates of the conjugate arcs VB, VC, VD.

XIII. We know that the circle circumscribing this triangle passes through the focus of the parabola. Now

$VT = m\tan\phi$, $VT' = m\tan\chi$, $T'A = m\tan\phi\sec\chi$, $TA = m\tan\chi\sec\phi$; hence

$$T'A + TA = m(\tan\phi\sec\chi + \tan\chi\sec\phi),$$

therefore

$$m\tan\omega = T'A + TA.$$

When VB, VC together constitute a focal arc, the angle TAT′ is a right angle.

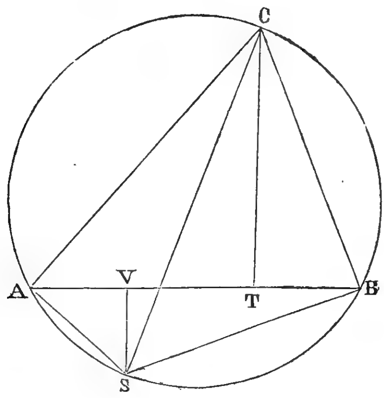
The diameter of this circle is $m\sec\phi\sec\chi$.

The demonstration of these properties follows obviously from the figure.

XIV. It may be convenient, by a simple geometrical illustration, to show the magnitude of the functions $\sec(\phi \perp \chi)$ and $\tan(\phi \perp \chi)$.

Let $SV = m$, $ASV = \chi$, $BSV = \phi$, the line AB being at right angles to SV. Through the three points ABS describe a circle. Draw the diameter SC, and join the point C with A and B. Let fall the perpendicular CT.

Fig. 4.



Then $m\sec(\phi \perp \chi) = SC + CT$, and $m\tan(\phi \perp \chi) = AC + CB$.

Moreover also it follows, since $\sec(\phi \perp \chi) + \tan(\phi \perp \chi) = (\sec\phi + \tan\phi)(\sec\chi + \tan\chi)$, as has been established in (6) of (III.), that

$$m(SC + CT + AC + CB) = (SB + BV)(AS + AV). \quad . \quad . \quad (13)$$

Of this theorem it is easy to give an independent geometrical demonstration. We have manifestly also

$$CT(SC + m + SA + SB) = (AC + AT)(BC + BT). \quad . \quad . \quad (14)$$

XV. Let $\bar{\omega}$ be the conjugate amplitude of ω and ψ, while ω is the conjugate amplitude, as before, of ϕ and χ. Then as

$$\int \sec\bar{\omega}\, d\bar{\omega} = \int \sec\omega\, d\omega + \int \sec\psi\, d\psi, \text{ and } \int \sec\omega\, d\omega = \int \sec\phi\, d\phi + \int \sec\chi\, d\chi,$$

we shall have

$$\int \sec \bar{\omega}\, d\bar{\omega} = \int \sec \phi\, d\phi + \int \sec \chi\, d\chi + \int \sec \psi\, d\psi \,; \quad . \quad . \quad . \quad (15)$$

and if $\Pi(m\,.\,\bar{\omega})$, $\Pi(m\,.\,\phi)$, $\Pi(m\,.\,\chi)$, and $\Pi(m\,.\,\psi)$ are four conjugate parabolic arcs,

$$\Pi(m.\bar{\omega}) - \Pi(m.\phi) - \Pi(m.\chi) - \Pi(m.\psi) = \\ 2m \tan(\phi \perp \chi) \tan(\phi \perp \psi) \tan(\chi \perp \psi), \quad . \quad . \quad . \quad . \quad (16)$$

which gives a simple relation between four conjugate parabolic arcs*.

When there are five parabolic arcs, whose normal angles ϕ, χ, ψ, v, Ω are related as above, namely

$$\omega = \phi \perp \chi, \quad \bar{\omega} = \omega \perp \psi = \phi \perp \chi \perp \psi, \quad \Omega = \phi \perp \chi \perp \psi \perp v,$$

we may proceed to obtain in like manner a formula which will connect five parabolic arcs, whose amplitudes are connected by the given law.

XVI. To exemplify the foregoing formula. Let us assume the following arithmetical values for the angles $\bar{\omega}$, ϕ, χ, ψ:—

$$\tan \bar{\omega} = \frac{10+4\sqrt{5}}{3}, \quad \tan \phi = \frac{1}{2}, \quad \tan \chi = \frac{\sqrt{5}}{2}, \quad \tan \psi = \frac{4}{3},$$

$$\sec \bar{\omega} = \frac{8+5\sqrt{5}}{3} \quad \sec \phi = \frac{\sqrt{5}}{2}, \quad \sec \chi = \frac{3}{2}, \quad \sec \psi = \frac{5}{3}.$$

Hence

$$\left.\begin{aligned}
&\Pi\left(m\,.\,\tan^{-1}\left[\frac{10+4\sqrt{5}}{3}\right]\right) = m(20+9\sqrt{5}) + m\frac{\sqrt{5}}{9} + m\log(6+3\sqrt{5}) \\
&\Pi\left(m\,.\,\tan^{-1}\frac{1}{2}\right) = m\frac{\sqrt{5}}{4} + m\log\left(\frac{1+\sqrt{5}}{2}\right) \\
&\Pi\left(m\,.\,\tan^{-1}\frac{\sqrt{5}}{2}\right) = m\frac{3\sqrt{5}}{4} + m\log\left(\frac{3+\sqrt{5}}{2}\right) \\
&\Pi\left(m\,.\,\tan^{-1}\frac{4}{3}\right) = m\frac{20}{9} + m\log 3.
\end{aligned}\right\}(17)$$

* This latter theorem may be proved as follows:—Since $\bar{\omega}$ is conjugate to ω and ψ, we shall have by (8),

$$\Pi(m\,.\,\bar{\omega}) - \Pi(m\,.\,\omega) - \Pi(m\,.\,\psi) = 2\,m \tan \bar{\omega} \tan \omega \tan \psi\,;$$

and since ω is conjugate to ϕ and χ,

$$\Pi(m\,.\,\omega) - \Pi(m\,.\,\phi) - \Pi(m\,.\,\chi) = 2\,m \tan \omega \tan \phi \tan \chi.$$

Hence, adding these equations, $\Pi(m\,.\,\omega)$ will disappear, and

$$\Pi(m\,.\,\bar{\omega}) - \Pi(m\,.\,\phi) - \Pi(m\,.\,\chi) - \Pi(m\,.\,\psi) = 2m \tan \omega [\tan \bar{\omega} \tan \psi + \tan \phi \tan \chi].$$

Now $\tan \bar{\omega} = \tan(\omega \perp \psi)$.

Therefore $\tan \bar{\omega} = \tan \omega \sec \psi + \tan \psi \sec \omega$.

But $\tan \omega = \tan \phi \sec \chi + \tan \chi \sec \phi$.

Substituting this value in the preceding equation, and multiplying by $\tan \psi$,

$$\tan \bar{\omega} \tan \psi = \tan \phi \sec \chi \sec \psi \tan \psi + \tan \chi \sec \phi \sec \psi \tan \psi \\ + \sec \phi \sec \chi \tan^2 \psi + \tan \phi \tan \chi \tan^2 \psi,$$

and

$$\tan \phi \tan \chi = \sec^2 \psi \tan \phi \tan \chi - \tan^2 \psi \tan \phi \tan \chi.$$

Consequently

$$\tan \bar{\omega} \tan \psi + \tan \phi \tan \chi = (\sec \psi \tan \phi + \sec \phi \tan \psi)(\sec \chi \tan \psi + \sec \psi \tan \chi) \\ = \tan(\phi \perp \psi) \tan(\chi \perp \psi), \text{ and } \omega = \phi \perp \chi.$$

Now adding the three latter equations together, and subtracting the sum from the former, the logarithms disappear, for

$$\log\left(\frac{1+\sqrt{5}}{2}\right)+\log\left(\frac{3+\sqrt{5}}{2}\right)+\log 3=\log\left[3.\left(\frac{1+\sqrt{5}}{2}\right)\left(\frac{3+\sqrt{5}}{2}\right)\right]$$

$$=\log(6+3\sqrt{5}); \quad \ldots \quad (18)$$

consequently

$$\Pi(m.\bar{\omega})-\Pi(m.\phi)-\Pi(m.\chi)-\Pi(m.\psi)$$

$$=m\left(\frac{160+73\sqrt{5}}{9}\right)=2m.2.\left(\frac{5+4\sqrt{5}}{6}\right)\left(\frac{12+5\sqrt{5}}{6}\right); \quad . \quad (19)$$

since $\tan(\phi \perp \chi)=2$, $\tan(\phi \perp \psi)=\frac{5+4\sqrt{5}}{6}$, and $\tan(\chi \perp \psi)=\frac{12+5\sqrt{5}}{6}$.

XVII. Let, in the preceding formula (16), $\phi=\chi=\psi$, and we shall have

$$\Pi(m.\bar{\omega})-3\Pi(m.\phi)=2m\tan^3(\phi \perp \chi)=16m\tan^3\phi\sec^3\phi.$$

We are thus enabled to assign the difference between an arc of a parabola whose amplitude is $\bar{\omega}=(\phi \perp \phi \perp \phi)$ and three times another arc.

If in (ϖ) (III.) we make $\phi=\chi=\psi$,

$$\tan\bar{\omega}=4\tan^3\phi+3\tan\phi. \quad \ldots \quad (20)$$

Introduce into this expression the imaginary transformation

$$\tan\phi=\sqrt{-1}\sin\theta, \text{ change } \perp \text{ into } +,$$

and we shall get $\sin 3\theta=-4\sin^3\theta+3\sin\theta$, which is the known formula for the trisection of a circular arc. (20) may therefore be taken as the formula which gives the trisection of an arc of a parabola.

XVIII. The following illustration of the triplication of the arc of a parabola may be given:—

Take the arcs whose ordinates Y and y are $4m$ and m respectively. Let $\bar{\omega}$ and ϕ be the amplitudes which correspond to these ordinates; then as

$$Y=2m\tan\bar{\omega}=4m, \quad \tan\bar{\omega}=2, \quad \sec\bar{\omega}=\sqrt{5};$$

and as

$$y=2m\tan\phi=m, \quad \tan\phi=\frac{1}{2}, \quad \sec\phi=\frac{\sqrt{5}}{2}.$$

Now these values of $\tan\bar{\omega}$ and $\tan\phi$ satisfy the equation of condition (20), namely

$$4\tan^3\phi+3\tan\phi=\tan\bar{\omega}.$$

But

$$\Pi(m.\tan^{-1}2)=m2\sqrt{5}+m\log(2+\sqrt{5}),$$

and

$$\Pi\left(m.\tan^{-1}\frac{1}{2}\right)=m\frac{1}{2}\frac{\sqrt{5}}{2}+m.\log\left(\frac{1+\sqrt{5}}{2}\right);$$

and three times this arc is

$$3\Pi\left(m.\tan^{-1}\frac{1}{2}\right)=m\frac{3}{4}\sqrt{5}+m\log(2+\sqrt{5}),$$

since

$$\left(\frac{1+\sqrt{5}}{2}\right)^3=2+\sqrt{5}.$$

Subtracting this latter equation from the former, the logarithms disappear, and we get

$$\Pi(m.\tan^{-1}2)-3\Pi\left(m.\tan^{-1}\frac{1}{2}\right)=\frac{m5\sqrt{5}}{4}=16m\tan^3\phi\sec^3\phi. \quad . \quad (21)$$

Now as the radius of curvature R is equal to the cube of the normal divided by the square of the semiparameter, $R=\frac{m5\sqrt{5}}{4}$, since $N=2m\sec\varpi$. We have therefore the following theorem:

The arc of the parabola whose ordinate is equal to 4m, or to the abscissa, diminished by the radius of curvature of its extremity, is equal to three times the arc whose ordinate is m, or one-fourth that of the former arc.

It is evident that the chord of the greater arc is inclined by an angle of 45 to the axis, or the ordinate is equal to the abscissa, while in the lesser arc the ordinate is four times the abscissa.

This is the point on the parabola up to which the ordinate is greater than the abscissa; beyond this point it is less than the abscissa.

XIX. Another example of the triplication of the arc of a parabola, or of finding an arc, which, diminished by an algebraic quantity, shall be equal to three times another arc, may be given.

Let

$$\tan\phi=\frac{3}{2}, \qquad \tan\varpi=18,$$

$$\sec\phi=\frac{\sqrt{13}}{2}, \quad \sec\varpi=5\sqrt{13}.$$

These values satisfy the equation of condition,

$$4\tan^3\phi+3\tan\phi=\tan\varpi.$$

Hence

$$\Pi(m.\tan^{-1}.18)=m\,90.\sqrt{13}+m\log(18+5\sqrt{13})$$

$$\Pi\left(m.\tan^{-1}\frac{3}{2}\right)=m\frac{3\sqrt{13}}{4}+m\log\left(\frac{3+\sqrt{13}}{2}\right);$$

and three times this arc is

$$3\Pi\left(m.\tan^{-1}\frac{3}{2}\right)=\frac{m9\sqrt{13}}{4}+m\log(18+5\sqrt{13}),$$

since

$$\left(\frac{3+\sqrt{13}}{2}\right)^3=18+5\sqrt{13}.$$

Therefore subtracting the latter equation from the former,

$$\Pi(m.\tan^{-1}18)-3\Pi\left(m.\tan^{-1}\frac{3}{2}\right)=m\frac{351\sqrt{13}}{4}=16m\left(\frac{3}{2}\right)^3\left(\frac{\sqrt{13}}{2}\right). \quad (22)$$

XX. To find the arc of a parabola which shall differ from n times a given arc by an algebraic quantity, may be thus investigated:—

Let ϕ be the amplitude of the given arc, then

$$\Pi(m.\phi)=m\sec\phi\tan\phi+m\log(\sec\phi+\tan\phi),$$

and n times this arc is

$$n\Pi(m.\phi)=nm\sec\phi\tan\phi+m\log(\sec\phi+\tan\phi)^n.$$

Let $\phi\perp\phi\perp\phi\perp\phi$ to n terms$=\Phi$, then

$$\Pi(m.\Phi)=m\sec\Phi\tan\Phi+m\log(\sec\Phi+\tan\Phi).$$

Now $\sec\Phi+\tan\Phi=(\sec\phi+\tan\phi)^n$, as shown in (6). Hence

$$\Pi(m\,.\,\Phi)-n\Pi(m\,.\,\phi)=m[\sec\Phi\tan\Phi-n\sec\phi\tan\phi].$$

Let $\sec\phi+\tan\phi=\lambda$, then $\sec\Phi+\tan\Phi=\lambda^n$, and

$$\sec\phi=\frac{\lambda+\lambda^{-1}}{2},\ \tan\phi=\frac{\lambda-\lambda^{-1}}{2}.$$

We have also $\sec\Phi=\dfrac{\lambda^n+\lambda^{-n}}{2}$, $\tan\Phi=\dfrac{\lambda^n-\lambda^{-n}}{2}$. Hence

$$\Pi(m\,.\,\Phi)-n\Pi(m\,.\,\phi)=m\left[\frac{(\lambda^{2n}-\lambda^{-2n})-n(\lambda^2-\lambda^{-2})}{4}\right].\quad .\ .\ .\ (23)$$

Let $n=3$, $\tan\phi=\frac{3}{4}$, $\sec\phi=\frac{5}{4}$, $\lambda=2$. Then

$$\Pi(m\,.\,\Phi)-3\Pi(m\,.\,\phi)=\frac{m}{4}\left(\frac{3\,.\,5}{4}\right)^3.$$

When $n=4$,

$$\Pi(m\,.\,\Phi)-4\Pi(m\,.\,\phi)=m\,\frac{5\,.\,3^3\,.\,457}{2^{10}};$$

and so may n be taken any other integral number.

XXI. The equation (20) affords a very simple mode of expressing the real root of a cubic equation.

Let the cubic equation under the ordinary form be $x^3+px=q$.

Let the parabolic equation $\tan^3\omega+\frac{3}{4}\tan\omega=\dfrac{\tan\Omega}{4}$ be written

$$\tan^3\omega+\frac{3m^2}{4}\tan\omega=\frac{m^3}{4}\tan\Omega,$$

hence

$$p=\frac{3}{4}m^2,\quad q=\frac{m^3}{4}\tan\Omega.$$

Now since the value of x found by the ordinary methods is

$$x=\sqrt[3]{\frac{q}{2}+\sqrt{\frac{p^3}{27}+\frac{q^2}{4}}}+\sqrt[3]{\frac{q}{2}-\sqrt{\frac{p^3}{27}+\frac{q^2}{4}}},$$

we shall have

$$2x=m\sqrt[3]{\sec\Omega+\tan\Omega}-m\sqrt[3]{\sec\Omega-\tan\Omega},\quad .\ .\ .\ (24)$$

and

$$m=2\sqrt{\frac{p}{3}},\quad \tan\Omega=\frac{3}{2}\frac{q}{p}\sqrt{\frac{3}{p}}.$$

When the sign of p is negative, the solution must be sought in the trigonometry of the circle.

SECTION III. *On the Geometrical Origin of Logarithms.*

XXII. In the trigonometry of the circle we find the formula

$$\vartheta=\tan\vartheta-\frac{\tan^3\vartheta}{3}+\frac{\tan^5\vartheta}{5}-\frac{\tan^7\vartheta}{7}+\&c.\quad .\ .\ .\ .\ .\ .\ (a)$$

And if we develope by common division the expression

$$\frac{1}{\cos\theta}=\frac{\cos\theta}{1-\sin^2\theta}=\cos\theta(1+\sin^2\theta+\sin^4\theta+\sin^6\theta+\&c.),$$

and integrate,

$$\int\frac{d\theta}{\cos\theta}=\int\sec\theta\,d\theta=\sin\theta+\frac{\sin^3\theta}{3}+\frac{\sin^5\theta}{5}+\frac{\sin^7\theta}{7}+\&c. \quad . \quad . \quad (b)$$

If we now inquire what, in the circle, is the magnitude of the *trigonometrical tangent* of the arc which differs from its subtangent, by the distance between the vertex and its focus; or, as the subtangent is 0 in the circle, and the focus is the centre, the question may be changed into this other, what is the trigonometrical tangent of the arc of a circle which is equal in length to the radius? This question would be answered by putting 1 for ϑ in (a), and reverting the series

$$1=\tan(1)-\frac{\tan^3(1)}{3}+\frac{\tan^5(1)}{5}-\frac{\tan^7(1)}{7}+\&c. \quad . \quad . \quad . \quad (c)$$

By this process we should get, in functions of the numbers of Bernoulli, the value of tan (1), as is shown in most treatises on trigonometry.

Let us now make a like inquiry in the case of the parabola, and ask what is the value of the *subtangent of the amplitude* which will give the difference between the arc of the parabola and this subtangent equal to the distance between the focus and the vertex of the parabola. Now if θ be this angle, we must have $\Pi(m\,.\,\theta)-m\sec\theta\tan\theta=m$. But in general, as shown in IV.,

$$\Pi(m\,.\,\theta)-m\sec\theta\tan\theta=m\int\sec\theta\,d\theta.$$

We must therefore have, in this case, $\int\sec\theta d\theta=1$. If we now revert the series (b), putting 1 for $\int\sec\theta\,d\theta$, we shall get from this particular value of the series, namely

$$1=\sin\theta+\frac{\sin^3\theta}{3}+\frac{\sin^5\theta}{5}+\frac{\sin^7\theta}{7}+\&c., \quad . \quad . \quad . \quad (d)$$

an arithmetical value for $\sin\theta$*. This we shall find to be $\sin\theta=\frac{e^1-e^{-1}}{e^1+e^{-1}}$, e being the number called the base of the Napierian logarithms. Hence $\sec\theta+\tan\theta=e$; or if we write ϵ for this particular value of θ to distinguish it from every other,

$$\sec\epsilon+\tan\epsilon=e=2{\cdot}718281828,\ \&c. \quad . \quad . \quad . \quad . \quad . \quad (25)$$

We are thus (for the first time, it is believed) put in possession of the geometrical origin of that quantity so familiarly known to mathematicians—the Napierian base. From the above equations we may derive

$$\sec\epsilon=\frac{e^1+e^{-1}}{2},\quad \tan\epsilon=\frac{e^1-e^{-1}}{2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (26)$$

or $$\tan\epsilon=1{\cdot}175201192,\ \text{whence}\ \epsilon={\cdot}8657606,$$

or $$\epsilon=49^\circ\ 36'\ 49''.$$

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* As $$\log\left(\frac{1+x}{1-x}\right)=2\left(x+\frac{x^3}{3}+\frac{x^5}{5}+\frac{x^7}{7}+\frac{x^9}{9}\ \&c.\right),$$

$x=\sin\theta$, then

$$\log\left(\frac{1+\sin\theta}{1-\sin\theta}\right)=2\left(\sin\theta+\frac{\sin^3\theta}{3}+\frac{\sin^5\theta}{5}+\frac{\sin^7\theta}{7}+\frac{\sin^9 x}{9}\ \&c.\right)=2,$$

or

$$\left(\frac{1+\sin\theta}{1-\sin\theta}\right)=e^2,\ \text{or}\ \left(\frac{1+\sin\theta}{\cos\theta}\right)^2=e^2.\ \ \textbf{Hence}\ \sec\theta+\tan\theta=e.$$

The corresponding arc of the parabola will be given by the following series:—

$$\Pi(m \,.\, \epsilon)=2m\left[1+\frac{2^1}{123}+\frac{2^3}{12345}+\frac{2^5}{1234567}\&c.\right],$$

since the subtangent in this case is equal to $m \sec \epsilon \tan \epsilon = \frac{m}{4}(e^2-e^{-2})$.

XXIII. If we now extend this inquiry, and ask what is the magnitude of the amplitude of the arc of the parabola which shall render the difference between this parabolic arc and its subtangent equal to n times the distance between the focus and the vertex, we shall have, as before, by the terms of the question,

$$\Pi(m \,.\, \theta)-m \sec \theta \tan \theta = nm.$$

But, in general, $$\Pi(m \,.\, \theta)-m \sec \theta \tan \theta = m\int \sec \theta \, d\theta ;$$

hence we must have

$$n=\int \sec \theta \, d\theta = \log(\sec \theta + \tan \theta), \text{ or } \sec \theta + \tan \theta = e^n.$$

Now we may solve this equation in two ways; either by making n a given number, and then determine the value of $\sec \theta + \tan \theta$, which may be called the *base*; or we may assign an arbitrary value to $\sec \theta + \tan \theta$, and then derive the value of n. Taking the latter course, let, for example,

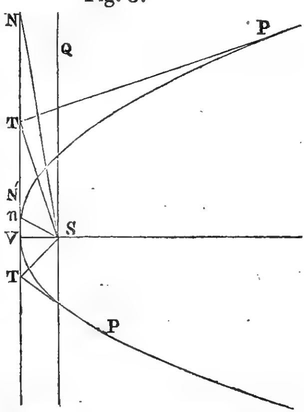
$$\sec \theta + \tan \theta = 10, \text{ then } n = \log 10;$$

or putting δ for this angle, $$\sec \delta + \tan \delta = 10. \quad . \; . \; . \; . \; . \; . \; . \; . \quad (27)$$

Hence as every number whose logarithm is to be exhibited must be put under the form $\sec \theta + \tan \theta$, which is of the form $1+x$, since the limiting value of $\sec \theta$ is 1, we discover the reason why in developing the logarithm of a number, the number itself must be put under the form $1+x$, and not simply under that of x.

XXIV. Given a number to find its logarithm, may be exhibited by the following geometrical construction:—

Fig. 5.



Let SVP be a parabola. Through the focus S draw the perpendicular SQ to the axis VS. Through V let a tangent of indefinite length be drawn, which may be called the *scalar*. On this tangent take the line VN to represent the given number. Join NS, and make the angle NST *always* equal to the angle NSQ. Draw TP at right angles to TS. This line will touch the parabola in the point P, and the arc of the parabola VP diminished by the subtangent PT, or the *tangential difference* for the arc VP, will be the logarithm of VN.

The line SN makes the angle $\left(\frac{\pi}{4}+\frac{\theta}{2}\right)$ with the axis of the parabola.

When $SN'=VS=$ the unit m, the angle $N'SQ$ is equal to half a right angle. Hence the point T in this case will coincide with V. The parabolic arc therefore vanishes, or the logarithm of 1 is 0. When $\sec \theta + \tan \theta = 1$, $\theta = 0$.

When the number is less than 1, the point N will fall below N' in the position n. Hence nSQ is greater than half a right angle. Therefore T will fall *below* the axis in the point T'; and if we draw through T' a tangent

T′p, it will give the *negative* arc of the parabola T′p, corresponding to the number Vn. Fractional numbers, or numbers between +1 and 0, must therefore be represented by the expression $m(\sec\theta - \tan\theta)$, since $\tan\theta$ changes its sign.

When the number is 0, n coincides with V, and the angle NSQ in this case is a right angle. Therefore the point T′ will be the intersection of VT′ and SQ. Hence T′ is at an infinite distance below the axis, and therefore the logarithm of +0 is $-\infty$.

Hence the tangential difference due to the amplitude θ, is the logarithm of the number $\sec\theta + \tan\theta$.

Consequently it follows that negative numbers have no logarithms, at least no real ones; and imaginary ones can only be educed by the transformation so often referred to, and this leads us to seek them among the properties of the circle. For as θ always lies between 0 and a right angle, or between 0 and the half of $\pm\pi$, $\sec\theta \pm \tan\theta$ is *always* positive; therefore *negative* numbers can have no real or *parabolic* logarithms, but they may have imaginary or *circular* logarithms; for in the expression

$$\log\{\cos\vartheta + \sqrt{-1}\sin\vartheta\} = \vartheta\sqrt{-1}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (28)$$

we may make $\vartheta = (2n+1)\pi$, and we shall get $\log(-1) = (2n+1)\pi\sqrt{-1}$.

Hence also, as the length of the parabolic arc TP, without reference to the sign, depends solely on the amplitude θ, it follows that the logarithm of $\sec\theta - \tan\theta$ is equal to the logarithm of $\sec\theta + \tan\theta$. We may accordingly infer that the logarithm of any number is equal to the logarithm of its reciprocal, with the sign changed, since $(\sec\theta + \tan\theta)(\sec\theta - \tan\theta) = 1$.

When θ is very large, $\sec\theta + \tan\theta = 2\tan\theta$ nearly. It follows, therefore, if we represent a large number by an ordinate of a parabola whose focal distance to the vertex is 1, the difference between the corresponding arc and its subtangent will represent its logarithm.

Since $VT + TP > \text{arc } VP$, therefore

$$VT > \text{arc } VP - TP > \log VN.$$

Hence VT or $\tan\theta$ is always greater than the logarithm of $(\sec\theta + \tan\theta)$ in the Napierian system of logarithms. This may be shown on other principles: thus

$$\sec\theta + \tan\theta = \frac{1+\sin\theta}{\cos\theta} = \frac{\sin^2\frac{\theta}{2} + \cos^2\frac{\theta}{2} + 2\sin\frac{\theta}{2}\cos\frac{\theta}{2}}{\cos^2\frac{\theta}{2} - \sin^2\frac{\theta}{2}} = \frac{1+\tan\frac{\theta}{2}}{1-\tan\frac{\theta}{2}}.$$

Let $\tan\frac{\theta}{2} = u$. Then

$$\log(\sec\theta + \tan\theta) = \log\left(\frac{1+u}{1-u}\right) = 2\left(u + \frac{u^3}{3} + \frac{u^5}{5} + \frac{u^7}{7} \text{ \&c.}\right),$$

$$\text{and } \tan\theta = \frac{2\tan\frac{\theta}{2}}{1-\tan^2\frac{\theta}{2}} = 2(u + u^3 + u^5 + u^7 + \text{ \&c.}).$$

Hence $$\tan\theta > \log(\sec\theta + \tan\theta),$$

or $\frac{n - n^{-1}}{2}$ is always greater than the logarithm of n.

XXV. Let $\int \sec\phi\, d\phi = p$, $\int \sec\chi\, d\chi = q$; then as

$$\int \sec\omega\, d\omega = \int \sec\phi\, d\phi + \int \sec\chi\, d\chi, \text{ see (5)},$$

$$\int \sec\omega\, d\omega = p + q, \text{ and } \omega = \phi \perp \chi.$$

Hence if ϕ be the amplitude which gives the tangential difference $=p$, and χ the amplitude which gives the tangential difference $=q$, $\phi \perp \chi$ is the amplitude which will give the tangential difference $=p+q$. In the same way we might show, that if ψ be the angle which gives this difference $=r$, $(\phi \perp \chi \perp \psi)$ is the angle which will give this difference $=p+q+r$.

Let α be the amplitude of the number A, and p its logarithm; β the amplitude of the number B, and q its logarithm; r the amplitude of the number C, and c its logarithm. Then

$$A = \sec\alpha + \tan\alpha, \quad B = \sec\beta + \tan\beta, \quad C = \sec\gamma + \tan\gamma,$$

and $\log A = p$, $\log B = q$, $\log C = r$, or

$$p + q + r = \log A + \log B + \log C.$$

We have also

$$ABC = (\sec\alpha + \tan\alpha)(\sec\beta + \tan\beta)(\sec\gamma + \tan\gamma)$$
$$= \sec(\alpha \perp \beta \perp \gamma) + \tan(\alpha \perp \beta \perp \gamma).$$

Now as p is the logarithm of $\sec\alpha + \tan\alpha$, q the logarithm of $\sec\beta + \tan\beta$, r the logarithm of $\sec\gamma + \tan\gamma$,

$p+q+r$ is the log of $\sec(\alpha \perp \beta \perp \gamma) + \tan(\alpha \perp \beta \perp \gamma)$, or of A B C,

as shown above. We may therefore conclude that

$$\log(ABC) = \log A + \log B + \log C. \quad . \quad . \quad . \quad . \quad . \quad (29)$$

XXVI. If ϵ be the angle which gives the difference between the parabolic arc and its subtangent equal to m, $(\epsilon \perp \epsilon)$ is the angle which will give this difference equal to $2m$, $(\epsilon \perp \epsilon \perp \epsilon)$ is the angle which will give this difference equal to $3m$, and so on to any number of angles. Hence, in the circle, if ϑ be the angle which gives the circular arc equal to the radius, 2ϑ is the angle which will give an arc equal to twice the radius, and so on for any number of angles. This is of course self-evident in the case of the circle, but it is instructive to point out the complete analogy which holds in the trigonometries of the circle and of the parabola.

Hence the amplitude which gives the difference between the parabolic arc and its subtangent equal to the semiparameter is given by the simple equation

$$\sec\epsilon' + \tan\epsilon' = e^2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (30)$$

And more generally, if ϵ^ν be the amplitude which gives the difference between the parabolic arc and its subtangent equal to n times the modulus, we shall have

$$\sec\epsilon^\nu + \tan\epsilon^\nu = e^n. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (31)$$

In the same way it may be shown that if ϵ_ν be the angle which gives the difference between the parabolic arc and its subtangent equal to $\frac{1}{n}$th part the modulus, we shall have

$$\sec\epsilon_\nu + \tan\epsilon_\nu = e^{\frac{1}{n}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (32)$$

Let the difference be equal to one-half the modulus, then $n=2$, and $\sec\epsilon_{\prime} + \tan\epsilon_{\prime} = e^{\frac{1}{2}}$.

This is easily shown.

Let $\epsilon_{\prime} \perp \epsilon_{\prime} = \epsilon$. Then $\sec(\epsilon_{\prime} \perp \epsilon_{\prime}) = \sec \epsilon = \sec^2 \epsilon_{\prime} + \tan^2 \epsilon_{\prime}$, and

$$\tan(\epsilon_{\prime} \perp \epsilon_{\prime}) = \tan \epsilon = 2 \sec \epsilon_{\prime} \tan \epsilon_{\prime}.$$

Therefore $\sec(\epsilon_{\prime} \perp \epsilon_{\prime}) + \tan(\epsilon_{\prime} \perp \epsilon_{\prime}) = \sec \epsilon + \tan \epsilon = e =$
$\sec^2 \epsilon_{\prime} + \tan^2 \epsilon_{\prime} + 2 \sec \epsilon_{\prime} \tan \epsilon_{\prime} = (\sec \epsilon_{\prime} + \tan \epsilon_{\prime})^2$.

Hence $$\sec \epsilon_{\prime} + \tan \epsilon_{\prime} = \sqrt{e}. \quad (33)$$

Since $\tan \epsilon = \frac{e^1 - e^{-1}}{2}, \quad \sec \epsilon = \frac{e^1 + e^{-1}}{2};$

$$\tan(\epsilon \perp \epsilon) = \frac{e^2 - e^{-2}}{2}, \quad \sec(\epsilon \perp \epsilon) = \frac{e^2 + e^{-2}}{2};$$

$$\tan(\epsilon \perp \epsilon \perp \epsilon) = \frac{e^3 - e^{-3}}{2}, \quad \sec(\epsilon \perp \epsilon \perp \epsilon) = \frac{e^3 + e^{-3}}{2};$$

$$\tan(\epsilon \perp \epsilon \perp \text{ to } n \text{ terms}) = \frac{e^n - e^{-n}}{2}, \quad \sec(\epsilon \perp \epsilon \text{ to } n \text{ terms}) = \frac{e^n + e^{-n}}{2}.$$

Therefore $2 \sec \epsilon \tan \epsilon = \tan(\epsilon + \epsilon)$

$$2 \sec(\epsilon \perp \epsilon) \tan(\epsilon \perp \epsilon) = \tan(\epsilon \perp \epsilon \perp \epsilon \perp \epsilon),$$

and generally

$$2 \sec(\epsilon \perp \epsilon \perp \text{ to } n \text{ terms}) \tan(\epsilon \perp \epsilon \perp \text{ to } n \text{ terms}) = \tan(\epsilon \perp \epsilon \perp \epsilon \perp \epsilon \perp \text{ to } 2n \text{ terms}).$$

Now $2 \sec(\epsilon \perp \epsilon \perp \text{ to } n \text{ terms}) \tan(\epsilon \perp \epsilon \perp \text{ to } n \text{ terms})$ is the portion of the tangent to the curve intercepted between the axis of the parabola and the point of contact whose amplitude, or the angle it makes with the ordinate is ($\epsilon \perp \epsilon \perp$ to n terms), while $\tan(\epsilon \perp \epsilon \perp \epsilon \perp \epsilon \perp \text{ to } 2n \text{ terms})$ is half the ordinate of that point of the curve whose amplitude is ($\epsilon \perp \epsilon \perp \epsilon \perp \epsilon$ to $2n$ terms). Hence we derive this very general theorem:—

That if two points be taken on a parabola such that the intercept of the tangent to the one between the point of contact and the axis shall be equal to one-half the ordinate to the other, the amplitudes of the two points will be

($\epsilon \perp \epsilon \perp$ to n terms) *and* ($\epsilon \perp \epsilon \perp \epsilon \perp \epsilon$ to $2n$ terms) *respectively.*

This theorem suggests a simple method of graphically finding a parabolic arc whose amplitude shall be the *duplicate* of the amplitude of a given arc. Let P be the point on the parabola whose amplitude is given. Draw the tangent PQ meeting the axis in Q. Erect VT at the vertex =PQ. Through T draw the tangent TP′, the amplitude of the arc VP′ will be the duplicate of the amplitude of the arc VP, or ($\theta \perp \theta \perp$ to n terms) and ($\theta \perp \theta \perp$ to $2n$ terms) will be the amplitudes of VP and VP′ respectively. We may therefore conclude that in the circle

$$2 \cos(\theta + \theta + \text{ to } n \text{ terms}) \sin(\theta + \theta + \text{ to } n \text{ terms}) = \sin(\theta + \theta + \theta + \theta \text{ to } 2n \text{ terms}).$$

XXVII. In the trigonometry of the circle, the sine of the arc, which is x times the radius, is given by the formula

$$\sin x = x - \frac{x^3}{123} + \frac{x^5}{12345} - \frac{x^7}{1234567}, \text{ \&c.},$$

and the cosine of the same arc by the formula

$$\cos x = 1 - \frac{x^2}{12} + \frac{x^4}{1234} - \frac{x^6}{123456}.$$

This suggests the analogous theorem, that if ξ be the angle or amplitude which gives the difference between the parabolic arc and its subtangent, or the *tangential difference* equal to x times the modulus, or the distance of the focus from the vertex, we shall have

$$\tan\xi = x + \frac{x^3}{123} + \frac{x^5}{12345} + \frac{x^7}{1234567}, \text{ \&c.,}$$

and

$$\sec\xi = 1 + \frac{x^2}{12} + \frac{x^4}{1234} + \frac{x^6}{123456}, \text{ \&c.} \quad . \quad . \quad . \quad . \quad . \quad . \quad (34)$$

But (Lacroix, 'Traité du Calcul Différentiel et du Calcul Intégral,' vol. iii. p. 442) the first of these two series is equivalent to

$$x\left(1+\frac{x^2}{\pi^2}\right)\left(1+\frac{x^2}{4\pi^2}\right)\left(1+\frac{x^2}{9\pi^2}\right)\left(1+\frac{x^2}{16\pi^2}\right), \text{ \&c.,}$$

and the latter to

$$\left(1+\frac{4x^2}{\pi^2}\right)\left(1+\frac{4x^2}{9\pi^2}\right)\left(1+\frac{4x^2}{25\pi^2}\right), \text{ \&c.}$$

Hence

$$\tan\xi = x\left(1+\frac{x^2}{\pi^2}\right)\left(1+\frac{x^2}{4\pi^2}\right)\left(1+\frac{x^2}{9\pi^2}\right)\left(1+\frac{x^2}{16\pi^2}\right)$$

$$\sec\xi = \left(1+\frac{4x^2}{\pi^2}\right)\left(1+\frac{4x^2}{9\pi^2}\right)\left(1+\frac{4x^2}{25\pi^2}\right), \text{ \&c.}$$

When x is small, $\tan\xi = x$. Let the angle ξ be divided into an indefinitely large number n of parts, so that $\xi = \frac{x}{n} \perp \frac{x}{n} \perp \frac{x}{n} \perp$ to n terms. Then

$$\sec\frac{x}{n} = 1, \quad \tan\frac{x}{n} = \frac{x}{n};$$

and as

$$\sec(\alpha \perp \alpha \perp \alpha \perp \text{ to } n \text{ terms}) + \tan(\alpha \perp \alpha \perp \alpha \perp \text{ to } n \text{ terms}) = (\sec\alpha + \tan\alpha)^n$$

$$\sec\xi + \tan\xi = \left(1+\frac{x}{n}\right)^n, \text{ but } \sec\xi + \tan\xi = e^x.$$

Hence when n is indefinitely large,

$$\left(1+\frac{x}{n}\right)^n = e^x.$$

In like manner,

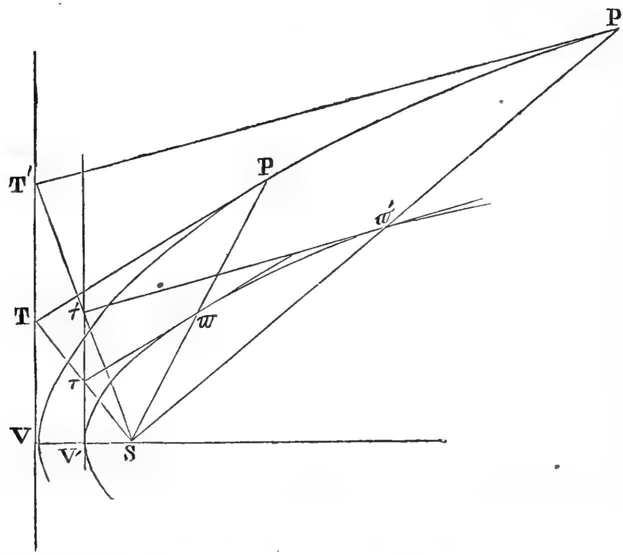
$$\left(1-\frac{x}{n}\right)^n = e^{-x}.$$

These theorems, given in Price's 'Treatise on the Infinitesimal Calculus,' vol. i. p. 32, are the limiting cases of the very general theorem established in (6).

XXVIII. To represent the decimal or any other system of logarithms by parabola.

The parabola which is to give the Napierian system of logarithms being drawn, whose vertical focal distance m is assumed as the *arithmetical unit,* let another *confocal* parabola be described having its axis coincident with the former, and such that its vertical focal distance shall be m'. The numbers being set off, as before, on the *scalar,* which is a tangent to the Napierian parabola at its vertex, the differences between the similar parabolic arcs and their subtangents in the two parabolas will give the logarithms in the two systems, of the *same* number drawn upon the *scalar*; for as all parabolas, like circles, are similar figures, and these are confocal and similarly placed, any line drawn through their common focus will cut the curves in the same angle, and cut off proportional segments. Hence the two triangles SPT and $S\varpi\tau$ are similar, and the tangential differences $PV-PT$ and $\varpi v-\varpi\tau$ are proportional to $4m$ and $4m'$, the parameters of the parabolas.

Fig. 6.



Let log denote the Napierian logarithm, and Log the decimal logarithm of the same number.

Draw the line ST, making the angle ϵ with the axis such that $\sec\epsilon+\tan\epsilon=e$. Then as $PV-PT:\varpi v-\varpi\tau::m:m'$, and $PV-PT=m=1$, since e is the base of the Napierian system; and $\varpi v-\varpi\tau=\text{Log }e$ on the decimal parabola, therefore

$$m:\text{Log }e::m:m',\ \text{ or }\ m'=\text{Log }e.$$

We may therefore conclude that the modulus of the decimal system is the decimal logarithm of the Napierian base e.

Draw the line ST′ making with the axis an angle δ, such that $\sec\delta+\tan\delta=10$. Now

$$P'V-PT':\varpi' v-\varpi'\tau'::m:m';$$

but

$$P'V-PT'=m\log 10,\ \text{ hence }\ \varpi' v-\varpi'\tau'=m'\log 10.$$

Now in order that 10 may be a *base*, or in other words, in order that its logarithm may be unity, we must have $\varpi' v-\varpi'\tau'=m'\log 10=m$; or if $m=1$, we must have $m'\log 10=1$, or $m'=\frac{1}{\log 10}$; that is, the parameter of the *Decimal* parabola must be reduced compared with that of the *Napierian* parabola in the ratio of log 10 : 1. Hence, as is well known, the modulus m' of the decimal system is the reciprocal of the Napierian logarithm of 10.

It is therefore obvious, that as any number of systems of logarithms may be represented by the differences between the *similar* arcs and their subtangents of as many *confocal* parabolas, the logarithms of the *same* number in these different systems will be to one another simply as the magnitudes of the parabolas whose arcs represent them, that is, as the parameters of these parabolas. Accordingly the moduli of these several systems are represented by the halves of the semiparameters of the several parabolas.

The Napierian parabola differs from the decimal and other parabolas in this, that the focal distance of its vertex is taken as the arithmetical unit, and that the *scalar* line on which the numbers are set off is a tangent to it at its vertex.

Hence if m, the vertical focal distance of the Napierian parabola, be taken as 1, the vertical focal distance m' of the decimal parabola is .4342 &c., or if $m=1$, $m'=.4342$ &c.

XXIX. In every system of logarithms whatever, the logarithm of 1 is 0.

For when the point T coincides with V, the corresponding point τ will coincide with v, whatever be the magnitude of its modulus m'. It is obvious that the circle whose radius is unity is analogous to the parabola whose vertical focal distance is unity, and that the Napierian logarithms have the same analogy to trigonometrical lines computed from a radius equal to unity, which any other system of logarithms has to trigonometrical lines computed from a radius r. As we may represent different systems of trigonometry by a series of concentric circles whose radii are 1, r, r' &c., so we may in like manner exhibit as many systems of logarithms by a series of confocal parabolas whose focal distances or moduli are 1, m', m'' &c. The modulus in the trigonometry of the parabola corresponds with the radius in the trigonometry of the circle. But while the base in the trigonometry of the parabola is real, in the circle it is imaginary. In the parabola, the angle of the base is given by the equation $\sec\theta+\tan\theta=e$. In the circle, $\cos\theta+\sqrt{-1}\sin\theta=e^{\theta\sqrt{-1}}$; and making $\theta=1$, we get

$$\cos(1)+\sqrt{-1}\sin(1)=e^{\sqrt{-1}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (35)$$

Hence, while e^1 is the *parabolic* base, $e^{\sqrt{-1}}$ is the *circular* base. Or as $[\sec\epsilon+\tan\epsilon]$ is the Napierian base, $[\cos(1)+\sqrt{-1}\sin(1)]$ is the *circular* or imaginary base. Thus

$$[\cos(1)+\sqrt{-1}\sin(1)]^{\vartheta}=\cos\vartheta+\sqrt{-1}\sin\vartheta.$$

We may therefore infer, speaking more precisely, that imaginary numbers have real logarithms, but an imaginary base. We may always pass from the real logarithms of the parabola to the imaginary logarithms of the circle by changing $\tan\theta$ into $\sqrt{-1}\sin\vartheta$, $\sec\theta$ into $\cos\vartheta$, and e^1 into $e^{\sqrt{-1}}$.

As in the parabola the angle θ is non-periodic, its limit being $\frac{1}{2}\pi$, while in the circle ϑ has no limit, it follows that while a number can have only one real or *parabolic* logarithm, it may have innumerable imaginary or *circular* logarithms.

Along the *scalar*, which is a tangent to the Napierian parabola at its vertex, as in the preceding figure, draw, measured from the vertex, a series of lines in geometrical progression,

$$m(\sec\theta+\tan\theta),\quad m(\sec\theta+\tan\theta)^2,\quad m(\sec\theta+\tan\theta)^3\ldots\ldots m(\sec\theta+\tan\theta)^n.$$

Join N, the general representative of the extremities of these right lines, with the focus S. Erect the perpendicular SQ, and make the angle NST *always* equal to the angle NSQ. The line ST will be $=m \sec \theta$, the line $ST_{,}$ $=m \sec(\theta \perp \theta)$, the line $ST_{,,}$ $=m \sec(\theta \perp \theta \perp \theta)$, &c., and we shall likewise have

$$VT=m \tan \theta, \quad VT_{,}=m \tan(\theta \perp \theta), \quad VT_{,,}=m \tan(\theta \perp \theta \perp \theta), \text{ \&c.}$$

This follows immediately from (6) of III.; for any integral power of $(\sec \theta + \tan \theta)$ may be exhibited as a linear function of $\sec \Theta + \tan \Theta$, writing Θ for $\theta \perp \theta \perp \theta$ ... &c., since

$$\sec(\theta \perp \theta \perp \theta \perp \theta \text{ \&c. to } n\theta) + \tan(\theta \perp \theta \perp \theta \perp \theta \text{ \&c. to } n\theta) = (\sec \theta + \tan \theta)^n.$$

Hence the parabola enables us to give a graphical construction for the angle $(\theta \perp \theta \perp \theta$ &c.) as the circle does for the angle $(\theta + \theta + \theta$ &c.).

XXX. The analogous theorem in the circle may be developed as follows: In the circle SBA take the arcs

$$AB=BB_{,}=B_{,}B_{,,}=B_{,,}B_{,,,} \ldots \text{ \&c. } =2\vartheta.$$

Let the diameter be D; then

$$SB=D \cos \vartheta, \quad SB_{,}=D \cos 2\vartheta, \quad SB_{,,}=D \cos 3\vartheta \ldots \text{ \&c.},$$

and

$$AB=D \sin \vartheta, \quad AB_{,}=D \sin 2\vartheta, \quad AB_{,,}=D \sin 3\vartheta \ldots \text{ \&c.}$$

Now as the lines in the second group are always at right angles to those in the first, and as such a change is denoted by the symbol $\sqrt{-1}$, we get

$$SB+BA=D\{\cos \vartheta + \sqrt{-1} \sin \vartheta\},$$

$$SB_{,}+B_{,}A=D\{\cos 2\vartheta + \sqrt{-1} \sin 2\vartheta\}=D\{\cos \vartheta + \sqrt{-1} \sin \vartheta\}^2;$$

$$SB_{,,}+B_{,,}A=D\{\cos 3\vartheta + \sqrt{-1} \sin 3\vartheta\}=D\{\cos \vartheta + \sqrt{-1} \sin \vartheta\}^3 \text{ \&c.}$$

. . . .

$$SB_n+B_nA=D[\cos n\vartheta + \sqrt{-1} \sin n\vartheta]=D[\cos \vartheta + \sqrt{-1} \sin \vartheta]^n.$$

When the points B′, B″ fall *below* the line SA, the angle θ becomes negative, and we get

$$SB'-B'A=\cos \vartheta - \sqrt{-1} \sin \vartheta$$

$$SB''-B''A=\cos 2\vartheta - \sqrt{-1} \sin 2\vartheta=[\cos \vartheta - \sqrt{-1} \sin \vartheta]^2.$$

. . . .

Therefore

$$\log(SB+BA)=\log(\cos \vartheta + \sqrt{-1} \sin \vartheta)=\vartheta \sqrt{-1}. \quad . \quad . \quad . \quad (36)$$

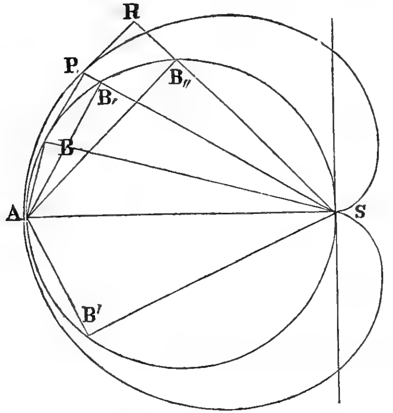
Let $\vartheta=1$, then

$$\log[\cos(1)+\sqrt{-1} \sin(1)]=\sqrt{-1}.$$

Hence generally $\vartheta\sqrt{-1}$ is the logarithm of the bent line whose extremities are at S and A, and which meets the circle in the point B, $ASB=\vartheta$.

It is singular that the imaginary formulæ in trigonometry have long been discovered, while the corresponding real expressions have escaped notice. Indeed it was long ago observed by Bernoulli, Lambert, and by others—the remark has been repeated in almost every treatise on the subject since—that the ordinates of an equilateral hyperbola might be expressed by real exponentials, whose exponents are sectors of the hyperbola; but the analogy, being illusory, never led to any useful results. And the analogy was illusory from this; that it so *happens* the length and area of a circle are expressed by the *same* function, while the area of an equilateral hyperbola is a function of an arc of a parabola, as will be shown further on. The true analogue of the circle is the parabola.

Fig. 7.



XXXI. There are some curious analogies between the parabola and the circle, considered under this point of view.

In the parabola, the points T, $T_{\prime}$, $T_{\prime\prime}$, which divide the lines

$$m(\sec\theta+\tan\theta),\quad m[\sec(\theta\perp\theta)+\tan(\theta\perp\theta)]$$

into their component parts, are upon tangents to the parabola. The corresponding points B, $B_{\prime}$, $B_{\prime\prime}$ in the circle are on the circumference of the circle.

In the parabola, the extremities of the lines $m(\sec\theta+\tan\theta)$ are on a right line VT; in the circle, the extremities of the bent lines are all in the point A.

The analogy between the expressions for parabolic and circular arcs will be seen by putting the expressions under the following forms:—

$$\text{Parabolic arc} - \log(\sec\theta+\tan\theta) - \text{subtangent} = 0,$$

$$\text{Circular arc} + \log(\cos\theta+\sqrt{-1}\sin\theta)^{\sqrt{-1}} - \text{subtangent} = 0. \quad . \ (37)$$

The locus of the point T, the intersections of the tangents to the parabola with the perpendiculars from the focus, is a right line; or in other words, while one end of a subtangent rests on the parabola, the other end rests on a right line. So in the circle; while one end of the subtangent rests on the circle, the other end rests on a *cardioide*, whose diameter is equal to that of the circle, and whose cusp is at S. SPA is the cardioide.

The length of the tangent VN to any point N is $m(\sec\theta+\tan\theta)=2m\tan\theta$, when θ is very large. The length of the cardioide is $2\text{D}\sin\vartheta$.

XXXII. The radius vector of a circle whose radius is r, drawn from any point on the circumference, and making the angle θ with a diameter drawn through this point, is given by the equation $\rho=2r\cos\theta$, and since the coinciding perpendicular from this point as focus on a tangent to a parabola is $p=m\sec\theta$, it follows that $\rho p=2mr$, a constant quantity. Hence the curves are polar reciprocals one of the other. The circumference of the circle passes through the focus of the parabola.

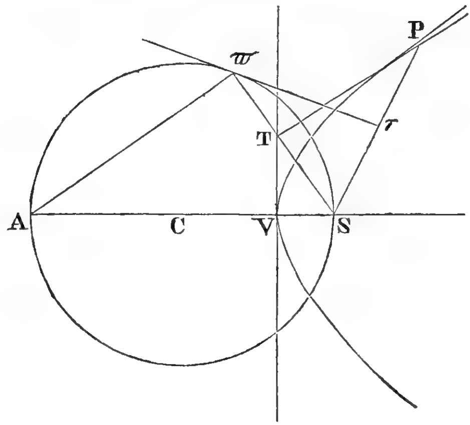
The centre of the circle is the pole of the directrix of the parabola.

As the extremities N of all the numbers measured along the *scalar* are on a right line VN, the reciprocals of these points will all pass through the point A, the pole of the scalar VN.

The point ϖ on the circle is the pole of the tangent PT to the parabola, and the point P on the parabola is the pole of the tangent $\varpi\tau$ to the circle.

As the parabolic arc VP—PT is the logarithm of the number VN, so the circular arc $A\varpi$ is the logarithm of the bent line $A\varpi+\varpi S$.

Fig. 8.



The locus of the point τ, the foot of the perpendicular from S on the tangent to the circle at ϖ, is a cardioide whose cusp is at S, and whose diameter is that of the circle.

While the circle is the *polar reciprocal* of the parabola, the *cardioide* is its *inverse* curve; for the cusp polar equation of the cardioide is $\rho=2r(1+\cos\theta)$, while the focal equation of the parabola is $\rho_{\prime}=\frac{2m}{1+\cos\theta}$; hence $\rho\rho_{\prime}=4m^2$.

Since the parabola and the circle are reciprocal polars one of the other, the circumference of the circle passing through the focus of the parabola, we have been able by the help of this reciprocal circle to give geometrical representations, as in XII. and XIV., of the properties of the trigonometry of the parabola.

There is this further analogy between the properties of the circle and those of the parabola,—that as the arc which is equal to the radius subtends no exact submultiple of any number of right angles, however large, so in the parabola the angle or amplitude which gives the tangential difference or logarithm equal to the modulus is incommensurable with any number of right angles. In the former there are 206265 seconds, in the latter there are 178575 seconds*.

The theorem given above, that a parabola is the reciprocal polar of a circle whose circumference passes through its focus, suggests a transformation which will exhibit a much closer analogy between the formulæ for the rectification of the parabola and the circle, than when the centre of the latter curve is taken as the origin.

XXXIII. Let SBA be a semicircle; let the origin be placed at S; let the angle

* It is worthy of investigation to ascertain whether any relation can be found between the angle or arc (1), and the angle ϵ which gives the tangential difference equal to the modulus in the parabola.

ASB$=\vartheta$; and let D, as before, be the diameter of the circle. Through B draw the tangent BP; let fall on this tangent the perpendicular SP$=p$, and let BP, the subtangent, be equal to t.

Now as $p=\mathrm{D}\cos^2\vartheta$, and $t=\mathrm{D}\sin\vartheta\cos\vartheta$, as also the angle ASP$=2\vartheta$, if we apply to the circle the formula for rectification in IV., we shall have the arc

$$\mathrm{AB}=s=2\mathrm{D}\int\cos^2\vartheta d\vartheta-\mathrm{D}\sin\vartheta\cos\vartheta. \quad . \quad . \quad . \quad . \quad (38)$$

The subtangent to the circle, which is exhibited in this formula, disappears in the actual process of integration; while in the parabola, the subtangent which is involved in the differential is evolved by the process of integration.

As in the parabola, the perpendicular from the focus on the tangent bisects the angle between the radius vector and the axis of the curve; so in the circle, the radius vector SB drawn from the extremity of the diameter, bisects the angle between the perpendicular SP and the diameter SA.

It is easily seen that while the line SB makes the angle θ with the axis, the line SP makes the angle 2θ, and the perpendicular SR on the tangent to the cardioide makes the angle 3θ with the axis.

Hence if we take the reciprocal polar of the cardioide, the line drawn perpendicular to the tangent at any point on the curve trisects the angle between the axis and this radius vector. Consequently the polar reciprocal of the cardioide is a curve, such that if a point be taken anywhere on the curve, and a perpendicular be drawn to the tangent at this point, it will trisect the angle between the axis and the radius vector drawn to the point of contact. Hence the reciprocal polar of the cardioide enables us to trisect an angle, in the same way as a parabola gives us the means to bisect it.

XXXIV. To determine the *tangential equation** of the reciprocal polar of the cardioide. The radius vector u of the cardioide being connected with the polar angle θ by the equation $u=r(1+\cos\theta)$, and p being the perpendicular on the tangent of its polar reciprocal, we shall have $\frac{1}{p}=\frac{1}{r}(1+\cos\theta)$. Let $\rho=\frac{1}{r}$, then as $\cos\theta=p\xi$ and $\frac{1}{p}=\sqrt{\xi^2+v^2}$, ξ and v being the tangential coordinates of the curve, we shall have

$$\sqrt{\xi^2+v^2}=\rho+\frac{\rho\xi}{\sqrt{\xi^2+v^2}}.$$

Consequently $$[(\xi^2+v^2)-\rho\xi]^2-\rho^2(\xi^2+v^2)=0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (39)$$

is the tangential equation of the reciprocal polar of the cardioide. The common equation of the cardioide, the cusp being the pole, is

$$[(x^2+y^2)-rx]^2-r^2(x^2+y^2)=0. \quad . \quad . \quad . \quad . \quad . \quad . \quad (40)$$

The reader will observe, that the equation between the coordinates x and y of the cardioide is exactly the same as the equation between the tangential coordinates ξ and v of the reciprocal polar of the cardioide.

XXXV. The quadrature of the hyperbola depends on the rectification of the parabola.

Through a point P on the parabola draw a line PQ parallel to the axis and terminated in the vertical tangent to the parabola at R. Take the line RQ *always* equal to the normal at P, the locus of Q is an equilateral hyperbola. For $x=2m\sec\phi$, and as before $y=2m\tan\phi$, therefore

$$x^2-y^2=4m^2, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (41)$$

* Tangential coordinates, p. 70.

the equation of an equilateral hyperbola whose centre is at V, the vertex of the parabola, and whose transverse axis is the parameter of the parabola.

The area of this curve, the elements being taken parallel to the axis, or the area between the curve and the vertical axis passing through V, is found by integrating the value of xdy.

Now

$$x=2m\sec\phi, \text{ and } y=2m\tan\phi,$$

therefore

$$\int xdy=4m^2\int\sec^3\phi d\phi=2m\left[m\sec\phi\tan\phi+m\int\sec\phi\, d\phi\right].$$

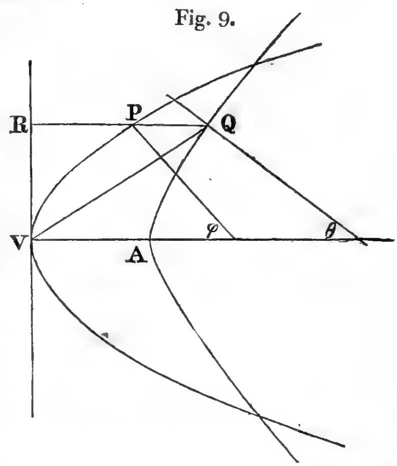
But it has been shown in IV. that

$$\Pi(m\,.\,\phi)=m\sec\phi\tan\phi+m\int\sec\phi\, d\phi.$$

Hence the hyperbolic area VAQR $= 2m\,\Pi(m\,.\,\phi)$. . . . . . . (42)

Therefore as the hyperbolic area is equal to a constant multiplied into the corresponding arc of the parabola, the evaluation of the hyperbolic area depends on the properties of logarithms.

Fig. 9.



It also follows, from what has been established in the preceding part of this paper, that hyperbolic areas may be multiplied and compared according to the laws which regulate parabolic arcs.

Let ϕ and θ be the angles in which the normals to the corresponding points of the parabola and the hyperbola cut the axis, then if ϕ and θ be these angles, it is easily shown, since VQ = normal at Q, that

$$\tan\theta=\sin\phi. \quad . \quad . \quad (43)$$

This expression will enable us to express the hyperbolic area in terms of the angle which the normal to the hyperbola makes with the axis instead of the parabolic amplitude; for as the parabolic amplitude ϕ is related to the normal angle of the hyperbola θ by the equation $\tan\theta=\sin\phi$,

$$2\tan\phi\sec\phi=\frac{2\tan\theta}{1-\tan^2\theta}=\tan 2\theta,$$

and

$$\sec\phi+\tan\phi=\sqrt{\sec 2\theta+\tan 2\theta}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (44)$$

Now

$$\Pi(m\,.\,\phi)=m\sec\phi\tan\phi+m\log(\sec\phi+\tan\phi),$$

or, substituting for the preceding values of ϕ,

$$2\Pi(m\,.\,\phi)=m\tan 2\theta+m\log(\sec 2\theta+\tan 2\theta);$$

but taking the amplitude 2θ,

$$\Pi(m\,.\,2\theta)=m\sec 2\theta\tan 2\theta+m\log(\sec 2\theta+\tan 2\theta).$$

Hence, subtracting the former from the latter,

$$\Pi(m\,.\,2\theta)-2\Pi(m\,.\,\phi)=m\tan 2\theta(\sec 2\theta-1).$$

Accordingly,

$$\text{the hyperbolic area } = m\Pi(m\,.\,2\theta)-m^2\tan 2\theta\,(\sec 2\theta-1). \quad . \quad (45)$$

Since

$$2\tan 2\theta=2\tan\phi\sec\phi,$$

we have

$$2\theta=\phi\perp\phi. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (46)$$

Hence the normal angles θ and ϕ of the *corresponding points* of the parabola and hyperbola are so related that

$$2\theta=\phi\perp\phi,$$

whence we might at once have inferred the relation established in (44), namely

$$(\sec\phi+\tan\phi)^2=\sec 2\theta+\tan 2\theta.$$

The points P and Q on the parabola and hyperbola respectively may be called *conjugate points.* They are always found in a line parallel to the axis.

If through the points P *and* Q *on the parabola and hyperbola we draw diameters to these curves, they will make angles with the normals to them at these points, one of which is the* duplicate *of the other.*

For these angles are 2θ and ϕ respectively,

but

$$2\theta=\phi\perp\phi.$$

XXXVI. Let P_0, P_1, P_2, P_3, P_4 . . . P_{n-1}, P_n be perpendiculars let fall from the focus on the n sides of a polygon circumscribing a parabola, and making with the axis the angles 0, θ, $\theta\perp\theta$, $\theta\perp\theta\perp\theta$, $\theta\perp\theta\perp\theta\perp\theta$, . . . to n terms respectively.

Let

$$\sec\theta+\tan\theta=u,$$

then

$$\left.\begin{array}{l}\sec(\theta\perp\theta)+\tan(\theta\perp\theta)=u^2,\\ \sec(\theta\perp\theta\perp\theta)+\tan(\theta\perp\theta\perp\theta)=u^3\end{array}\right\} \quad . \quad . \quad . \quad . \quad (47)$$

$$. \quad . \quad . \quad . \quad . \quad . \quad . \quad .$$

$$\sec(\theta\perp\theta\perp \;\ldots\; \text{to } n \text{ terms})+\tan(\theta\perp\theta\perp \text{ to } n \text{ terms})=u^n.$$

Hence as

$$\left.\begin{array}{l}2P_0=m(u^0+u^{-0})\\ 2P_1=m(u^1+u^{-1})\\ 2P_2=m(u^2+u^{-2})\\ \quad . \quad . \quad . \quad . \quad . \quad . \\ 2P_n=m(u^n+u^{-n}),\end{array}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (48)$$

we shall have

$$2\,.\,2\,.\,P_n\,.\,P_1=m^2(u^n+u^{-n})(u^1+u^{-1})$$
$$=m^2\Big[(u^{n+1}+u^{-(n+1)})+(u^{n-1}+u^{-(n-1)})\Big],$$

or

$$2P_n\,.\,P_1=m(P_{n+1}+P_{n-1});$$

but

$$P_1=m\sec\theta,$$

therefore

$$\sec\theta\, P_n = \frac{P_{n+1}+P_{n-1}}{2}, \quad \ldots\ldots\ldots \quad (49)$$

or *any perpendicular multiplied by the secant of the first amplitude, is an arithmetical mean between the perpendiculars immediately preceding and following it.* Thus, for example, $P_0=m$, $P_1=m\sec\theta$, $P_2=m\sec(\theta\perp\theta)$, or

$$\sec\theta\, m\sec\theta = \frac{m+m\sec(\theta\perp\theta)}{2};$$

but

$$\sec(\theta\perp\theta)=\sec^2\theta+\tan^2\theta;$$

hence the proposition is manifest.

Again, as hence

$$\left.\begin{array}{ll} 2P_0=m(u^0+u^0), & 2\cdot2\cdot P_0\,P_1=m^2(u^1+u^{-1}+u^1+u^{-1}). \\ 2P_1=m(u+u^{-1}), & 2\cdot2\cdot P_1\,P_2=m^2(u^3+u^{-3}+u^1+u^{-1}). \\ 2P_2=m(u^2+u^{-2}), & 2\cdot2\cdot P_2\,P_3=m^2(u^5+u^{-5}+u^1+u^{-1}). \\ 2P_3=m(u^3+u^{-3}), & 2\cdot2\cdot P_3\,P_4=m^2(u^7+u^{-7}+u^1+u^{-1}). \end{array}\right\}\ldots (50)$$

$$\ldots\ldots\ldots\ldots\ldots$$

$$\ldots\ldots\ldots\ldots\ldots$$

$$2P_n=m(u^n+u^{-n}), \qquad 2\cdot2\cdot P_{n-1}\,P_n=m^2(u^{2n-1}+u^{-(2n-1)}+u^1+u^{-1}).$$

We have, therefore, adding the preceding expressions,

$$\left.\begin{array}{l} 2[P_0P_1+P_1\,P_2+P_2\,P_3+P_3\,P_4 \quad\ldots\ldots\quad P_{n-1}P_n]= \\ m\left[+P_1+P_3+P_5+P_7 \quad\ldots\ldots\quad P_{2n-1}+(n)\,P_1\right], \end{array}\right\}\cdot \quad (51)$$

or twice the sum of all the products of the perpendiculars taken two by two up to the n*th, is equal to the sum of all the odd perpendiculars up to the* $(2n-1)$*th* $+n$ *times the first perpendicular.*

Thus, taking the first three perpendiculars,

$$P_0=m,\ P_1=m\sec\theta,\ P_2=m\sec(\theta\perp\theta)=m(\sec^2\theta+\tan\theta),$$

$$P_3=m\sec(\theta\perp\theta\perp\theta)=m(4\sec^3\theta-3\sec\theta);$$

then the truth of the proposition may be shown in this particular case for

$$2[P_0\,P_1+P_1\,P_2]=4m^2\sec^3\theta=m(P_1+P_3+2P_1).$$

Again, since

$$2P_{2n}=m(u^{2n}+u^{-2n}),$$

and

$$4P_n^2=m^2(u^{2n}+2+u^{-2n}),$$

we shall have

$$2P_n^2-m^2=mP^{2n}. \quad\ldots\ldots\ldots\ldots \quad (52)$$

Thus, for example, *twice the square of the perpendicular on the fifth side of the polygon diminished by the square of the modulus, is equal to the tenth perpendicular multiplied by the modulus.*

In the same way we may show that

$$4P_n^3-3m^2P_n=m^2P_{3n}.$$

Let $n=5$ and $m=1$, then *four times the cube of the fifth perpendicular, diminished by three times the same perpendicular, is equal to the fifteenth perpendicular, or to the perpendicular on the fifteenth side of the polygon.*

XXXVII. Since

$$\log u = u - u^{-1} - \tfrac{1}{2}(u^2 - u^{-2}) + \tfrac{1}{3}(u^3 - u^{-3}) - \tfrac{1}{4}(u^4 - u^{-4}), \text{ \&c.},$$

and as

$$u - u^{-1} = 2\tan\theta,\ u^2 - u^{-2} = 2\tan(\theta \perp \theta),$$

$$u^n - u^{-n} = 2\tan(\theta \perp \theta \perp \theta \perp \text{to } n \text{ terms}),$$

while

$$u = \sec\theta + \tan\theta.$$

We have therefore

$$\log u = \frac{\text{PV} - \text{PT}}{2} = \tan\theta - \tfrac{1}{2}\tan(\theta \perp \theta) + \tfrac{1}{3}\tan(\theta \perp \theta \perp \theta, \text{ \&c.}). \quad (53)$$

We may convert this into an expression for the arc of a circle by changing $\perp$ into $+$, tan into $\sqrt{-1}$ sin, and the parabolic arc into the circular arc multiplied by $\sqrt{-1}$.

Hence, since PT in the circle is equal to 0,

$$\frac{\theta}{2} = \sin\theta - \tfrac{1}{2}\sin 2\theta + \tfrac{1}{3}\sin 3\theta - \tfrac{1}{4}\sin 4\theta,$$

a formula given in Lacroix, 'Traité du Calcul Différentiel et du Calcul Intégral,' tom. i. p. 94.

XXXVIII. In the trigonometry of the circle, the sines and cosines of multiple arcs may be expressed in terms of powers of the sines and cosines of the simple arcs. Thus

$$\left.\begin{aligned}
\cos 2\theta &= 2\cos^2\theta - 1\\
\cos 3\theta &= 4\cos^3\theta - 3\cos\theta\\
\cos 4\theta &= 8\cos^4\theta - 8\cos^2\theta + 1\\
\cos 5\theta &= 16\cos^5\theta - 20\cos^3\theta + 5\cos\theta\\
\cos 6\theta &= 32\cos^6\theta - 48\cos^4\theta + 18\cos^2\theta - 1\\
&\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\\
\sin 2\theta &= \sin\theta\,(2\cos\theta)\\
\sin 3\theta &= \sin\theta\,(4\cos^2\theta - 1)\\
\sin 4\theta &= \sin\theta\,(8\cos^3\theta - 4\cos\theta)\\
\sin 5\theta &= \sin\theta\,(16\cos^4\theta - 12\cos^2\theta + 1)\\
\sin 6\theta &= \sin\theta\,(32\cos^5\theta - 32\cos^3\theta + 6\cos\theta).
\end{aligned}\right\}\quad \cdot\ \cdot\ (54)$$

Hence in the trigonometry of the parabola,

$$\left.\begin{aligned}
\sec(\theta\perp\theta) &= 2\sec^2\theta - 1\\
\sec(\theta\perp\theta\perp\theta) &= 4\sec^3\theta - 3\sec\theta\\
\sec(\theta\perp\theta\perp\theta\perp\theta) &= 8\sec^4\theta - 8\sec^2\theta + 1\\
\sec(\theta\perp\theta\perp\theta\perp\theta\perp\theta) &= 16\sec^5\theta - 20\sec^3\theta + 5\sec\theta\\
\sec(\theta\perp\theta\perp\theta\perp\theta\perp\theta\perp\theta) &= 32\sec^6\theta - 48\sec^4\theta + 18\sec^2\theta - 1\\
&\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\\
\tan(\theta\perp\theta) &= \tan\theta\,(2\sec\theta)\\
\tan(\theta\perp\theta\perp\theta) &= \tan\theta\,(4\sec^2\theta - 1)\\
\tan(\theta\perp\theta\perp\theta\perp\theta) &= \tan\theta\,(8\sec^3\theta - 4\sec\theta)\\
\tan(\theta\perp\theta\perp\theta\perp\theta\perp\theta) &= \tan\theta\,(16\sec^4\theta - 12\sec^2\theta + 1)\\
\tan(\theta\perp\theta\perp\theta\perp\theta\perp\theta\perp\theta) &= \tan\theta\,(32\sec^5\theta - 32\sec^3\theta + 6\sec\theta)\\
&\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot
\end{aligned}\right\}\ (55)$$

The preceding formulæ may easily be verified.

If we add in the above series any two corresponding secants and tangents, the sum will be an integral power of $\sec\theta+\tan\theta$.

Thus $$\sec(\theta \perp \theta)+\tan(\theta \perp \theta)=(\sec\theta+\tan\theta)^2.$$

Again, since in the circle

$$\left.\begin{aligned}
\cos\theta&=\cos\theta\\
2\cos^2\theta&=\cos 2\theta+1\\
4\cos^3\theta&=\cos 3\theta+3\cos\theta\\
8\cos^4\theta&=\cos 4\theta+4\cos 2\theta+1\\
&\ldots\ldots \text{ and}\\
\sin\theta&=\sin\theta\\
2\sin^2\theta&=-\cos 2\theta+1\\
4\sin^3\theta&=-\sin 3\theta+3\sin\theta\\
8\sin^4\theta&=\cos 4\theta-4\cos 2\theta+3.
\end{aligned}\right\}(56)$$

Hence in parabolic trigonometry,

$$\left.\begin{aligned}
\sec\theta&=\sec\theta\\
2\sec^2\theta&=\sec(\theta\perp\theta)+1\\
4\sec^3\theta&=\sec(\theta\perp\theta\perp\theta)+\sec 3\theta\\
8\sec^4\theta&=\sec(\theta\perp\theta\perp\theta\perp\theta)+4\sec(\theta\perp\theta)+1\\
&\ldots\ldots\\
\tan\theta&=\tan\theta\\
2\tan^2\theta&=\sec(\theta\perp\theta)-1\\
4\tan^3\theta&=\tan(\theta\perp\theta\perp\theta)-3\tan\theta\\
8\tan^4\theta&=\sec(\theta\perp\theta\perp\theta\perp\theta)-4\sec(\theta\perp\theta)+3.
\end{aligned}\right\}(57)$$

XXXIX. The roots of the expression

$$z^{2n}-2az^n+1=0 \quad \ldots\ldots \quad (58)$$

may be represented under the form $\cos A+\sqrt{-1}\sin A$, when a is *less* than 1. This has long been known. It is not difficult to show that when a is *greater* than 1, the roots may be exhibited under the form

$$\sec A+\tan A. \quad \ldots\ldots \quad (59)$$

Since a is greater than 1, let $a=\sec\theta$, and let θ be divided into n angles ϕ, connected by the relation

$$\phi \perp\phi \perp\phi \perp\phi \;\; \&c.=\theta; \quad \ldots\ldots \quad (60)$$

and it has been shown in (6) that

$$\sec(\phi\perp\phi\perp\phi\perp\phi \text{ to } n\phi)+\tan(\phi\perp\phi\perp\phi\perp\phi \text{ to } n\phi)=(\sec\phi+\tan\phi)^n.$$

Let $\sec\phi+\tan\phi=u$, then $2\sec\phi=u^1+u^{-1}$,

and therefore $2\sec\theta=2\sec(\phi\perp\phi\perp\phi\perp \text{to } n\phi)=u^n+u^{-n}$.

Substitute this value of $2\sec\theta$ in (58), and we shall have

$$z^{2n}-(u^n+u^{-n})z^n+1=0,$$

or resolving into factors,

$$\left(\frac{z^n}{u^n}-1\right)\left(z^nu^n-1\right)=0. \quad \ldots\ldots \quad (61)$$

Now finding the roots of these binomial factors by the ordinary methods, we shall have, since $u=\sec\phi+\tan\phi$,

$$\left.\begin{array}{l} z=(\sec\phi+\tan\phi)\text{ (multiplied successively into the } n \text{ roots of unity)} \\ \quad\text{and } (\sec\phi-\tan\phi)\text{ (multiplied successively into the } n \text{ roots of unity).}\end{array}\right\} \quad (62)$$

We are thus enabled to exhibit the $2n$ roots when $a>1$.

Thus, let $n=3$, then the equation becomes

$$z^6-2\sec\theta\, z^3+1=0,$$

and

$$\phi+\phi+\phi=\theta;$$

consequently the six roots are

$$\left.\begin{array}{l}(\sec\phi+\tan\phi)\left(1, \dfrac{-1\pm\sqrt{-3}}{2}\right), \\ \text{and} \\ (\sec\phi-\tan\phi)\left(1, \dfrac{-1\pm\sqrt{-3}}{2}\right).\end{array}\right\} \quad . \quad . \quad . \quad . \quad (63)$$

By the same method we may exhibit the roots when a is less than 1, or $a=\cos\theta$.

XL. We might pursue this subject very much further, but enough has been done to show the analogy which exists between the trigonometry of the circle and that of the parabola. As the calculus of angular magnitude has always been referred to the circle as its type, so the calculus of logarithms may in precisely the same way be referred to the parabola as its type.

The obscurities which hitherto have hung over the geometrical theory of logarithms are, it is hoped, now removed. It is possible to represent logarithms, as elliptic integrals usually have been represented, by curves devised to exhibit some special property only; and accordingly such curves, while they place before us the properties they have been devised to represent, fail generally to carry us any further. The close analogies which connect the theory of logarithms with the properties of the circle will no longer appear inexplicable.

To devise a curve that shall represent one condition of a theory, or one truth of many, is easy enough. Thus, if we had first obtained by pure analysis all the properties of the circle without any previous conception of its form, and then proceeded to find a geometrical figure which should satisfy all the conditions developed in the theory, we might hit upon several geometrical curves that would satisfy some of the established conditions, though not all. That all lines passing through a fixed point and terminated both ways by the curve shall be bisected in that point, would be satisfied as well by an ellipse or an hyperbola as by a circle. That all the lines passing through this point and terminated both ways by the curve shall be equal, would be satisfied as well by the cusp of a cardioide as by the centre of a circle; but no curve but the circle will fulfil all the analytical conditions of the theory of the circle.

In the same way, no curve but the parabola will satisfy all the conditions of the arithmetical theory of logarithms.

The equilateral hyperbola gives a false analogy and leads into error, because to base the properties of logarithms on those of the equilateral hyperbola leads to the conclusion that negative numbers have real logarithms.

The foregoing theory decides a controversy long carried on between Leibnitz and J. Bernoulli on the subject of the logarithms of negative numbers. Leibnitz insisted they were imaginary, while Bernoulli argued they were real, and the same as the logarithms of equal positive numbers. Euler espoused the side of the former, while D'Alembert coincided with the views of Bernoulli. Indeed, if we derive the theory of logarithms from the properties of the hyperbola (as geometers always have done), it will not be easy satisfactorily to answer the argument of Bernoulli—that as an hyperbolic area represents the logarithm of a positive number, denoted by the positive abscissa $+x$, so a negative number, according to conventional usage, being represented by the negative abscissa $-x$, the corresponding hyperbolic area should denote its logarithm also. And this is the more remarkable, because by Van Huraet's method the quadrature of the hyperbola itself depends on the rectification of the parabola, as shown in XXXV. All this obscurity is cleared up by the theory developed in the text, which completely establishes the correctness of the views of Leibnitz and Euler.

It is somewhat remarkable in the history of mathematical science, that although the arithmetical properties of logarithms have been familiarly known to every geometer since the time of Napier, their inventor, or rather discoverer, no mathematician has hitherto divined their true geometrical origin. And this is the more singular, because the properties of the logarithms of imaginary numbers are intimately connected with those of the circle. No satisfactory reason has been shown why this should be so. The logarithmic curve which has been devised to represent one well-known property of logarithms, is a transcendental curve, and has no connexion with the circle. Neither has any attempt been made to show how the Napierian base e, an abstract isolated incommensurable number, may be connected with our known geometrical knowledge. Had the circle never been made a geometrical conception, the same obscurity might probably have hung over the signification of π, which has hitherto concealed from us the real interpretation of the Napierian base e.

This affords another instance, were any needed, to show how thin the veil may be which is sufficient to conceal from us the knowledge of apparently the simplest truths, the clue to whose discovery is even already in our hands. The geometrical origin of logarithms and the trigonometry of the parabola ought, in logical sequence, to have been developed by Napier, or by one of his immediate successors. They had many indications to direct them aright in their investigations. So true it is that men, in the contemplation of remote truths, often overlook those that are lying before their feet!

I have shown in this memoir that the theory of logarithms is a result of the solution of the geometrical problem to find and compare the lengths of arcs of a parabola, just as plane trigonometry is nothing but the development of the same problem for the circle. I have shown, too, elsewhere*, that elliptic integrals of the three orders do in all cases represent the lengths of curves which are the symmetrical intersections of the surfaces of a sphere or a paraboloid by ruled surfaces. These functions divide themselves into two distinct groups, representing spherical and paraboloidal curves, and by no rational transformation can we pass from the one group to the other. The transition is always made by the help of imaginary transformations, as when we pass from the real logarithms of the parabola to the imaginary logarithms of the circle. When we take plane sections of those surfaces, that is to say, a circle and a

* "Researches on the Geometrical Properties of Elliptic Integrals," Philosophical Transactions for 1852, p. 316.

parabola, the theory of elliptic integrals becomes simply common trigonometry, or parabolic trigonometry with the theory of logarithms.

These views will suggest to us the reflection, how very small is the field of that vast region, the Integral Calculus, which has hitherto been cultivated or even explored! When we find that the highest and most abstruse of known functions, not only circular functions and logarithms, but also elliptic integrals of the three orders, are exhausted, "used up," in representing the symmetrical intersections of surfaces of the second order, who shall exhibit and tabulate the integrals of those functions which represent the unsymmetrical sections of surfaces of the second order, or generally those curves of double curvature in which surfaces of the third and higher orders intersect? Considerations such as these but add fresh evidence to the truth, how small even in mathematics is the proportion which the known bears to the unknown!

Cheltenham, August 8, 1856.

In revising this memoir for publication among the Reports of the British Association, I have supplied several numerical examples to illustrate the theory. I have added some new theorems, such as the curious properties of the polygon of n sides circumscribing the parabola, p. 95; the theorem which connects the *corresponding points* of the parabola and the equilateral hyperbola, p. 94; a new trigonometrical form for the roots of a cubic equation, p. 81; and the geometrical expressions for the $2n$ roots of a trinomial equation, in the excepted case, by the help of parabolic trigonometry, p. 99. I have also made a few other additions, and several corrections.—J. B.

The Vicarage, Wandsworth, Nov. 10, 1856.

Report on the Marine Testaceous Mollusca of the North-east Atlantic and neighbouring Seas, and the physical conditions affecting their development. By ROBERT MACANDREW, *F.R.S.*

IN the following Report, prepared in compliance with a wish expressed by the Committee of the Natural History Section of the British Association at the Glasgow Meeting last year, I have endeavoured to embody the results of personal research, obtained principally by means of the dredge, at various intervals during the past twelve years.

The field of my labours has extended from the Canary Islands to the North Cape (about 43 degrees of latitude), and with reference to the following Tables, it should be explained that when a species is stated to extend northwards to the latter, or southwards to the former of these limits, it is not to be inferred that it does not range further; and this it is more important to bear in mind, because a large proportion of the Mollusca inhabiting the coasts of Finmark are known to be widely distributed in the Arctic Seas, while a considerable number of the Canary species extend to, and in some cases attain their maximum of development in, the tropical region.

It is hardly necessary to add, that even within the district to which my observations have been confined, many species of mollusca are recorded to have been obtained which it has not been my good fortune to meet with or identify, and that of all such I have taken no note.

Report on Mollusca of the North-east Atlantic, &c.

Species.	Geographical range.	Vertical range.	Locality of principal development.	Ground.	Frequency.	Remarks.
Acephala.						
Teredo, *Adanson.*						
sp. not identified.						
Xylophaga, *Turton.*						
dorsalis, *Turton*	Firth of Clyde and Hammerfest	at 20 fathoms	Northern seas		moderate	perforated in wood.
Pholas, *Lin.*						
dactylus, *Lin.*	Mediterranean to Britain	littoral and sublittoral	Britain	in stone, chalk & clay.	frequent	of large size in Wales.
parva, *Lam.*	Malaga, South of England	littoral to 15 fathoms	South of England	stone, clay, &c.	frequent	at greatest depth off Portland.
crispata, *Lin.*	England, Drontheim	littoral and sublittoral	Britain	stone, turf, &c.	frequent.	
candida, *Lin.*	Mogador, Britain	littoral and sublittoral	South of England	chalk, turf	frequent.	
Pholadidea, *Leach.*						
papyracea, *Solander*	South of England	low water to 20 faths.	South of England	stone, turf	local	I have only obtained it on the south coast of England.
Clavagella, *Lam.*						
sp.	Canary Islands	at 20 fathoms				in volcanic scoria, British Museum.
Gastrochæna, *Spengler.*						
modiolina, *Lam.* } cuneiformis, *Lam.* }	Canary Islands to South of England.	low water to 60 faths.	Spain and Portugal.	limestone and dead shells.	frequent.	
Pandora, *Lin.*						
rostrata, *Lam.*	North of Spain, Gibraltar, Mogador.	shore to 8 fathoms	South of Spain	sand and mud	moderate.	
obtusa, *Leach*	Canary Islands to Zetland	10 to 90 fathoms	England to Spain	sand and mud	moderate.	
Lyonsia, *Turton.*						
Norvegica, *Chem.*	Madeira to North Drontheim	4 to 80 fathoms	Britain, and at 10 to 25 fathoms.	sand and mud	moderate	at Madeira and North Drontheim small.
arenosa, *Möller*	Nordland and Finmark	12 fathoms	Nordland	mud	rare	several specimens at Bodoe.
Thracia, *Leach.*						
phaseolina, *Lam.*	Canary Islands to Nordland	3 to 80 fathoms	Britain, at 5 to 10 fathoms.	sand	moderate.	
villosiuscula, *Macgil.*	Britain	10 to 20 fathoms	Zetland	sand	moderate.	
pubescens, *Pulteney*	British Channel, Gibraltar	8 fathoms		sand	rare.	
convexa, *Wood*	Gibraltar to Britain, Finmark?	5 to 50 fathoms	Bantry Bay, 5 fath.	sand and mud	rare	in Norway more frequent, but small.
distorta, *Mont.*	Britain, Norway	12 to 15 fathoms	uncertain	sand	rare	at Isle of Man free; at Portland perforated in hard clay.

Periploma, *Schum.*						
prætenuis, *Pulteney*	Britain to Nordland	10 fathoms	Zetland and Norway	sand	local.	
Saxicava, *F. de Bellevue.*						
arctica, *Lin.*	general	low water to 160 faths.	Arctic seas and Zetland, 4 to 10 fathoms.	sand, mud, and stones.	frequent.	
rugosa, *Lin.*	Britain, Asturias, Spain	low water to 20 faths.	South of England, low water.	limestone rock	local	abundant in Torbay.
Panopæa, *Menard de la Groye*						
Aldrovandi, *Mont.*	Portugal, Mediterranean	shallow water	Faro in Portugal	sand	local.	
Poromya, *Forbes.*						
granulata, *Nyst & West.*	Hebrides and Madeira	20 to 40 fathoms	uncertain	sandy gravel	very rare.	
Korenii (Embla), *Lovén*	Finmark	40 to 80 fathoms	Finmark	sand and gravel	unfrequent.	
Neæra, *Gray.*						
cuspidata, *Olivi*	Canary Islands to Hammerfest.	12 to 80 fathoms	Firth of Clyde, 20 to 40 fathoms.	muddy sand	rare	generally coated with mud when living.
costellata, *Deshayes*	Canary Islands to Drontheim	10 to 100 fathoms	Mediterranean, 20 to 50 fathoms.	sand and mud	local.	
abbreviata, *Deshayes*	Loch Fyne	40 to 80 fathoms	uncertain	mud	local	I have only obtained it in one locality.
obesa, *Lovén*	Finmark, Hammerfest	20 to 40 fathoms	uncertain	mud	moderate.	
Corbula, *Bruguière.*						
nucleus, *Lam.*	Canary Islands, Drontheim	6 to 30 fathoms	Britain to the Mediterranean.	mud	very abund.	at 30 fathoms the specimens small, as though they were all young.
rosea, *Brown*	Mediterranean	6 fathoms	uncertain	sand and mud	local	frequent in Port Mahon.
Sphænia, *Turton.*						
Binghami, *Turton*	Mediterranean, North of Spain, Britain.	10 to 35 fathoms	uncertain	sand	local & rare	one specimen obtained in the Gulf of Tunis.
Mya, *Lin.*						
truncata, *Lin.*	Britain, Finmark	low water to 100 faths.	Britain, at low water to 6 fathoms.	sand	abundant	obtained by digging at low water, and by the dredge in roots of Laminaria.
arenaria, *Lin.*	Britain, Finmark	low water	Ireland	sand and gravel	abundant.	
Solen, *Lin.*						
siliqua, *Lin.*	Britain, Mediterranean	low water and sub-littoral.	Scotland and North of Ireland.	sand	frequent.	
ensis, *Lin.*	Mediterranean, Nordland	littoral and sublittoral.	Britain	sand	abundant.	
marginatus, *Pulteney*	Mediterranean, Britain	littoral and sublittoral.	Spain	sand	local.	
pellucidus, *Pennant*	Mediterranean to Nordland	5 to 100 fathoms	North Britain	sand	frequent	largest in Zetland and Norway; very small in Mediterranean.

Species.	Geographical range.	Vertical range.	Locality of principal development.	Ground.	Frequency.	Remarks.
Acephala (*continued*).						
Ceratisolen, *Forbes*.						
legumen, *Lin.*	Mogador to Britain	shore to 6 fathoms	Wales	sand	local.	
Solecurtus, *Blainv.*						
coarctatus, *Gmel.*	Canary and Madeira Islands to the Hebrides.	7 to 25 fathoms	Spain	mud	moderate.	
candidus, *Renieri*	Canary Islands to Hebrides.	10 to 30 fathoms	uncertain	sand	rare	found living in sand dredged for manure in Bantry Bay.
strigilatus, *Lin.*	Portugal and Mediterranean.	shore to 10 fathoms	Gibraltar, Naples	sand	frequent.	
Syndosmya, *Recluz.*						
alba, *Wood*	Finmark to Mogador	3 to 40 fathoms	Britain	mud	abundant.	
prismatica, *Mont.*	Finmark to Mediterranean	3 to 100 fathoms	Britain	sand	frequent.	
intermedia, *Thompson*	Finmark to Britain	15 to 100 fathoms	Norway	sand and mud	frequent.	
Renieri, *Bronn*	Mediterranean, Mogador	8 to 40 fathoms	Mediterranean	sand and mud	frequent.	
tenuis, *Mont.*	South of England to Tunis	shore	North of Spain ?	sand	local.	
Scrobicularia, *Schumacher.*						
piperata, *Gmel.*	Britain to Mediterranean	shore	Britain ?	mud	abundant.	
Cottardi, *Payr.*	Mediterranean	shore	Gibraltar ?		rare.	
Donax, *Lin.*						
anatinus, *Lam.*	North of Spain (Vigo) to Drontheim.	littoral	Britain	sand	abundant.	
trunculus, *Lin.*	Mediterranean	shore to 1 fathom	Malaga	sand	abundant.	
venustus, *Poli*	Mediterranean, Portugal, Mogador, Canaries ?.	littoral	Mediterranean	sand	abundant.	
politus, *Poli*	South of England and Ireland to Mediterranean.	6 to 12 fathoms	uncertain	sand	rare.	
Ervilia, *Turton.*						
castanea, *Mont.*	Cornwall to Canaries, Mediterranean, and Azores.	2 to 50 fathoms	Faro, Portugal	sand	local	frequent in Canaries, Madeira, and Azores, but of small size.
nitens, *Mont.* ?	Gibraltar, Canaries, Madeira.	12 to 20 fathoms	Madeira	sand	frequent	varies in colour from white to scarlet.
Mesodesma, *Desh.*						
donacilla, *Desh.*	North of Spain, Mediterranean.	shallow water	Spain	sand	frequent.	
Psammobia, *Lam.*						
vespertina, *Chem.*	Canary Islands to Cardigan Bay.	sublittoral to 12 faths.	Spain	sand	frequent	large in Gibraltar, very small in Canaries.

tellinella, *Lam.*	Mediterranean to Nordland	5 to 30 fathoms	Britain, 20 to 30 fathoms.	sand and gravel	frequent.	
costulata, *Turton*	Canaries, Madeira, Britain	8 to 60 fathoms	Mediterranean and Madeira.	sand	frequent	takes the place of *P. tellinella* in southern latitudes.
Ferroensis, *Chem.*	Canaries to Nordland	2 to 80 fathoms	Britain, 4 to 10 fath.	sand	frequent.	
costata, *Hanley*	Faro, Mogador	shore	Faro	sand	local	a handsome species found north and south of Gibraltar, but not in the Mediterranean.
Gastrana, *Schum.*						
fragilis, *Lin.*	Mediterranean to Drontheim	shore	South of Spain	sand	local.	
Tellina, *Lin.*						
crassa, *Pennant*	Gibraltar to Britain	low water to 30 faths.	South of Ireland	sand	local.	
balaustina, *Lin.*	Teneriffe to Hebrides	10 to 45 fathoms	Mediterranean	sand	rare	British specimens the largest, small in Mediterranean.
donacina, *Lin.*	Madeira and Mediterranean to Britain.	4 to 20 fathoms	Anglesea, Algiers	sand and mud	local	Mediterranean varieties smaller and narrower than the British.
pygmæa, *Phil.*	Cape Wrath, Orkney	5 to 45 fathoms	Orkney, 4 to 10 fathoms.	sand	local.	
incarnata, *Lin.*	Canary Islands to Britain	5 to 10 fathoms	South of Spain	sand	frequent.	
tenuis, *Da Costa*	Mediterranean to Britain	shore	uncertain	sand	frequent.	
fabula, *Gronovius*	Mogador to Nordland	shore to 12 fathoms	Britain	sand	frequent.	
solidula, *Pulteney*	Britain, Finmark	shore	Britain	sand	frequent.	
proxima, *Brown*	Britain, Finmark	4 to 40 fathoms	Arctic seas, 4 to 10 fathoms.	sand and mud	frequent	the *Tellina* of Arctic seas.
distorta, *Poli*	Mediterranean to Canary Islands.	10 to 50 fathoms	Mediterranean	sand	frequent.	
serrata, *Brocchi*	Vigo to Canary Islands	20 to 40 fathoms	Canary Islands ?	sand and mud	rare.	
pulchella, *Lam.*	Mediterranean	shore	Malaga	sand	frequent.	
Costæ, *Ph.*	Portugal, Mogador	shore	Mediterranean	sand	moderate.	
planata, *Lin.*	Portugal and Mediterranean.	shore (15 faths.), dead	Mediterranean	sand	local.	
punicea ?, *Lin.*	Mediterranean	shore to 6 fathoms	Malaga	sand	local.	
sp.		shore	Malaga	sand	local	the form of *T. Costæ*.
sp.	Mogador, Madeira	16 to 35 fathoms	Madeira	sand	frequent	striated, compressed.
Lutraria, *Lam.*						
elliptica, *Lam.*	Mediterranean to North of Scotland.	shallow water	Britain	sand	frequent	very large at Stornoway; varieties from Bantry Bay narrower and stronger.
oblonga, *Chem.*	Mediterranean to South of England.	shallow water	Spain and Portugal	sand	local.	
Mactra, *Lin.*						
rugosa, *Chem.*	Vigo to Mogador	shore	Faro ?	sand	local	largest at Vigo, small at Cadiz and Mediterranean, rare in Mediterranean.
solida, *Lin.*	Britain to Vigo	5 to 35 fathoms	Britain, at 5 faths.	sand	frequent.	
elliptica, *Brown*	Britain to Finmark	7 to 50 fathoms	Britain, 20 to 30 fathoms.	sand	frequent.	

Species.	Geographical range.	Vertical range.	Locality of principal development.	Ground.	Frequency.	Remarks.
Acephala (*continued*).						
Mactra, *Lin.*						
subtruncata, *Da Costa*	Britain to Canary Islands	shore to 30 fathoms	Britain ?	sand and mud	frequent.	
stultorum, *Lin.*	Britain to Canary Islands	shallow water	Mediterranean	sand and mud	frequent	At Teneriffe only one valve from 35 fathoms, several varieties in Mediterranean.
helvacea, *Chem.*	Portugal and Mediterranean.	shallow water	South of Europe		rare	I have never obtained alive.
Petricola, *Lam.*						
lithophaga, *Retzius*	North of Spain, South of Portugal.	littoral	Portugal ?	limestone	frequent.	
Venerupis, *Lam.*						
irus, *Lin.*	South of England to Canaries	littoral	Spain and Portugal	limestone	frequent.	
Tapes, *Muhlfeldt.*						
decussata, *Lin.*	Cardigan Bay to Mediterranean.	littoral and sublittoral	Spain and Portugal	sand and gravel	abundant	Much esteemed, and sought as an esculent.
pullastra, *Wood*	Nordland to Mogador Islands	shore to 10 fathoms	Bantry Bay, Vigo	sand and gravel	abundant.	
virginea, *Gmel.*	Nordland to Gibraltar and Mediterranean.	4 to 40 fathoms	Zetland, Vigo	sand and mud	abundant.	
aurea, *Gmel.*	South of Scotland to Mediterranean.	littoral and sublittoral	Vigo, Gibraltar	sand and mud	local.	
nitens, *Scacchi*	Mediterranean	10 fathoms	Sicily, Algiers	sand	rare.	
geographica, *Lin.* }					frequent.	
florida, *Lam.* }	Cadiz and Mediterranean	sublittoral	Gibraltar	sand and mud	abundant.	
Beudantii, *Payr.* }					frequent.	
Lucinopsis, *Forbes.*						
undata, *Pennant*	Britain to Mediterranean	3 to 30 fathoms	Britain	sand and mud	moderate.	
Artemis, *Poli.*						
exoleta, *Lin.*	Nordland to Mediterranean	shore to 20 fathoms	Vigo	sand	abundant	at Vigo dug up at low tide for food.
lincta, *Pulteney*	Nordland to Mediterranean	shore to 60 fathoms	Britain	sand	frequent	Mediterranean variety, more compressed.
Cytherea, *Lam.*						
chione, *Lin.*	Carnarvon Bay to Canary Islands, Azores, and Madeira Islands.	sublittoral to 40 fathoms.	Spain	sand	frequent	Canaries and Madeira, variety small.
venetiana, *Lam.*	Mediterranean to Canaries	sublittoral to 40 fathoms.	Mediterranean	mud	moderate.	

sp. ined.	Mediterranean to Canary and Madeira Islands.	15 to 50 fathoms	Gibraltar	sand and mud	rare	resembling last in form, but white and striated.
sp. ined.	Orotava of Teneriffe	50 fathoms	unknown	sand	very rare	compressed, Mactra-shaped, white with brown spots, a single specimen in British Museum.
Venus, *Lin.*						
verrucosa, *Lin.*	Carnarvon Bay to Canary Islands.	shore to 60 fathoms	Mediterranean in 5 or 6 fathoms.	sand and mud	frequent	Canary specimens small, but beautifully coloured.
casina, *Lin.*	Drontheim to Canaries and Madeira.	8 to 40 fathoms	uncertain	sand	frequent	southern specimens beautifully coloured, not obtained in Mediterranean, East of Gibraltar.
striatula, *Donovan*	Finmark to Mogador	littoral to 100 fathoms	Britain	sand	abundant.	
gallina, *Lin.*	Mediterranean	shore to 4 fathoms	Malaga	sand	abundant	much esteemed for culinary purposes.
fasciata, *Costa*	Drontheim to Gibraltar	4 to 20 fathoms	Spain ?	sand, gravel and mud.	frequent.	
ovata, *Pennant*	Finmark to Mediterranean	4 to 100 fathoms	Britain	sand, gravel and mud.	various.	
sp. ined.	Orotava	50 fathoms	unknown	sand	very rare	only obtained a few valves, in British Museum.
sp. ined.	Malaga to Mogador	30 fathoms	Malaga ?	mud	rare.	
Cardita, *Bruguière.*						
calyculata, *Brug.*	Mediterranean to Canaries, Madeira, and Azores.	littoral	Mediterranean	stone	frequent.	
trapezia, *Lin.*	Mediterranean	shore to 8 fathoms	Mediterranean	stones	local.	
squamosa, *Lam*	Mediterranean	15 to 45 fathoms	Gibraltar	gravel	local.	
sulcata, *Brug.*	Mediterranean	shore to 10 fathoms	Gibraltar	sand and mud	abundant.	
corbis, *Phil.*	Tunis, Pantellaria, Syracuse	12 to 40 fathoms	Gulf of Tunis, &c.	sand	rare.	
Isocardia, *Lam.*						
cor, *Lin.*	Scotland	20 to 30 fathoms	uncertain	mud	rare	I have taken it alive in the Hebrides, but not elsewhere.
Astarte, *Sow.*						
arctica, *Gray*	Finmark	shore to 15 fathoms	Finmark, sublittoral	mud	frequent.	
sulcata, *Da Costa*	Arctic circle, Norway to Gibraltar.	5 to 160 fathoms	British seas	sand and mud	abundant	not in the Mediterranean, East of Gibraltar.
compressa, *Mont.*	Finmark to Britain	5 to 50 fathoms	Norway, 5 to 10 fathoms.	sand, mud and Nullipore.	frequent.	
triangularis, *Mont.*	Zetland to Canary Islands	5 to 50 fathoms	Western coasts of Britain.	sand	frequent	most abundant in Iona Sound, 5 fathoms, not met with in Mediterranean, East of Gibraltar.
incrassata, *Brocchi*	Mediterranean to Canary Islands.	16 to 70 fathoms	Canaries?	sand	moderate.	
fusca, *Desh.*	Mediterranean and Gibraltar	30 to 40 fathoms	Malta ?	mud and sand	rare	probably a distinct species from preceding.

Species.	Geographical range.	Vertical range.	Locality of principal development.	Ground.	Frequency.	Remarks.
Acephala (*continued*).						
Astarte, *Sow.*						
crebricostata, *Forbes*	Arctic Norway	20 to 160 fathoms	Hammerfest	mud	frequent	described as British on the faith of the fossil specimens dredged in the Sound of Skye.
elliptica, *Brown*	Clyde to Finmark	4 to 16 fathoms	Nordland	Nullipore & mud	frequent	
bipartita, *Phil.*	Gulf of Tunis, Pantellaria	35 fathoms	uncertain	sand	very rare.	
sp. ined.	Zembretta (Gulf of Tunis)	35 fathoms	unknown	sand	very rare	small, sulcated.
Circe, *Schumacher.*						
minima, *Mont.*	West of Scotland to Canary Islands.	8 to 50 fathoms	Mediterranean, Madeira.	sand	frequent.	
Cyprina, *Lam.*						
Islandica, *Lin.*	Finmark to Scilly	5 to 80 fathoms	Scotland	sand and mud	frequent.	
Galeomma, *Turton.*						
Turtoni, *Sowerby*	South of England to Mediterranean.	littoral and sublittoral (50 fathoms, dead).	Spain?	rock	rare	in crevices of stones, and roots of Laminariæ.
Lepton, *Turton.*						
squamosum, *Mont.*	Irish sea to Gibraltar	8 to 12 fathoms, shore at Gibraltar.	uncertain	sand	rare.	
convexum, *Alder*	Bantry Bay	15 fathoms	unknown	sand	very rare	detected by Mr. Hanley among some small shells dredged by me in the locality named.
Montacuta, *Turton.*						
substriata, *Mont.*	Drontheim to Mediterranean	10 to 100 fathoms	Zetland, 10 fathoms	sand and mud	frequent	on species of *Spatangus purpureus*, and in Norway occasionally on another species of Echinoderm.
ferruginosa, *Mont.*	North of Scotland to Mogador and Madeira.	3 to 40 fathoms	Murray Firth?	sand and mud	rare	Naples, &c., in Mediterranean.
bidentata, *Mont.*	Arctic Circle, Norway to Mogador.	shore to 50 fathoms	North Britain	sand and mud	frequent.	
Kellia, *Turton.*						
suborbicularis, *Mont.*	Drontheim to Canary Islands	sublittoral to 50 fathoms.	Scotland	mud, &c.	moderate.	
corbuloides, *Phil.*	Portugal to Mogador	littoral	Gibraltar?	stones	frequent	under stones, living.
complanata, *Phil.*	Gibraltar and Mogador	shore	unknown		very rare	valves on the shore.
rubra, *Mont.*	England to Canary Islands and Madeira.	littoral	England	rocks	abundant	rare in Mediterranean and Canaries.
Pythina, *Hinds.*						
sp.	Atlantic coasts of Spain and Portugal.	littoral	South of Portugal	stones	local.	

Ungulina, *Daudin*.						
oblonga, *Daudin*?	Cadiz	low water	unknown	in rocks	rare	specimens in British Museum.
Diplodonta, *Bronn*.						
rotundata, *Mont.*	Britain, Canaries, Mediterranean, Madeira.	5 to 50 fathoms	Britain?	sand	rare.	
apicalis, *Phil.*	Mediterranean to Canaries and Madeira.	12 to 60 fathoms	uncertain	sand	local.	
Lucina, *Bruguière*.						
borealis, *Lin.*	Finmark to Mogador	shore to 80 fathoms	North of Scotland	sand and mud	frequent.	
spinifera, *Mont.*	North Dronthein to Canaries	12 to 80 fathoms	West Scotland, Ireland and Vigo.	sand and mud	frequent	largest specimens in Scotland and Ireland, yellow var. at Vigo and southward.
divaricata, *Lin.*	Mediterranean, Canaries, Madeira.	5 to 40 fathoms	uncertain	sand	rare.	
flexuosa, *Mont.*	Finmark to Canaries	shore to 150 fathoms.	Zetland & Norway.	sand	frequent	small in the more southern latitudes.
leucoma, *Turton*	South of England to Carnarvon.	6 to 16 fathoms	Mediterranean	sand	frequent	rare in Britain.
Sarsii, *Phil.*?	Drontheim to Finmark	30 to 100 fathoms	Finmark	sand	rare	dead.
ferruginosa, *Forbes*	Nordland to Loch Fyne	20 to 100 fathoms	Loch Fyne, 70 faths.	mud	frequent	obtained by Prof. E. Forbes in the Ægean.
bullata, *Reeve*	Bay of Naples	8 fathoms	uncertain	sand and mud	local.	
Adansoni, *W. & B.* } columbella, *Lam.* }	Lancerotte	12 to 16 fathoms	uncertain	sand and mud	frequent.	
transversa, *Phil.*	Lancerotte	12 to 16 fathoms	uncertain	sand and mud	moderate	new as a recent species.
digitalis, *Lin.*	Vigo to Mediterranean	4 to 30 fathoms	Gibraltar	sand and mud	frequent.	
pecten, *Lam.*	Asturias, Sicily, and Canaries	shore to 6 fathoms	uncertain	sand	frequent	equally common in all the localities, largest in the North.
——	Lancerotte	12 fathoms				minute, yellow.
——	Madeira	20 fathoms				minute.
—— ?	Nordland	90 fathoms				minute, genus uncertain.
Cardium, *Lin.*						
erinaceum, *Lam.*	Gibraltar	8 fathoms	Gibraltar and Mediterranean.	sand and mud	rare	a white variety, smaller.
aculeatum, *Lin.*	Devonshire, Malaga	shore to 8 fathoms	Gibraltar	sand	abundant.	
echinatum, *Lin.*	Finmark to Canary and Madeira Islands.	4 to 80 fathoms	Britain, 6 to 8 fathoms.	sand and mud	abundant.	
rusticum, *Lin.*	Devonshire to Mediterranean, Canary, and Madeira.	2 to 40 fathoms	Spain, 6 to 10 fathoms.	sand and mud	abundant	in Canaries at 16 to 40 fathoms, and very small size, a var. white.
ciliare, *Penn.*	Vigo and Mediterranean	4 to 10 fathoms	Spain and Portugal	mud	frequent.	
edule, *Lin.*	Finmark to Mogador	shore to 5 fathoms	Britain, littoral	sand	very abund.	at 4 to 5 fathoms in Mediterranean.
nodosum, *Turton*	Britain to Finmark	4 to 80 fathoms	Zetland, 4 to 10 fath.	sand	frequent	abundant on Laminaria in Balta Sound.
fasciatum, *Mont.*	Finmark to Canary and Madeira Islands.	5 to 100 fathoms	Norway	sand, mud, gravel	frequent.	

Species.	Geographical range.	Vertical range.	Locality of principal development.	Ground.	Frequency.	Remarks.
Acephala (*continued*).						
Cardium, *Lin.*						
pygmæum, *Don.*	Britain to Mediterranean and Azores.	2 to 10 fathoms	South of England, Vigo.	mud	local	most common in weedy ground of estuaries, largest specimens at Vigo, small in Mediterranean.
Suecicum, *Reeve*	Britain to Finmark	20 to 100 fathoms	Drontheim	sand and mud	frequent.	
Norvegicum, *Spengler*	Britain to Canary Islands	shore to 30 fathoms	South of England and Ireland.	sand and mud	frequent.	
papillosum, *Poli*	Vigo to Canaries	10 to 50 fathoms	Gibraltar ?	sand and mud	frequent.	
punctatum, *Brocchi*	Gibraltar, Canaries, Madeira	20 to 30 fathoms	unknown	sand and mud	rare.	
minimum, *Phil.*	Gibraltar	30 fathoms	unknown	sand	very rare.	
elegantulum, *Möller*	Hammerfest	30 fathoms	uncertain	sand and mud	moderate.	
sp. ?	Mageroe Island	30 fathoms	uncertain	sand	very rare.	
Chama, *Lin.*						
gryphoides, *Lin.*	Mediterranean to Canaries	shore to 20 fathoms	uncertain	sand and mud	frequent.	
Solemya, *Lam.*						
Mediterranea, *Lam.*	Mediterranean to Canaries	shore to 12 fathoms	Mediterranean	sand and mud	moderate.	
Yoldia, *Möller.*						
pygmæa, *Munster*	Hebrides to Arctic Circle, Norway.	20 to 120 fathoms	Arctic seas ?	sand and mud	local.	
lucida, *Bland.*	Drontheim to North Cape	30 to 160 fathoms	Finmark ?	sand and mud	frequent.	
limatula, *Say*	Nordland	120 fathoms	unknown	sand	very rare.	
Leda, *Schumacher.*						
caudata, *Donovan*	Britain to Finmark	10 to 160 fathoms	Scotland, Norway	sand and mud	frequent.	
pernula, *Müller*	Drontheim to North Cape	35 to 160 fathoms	Nordland and Finmark.	sand and mud	frequent	dead specimens (fossil ?) frequent in the Sound of Skye.
emarginata, *Lam.*	South-east of Portugal and Mediterranean.	4 to 8 fathoms	Mediterranean	mud	moderate.	
striata, *Lam.*	Mediterranean	35 to 40 fathoms	Gibraltar, Algiers	fine sand	frequent.	
Nucula, *Lam.*						
nucleus, *Lin.*	Nordland to Mediterranean and Mogador.	6 to 80 fathoms	Britain	sand and mud	abundant.	
nitida, *Sow.*	Britain to Mediterranean	4 to 40 fathoms	Britain	sand and mud	abundant.	
radiata, *Hanley*	Britain to Mediterranean	20 to 40 fathoms	South of England	sand and mud	local.	
decussata, *Sow.*	West of Scotland to Mediterranean.	30 to 100 fathoms	Malaga ?	mud	moderate.	
tenuis, *Mont.*	Scotland, Finmark	40 to 150 fathoms	uncertain	mud	frequent.	
corticata, *Möller* ?	Nordland and Finmark	100 to 150 fathoms	uncertain	sand and mud	very rare.	

Limopsis, *Sassi.*						
pygmæa, *Phil.*	Nordland and Finmark	70 to 150 fathoms	uncertain	fine sand	rare.	
Pectunculus, *Lam.*						
glycimeris, *Lin.*	Britain, Canaries, Mediterranean, Madeira.	10 to 40 fathoms	Britain	gravelly	abundant	of small size in Canaries & Madeira.
violascens, *Lam.*	Mediterranean	4 to 8 fathoms	Malaga, Algiers	mud	abundant	in vast quantities on the shore at Algiers.
Siculus, *Reeve*	Madeira, Canaries	20 to 30 fathoms	uncertain	sand	frequent	I have never met with it in the Mediterranean.
pilosus, *Lam.*	Gibraltar and Mediterranean.	shore	uncertain		rare	a valve of very large size.
Arca, *Lin.*						
Noæ, *Lin.*	Mediterranean and Cadiz	2 fathoms	Naples, &c.	rocks	frequent	sold in the market at Naples.
tetragona, *Poli*	Zetland to Mediterranean, Canaries, and Madeira.	shore to 50 fathoms	uncertain	stones	frequent	generally in deep water.
barbata, *Lin.*	Cadiz, Naples, &c.	sublittoral	Cadiz	rocks	frequent.	
antiquata, var.?, *Poli*	Gibraltar, Malta, Teneriffe	35 to 45 fathoms	Gibraltar	mud	moderate.	
lactea, *Lin.*	South of England to Canary Islands.	10 to 20 fathoms	Cadiz and Mediterranean.	shells and stones	frequent.	
nodulosa, *Lovén*	North Drontheim	15 to 40 fathoms	uncertain	stones	rare.	
raridentata, *S. Wood*	Finmark to Gibraltar	20 to 150 fathoms	Arctic Norway	sand, mud, and stones.	moderate	large in Norway, small in Britain, smallest at Gibraltar.
obliqua, *Phil.*	Gibraltar and Mediterranean.	40 fathoms	unknown	sand	rare	I have not obtained it living.
navicularis, *Brug.*	Cadiz and Mediterranean	shore	unknown		rare.	
imbricata, *Brug.*	Malta, Catania, and Teneriffe	40 fathoms	unknown	sand	rare.	
diluvii, *Lam.?*	Cadiz	shore	unknown		rare	valves on shore.
sp.	Zembretta	35 fathoms	unknown		rare	one valve, sp. uncertain.
Modiola, *Lam.*						
modiolus, *Lin.*	Finmark to Britain	shore to 100 fathoms.	Scotland	gravel	abundant.	
tulipa, *Lam.*	Britain to Gibraltar, Mediterranean, and Canaries.	10 to 25 fathoms	Britain ?	sand	rare.	
phaseolina, *Phil.*	Finmark to Britain	30 to 150 fathoms	Nordland, 35 faths.	sand and mud	frequent.	
barbata, *Lin.*	South of England to Mediterranean and Mogador.	4 to 40 fathoms	Cadiz, &c.	mud	frequent	rare in Britain.
sp. ined.	Hammerfest	35 fathoms	unknown	mud	moderate	a minute species.
Petagnæ, *Scacchi*	Mediterranean, Canaries, and Madeira.	shore to 50 fathoms	Canary ?	stones and Nullipore.	frequent.	
Crenella, *Brown.*						
discors, *Lin.*	Britain, Finmark	shore to 100 fathoms.	Finmark	rock, weed, and mud.	frequent.	
marmorata, *Forbes*	Finmark to Canary Islands	shore to 100 fathoms.	West of Scotland	mud and gravel.	frequent	generally imbedded in mantle of *Ascidia mentula.*
nigra, *Gray*	Scotland to Finmark	5 to 150 fathoms	Norway and Northern seas.	mud	frequent.	

Species.	Geographical range.	Vertical range.	Locality of principal development.	Ground.	Frequency.	Remarks.
Acephala (*continued*).						
Crenella, *Brown.*						
vestita, *Phil.*	Straits of Gibraltar and Mediterranean.	20 to 40 fathoms	Mediterranean	mud	moderate.	
costulata, *Risso*	South of England to Mogador.	shore to 5 fathoms	Spain, &c.	sand and mud	moderate	appears to replace *C. discors* in southern latitudes.
rhombea, *Berkeley*	Weymouth to Lancerotte	12 to 40 fathoms	Zembrettain 35 fath. Lancerotte, 12 fath.	sand	frequent.	
decussata, *Mont.*	West of Scotland to Finmark.	5 to 100 fathoms	Finmark and Balta Sound.	sand	frequent	larger size in Norway, most abundant in Balta Sound, Zetland.
Lithodomus, *Cuvier.*						
dactylus, *Cuvier*	Cadiz and Mediterranean	littoral and sublittoral	Mediterranean	rocks	frequent	sold in the market at Algiers, &c.
caudigerus, *Sow.*	North of Spain and Portugal.	low water	uncertain	rocks	moderate.	
Mytilus, *Lin.*						
edulis, *Lin.*	Finmark to Mogador	shore to 40 fathoms	Britain, 0 to 4 faths.	stones	very abund.	var. *Gallo provincialis* attains a large size at Algiers.
minimus, *Poli*	Mediterranean	shore	Carthagena, Malta	rocks	very abund.	
Afer, *Gmel.*	Malaga, Mogador	shore	uncertain	rocks	frequent	not found east of Malaga.
Pinna, *Lin.*						
pectinata, *Lin.*	British Channel and South of Ireland.	4 to 50 fathoms	South of Ireland ?	gravel	local.	
muricata, *Poli*	Mediterranean	shore to 30 fathoms	Mediterranean ?	sand and gravel	local.	
rudis, *Lin.*	Madeira, Canaries	littoral and sublittoral	uncertain	rocks and gravel	rare	living at low water, adhering to rocks and stones.
Avicula, *Brug.*						
Tarentina, *Lam.*	Vigo, Mediterranean, Canaries, and Madeira.	8 to 35 fathoms	Mediterranean	mud and sand	frequent	I have not personally obtained British specimens.
Lima, *Bruguière.*						
subauriculata, *Mont.*	Canaries, Nordland	15 to 120 fathoms	Britain	mud and sand	local.	
sulculus, *Lovén*	Britain ?, Norway	20 to 120 fathoms	Norway	sand and gravel	rare.	
Loscombii, *Sow.*	Nordland, Mediterranean	15 to 50 fathoms	Britain (Isle of Man)	sand and gravel	moderate.	
hians, *Gmel.*	Britain, Finmark	4 to 25 fathoms	Scotland, Norway	mud & Nullipore	abundant	forms a nest.
fragilis, *Scacchi*	North of Spain to Canary and Azores Islands.	shore to 30 fathoms	Spain ?	sand	moderate	differs from last in being smaller, flatter, and not gregarious.
squamosa, *Lam.*	Malta and Sicily, Canaries, Madeira.	littoral, living, to 60 fathoms (dead).	uncertain	stones	moderate	not found on the coasts of Spain and Portugal.
inflata, *Lam.*	Cadiz and Mediterranean	littoral and sublittoral	Mediterranean	stones	moderate.	
excavata, *J. C. Fabricius*	North Drontheim to Finmark	50 to 150 fathoms	Norway	stones	rare	one specimen living, 5½ by 4¼ in., adheres by a small byssus.
Pecten, *O. F. Müller.*						
varius, *Lin.*	Britain to Mediterranean	shore to 20 fathoms	Britain ?	sand and gravel	abundant	scarlet var. at Malta.

niveus, *Macgillivray*	North Argyleshire	shore to 10 fathoms	Oban	stones and Laminaria.	frequent.	
pusio, *Pennant*	North Drontheim, Canaries, Azores, and Madeira.	shore to 90 fathoms	Britain (Isle of Man), 12 to 15 fathoms.	gravel and stones	frequent.	
striatus, *Müller*	Finmark to Mediterranean	5 to 90 fathoms	Scotland, Norway	stones, Laminaria, &c.	frequent.	
tigrinus, *Müller*	Finmark to Gibraltar	10 to 100 fathoms	Scotland, Norway	gravel	frequent.	
Danicus, *Chem.*	Finmark to West of Scotland	20 to 100 fathoms	uncertain	gravel and mud	local.	
similis, *Laskey*	Finmark to Mediterranean and Madeira.	10 to 60 fathoms	Hebrides?	sand, mud, and gravel.	local.	
maximus, *Lin.*	Orkney to Canaries and Madeira.	5 to 30 fathoms	Britain	gravel	frequent	not in the Eastern Mediterranean, where it is replaced by next species.
Jacobæus, *Lin.*	Mediterranean, from Balearic Islands eastward.	12 to 15 fathoms	Mediterranean	gravel and sand	frequent.	
opercularis, *Lin.*	Nordland to Canary and Madeira.	5 to 100 fathoms	Britain	sand	frequent	only one small specimen in Canary Islands at 60 fathoms.
Islandicus, *Müller*	Norway	5 to 100 fathoms	Norway, 10 to 20 fathoms.	sand	frequent.	
polymorphus, *Bronn*	Lisbon, Cadiz, Mediterranean, and Madeira.	6 to 40 fathoms	Cadiz and Gibraltar	sand, mud, and gravel.	frequent.	
hyalinus, *Poli*	Mediterranean, from Carthagena eastward.	6 to 8 fathoms	Malta and Sicily	mud	frequent	not found at Gibraltar or Malaga.
sulcatus, *Lam.*	Malta, Algiers	6 to 40 fathoms	Mediterranean	sand	local.	
glaber, *Lin.*	Mediterranean	10 to 12 fathoms	Malta, &c.	sand	moderate.	
testæ, *Bivon*	Mediterranean	25 to 50 fathoms	Malta, &c.	sand	moderate	var. of *P. striatus*?
pes-felis, *Lin.*	Cadiz, Mediterranean, Teneriffe.	shore to 50 fathoms (dead).	uncertain	sand	very rare.	
gibbus, *Lin.*?	Mediterranean, Canaries, Madeira.	15 to 50 fathoms	Mediterranean, Madeira.	sand	rare.	
Grœnlandicus, *Sow.*	Nordland and Finmark	90 to 150 fathoms	Arctic Sea	sand	rare.	
sp. ined.	Nordland, lat. 66°	70 fathoms	uncertain	sand	very rare	one specimen living.
sp. ined.	Nordland and Finmark	90 to 150 fathoms	unknown	sand	rare.	
sp. ined.	Nordland and Finmark	90 to 150 fathoms	unknown	sand	rare.	
corallinoides, *D'Orb.*	Canary and Madeira Islands	12 to 50 fathoms	uncertain	sand	moderate.	
Spondylus, *Lin.*						
gædaropus, *Lin.*	Mediterranean, Canary Islands.	shore to 60 fathoms	Mediterranean	rock and stones	frequent.	
Anomia, *Lin.*						
ephippium, *Lin.*	Finmark to Mediterranean and Madeira.	shore to 160 fathoms.	South of Ireland, North of Spain.	gravel, mud, and sand.	frequent.	
patelliformis, *Lin.*	Nordland to Mediterranean	4 to 50 fathoms	Britain	stones and sand	frequent.	

Species.	Geographical range.	Vertical range.	Locality of principal development.	Ground.	Frequency.	Remarks.
Acephala (*continued*).						
Anomia, *Lin.*						
striata, *Lovén*	Drontheim to W. of Scotland	30 to 50 fathoms	West of Scotland	stones and mud	local.	
aculeata, *Müller*	Finmark, Britain	5 to 70 fathoms	Britain	gravel, corallines, &c.	frequent.	
Ostrea, *Lin.*						
edulis, *Lin.*	Britain, Mediterranean	4 to 40 fathoms	Britain	gravel, mud	frequent.	
plicatula, *Phil.* ?	Lisbon to Canary Islands and Madeira.	shore to 40 fathoms	Tagus	sand	abundant.	
Crania, *Retzius.*						
anomala, *Müller*	Nordland to Vigo	25 to 70 fathoms	West of Scotland	stones and shells.	abundant	one living specimen at Vigo.
Rhynchonella, *Fischer.*						
psittacea, *Chem.*	Finmark	30 to 50 fathoms	Arctic seas	gravel	local	I did not meet with it south of lat. 70°.
Argiope, *E. Deslongchamps.*						
decollata, *Chem.*	Mediterranean, Madeira, and Canaries.	20 to 45 fathoms	Mediterranean, Madeira.	gravel	abundant.	
Neapolitana, *Scacchi*	Mediterranean, Canaries	45 to 50 fathoms	uncertain	sand and stones	rare.	
cuneata, *Risso*	Mediterranean, Canaries	45 to 50 fathoms	uncertain	shells	very rare.	
cistellula, *Searles Wood*	Sound of Skye	40 fathoms	uncertain	stones	local	obtained above 20 specimens upon one stone.
Megerlia, *King.*						
truncata, *Lin.*	Mediterranean & Canary Isds.	60 fathoms	Mediterranean ?	sand and stones	local.	
Terebratulina, *D'Orb.*						
caput-serpentis, *Lin.*	Finmark to British Channel.	25 to 100 fathoms	West of Scotland	gravel and stones	abundant	I have not obtained it south of the coast of Brittany.
Waldheimia, *King.*						
cranium, *Gmel.*	Nordland and Finmark	35 to 200 fathoms	Nordland, 40 faths.	gravel and stones	abundant.	
Pteropoda.						
Spirialis, *Eydoux & Souleyet.*						
Flemingii, *Forbes*	British seas	unknown	Hebrides ?	none	local	in tow-net near Skye.
Macandrei, *Forbes and Hanley.*	South of Ireland	60 fathoms (dead)	unknown		rare.	
sp.	Canary Islands	60 fathoms (dead)	unknown		rare.	
Cuvieria, *Rang.*						
columnella, *Rang* ?	Canary and Madeira Islands.	20 fathoms	unknown	mud	rare.	
Creseis, *Rang.*						
recta, *Lesueur*	Mediterranean, Canaries	unknown	Mediterranean, &c.		abundant	taken in tow-net, rise to the surface towards sunset.
striata, *Rang*	Mediterranean, Canaries	unknown	Mediterranean, &c.		abundant	
subulata, *Quoy & Gaimard*	Mediterranean, Canaries	unknown	Mediterranean, &c.		abundant	

tridentata, *Lam.*	Mediterranean, Canaries, Madeira.		uncertain		rare.	
trispinosa, *Lesueur*	Mediterranean, Canaries, Madeira.		uncertain		rare.	
vaginella, *Cantraine*	Mediterranean, Canaries, Madeira.		uncertain		rare.	
sp. ined.	Canary and Madeira Islands		uncertain		rare.	
gibbosa, *Rang*	Canary and Madeira Islands		uncertain		rare.	
Atlanta, *Peron.*						
Peronii, *Lesueur*	Mediterranean		uncertain		abundant	very abundant between Tunis and Malta.
Oxygyrus.						
Keraudrenii	off Grand Canary		uncertain		very rare	one specimen, in British Museum.
Gasteropoda.						
Umbrella, *Chem.*						
Mediterranea, *Lam.*	Mediterranean, Algiers, &c.	8 fathoms (dead)	Mediterranean	sand	rare.	
Tylodina, *Rafinesque.*						
citrina	Lancerotte	12 fathoms (dead)	unknown	sand and mud	rare	½ inch diameter.
Aplysia, *Gmel.*						
hybrida, *Sow.*	Nordland to Mogador and Canaries.	shore to 12 fathoms	Scotland	weed	frequent.	
Pattersoni	Spain and Portugal	shore	Asturias, Vigo	sand and rocks	frequent.	
ocellata	Canaries	shore	Canaries	sand and rocks	frequent	Animal larger, shell smaller than last specimen.
Philine, *Ascanius.*						
aperta, *Lin.*	North Drontheim to Canaries	shore to 30 fathoms	Britain	sand	frequent.	
quadrata, *Searles Wood*	Finmark, Zetland, and North Sea.	40 to 150 fathoms	Norway	sand	moderate.	
scabra, *O. Müller*	Nordland, Mediterranean	10 to 40 fathoms	Britain (Hebrides)	sand	moderate.	
catena, *Mont.*	Britain	5 to 40 fathoms	Britain	sand	rare.	
punctata, *Clark*	Britain	5 to 40 fathoms	Britain	sand	rare.	
pruinosa, *Clark*	Britain, Mediterranean?	30 to 40 fathoms	Britain	sand	rare	a specimen taken at Algiers, 30 fathoms, I believe to belong to this species.
Smaragdinella, *A. Adams.*						
algira, *Hanley*	Algiers	6 fathoms	unknown	sand	very rare	1 specimen, I believe unique, in British Museum.
Scaphander, *Mont.*						
lignarius, *Lin.*	Drontheim to Britain and Mediterranean.	shore to 40 fathoms	Britain (West)	sand	local	abundant at Anglesea.
librarius, *Loven*	Drontheim, Hammerfest	30 to 35 fathoms	Northern Scandinavia.	mud	moderate.	

Species.	Geographical range.	Vertical range.	Locality of principal development.	Ground.	Frequency.	Remarks.
Gasteropoda (*continued*).						
Amphisphyra, *Lovén.*						
hyalina, *Turton*	Finmark, Canaries, Madeira	shore to 60 fathoms	Britain (Murray Frith).	sand	rare.	
Cylichna, *Lovén.*						
cylindracea, *Pen.*	Nordland to Teneriffe	shore to 90 fathoms	Britain	sand	moderate.	
truncata, *Mont.*	Nordland ?, Canary Islands	10 to 60 fathoms	Mediterranean	sand and mud	frequent.	
obtusa, *Mont.*	Britain	shore and sublittoral	Britain	sand	abund., local	Liverpool, Balta Sound.
mamillata, *Phil.*	Britain to Canary Islands	30 to 40 fathoms	Mediterranean	sand	frequent.	
umbilicata, *Mont.*	Nordland to Mediterranean	20 to 30 fathoms	uncertain	sand	rare	Murray Frith, 30 fathoms.
fragilis, *Jeffreys*	Mediterranean (Carthagena) to Canary Islands.	30 to 40 fathoms	uncertain	sand	rare.	
alba, *Lovén*	Drontheim, Finmark	20 to 100 fathoms	Northern Norway	sand and mud	frequent.	
Akera, *O. F. Müller.*						
bullata, *Müll.*	Britain to Lisbon	shore, 4 fathoms	Vigo ?	sand and mud	local.	
Hanleyi, *A. Ad.*	Zetland	6 fathoms	Balta Sound	sand	frequent	possibly a minute variety of preceding.
Bulla, *Lin.*						
hydatis, *Lin.*	Britain, Mediterranean	shore, 4 fathoms	Vigo	sand and mud	frequent	small in Mediterranean, intermediate in size at Lisbon.
Cranchii, *Leach*	Hebrides to Canaries	10 to 100 fathoms	Britain	sand and mud	rare.	
ovulata, *Ph.*	Carthagena, Algiers, &c.	30 to 40 fathoms	Mediterranean	sand	rare.	
sp. ined.	Lisbon	shore		sand	local	extremely fragile.
sp. ined.	Canaries and Madeira	10 to 60 fathoms	Canaries	sand	frequent	white banded with opake white.
sp. ined.	Canary Islands	shore	Canaries	sand	frequent	more expanded than *B. hydatis.*
striata, *Bruguière*	Portugal, Cadiz	shore	Cadiz ?	sand and mud	frequent.	
ampulla, *Lin.* ?	Canaries	shore to 50 fathoms	uncertain	sand	moderate	only met with very young, or broken specimens.
Tornatella, *Lam.*						
fasciata, *Lam.*	Nordland to Mogador	shore to 40 fathoms	Britain (Anglesea)	sand and mud	frequent	large size at Anglesea on the shore, small and deep colour in Mediterranean.
Auricula, *Lam.*						
alba, *Jeffreys*	Azores, Oban, Ilfracombe	shore	Britain	stones and rock	frequent	under stones and in crevices of rock.
denticulata, *Mont.*	Britain	shore	Britain ?	sand	local	under algæ, deposited by the tide.
Ferminii, *Payr.*	Canary Islands	shore	Canaries ?	rocks	frequent.	
Pedipes, *Adanson.*						
sp. ined. ?	Canaries, Azores	shore	uncertain	rocks	frequent.	
Chiton, *Lin.*						
fascicularis, *Lin.* } discrepans, *Brown* }	Britain to Canary Islands, Madeira and Azores.	shore to 40 fathoms	uncertain	rocks and shells	frequent	largest size at Mogador, subject to great variety in size, colour, &c.

[illegible]	Britain to Nordland	20 to 100 fathoms	North Scandinavia.	stones and shells.	rare.	
ruber, *Lin.*	Britain to Finmark	shore to 20 fathoms	Zetland & Norway, laminarian zone.	stones	frequent.	
cinereus, *Lin.*	Nordland to North of Spain and Mogador.	shore	Britain	stones	frequent.	
albus, *Lin.*	Scotland to Finmark	4 to 20 fathoms	Norway	stones	moderate.	
asellus, *Chem.*	Vigo to Finmark	4 to 20 fathoms	Zetland and Norway.	stones and shells.	frequent.	
cancellatus, *Sow.*	Vigo to North Drontheim	8 to 40 fathoms	Hebrides.	Nullipore, &c.	local.	
lævis, *Pennant*	Finmark to Gibraltar and Mediterranean.	4 to 40 fathoms	Britain	stones and shells	moderate.	
marmoreus, *O. Fab.*	Finmark to Scotland	shore to 10 fathoms	Norway ?	stones	frequent	large near Oban, Loch Spelive, Mull Island.
fulvus, *Wood*	Vigo, Lisbon	shore to 12 fathoms	Vigo	sand and stones.	abundant.	
Cajetanus, *Poli*	Syracuse, Asturias	shore	uncertain	rocks	local.	
Rissoi, *Payr.*	Gibraltar, Carthagena	shore to 8 fathoms	Gibraltar ?	rocks and stones.	local.	
Siculus, *Gray*	Cadiz and Mediterranean	shore	Mediterranean	rocks	frequent.	
Polii, *Phil.*	Malta and Mediterranean	shore	Mediterranean	rocks	frequent	at Malta above the sea margin, but within reach of the ripple.
Canariensis, *Webb & Berth.*	Teneriffe	shore	uncertain	rocks	rare.	
alveolus, *Sars*	Northern Norway	100 to 150 fathoms	unknown	shells	rare.	
sp. ined.	Mogador, Canaries	shore	Mogador	rocks	abundant	cream colour, rare in Canaries.
Dentalium, *Lin.*						
entalis, *Lin.* } tarentinum, *Lam.* }	Finmark to Mogador	2 to 200 fathoms	Spain and Portugal?	sand and mud	abundant	I believe to be varieties of same species, the specimens from Norway being intermediate.
dentalis, *Lin.*	Vigo to Canaries and Madeira	2 to 50 fathoms	Spain and Portugal	sand and mud	abundant	very rare in Canaries, where obtained only 1 specimen in 50 fathoms.
rubescens, *Desp.*	Mediterranean, Canaries, and Madeira.	shore to 20 fathoms	Mediterranean	sand and mud	frequent	variety transparent white, more slender at Tunis.
sp. ined.	Vigo	20 to 30 fathoms	Vigo ?	mud	local	very slender.
sp. ined.	Northern Norway	80 to 200 fathoms	Arctic sea	sand and mud	rare	short, smooth, pellucid.
Siphonaria, *Blainv.*						
algesira, *Quoy*	Malaga, Mogador	shore	Gibraltar and Malaga ?	rocks	frequent	does not range eastward in the Mediterranean.
Gadinia, *Gray.*						
Garnoti, *Payr.*	Naples, Algiers, &c.	8 to 10 faths. (dead).	uncertain	sand	rare.	
afer, *Gray ?*	Canary Islands	12 fathoms	uncertain	sand and mud	rare.	
Acmæa, *Eschscholtz.*						
testudinalis, *Müller*	Isle of Man to North Cape	shore to 10 fathoms	Arctic seas	rocks and stones	frequent.	
virginea, *Müller*	Nordland to Mogador	shore to 56 fathoms	Zetland ?	shells, &c.	frequent	at Gibraltar, but very rare eastward in Mediterranean.

Species.	Geographical range.	Vertical range.	Locality of principal development.	Ground.	Frequency.	Remarks.
Gasteropoda (*continued*).						
Lepeta, *Gray*						
ancyloides, *Forbes*	West of Scotland	30 to 90 fathoms	uncertain	sand and shells	rare	probably a stunted variety of following.
cæca, *Müller*	Northern Norway	20 to 70 fathoms	Northern Norway	stones and mud	abundant	largest specimens obtained east of North Cape.
Pilidium, *Forbes.*						
fulvum, *Müller*	South of Ireland, Finmark	20 to 80 fathoms	Northern Norway	stones	frequent.	
Patella, *Lin.*						
vulgata, *Lin.*	Nordland to Mediterranean, Azores, Mogador?	shore	Britain?	rocks	abundant.	
cærulea, *Lam.*	Gibraltar, Algiers, &c.	shore	Mediterranean	rocks	abundant.	
athletica, *Bean*	Britain, Gibraltar? &c.	shore	uncertain	rocks	abundant.	
crenata, *D'Orb.*	Canary and Madeira Islands	shore	Canaries & Madeira	rocks	frequent.	
guttata, *D'Orb.*	Canaries and Madeira	shore	Canaries & Madeira	rocks	frequent.	
aspera, *Lam.*	Gibraltar, &c.	shore	Mediterranean	rocks	frequent.	
Lowei, *D'Orb.*	Canaries and Madeira	shore	Canaries & Madeira	rocks	frequent.	
scutellaris, *Lam.*	Gibraltar	shore	Mediterranean	rocks	frequent.	
Candei, *D'Orb.*	Canaries and Madeira	shore	Canaries & Madeira	rocks	frequent.	
tenuis, *Dillwynn*	Madeira	shore	Madeira	rocks	frequent.	
Gussonii, *Costa*	Canaries, Madeira, and Azores	12 to 20 fathoms	Canaries (Lancerotte).	weed	frequent	not many specimens living, these upon a red fucus.
nigropunctata, *Lam.*	Algiers, &c.	shore	Mediterranean	rocks	frequent.	
pellucida, *Lin.*	North Cape to Mogador	shore to 12 fathoms	Britain and Norway	Laminaria	frequent.	
Pileopsis, *Lam.*						
Hungarica, *Lin.*	Nordland to Mediterranean	15 to 80 fathoms	Britain (South)	shells	moderate	southern specimens are smaller.
Crepidula, *Lam.*						
unguiformis, *Lam.*	Carthagena, Algiers, &c.	shore	Mediterranean?	shells	moderate.	
gibbosa, *Def.*	Mediterranean	30 to 40 fathoms	uncertain	shells	rare.	
Calyptræa, *Lam.*						
Sinensis, *Lin.*	Milford Haven to Canary Islands.	shore to 10 fathoms	Spain	shells	abundant.	
Emarginula, *Lam.*						
reticulata, *Sow.*	Nordland to Canary Islands	shore to 100 fathoms.	Britain	stones and shells	frequent.	
rosea, *Bell.*	South of England and Vigo	6 to 20 fathoms	uncertain	stones and shells	local.	
crassa, *J. Sowerby*	Carnarvon Bay to Drontheim	10 to 40 fathoms	Loch Fyne?	stones	rare.	
elongata, *Costa*	Mediterranean and Canary Islands.	8 to 20 fathoms	Mediterranean?	stones and shells	moderate.	
pileolus, *Michaud*	Mediterranean	35 to 50 fathoms	Mediterranean	shells and sand	local.	

sp. ined.	Madeira and Azores	shore to 20 fathoms	Madeira ?	stones and mud	frequent.	
Puncturella, *Lowe.*						
Noachina, *Lin.*	Firth of Clyde to Finmark	20 to 100 fathoms	uncertain	stones and shells	frequent.	
Fissurella, *Lam.*						
reticulata, *Don.*	Britain to Canaries and Madeira.	shore to 50 fathoms	Mediterranean ?	shells and stones	frequent.	
rosea, *Lam.*	Mediterranean, Gibraltar, and Mogador.	shore to 4 fathoms	Mediterranean	stones	frequent.	
gibba, *Phil.*	Asturias to Canary Islands	shore to 60 fathoms	Mediterranean	sandstones	moderate.	
Ianthina, *Lam.*						
communis, *Lam.*	Canaries, Madeira, and Azores		uncertain		abundant.	
prolongata, *Blainv.*	Mediterranean, Madeira		uncertain		abundant	Mediterranean specimens much smaller than those of Atlantic.
exigua, *Lam.*	Canaries, Madeira, and Azores		uncertain		rare.	
sp. ined. ?	Asturias		Bay of Biscay		local	possibly a var. of *I. communis*, but much smaller.
Scissurella, *D'Orb.*						
crispata, *Fleming*	Orkney, Northern Scandinavia.	shore to 100 fathoms.	uncertain	sand	rare.	
Bertheloti, *D'Orb.*	Canary Islands	50 fathoms (dead)	uncertain	sand	rare.	
angulata, *Lovén.*	Nordland	40 fathoms	uncertain	sand	very rare	much larger than other species.
Haliotis, *Lin.*						
tuberculata, *Lin.*	Guernsey to Mediterranean, Azores and Canary Islands?	shore	uncertain	rock	frequent	attains larger size in Channel Islands than to the southward.
lamellosa, *Lam.*	Gibraltar, Naples	shore	Mediterranean	rock	frequent	possibly a variety of preceding.
sp. ?	Canary and Madeira Islands.	shore	Canary and Madeira	rock	frequent	Ditto.
Adeorbis, *Searles Wood.*						
subcarinatus	South of England, Mogador	3 to 60 fathoms	uncertain	sand and mud	rare	Mogador 3 fathoms, Vigo 4 fathoms, Dartmouth 10 fathoms.
Margarita, *Leach.*						
helicina, *O. Fab.*	North of England to Finmark	low water to 20 faths.	Norway	Lamellaria	frequent.	
undulata, *Sow.*	Oban to Finmark	4 to 100 fathoms	Norway	weed, sand, and gravel.	frequent.	
alabastrum, *Beck*	Orkney to Finmark	25 to 100 fathoms	Finmark	sand and stones	local, moderate.	British pure white 50 fathoms, Norwegian 30 to 40 fathoms, banded with gold.
cinerea, *Couthouy*	Nordland, Finmark	10 to 130 fathoms	Finmark at 20 fathoms.	sand and weed	frequent	most frequent on red weed from 20 fathoms.
Trochus, *Lin.*						
zizyphinus, *Lin.*	British seas, Mediterranean, Canaries, Madeira, Azores.	shore to 60 fathoms	Britain	sand, gravel, &c.	frequent	subject to great variety in form, colour and sculpture, according to habitat.
conulus, *Lin.*	Mediterranean, Canaries, and Madeira.	4 to 20 fathoms	Mediterranean ?	sand and mud	frequent	very rare in Canary Islands.

Species.	Geographical range.	Vertical range.	Locality of principal development.	Ground.	Frequency.	Remarks.
Gasteropoda (*continued*).						
Trochus, *Lin.*						
granulatus, *Born.*	Isle of Man to Canary and Madeira Islands.	5 to 50 fathoms	uncertain	sand	moderate	a beautiful variety from deep water, Teneriffe.
striatus, *Lin.*	South of England and Ireland, Canaries, Madeira, and Azores.	shore to 15 fathoms	Gibraltar and Mediterranean, shore to 4 fathoms	sand and mud	abundant.	
Montagui, *Gray*	Britain to Mediterranean	7 to 60 fathoms	South of England and Ireland?	sand and mud	moderate	living in 15 fathoms, Gibraltar; 35 fathoms, Gulf of Tunis; 40 fathoms, Malta.
millegranus, *Phil.*	Mediterranean to Nordland	5 to 100 fathoms	West of Scotland	sand and mud	frequent.	
exiguus, *Pulteney*	South of England to Canary and Madeira Islands.	4 to 50 fathoms	North of Spain	sand	frequent.	
crenulatus, *Phil.*	Cadiz to Canaries & Madeira	shore to 20 fathoms	Mediterranean	sand and mud	frequent.	
tumidus, *Mont.*	North Cape to Vigo	2 to 80 fathoms	Zetland and Norway.	sand, gravel, &c.	abundant	most frequent on Laminaria.
cinerarius, *Lin.*	North Cape to Vigo	shore to 20 fathoms	Britain and Norway.	sand and Laminaria.	abundant	many varieties, particularly on the north coast of Spain.
umbilicatus, *Mont.*	West of Britain, North of Spain, Lisbon, Mogador.	shore	Isle of Man, Anglesea.	rocks	abundant	a western species, not found in the Mediterranean.
magus, *Lin.*	Zetland to Canary and Madeira Islands.	low water to 25 faths.	uncertain	gravel and mud	abundant	largest size in England, deeper colours to southward.
lineatus, *Da Costa*	South of England, North of Spain, Mogador?	shore	South-west of England.	rocks	abundant	does not enter the Mediterranean.
canaliculatus, *Phil.*	South of Portugal and Mediterranean.	shore, 2 fathoms	Mediterranean	gravel and weed.	abundant.	
fanulum, *Gmel.*	Mediterranean	6 to 8 fathoms	Mediterranean	mud	moderate.	
fragaroides, *Lam.*	Mediterranean, Canaries	shore	Mediterranean	rocks	abundant	sold in the streets at Algiers.
indecorus, *Phil.*	Canary and Salvage Islands.	shore	uncertain	rocks	abundant.	
Saulcyi, *W. & B.*	Lancerotte	shore	uncertain	rocks	frequent.	
Richardi, *Payr.*	Gibraltar and Mediterranean.	shore	Mediterranean	rocks	abundant	much variety in size and colour.
Laugieri, *Payr.*	Vigo to Mediterranean and Azores.	4 to 12 fathoms	Faro and Gibraltar.	mud	abundant	
Vieillotti, *Payr.*	Gibraltar and Mediterranean.	shore	Mediterranean	rocks	local	
Jussieui, *Payr.*	Malta and Sicily	8 to 12 fathoms	uncertain	sand	local	
urticulatus, *Lam.*	South of Portugal and Mediterranean.	shore, 3 fathoms	Mediterranean?	sand, mud, &c.	frequent	
divaricatus, *Lin.*	Gibraltar and Mediterranean.	shore	Mediterranean	rock and stones.	frequent	N.B. several species of Trochus from the coast of Asturias and

sanguineus, *Lin.*	Malta	12 to 15 fathoms	E. Mediterranean?	sand	local	from the Mediterranean, not identified.
villicus, *Phil.*	Sicily	10 fathoms	uncertain	sand	local	
Bertheloti (Monodonta), *D'Orb.*	Canary, Madeira Islands, and Azores.	shore	Canary Islands	rocks	frequent	
Phasianella, *Lam.*						
pullus, *Lin.*	South and West of Britain, to Mogador, Madeira, and Azores.	3 to 5 fathoms	Asturias	weed	abundant.	
intermedia, *Scacchi*	South of Portugal and Mediterranean.	4 and 5 fathoms	Mediterranean	on *Zostera marina.*	local.	
Vieuxii, *Payr.*	Malta and Sicily	5 to 12 fathoms	Eastern Mediterranean.	sand	frequent.	
Turbo, *Lin.*						
rugosus, *Lin.*	Asturias to Canaries and Azores.	8 to 60 fathoms	Gibraltar, 8 faths.	mud	abundant	rare in Asturias, small in Canaries.
sp. ined.	Mogador	shore	unknown	rocks	moderate	smallish, compressed.
Neritina, *Lam.*						
viridis, *Lin.*	Mediterranean, Canaries, and Madeira.	4 to 20 fathoms	uncertain	sand	abundant	on Zostera, near Malaga.
Truncatella, *Lowe.*						
truncatula, *Drap.*	Malaga and Canaries	shore	Mediterranean	s	local.	
Skenea, *Fleming.*						
planorbis, *O. Fabr.*	Britain, Norway	shore	Hebrides	weed	abundant.	
sp.	Orotava	60 fathoms	unknown	sand	rare.	
sp.	Norway	15 to 40 fathoms	Norway?	mud and gravel	frequent.	
Rissoa, *Frem.*						
striatula, *Mont.*	South of England and Cadiz.	shore, 7 fathoms	uncertain	sand	rare.	
lactea, *Michaud*	Vigo and Mediterranean, Mogador.	shore, 4 fathoms	Vigo and Cadiz	sand and mud	abundant.	
Zetlandica, *Mont.*	Zetland, Hebrides	20 to 70 fathoms	uncertain	sand	rare.	
crenulata, *Mich.*	South of England to Canaries, Madeira, and Azores.	shore to 50 fathoms.	Spain	sand	frequent.	
Beanii, *Hanley*	West of Scotland and Wales.	15 to 30 fathoms	uncertain	sand and mud	local.	
abyssicola, *Forbes*	West of Scotland and South of Ireland.	50 to 150 fathoms	Loch Fyne	mud	moderate.	
calathus, *Forbes & Hanley*	Drontheim? South and West of Britain and Ireland, Vigo, and Azores.	8 to 50 fathoms	uncertain	sand	moderate.	
granulata, *Phil.*	Cadiz, Mediterranean, and Azores.	shore (dead)	Mediterranean?	sand	abundant	*not R. calathiscus* of Mont
sculpta, *Phil.*	Hebrides, Scilly	30 to 50 faths. (dead).	uncertain	sand	local.	
punctura, *Mont.*	Scilly	50 fathoms (dead)	South of England.	sand	frequent.	

Species.	Geographical range.	Vertical range.	Locality of principal development.	Ground.	Frequency.	Remarks.
Gasteropoda (*continued*).						
Rissoa, *Frem.*						
costata, *Adams*	Britain to Canaries	shore to 60 fathoms	Mediterranean and Canaries.	sand	frequent.	
striata, *Mont.*	Nordland to Vigo	low water to 80 faths.	Britain	sand and stones.	abundant.	
parva, *Costa* } interrupta, *Adams* }	Nordland to Canaries	shore to 20 fathoms	Britain	weed	abundant.	
costulata, *Alder*	South of England to Mediterranean.	2 to 5 fathoms	North of Spain	weed	local.	
rufilabrum, *Alder*	Britain	4 to 5 fathoms	West of Scotland	weed	local.	
labiosa, *Mont.*	Britain, Canaries	low water to 10 faths., 60 faths. dead.	Southampton, Spain.	sand and weed	abundant	frequent on Zostera.
semistriata, *Mont.*	Britain	low water, 12 faths.	South of England?	sand and weed	local.	
rubra, *Adams*	Britain to Canaries	12 to 50 fathoms	uncertain	sand	moderate	I have not met with it living.
cingillus, *Mont.*	North of Scotland to North of Spain, Azores.	shore	Britain	under stones	abundant	the white variety in crevices of rocks.
vitrea, *Mont.*	Hebrides to Vigo	4 to 40 fathoms	uncertain	sand and mud	rare.	
ulvæ, *Pennant*	Finmark to Vigo	shore	Britain	sand and mud	abundant	of large size at Southampton.
Barleei, *Jeffreys*	Loch Fyne	70 fathoms	unknown	mud	rare	} 2 or 3 species from Mediterranean, 5 or 6 from Canaries, 3 from Madeira, undescribed.
violacea, *Desm.*	North of Spain to Madeira and Canaries.	shore to 12 fathoms	Mediterranean	sand	abundant	
monodonta, *Bivon*	Mediterranean, Lisbon	4 fathoms	Mediterranean	Zostera	frequent	
Bruguieri, *Payr.*	Carthagena, Malta	10 and 40 fathoms	Mediterranean	sand	rare	
auriscalpium, *Lin.*	Carthagena, Malta, &c.	shore to 40 fathoms	Mediterranean	sand	frequent	
Montagui, *Payr.*	Cadiz and Mediterranean	shore to 40 fathoms	Mediterranean	sand	frequent	
Desmarestii, *Forbes*	Tunis and Malta	30 to 40 fathoms	East Mediterranean	sand	rare	
sp. ined.	Malaga	30 fathoms	unknown	mud	rare	
Canariensis, *Webb & Berth.*	Canary and Madeira	20 to 50 fathoms	Canaries	sand	frequent	
Lacuna, *Turton.*						
pallidula, *Costa*	Anglesea, Zetland, and Drontheim, &c.	low water	Britain	Laminaria	frequent	very rare at Drontheim.
puteolus, *Turton*	Britain, Vigo?	shore to 4 fathoms	Britain	Laminaria and Zostera.	frequent	a single dead specimen at Vigo.
vincta, *Mont.*	Britain, North Cape	shore to 6 fathoms	Norway	Laminaria	frequent.	
labiosa, *Lovén*	Drontheim to North Cape	shore to 6 fathoms	Norway	Laminaria	rare.	
crassior, *Mont.*	Britain	4 to 40 fathoms	Britain	sand	local.	

Solarium, *Lam.*						
luteum, *Lam.*	Vigo to Canary	shore to 20 fathoms	uncertain	mud	rare	alive at 20 fathoms, Vigo.
stramineum, *Gmel.*	Vigo to Canaries and Madeira.	8 to 40 fathoms	Malaga and Mediterranean.	mud	moderate.	
pseudoperspectivum, *Bro.*	Gibraltar	40 fathoms	unknown	mud	very rare	1 recent but dead specimen in British Museum.
Bifrontia, *Deshayes.*						
zanclæa, *Philippi*	Madeira	18 to 24 fathoms	Madeira ?	sand and mud	frequent.	
Fossarus, *Philippi.*						
Adansoni, *Philippi*	Canary, Madeira, and Azores Islands.	shore	Azores ?	sand	moderate.	
Littorina, *Férussac.*						
neritoides, *Lin.*	Britain to Canaries and Madeira.	shore	Spain and Portugal?	rocks	abundant.	
littorea, *Lin.*	Nordland to Lisbon	shore	Scotland	stones	abundant.	
littoralis, *Lin.*	Finmark to Malaga	shore	Britain	fucus	abundant.	
rudis, *Don.*					abundant.	
tenebrosa, *Mont.*	Finmark to Vigo	shore	Britain	stones	abundant.	
saxatilis, *Johnston*					frequent.	
patula, *Jeffreys*					frequent.	
Syriaca, *Phil.*	Asturias, Malaga	shore	Spain ?	rocks	frequent.	
striata	Canaries, Madeira, and Azores.	shore	Canaries, &c.	rocks	abundant.	
Scalaria, *Lam.*						
Turtonis, *Turton*	England and Ireland to the Mediterranean and Madeira.	4 to 24 fathoms	Britain, Ireland	mud	local	
communis, *Lam.*	Britain, Mediterranean	4 to 10 fathoms	uncertain	mud	local	
clathratula, *Mont.*	South of England to Canaries and Azores.	10 to 30 fathoms	Spain	sand and mud	rare	
Grœnlandica, *Chem.*	Arctic seas, Britain ?	20 to 40 fathoms	Arctic seas	sand	moderate	Three or four other undescribed species of Scalaria from the Canary Islands, and two from Madeira.
Lovéni, *A. Adams*	Norway	20 to 4 fathoms	Norway	sand	rare	
Trevelliana, *Leach*	Zetland to Cape Clear	40 to 100 fathoms	Britain and Ireland	sand	moderate	
crenata, *Lin.*	Cadiz to Canaries	shore	Canaries?	rocks	moderate	
pseudoscalaris, *Brocchi*	Mediterranean to Canaries	shore	Canaries	rocks	frequent	
cochlea, *Sow.*	Lancerotte, Porto Santo	12 and 20 fathoms	uncertain	sand	rare	
Macandrei, *Forbes, MSS.*	Lancerotte	12 fathoms	uncertain	sand	frequent	
Webbii, *D'Orb.*	Teneriffe	20 fathoms	uncertain	mud	rare	
sp. ined.	Algiers, Tunis, Catania	30 to 40 fathoms	Mediterranean	sand	rare	
sp. ined.	Teneriffe	50 fathoms	uncertain	sand	rare	grooved like *S. Grœnlandica.*
Vermetus, *Adanson.*						
gigas, *Bivon*	Mediterranean	shore, sublittoral and littoral.	Mediterranean	stones and coral.	frequent.	
glomeratus, *Lin.*	Cadiz and Mediterranean	shore	Mediterranean	stones and rock.	frequent.	

Species.	Geographical range.	Vertical range.	Locality of principal development.	Ground.	Frequency.	Remarks.
Gasteropoda (*continued*).						
Vermetus, *Adanson.*						
corneus, *Forbes*	Mediterranean	25 to 40 fathoms	Mediterranean	sand and coral	frequent.	
Other species not identified.						
Cæcum, *Fleming.*						
elegantissimum, *Carp.*	Canary Islands	12 to 50 fathoms	uncertain	sand	frequent.	
trachea, *Mont.*	Britain to Mediterranean	8 to 50 fathoms	uncertain	sand and gravel	frequent.	
Searles Woodii, *Carp.*	Canary Islands	50 fathoms	uncertain	sand	very rare.	
glabrum, *Mont.*	Britain to Mediterranean	8 to 50 fathoms	uncertain	sand and gravel	frequent.	
vitreum, *Carp.*	Canary Islands	12 to 50 fathoms	uncertain	sand	frequent.	
Aclis, *Lovén.*						
ascaris, *Turton*	Britain to Mediterranean	shore to 80 fathoms	uncertain	sand	very rare	Isle of Man shore, Zetland 80 faths., Pantellaria 40 fathoms.
supranitida, *Searles Wood.*	South of England, Vigo, and Mediterranean.	8 to 15 fathoms	Bantry Bay? uncertain.	sand	rare.	
sp. ined.	Teneriffe	50 fathoms	unknown	sand	rare.	
? sp. ined.	Gibraltar	18 fathoms	unknown	sand	rare	2 specimens.
? sp. ined.	Madeira	20 fathoms	unknown	mud	rare.	
Turritella, *Lam.*						
communis, *Risso*	Nordland to Mediterranean and Mogador.	4 to 100 fathoms	Britain	sand and mud	abundant.	
triplicata, *Brocchi*	Vigo to Canary Islands	8 to 30 fathoms	Gibraltar	sand and mud	abundant	very small size in the Canaries.
Mesalia, *Gray.*						
brevialis, *Lam.*	Faro, Gibraltar, Mogador	3 to 15 fathoms	uncertain	sand	frequent	not met with in the Mediterranean.
striata, *A. Ad.*	Gibraltar, Madeira	15 to 30 fathoms	uncertain	mud	rare.	
Aporrhais, *Aldrovandus.*						
pes-pelecani, *Lin.*	Nordland, Mediterranean	5 to 100 fathoms	Britain	sand, mud, and gravel.	abundant.	
pes-carbonis, *Brong.*	Zetland, Nordland	70 to 100 fathoms	Zetland?	sand	rare.	
Triforis, *Deshayes.*						
adversa, *Mont.*	British seas	10 to 60 fathoms	Britain	sand	local	not obtained living.
perversa, *Brug.*	Vigo to Canaries	shore to 50 fathoms	Mediterranean	sand	frequent.	
Macandrei, *A. Adams*	Drontheim to North Cape	70 to 150 fathoms	unknown	sand	rare	the largest known species.
Cerithiopsis, *Forbes.*						
tubercularis, *Mont.*	Britain to Mediterranean	shore to 60 fathoms	South of England	sand	frequent	not obtained alive.
Cerithium, *Brug.*						
reticulatum, *Costa*	Drontheim to Canaries and Azores.	shore to 60 fathoms	Spain and Mediterranean.	sand and gravel	abundant.	

metula, *Lovén*	South of Zetland to Finmark	30 to 100 fathoms	Finmark, 35 fathoms	fine sand and mud	moderate.	
lacteum, *Philippi*	Pantellaria, Malta	40 fathoms	Mediterranean	sand	rare.	
angustinum, *Forbes*	Mediterranean, Teneriffe, and Madeira.	40 to 60 fathoms	uncertain	sand	rare.	
vulgatum, *Brug.*	South of Portugal to Canary Islands.	shore to 40 fathoms	Mediterranean and Canaries.	sand and weed	abundant	deep water variety, more slender and more strongly tuberculated.
fuscatum, *Da Costa*	Cadiz to Canary Islands	shore	Mediterranean and Canaries.	rock	abundant.	
Stylina, *Fleming.*						
1 or 2 sp.	Teneriffe	50 fathoms	unknown	sand	rare.	
Eulima, *Risso.*						
polita, *Lin.*	Nordland and Zetland to Mediterranean.	7 to 50 fathoms	Anglesea, Zetland	sand	moderate.	
distorta, *Desh.*	Scotland to Madeira, Azores, and Canaries.	10 to 60 fathoms	Firth of Clyde	sand	frequent	Mediterranean and southern specimens more characteristic than the British.
subulata, *Donovan*	Britain, Mediterranean, Madeira.	7 to 40 fathoms	uncertain	sand	moderate	on the shore dead.
bilineata, *Alder*	West of Scotland to North Cape.	20 to 100 fathoms	Norway	sand	moderate	a white var.? in Zetland (80 faths.) and Northern Norway.
nitida, *Lam.*	Mediterranean, Canary Islands, and Madeira.	30 to 40 fathoms	Mediterranean	sand	rare	probably an inhabitant of British seas, confounded with *E. polita* and *E. distorta.*
sp. ined.?	Canaries, Madeira, and Azores	12 to 40 fathoms	Canaries	sand	frequent	dead.
Chemnitzia, *D'Orb.*						
elegantissima, *Mont.*	Isle of Man to Lancerotte and Azores.	3 to 40 fathoms	uncertain	sand	frequent	abundant in Milford Haven, 7 faths.
fulvocincta, *Thompson*	Zetland to Lisbon	6 to 80 fathoms	Britain	sand	moderate.	
rufa, *Phil.*	Portugal to Canary Islands	10 to 30 fathoms	Mediterranean and Madeira.	sand	moderate.	
formosa, *Jeffreys*	Bantry Bay, Vigo	8 to 15 fathoms	uncertain	sand	rare	probably a variety of *C. fulvocincta.*
fenestrata, *Forbes & Jeff.*	South of England to Vigo	4 to 8 fathoms	uncertain	sand and mud	local.	
scalaris, *Phil.*	Milford Haven to Vigo and Gibraltar.	8 to 30 fathoms	uncertain	sand and mud	rare.	
rufescens, *Forbes*	Firth of Clyde to North Drontheim.	15 to 30 fathoms	Oban?	mud	rare.	
indistincta, *Mont.*	Britain to Canary Islands	10 to 50 fathoms	uncertain	sand	moderate.	
sp. ined.	Nordland and Finmark	20 to 50 fathoms	Nordland and Finmark.	sand	rare.	
sp. ined. }	Straits of Gibraltar }			sand	rare	pink.
sp. ined. }	off Cape Trafalgar }	30 fathoms	unknown	sand	rare	brown, slender.
sp. ined. }	off Cape Trafalgar }				rare	white, slender.

Species.	Geographical range.	Vertical range.	Locality of principal development.	Ground.	Frequency.	Remarks.
Gasteropoda (*continued*).						
Eulimella, *Forbes*.						
acicula, *Phil.*	Britain to Gibraltar and Mediterranean.	2 to 35 fathoms	uncertain	sand and mud	rare.	
affinis, *Phil.*	Britain, Finmark	20 to 30 fathoms	Murray Frith?	sand	rare.	
Scillæ, *Phil.*	North Drontheim to Canary Islands.	20 to 80 fathoms	Oban	sand	rare.	
Odostomia, *Fleming*.						
conoidea, *Brocchi*	Britain, Canaries	10 to 60 fathoms	Oban, 15 fathoms	sand and mud	frequent.	
acuta, *Jeffreys*	Britain to Gibraltar and Canaries.	15 to 30 fathoms	uncertain	sand and mud	rare.	
spiralis, *Mont.*	Britain and Gibraltar	8 to 30 fathoms	uncertain	sand	moderate.	
interstincta, *Mont.*	Britain, Canaries, Madeira	10 to 50 fathoms	uncertain	sand	moderate.	
conspicua, *Alder*	Lisbon	10 fathoms	unknown	mud	rare.	
plicata, *Mont.*	Madeira, Britain, Finmark	10 to 70 fathoms	uncertain	sand	moderate.	
glabrata, *Muhlfeldt*	Canaries	50 fathoms (dead)	unknown	sand	rare.	
obliqua, *Alder*	Canaries, Britain	12 fathoms	uncertain	sand	rare.	
tricincta, *Jeffreys*	Mediterranean, Canaries, and Madeira.	40 to 60 fathoms	Canaries?	sand	rare.	
*unidentata, *Mont.*	Britain, Madeira, Canaries	20 to 60 fathoms	uncertain	sand	moderate.	
Velutina, *Fleming*.						
lævigata, *Lin.*	Finmark to Vigo	low water to 40 faths.	Scotland and Norway.	sand, stones, and shells.	moderate.	
flexilis, *Mont.*	North of Britain to Finmark.	25 fathoms	Norway	stones	rare.	
Lamellaria, *Mont.*						
tentaculata, *Mont.*	Britain, Vigo, Mediterranean	8 to 20 fathoms	uncertain	sand and gravel.	moderate	in some foreign specimens the animal is bright orange.
perspicua, *Lin.*	Britain, Mediterranean? Madeira?	5 fathoms	uncertain	sand	moderate	in Cardigan Bay large, animal gray.
prodita, *Lovén*	Finmark	20 to 35 fathoms	Finmark	sand	frequent	brown and yellow.
sp. ined.	Canary Islands	40 to 60 fathoms	unknown	sand	rare	shell banded with opaque white.
Sigaretus, *Lam.*						
haliotideus, *Lin.*	South of Portugal and Malaga	shore (dead)	South of Portugal	sand	moderate	not met with alive.
Natica, *Lam.*						
monilifera, *Lam.*	Britain to North of Spain	shore to 5 fathoms	Britain	sand	frequent	living near low-water mark.
nitida, *Don.*	Finmark to Mediterranean	shore to 40 fathoms	Britain	sand	very freq.	
sordida, *Phil.*	Zetland to Mediterranean	30 to 80 fathoms	Britain	sand	local.	
helicoides, *Johnston*	East of Scotland, Finmark	2 to 45 fathoms	Norway, 10 to 12 fathoms.	sand and Nullipore.	moderate.	

			20 fathoms.			
Montagui, *Forbes*	Scotland and Ireland to Finmark.	4 to 50 fathoms	Hebrides, 20 faths.	sand, mud, and Nullipore.	frequent.	
clausa, *Sow.*	Nordland and Finmark	shore to 10 fathoms	Finmark	stones and rock	frequent	on Algæ between tide marks, in company with Littorinæ, Tromsoe.
aperta, *Lovén* ?	Finmark	15 to 20 fathoms	uncertain	sand	rare.	
intricata, *Don.*	Portugal, Cadiz, Mediterranean, and Azores ?	shore to 5 fathoms	Mediterranean	sand and mud	frequent.	
textilis, *Reeve*	Cadiz and Gibraltar	shore to 4 fathoms	Cadiz ?	sand and mud	frequent.	
olla, *M. de Serres*	Naples and Sicily	8 to 12 fathoms	Naples	sand and mud	moderate.	
millepunctata, *Lam.*	Mediterranean and Canaries	shore to 40 fathoms	Algiers ?	sand and mud	frequent	rare in Canary Islands.
Guilleminii, *Payr.*	South of Portugal and Mediterranean.	shore to 40 fathoms	Gibraltar, 12 faths.	sand and mud	frequent.	
macilenta, *Phil.*	Gibraltar and Mediterranean, Mogador.	30 to 40 fathoms	Mediterranean	sand and mud	frequent	possibly a variety of the last.
porcellana, *Webb & Berth.*	Canary and Madeira	shore to 60 fathoms	Canaries, 12 to 16 fathoms.	sand and mud	frequent.	
Sagrana, *D'Orb.*	South of Portugal to Canaries	shore to 20 fathoms	Malaga, shore to 8 fathoms.	sand and mud	frequent	rare, except at Gibraltar and Malaga.
sp. ined.	Canaries	12 to 20 fathoms	Canary Islands	sand and mud	frequent.	
sp. ined.	Canaries and Madeira	shore to 20 fathoms	uncertain	sand and mud	moderate.	
Ovulum, *Lam.*						
patulum, *Pennant*	South-west of Cornwall	20 fathoms	uncertain	sand	rare	only once obtained living.
spelta, *Lin.*	Mediterranean and Canary Islands.	8 to 60 fathoms	Mediterranean, 8 to 10 fathoms.	sand	rare	on Gorgonia.
carneum, *Lin.*	Algiers	35 fathoms	Mediterranean	sand	moderate.	
? acuminatum, *Brug.*	Britain, Mediterranean	30 to 40 fathoms	unknown	sand	rare.	
Erato, *Risso.*						
lævis, *Donovan*	Zetland to Mediterranean	12 to 50 fathoms	Mediterranean	sand and mud	rare	ranges by Scilly and West of Ireland to the Hebrides and Zetland.
Cypræa, *Lin.*						
Europea, *Mont.*	Vigten Islands in Norway to the Mediterranean.	low water to 20 faths.	Britain	rocks and stones	abundant.	
pulex, *Solander*	Cadiz, Mediterranean, Canaries, Madeira, and Azores.	shore to 24 fathoms	Malta, &c.		frequent	I have not obtained it living.
candidula, *Gaskoin*	Canary and Madeira Islands.	12 to 24 fathoms	uncertain	sand	moderate.	
spurca, *Lin.*	Eastern Mediterranean and Canary Islands.	low water and sub-littoral.	Canaries	rocks	moderate.	
pyrum, *Lin.*	Cadiz, Mediterranean, and Canaries.	shore (dead)	uncertain	rocks	rare.	
moneta, *Lin.*	Cadiz ? Canaries ?	shore (dead)	tropical			dead on the shore at the two localities named, not in the Mediterranean.

* I omit numerous species of Odostomia, all enumerated in the 'British Mollusca' of Forbes and Hanley, which I have obtained in the British Seas, but not identified in any foreign locality.

Species.	Geographical range.	Vertical range.	Locality of principal development.	Ground.	Frequency.	Remarks.
Gasteropoda (*continued*).						
Cypræa, *Lin.*						
lurida, *Lin.*	Canary Islands	shore (dead)	uncertain		rare	of large size. I have not obtained it in a second locality.
Marginella, *Lam.*						
miliacea, *Lam.*	Cadiz to Canary Islands	shore to 8 fathoms	Cadiz ?	rocks and sand	frequent.	
clandestina, *Brocchi*	Mediterranean to Canary Isds.	15 to 60 fathoms	uncertain	sand	frequent.	
guancha, *D'Orb.*	Canary and Madeira Islands.	15 to 60 fathoms	Canary	sand	frequent.	
secalina, *Phil.* ?	Gulf of Tunis, Malta, Canary Islands.	12 to 40 fathoms	uncertain	sand	moderate.	
glabella, *Lin.*	Mogador, Canary Islands	shore to 12 fathoms	uncertain	sand and stones	frequent	rare at Mogador.
sp. ined.	Mogador	3 to 5 fathoms	Mogador ?	sand	frequent.	
Mitra, *Lam.*						
columbellaria, *Scacchi*	Gibraltar and Mediterranean to Canary Islands.	8 to 60 fathoms	Gibraltar and Mediterranean.	sand	frequent.	
ebeneus, *Lam.*	Cadiz and Mediterranean to Mogador.	shore to 10 fathoms	Mediterranean	sand and rocks	frequent.	
Savignii, *Payr.*	Algiers, Tunis, Malta	12 to 45 fathoms	Eastern Mediterranean.	sand	moderate.	
fusca, *Swainson*	Canary, Madeira, and Azores Islands.	shore	Canaries, &c.	rocks	frequent.	
lutescens, *Lam.*	East coast of Sicily	10 fathoms	Eastern Mediterranean.	sand	rare.	
zebrina, *D'Orb.*	Mogador to Canary, Madeira Islands, and Azores.	shore	Canaries	rocks	frequent.	
sp. ined.	Canaries and Madeira	12 to 20 fathoms	Canaries	sand	frequent.	
sp.	Faro	shore (dead)	unknown	sand	rare	in British Museum.
Cymba, *Brod.*						
olla, *Lin.*	Rock of Lisbon to Canary Islands.	shore to 15 fathoms	South of Portugal and Gibraltar.	sand and mud	frequent	not found in the Mediterranean east of Malaga.
Lachesis, *Risso.*						
minima, *Mont.*	Cornwall to Mogador and Madeira.	low water to 8 faths.	Spain	stones and sand	frequent	probably more than one species under this name.
Defrancia, *Millet.*						
pyramidalis, *Strom.*	Northern Norway	20 to 50 fathoms	unknown	sand	rare.	
linearis, *Mont.*	Nordland to Canary Islands and Madeira	6 to 80 fathoms	Britain, Spain	sand and mud	frequent.	
purpurea, *Mont.*	Scotland to Gibraltar, Madeira, and Mogador.	shore to 8 fathoms	Britain ?	sand and gravel	moderate.	
Philberti, *Michaud*	Mediterranean, Canaries, and Madeira	shore to 40 fathoms	Mediterranean	sand	moderate	allied to last, and appears to take its place in southern latitudes.

			Mediterranean ...	sand and mud ...	frequent.	land, 50 fathoms.
Bela, *Leach*.						
turricula, *Mont*.	Britain to Arctic seas	4 to 100 fathoms	Norway, 10 fathoms	sand	frequent.	
Trevelliana, *Turton*	Britain to Arctic seas	4 to 100 fathoms	Norway	sand	frequent ...	British specimens most frequent on the East coast and Firth of Forth.
mitrula, *Lovén*	Nordland and Finmark	10 to 50 fathoms	Finmark ?	sand and gravel	moderate.	
rosea, *Sars*	Nordland and Finmark	10 to 50 fathoms	uncertain	sand	rare.	
rufa, *Mont*.	Britain to Finmark	shore to 12 fathoms	Nordland and Finmark.	sand and mud ...	frequent.	
septangularis, *Mont*.	Britain to Mediterranean and Azores.	shore to 8 fathoms ...	South of England, Vigo.	mud	rare.	
Mangelia, *Leach*						
?Holbollii, *Möller*	Drontheim, Finmark	3 to 30 fathoms	Northern coasts of Norway.	sand, weed, and Nullipore.	frequent.	
?nana, *Lovén*	Arctic seas to Orkney	30 fathoms (living)	uncertain	sand	rare.	
teres, *Forbes*	Drontheim to Canaries, Madeira, and Mediterranean.	15 to 100 fathoms ...	Britain (Berwick Bay).	sand and gravel	rare.	
gracilis, *Mont*.	Clyde to Teneriffe and Madeira.	8 to 30 fathoms	Gibraltar and Naples.	sand and mud ...	moderate.	
nebula, *Mont*.	Britain to Canary Islands ...	shore to 25 fathoms .	Mediterranean	sand and mud ...	frequent.	
lævigata, *Phil*.	Mediterranean, Mogador ...	4 to 8 fathoms	Malaga, &c.	sand and mud ...	moderate.	
brachystoma, *Phil*.	Zetland to Mogador	10 to 60 fathoms ...	Mediterranean, 30 fathoms.	fine sand	moderate.	
striolata, *Scacchi*	England to Canary and Madeira Islands	8 to 60 fathoms	Mediterranean and Madeira.	sand and mud ...	moderate.	
costata, *Pennant*	Scotland to Vigo and Portugal.	5 to 60 fathoms	Cornwall and Vigo, smaller var. north of England, and south of Scotland larger var. (coarctata).	sand	frequent.	
attenuata, *Mont*.	Britain to Mediterranean ...	2 to 18 fathoms	Mediterranean, 2 to 4 fathoms.	sand and mud ...	moderate.	
elegans, *Scacchi*	Asturias to Canary Islands...	6 to 25 fathoms	Gibraltar	sand and mud ...	moderate ...	did not meet with it in Madeira.
Vauquelinii, *Payr*.	Mediterranean, Canaries, Madeira.	shore to 25 fathoms .	Mediterranean	sand and mud ...	moderate	Several species of Mangelia new or not identified at Gibraltar, Madeira, and in the Mediterranean.
secalina, *Phil*.	Malta, &c., Madeira	6 to 15 fathoms	East Mediterranean	sand	moderate	
grana, *Phil*.	Malta	19 fathoms	uncertain	sand	rare	
rugulosa, *Phil*.	Naples, Sicily, &c.	10 to 30 fathoms ...	Naples, &c.	sand	rare	
nana, *Scacchi*	Gibraltar, Naples	8 to 10 fathoms	uncertain	mud	rare	
cuspata, *Cristof*.	Gibraltar, Tunis	35 and 40 fathoms ...	Mediterranean	sand	rare	
rudis, *Phil*.	Gulf of Tunis	35 fathoms	uncertain	sand	rare	

Species.	Geographical range.	Vertical range.	Locality of principal development.	Ground.	Frequency.	Remarks.
Gasteropoda (*continued*).						
Mangelia, *Leach.*						
nivale, *Lovén*	Nordland and Finmark	30 to 150 fathoms	Nordland and Finmark.	sand and mud	rare.	
balteata, *Beck*	Algiers, Teneriffe	30 and 60 fathoms	uncertain	sand	very rare.	
Conus, *Lin.*						
Mediterraneus, *Brug.*	South of Portugal to Canary Islands.	shore	Mediterranean	rocks and mud	abundant.	
papilionaceus, *Brug.*	Canary Islands	12 to 20 fathoms	uncertain	sand and mud	rare.	
Columbella, *Lam.*						
rustica, *Lin.*	South of Portugal, Canary, Madeira, and Azore Islds.	shore	uncertain	rocks	abundant.	
scripta, *Lin.*	Mediterranean to Mogador	3 to 10 fathoms	Gibraltar and Mediterranean.	sand and mud	moderate	many varieties.
minor, *Scacchi*	Mediterranean to Canary and Madeira Islands.	shore to 20 fathoms	Malaga, &c.	sand and mud	abundant	abundant on Zostera.
cribraria, *Lin.*	Canary and Madeira Islands	shore	uncertain	rocks and stones.	frequent.	
Broderipii, *Sow.*	Mogador, Canaries	4 fathoms	uncertain	sand	frequent.	
sp. ined.	Madeira	18 to 24 fathoms	unknown	sand and mud	rare.	
sp. ined.	Madeira	18 to 24 fathoms	unknown	sand and mud	rare.	
sp. ined.	Azores	shore			rare.	
Dolium, *Lam.*						
galea, *Lin.*	East Mediterranean and Canaries.	12 to 40 fathoms	uncertain	sand and mud	local	not found in the Western Mediterranean.
Cassidaria, *Lam.*						
echinophora, *Lin.*	Malta	6 fathoms	Mediterranean	sand	local.	
Cassis, *Lam.*						
sulcosa, *Lam.*	Mediterranean, Canaries, and Madeira.	shore to 10 fathoms	Mediterranean	sand	frequent.	
saburon, *Lam.*	Atlantic shores of Spain and Portugal.	shore dead, 8 fathoms living.	uncertain	sand	rare	living at Gijon, Asturias, rare.
Purpura, *Lam.*						
lapillus, *Lin.*	North Cape to Vigo	shore to 10 fathoms	Britain, shore	rocks, sand & mud	abundant.	
hæmastoma, *Lin.*	Asturias to Canary, Madeira and Azores Islands.	shore	Canaries and Madeira?	rocks	frequent	common on the Atlantic coasts, very rare in Mediterranean.
viveratoides, *Webb & Berth.*	Canary Islands (Lancerotte).	shore	uncertain		moderate	not obtained living.
Ringicula, *Desh.*						
auriculata, *Menke*	Vigo to Mediterranean, Canaries, and Madeira.	4 to 60 fathoms	uncertain	mud	abundant.	

reticulata, *Lin.*	Finmark to Canaries and Azores.	shore to 30 fathoms	Spain	rock, stones, mud and sand.	abundant.	
pygmæa, *Lam.*	South of England to Mediterranean.	4 to 15 fathoms	Mediterranean	sand and mud	abundant.	
variabilis, *Phil.*	Mediterranean to Canary and Madeira Islands.	shore, 4 fathoms	Gibraltar and Canaries.	sand and stones	abundant.	
sp. ined.	Lisbon and Mogador	4 and 20 fathoms	unknown	sand	rare	20 fathoms in the Tagus, 4 fathoms at Mogador, long and narrow.
prismatica, *Brocchi*	Algiers, Messina, Canaries, and Madeira.	20 to 40 fathoms	Canaries?	mud	local.	
mutabilis, *Lin.*	Mediterranean	4 to 8 fathoms	Mediterranean	sand and mud	frequent.	
neritea, *Lin.*	Cadiz and Mediterranean	shore to 8 fathoms	Mediterranean	sand	frequent	five distinct varieties from as many localities.
grana, *Lam.*	Malaga and Gibraltar	4 to 10 fathoms	Malaga?	sand and mud	frequent.	
trifasciata, *A. Ad.*	Vigo to Mogador	8 to 30 fathoms	Vigo?	sand and mud	abundant.	
glaberrima, *Gmel.*	Cadiz, Mogador, Canaries	shore	Canaries	rock and sand	abundant	not seen in the Mediterranean.
corniculum, *Oliv.*	North of Spain to Mogador	shore	Spain	stones and weed.	abundant.	
Terebra, *Lam.*						
sp.	Grand Canary	shore (dead)	unknown	rocks	very rare.	
Buccinum, *Lin.*						
undatum, *Lin.*	Arctic seas to South of England.	shore to 150 fathoms.	Scotland, Norway	sand, mud & rocks	abundant.	
Dalei, *J. Sowerby*	Finmark	80 to 150 fathoms	uncertain	sand	rare.	
Humphreysianum, *Bennet*	Zetland, Finmark	15 to 90 fathoms	uncertain	sand and gravel.	local.	
fusiforme, *Brod.*	South of Drontheim to the North Cape.	30 to 150 fathoms	uncertain	sand	rare.	
cyaneum, *Müller*	Finmark	littoral	Finmark	rocks and weed	abundant.	
sp. ined.	Mogador, Canaries	4 fathoms	unknown	sand	rare.	
Fusus, *Lam.*						
Islandicus, *Chem.*	Finmark	100 fathoms	Arctic sea	sand	rare	4½ inches in length.
gracilis, *Da Costa*	Britain to Finmark	5 to 100 fathoms	Zetland	sand	abundant.	
propinquus, *Alder*	South of England to Zetland	40 to 100 fathoms	Britain	sand	moderate.	
Berniciensis, *King.*	North Sea and Zetland	50 to 80 fathoms	uncertain	sand	very rare	have only obtained young shells and fragments.
antiquus, *Lam.*	Britain to Arctic seas	5 to 70 fathoms	North of England and Scotland.	sand and mud	frequent	all I obtained in Norway carinated.
Norvegicus, *Chem.*	North Sea, Finmark	40 to 100 fathoms	uncertain	sand	rare.	
contrarius, *Lam.*	Vigo	low water to 10 faths.	Vigo	sand	moderate.	
corneus, *Lin.*	Cadiz and Mediterranean	8 to 15 fathoms	Gibraltar	sand and mud	frequent.	
Syracusanus, *Lin.*	Sicily	8 fathoms	Sicily	sand	moderate.	

Species.	Geographical range.	Vertical range.	Locality of principal development.	Ground.	Frequency.	Remarks.
Gasteropoda (*continued*).						
Fusus, *Lam.*						
pulchellus, *Phil.*	Mediterranean and Canary Islands.	8 to 40 fathoms	Gibraltar	sand and mud	frequent.	
rostratus, *Olivi*	Mediterranean and Canary Islands.	8 to 20 fathoms	Gibraltar	sand and mud	frequent.	
craticulatus, *Phil.*	Mediterranean	8 fathoms	Sicily	sand and mud	rare.	
maroccanus, *Chem.*	Canary Islands	shore to 20 fathoms	uncertain	sand and rock	moderate.	
sp.	Gibraltar and Mediterranean	8 to 20 fathoms	Gibraltar	sand and mud	frequent.	
Trophon, *De Montfort.*						
clathratus, *Lin.*	Arctic Sea to the North coast of Anglesea.	5 to 100 fathoms	Norway	sand and mud	frequent.	
muricatus, *Mont.*	British seas to Vigo	12 to 50 fathoms	Britain	sand and mud	moderate.	
Barvicensis, *Johnston*	Norway to North of England	15 to 160 fathoms	North Britain	sand	moderate.	
Gunneri, *Lovén*	Drontheim, Finmark	8 to 140 fathoms	Norway	sand and mud	moderate.	
craticulatus, *Fab.*	Finmark	50 to 100 fathoms	uncertain	sand	rare.	
Trichotropis, *Brod.*						
borealis, *Sow.*	S.W. of Scotland, Finmark	5 to 150 fathoms	Zetland and Norway	sand, gravel, and stones.	frequent	as far south as Glenluce Bay.
Cancellaria, *Lam.*						
cancellata, *Lam.*	Cadiz and Mediterranean	4 to 25 fathoms	Gibraltar, Algiers	mud	frequent.	
assimilis, *Sow.*	Algiers	8 fathoms	uncertain	mud	rare.	
? sp. ined.	Gibraltar, Canary Islands, Madeira.	8 to 24 fathoms	uncertain	sand	rare.	
sp. ined.	Canary and Madeira Islands.	12 to 24 fathoms	uncertain	sand	rare.	
viridula, *O'Fab.* (Admete)	Finmark, Nordland	10 to 50 fathoms	Arctic seas	sand	frequent.	
Triton, *Lamarck.*						
nodiferus, *Lam.*	Asturias to Canary Islands, Madeira, and Azores.	shore to 4 fathoms	Gibraltar	sand and mud	moderate	a very small var. from the Azores.
corrugatus, *Lam.*	Vigo to Mediterranean	8 fathoms	Gibraltar	sand	moderate.	
cutaceus, *Lam.*	Asturias to Canary Islands	shore (dead)	uncertain		moderate.	
olearius, *Lin.* ?	Gibraltar	shore (dead)	uncertain		rare.	
scrobiculatus, *Lam.*	East Mediterranean, Azores	shore (dead)	uncertain, Azores?		moderate.	
pilearis, *Lam.*	Grand Canary, Madeira	shore	uncertain	sand	rare.	
tuberosus, *Lam.*	Grand Canary and Azores	20 to 40 fathoms	uncertain	sand	rare.	
Ranella, *Lam.*						
lævigata, *Lam.*	Canary Islands	20 to 50 fathoms	Canary Islands ?	sand	rare.	

Pisania, *Bivon.*						
maculosa, *Lam.*	Mediterranean to Azores	littoral	Mediterranean and Azores.	rocks	abundant.	
D'Orbignii, *Payr.*	Mediterranean	littoral	Sicily and Malta	rocks	frequent.	
Typhis, *Montfort.*						
Sowerbii, *Brod.*	Malta	40 fathoms	uncertain	sand	rare.	
Murex, *Lin.*						
erinaceus, *Lin.*	Britain, Mediterranean, Canaries and Madeira.	shore to 30 fathoms	Vigo, shore	sand and rocks	frequent.	
trunculus, *Lin.*	Faro, Cadiz, and Mediterranean.	4 to 8 fathoms	Mediterranean	sand, gravel, and mud.	abundant.	
brandaris, *Lin.*	Faro, Mediterranean to Canary Islands.	4 to 35 fathoms	Malaga, Naples, &c.	sand and mud	frequent	large size in the Canary Islands.
corallinus, *Scacchi*	Vigo to Canaries, Madeira, and Azores.	4 to 30 fathoms	Vigo and Gibraltar.	sand	frequent.	
Edwardsii, *Payr.*	Asturias to Canary Islands and Madeira.	shore to 15 fathoms	Vigo and Mediterranean.	rocks	frequent.	
cristatus, *Brocchi*	Mediterranean and Madeira	shore to 6 fathoms	Malta and Sicily	gravel and sand	frequent	rare in West Mediterranean and Madeira.
torosus, *Lam.*	Mogador	shore	Mogador	sand	frequent.	
sp. ined.	Madeira and Canary Islands.	shore	uncertain	rock and stones	moderate	white.
Cephalopoda.						
Spirula, *Lam.*						
Peronii, *Lam.*	Bay of Biscay to Azores and Canary Islands.	shore	Canary Islands	sand	abundant.	

Additional Observations which could not be conveniently embodied in the foregoing Table.

Saxicava arctica, *Lin.*—Absent from no district within the range of my researches, but is much more frequent and larger in the northern than in the southern latitudes. The large solid variety, now living only in the Arctic seas, is found dead (fossil?) in deep water on the coasts of Scotland.

Gastrochæna modiolina, *Lam.*; Gastrochæna cuneiformis, *Lam.*—Not having been able to detect any specific difference between the British specimens and those from the south of Europe, I treat them as identical. In the Canaries the specimens are smaller and inhabit greater depths than in other localities.

Ceratisolen legumen, *Lin.*—Is of much smaller size in southern localities; frequent at Malaga, but not eastward in the Mediterranean.

Donax anatinus, *Lam.*—I have dredged abundantly from 15 fathoms on the Dogger Bank, a remarkable exception from its ordinary habitat.

Donax venustus, *Poli.*—Is closely allied to *Donax anatinus*, of which it takes the place at Lisbon, Mogador and in the Mediterranean; in latter associated with *D. trunculus*.

Tellina solidula, *Pulteney.*—Is reported to be frequent in the Mediterranean, but I have never met with it south of Britain.

Mactra subtruncata, *Da Costa.*—There are two distinct varieties (? species), the one larger, solid and strongly rudely striated concentrically, is sublittoral, and most abundant on some of the Scottish shores; the other, small, smooth and thin, is more generally distributed, both as regards depth and climate.

Venus striatula, *Don.*—On the Mediterranean coasts of Spain and to the southward, it is comparatively rare and confined to deep water; in the British seas it frequents all the zones of depth.

Astarte arctica, *Gray.*—A valve obtained from west of Zetland, 50 fathoms, by Prof. E. Forbes and myself, and recorded in the 'British Mollusca,' is in my possession, and I have every reason to believe it to be fossil. The reasons which induce me to believe that this species is not an actual inhabitant of the British seas are, that it is a shallow-water species, very gregarious, and not met with on the coast of Norway, south of the Arctic Circle.

Astarte compressa, *Mont.*—Subject to great variety in form, size, &c. I believe *A. Banksii* to be only a variety of this species.

Kellia suborbicularis, *Mont.*—I incline to think that there are two species included under this name, if not, they are well-marked varieties; the one smaller, more orbicular and more pellucid; the other much larger, more elliptical and, when fully grown, less transparent. It is the last which is found imbedded in very fine mud contained in dead bivalves.

Cardium edule, *Lin.*—Varies greatly in size, form, number of ribs, &c. Near Tunis a narrow neck of land divides the bay from a shallow salt-water lake, at the head of which the city of Tunis is situated; on the one side of this neck of land (that facing the bay) all the specimens of *Cardium edule* were strong, triangular, and with few ribs, while on the side towards the lake, they were thinner, wider and much more numerously ribbed. The northern varieties attain the largest size.

Modiola Petagnæ, *Scacchi.*—In shallow water in the harbour of Carthagena, free. In the Canary Islands, at 12 to 15 fathoms, small and distorted, imbedded in Nullipore.

Crenella discors, *Lin.*—The largest British specimens I have obtained were on the north coast of the Isle of Man, 10 fathoms. At Southampton the pale green variety is frequent about low-water mark, adhering to the leaves of *Zostera marina*. Near Tromsoe in Finmark it is most abundant in beds covering the under surfaces of ledges of rock. Though reported to be found in the Mediterranean I have not met with it south of the British Channel, and believe it to have been confounded with *C. costulata* by Mediterranean authors.

Lithodomus caudigerus, *Sow.*—The authors of the 'British Mollusca' state that this is a South American species. It is frequent on the coast of Asturias, Bay of Biscay, also at Faro in the south of Portugal, at low water burrowed in limestone rocks, but not found in the south of Spain or Mediterranean, where its place is occupied by *L. dactylus*. I have never obtained them together in any locality.

Pecten Jacobæus, *Lin.*—Notwithstanding that this species is named after the Saint of Compostella, I have not been able to detect it on the coasts of Galicia, or the north of Spain.

Pecten Danicus, *Chem.*—This species would appear to have been formerly much more abundant on the west coasts of Scotland than it is at present, as the number of dead valves bears no proportion to that of living specimens. It is met with throughout the Hebrides, but is most frequent in Loch Fyne, the normal form in mud at about 70 fathoms, the smaller and strongly striated variety upon hard ground at about 40 fathoms. It is extremely rare in Finmark, and I only met with small dead specimens north of Drontheim.

Pecten Islandicus, *Müller.*—Is doubtless extinct in the British seas, though dead valves are frequent in the Firth of Clyde, Hebrides, Zetland, Murray Frith and North Sea. In Norway, north of Drontheim, it is by far the most abundant species of Pecten.

Anomia ephippium, *Lin.*—Unlike most testaceous mollusca, which only require to be better known to be esteemed as delicacies for the table, the Anomia is not to be eaten with impunity. On one occasion, having sent my yacht round from a neighbouring port to that of Villaviciosa in Asturias, where I purposed joining her after an excursion inland, my crew, having been told that there were oysters in the harbour, determined to dredge on their own account in my absence, and procured abundance of the Anomia in large agglomerated masses. Seeing by the complexion of the animals that they were not *common* oysters, only one of the men would venture upon eating them, and he suffered in consequence severe vomiting, &c., with swelling of the abdomen, from which he did not entirely recover for two or three days.

The most beautiful yellow and purple varieties are found in the sunny seas of the Mediterranean.

Ostrea edulis, *Lin.*—Subject to much variation, which has occasioned the making of one or two questionable species, and rendered uncertain the limits of its distribution. The common English or Welsh oyster is, however, certainly abundant and of excellent quality at Redondela, situated at the head of Vigo Bay; and I have likewise dredged it off Cape Trafalgar in sand, and off Malaga in mud, but have not noticed it further eastward in the Mediterranean.

Chiton fascicularis, *Lin.*; Chiton discrepans, *Brown.*—I must acknowledge my inability to discriminate satisfactorily between these species.

Chiton cancellatus, *Sav.*—Is more nearly allied to *C. Rissoi* of the Mediterranean than to *C. asellus*, of which it has been supposed to be a variety.

Chiton fulvus, *Wood.*—This fine species differs as much in its habits as in appearance from its European congeners. It enjoys greater powers of locomotion than any other Chiton of my acquaintance, creeping freely in the sand between tide marks in Vigo Bay, where it is very abundant, and where several were found adhering to the chain cable every time it was raised from our anchorage abreast of the town of Vigo. It is, nevertheless, extremely local, not recorded to be obtained in any locality but those I have named, unless from Patagonia, whence there are specimens in the British Museum under another name, but in no way to be distinguished from the present species.

Chiton Cajetanus, *Poli.*—Inhabits the Mediterranean and Bay of Biscay, but has not been detected in any intermediate locality, nor on the south coasts of Spain.

Patella vulgata, *Lin.*—Becomes a local species on the northern coasts of Norway, and I did not meet with it in Finmark.

Patella pellucida, *Lin.*—The distribution of this species is regulated by that of the Laminaria, on which it feeds. It is not unfrequent in the north of Spain; is absent from the south of Spain and Mediterranean, but unexpectedly appears again in the harbour of Mogador, where it is of small size. In high northern latitudes it is much paler in colour.

Patella Gussonii, *Phil.*—Among some hundreds of dead specimens I only took one or two living, and these were upon a deep-water red fucus.

Calyptræa Sinensis, *Lin.*—I have never obtained British specimens in less than 8 or 10 fathoms, whereas on the coasts of Spain it is generally found about the sea margin, and in shallow water.

Trochus crenulatus, *Phil.*—I believe to be specifically distinct from *T. exiguus*, is subject to great variation in colour; the grey variety is more common to the eastward.

Trochus millegranus, *Phil.*—Of this species there are two very distinct varieties, of which the smaller and more conical inhabits the Mediterranean and south coast of England and Wales, while the larger is common to the north-west coasts of Britain and Norway.

Rissoa abyssicola, *Forbes.*—A specimen received from Captain Spratt, dredged by him in 350 fathoms, about 40 miles from Malta.

Turritella communis, *Risso.*—The ordinary British form is wider in proportion and possesses fewer volutions than that of the Mediterranean. A large variety with numerous volutions is found in Cork Harbour and in Bressa Sound, always in shallow water, while the ordinary variety inhabits all the zones of depth. I have taken white specimens of both the forms, consequently absence of colour is not *always* the consequence of great depth.

Conus Mediterraneus, *Brug.*—Is very frequent at Lancerotte, but does not extend westward to Teneriffe or to the Salvage or Madeira Islands.

Purpura lapillus, *Lin.*—Though generally littoral, inhabits the depth of 8 or 10 fathoms in certain localities, and in these cases undergoes considerable modification of form; from deep water and mud, it is large and fusiform, from 8 fathoms and rough ground the specimens are beautifully imbricated.

Ringicula auriculata, *Menke.*—At Vigo, the northern limit of its range, it attains the greatest dimensions and is very abundant, but not striated as in the Mediterranean and Madeira.

Nassa trifasciata, *A. Adams.*—Most abundant at Vigo, but smaller than in the Mediterranean; in latter district it undergoes considerable variation in colour.

Fusus gracilis, *Da Costa*.—Notwithstanding the opinion of Middendorf, adopted by Forbes and Hanley, that this is only a variety of *F. Islandicus* of Chemnitz, I am quite satisfied of the contrary after obtaining the true *Fusus Islandicus* in the neighbourhood of the North Cape. It was from about 100 fathoms, and measured $4\frac{1}{2}$ inches in length, while adult specimens of *Fusus gracilis* from the same locality did not measure more than $2\frac{1}{10}$ inches in length.

Spirula Peronii, *Lam.*—This shell, possessing a peculiar aptitude for floating on the surface of the sea when dead, is liable to be drifted to localities very remote from its native habitat. A chance specimen has occasionally been picked up on the shores of Britain; on the south coast of the Bay of Biscay it is still rare, is more frequent at Gibraltar and Malaga, and abundant in the Canary Islands. I am not aware of its having been found in the eastern Mediterranean.

The following Table will be of assistance in a comparison of the Geographical range of the species and the number obtained in each of the districts.

Species.	Northern Scandinavia (Finmark and Nordland).	Drontheim.	Scotland.	British Channel.	North of Spain.	Portugal.	South of Spain and Mediterranean.	Mogador.	Canary Islands.	Madeira.	Azores.
Acephala.											
Xylophaga, *Turton.*											
dorsalis, *Turton*	*	*	*								
Pholas, *Lin.*											
dactylus, *Lin.*	......	......	......	*	*	*	*				
parva, *Lam.*	......	......	......	*	*	*	*				
crispata, *Lin.*	......	*	*	*							
candida, *Lin.*	......	......	*	*	*	*	*	*			
Pholadidea, *Leach.*											
papyracea, *Solander*	......	......	......	*							
Clavagella, *Lam.*											
sp. ined.	......	......	......	......	......	......	......	......	*		
Gastrochæna, *Spengler.*											
modiolina, *Lam.* } cuneiformis, *Lam.* }	......	......	......	*	*	*	*	*	*	*	
Pandora, *Lin.*											
rostrata, *Lam.*	......	......	......	......	*	*	*	*			
obtusa, *Leach.*	......	......	*	*	*	*	*	*	*		
Lyonsia, *Turton.*											
Norvegica, *Chem.*	......	*	*	*	*	......	......	......	......	*	
arenosa, *Möller*	*										
Thracia, *Leach.*											
phaseolina, *Lam.*	*	*	*	*	*	*	*	*	*	*	
villosiuscula, *Macgill.*	......	......	*	*							
pubescens, *Pulteney*	......	......	......	*	......	......	*				
convexa, *Wood*	*	*	*	*	......	......	*				
distorta, *Mont.*	*?	......	*	*							

Species.	Northern Scandinavia (Finmark and Nordland).	Drontheim.	Scotland.	British Channel.	North of Spain.	Portugal.	South of Spain and Mediterranean.	Mogador.	Canary Islands.	Madeira.	Azores.
Acephala (*continued*).											
Periploma, *Schum.*											
prætenuis, *Pulteney*	*	*	*	*							
Saxicava, *F. de Bellevue.*											
arctica, *Lin.*....................	*	*	*	*	*	*	*	*	*	*	
rugosa, *Lin.*....................	......	......	......	*	*						
Panopæa, *Menard de la Groye.*											
Aldrovandi, *Menard*	......	......	......	......	......	*	*				
Poromya, *Forbes.*											
granulata, *Nyst and Westendorp*	......	......	*	......	......	......	......	......	......	*	
Korenii (Embla), *Lovén*......	*										
Neæra, *Gray.*											
cuspidata, *Olivi*	*	*	*	......	*	......	*	......	*	*	
costellata, *Desh.*..............	......	*	*	......	......	......	*	......	*	*	
abbreviata, *Desh.*	......	......	*								
obesa, *Lovén*	*										
Corbula, *Bruguière.*											
nucleus, *Lam.*	......	*	*	*	*	*	*	*	*		
rosea, *Brown*	......	......	......	......	......	......	*				
Sphænia, *Turton.*											
Binghami, *Turton*..............	......	......	*	*	*	......	*				
Mya, *Lin.*											
truncata, *Lin.*..................	*	*	*	*							
arenaria, *Lin.*..................	*	*	*	*							
Solen, *Lin.*											
siliqua, *Lin.*....................	......	......	*	*	*	*	*				
ensis, *Lin.*	*	*	*	*	*	*	*				
marginatus, *Pulteney*	......	......	......	*	*	*	*				
pellucidus, *Pennant*	*	*	*	*	*	*	*				
Ceratisolen, *Forbes.*											
legumen, *Lin.*..................	......	......	......	*	*	*	*	*			
Solecurtus, *Blainville.*											
coarctatus, *Gmel.*	......	......	*	*	......	*	*	......	*	*	
candidus, *Renieri*	......	......	*	*	......	*	*	......	*	*	
strigilatus, *Lin.*	......	......	......	......	......	*	*				
Syndosmya, *Recluz.*											
alba, *Wood*......................	*	*	*	*	*	*	*	*			
prismatica, *Mont.*	*	*	*	*	*	*	*				
intermedia, *Thompson*	*	*	*								
Renieri, *Brown*	......	......	......	......	......	......	*	*			
tenuis, *Mont.*....................	......	......	......	*	*	......	*				
Scrobicularia, *Schumacher.*											
piperata, *Gmel.*	......	......	*	*	*	*	*				
Cottardi, *Payr*	......	......	......	......	......	......	*				
Donax, *Lin.*											
anatinus, *Lam.*	......	*	*	*	*						
trunculus, *Lin.*	......	......	......	......	......	*	*				
venustus, *Poli*	......	......	......	......	......	*	*	*	*?		
politus, *Poli*	......	......	......	*	......	*	*				
Ervilia, *Turton.*											
castanea, *Mont.*	......	......	......	*	......	*	......	......	*	*	*
nitens ?, *Mont.*	......	......	......	......	......	......	*	......	*	*	

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Acephala (*continued*).											
Mesodesma, *Desh.*											
donacilla, *Desh.*	...	...	...	...	*	...	*				
Psammobia, *Lam.*											
vespertina, *Chem.*	...	...	...	*	*	*	*	...	*		
tellinella, *Lam.*	*	*	*	*	*						
costulata, *Turton*	...	...	*	*	...	...	*	...	*	*	
Ferroensis, *Chem.*	*	*	*	*	...	*	*	...	*		
costata, *Hanley*	...	...	...	...	...	*	...	*			
Gastrana, *Schumacher.*											
fragilis, *Lin.*	...	*	...	*	*	*	*				
Tellina, *Lin.*											
crassa, *Pennant*	...	...	*	*	*	*	*				
balaustina, *Lin.*	...	...	*	...	...	...	*	...	*	*	
donacina, *Lin.*	...	...	*	*	*	...	*	...	...	*	
pygmæa, *Phil.*	...	...	*								
incarnata, *Lin.*	...	...	*	*	...	...	*	...	*	*	
tenuis, *Da Costa*	...	...	*	*	*	*	*	*?			
fabula, *Gronovius*	*	*	*	*	...	...	*	*?			
solidula, *Pulteney*	*	*	*	*							
proxima, *Brown*	*	*	*								
distorta, *Poli*	...	...	...	...	...	...	*	...	*	*	
serrata, *Brocchi*	...	...	...	...	*	*	*	...	*		
pulchella	...	...	...	...	...	...	*				
Costæ, *Phil.*	...	...	...	...	...	*	*	*			
planata, *Lin.*	...	...	...	...	...	*	*				
punicea ?, *Lin.*	...	...	...	...	...	...	*				
sp. ined.	...	...	...	...	...	...	*				
sp. ined.	...	...	...	...	...	...	...	*	...	*	
Lutraria, *Lam.*											
elliptica, *Lam.*	...	...	*	*	*	*	*				
oblonga, *Chem.*	...	...	...	*	*	*	*				
Mactra, *Lin.*											
rugosa, *Chem.*	...	...	...	...	*	*	*	*			
solida, *Lin.*	...	...	*	*	*						
elliptica, *Brown*	*	*	*	*							
subtruncata, *Da Costa*	...	...	*	*	*	*	*	*	*		
stultorum, *Lin.*	...	...	*	*	*	*	*	*	*		
helvacea, *Chem.*	...	...	...	...	...	*	*				
Petricola, *Lam.*											
lithophaga, *Retzius*	...	...	...	...	*	*					
Venerupis, *Lam.*											
irus, *Lin.*	...	...	...	*	*	*	*	...	*	*	
Tapes, *Muhlfeldt.*											
decussata, *Lin.*	...	...	...	*	*	*	*				
pullastra, *Wood*	*	*	*	*	*	*	*	*			
virginea, *Gmel.*	*	*	*	*	*	*	*				
aurea, *Gmel.*	...	...	...	*	*	*	*				
nitens, *Scacchi*	...	...	...	...	...	...	*				
geographica, *Lin.*	...	...	...	...	...	...	*				
florida, *Lam.*	...	...	...	...	...	...	*				
Beudantii, *Payr.*	...	...	...	...	...	...	*				
Lucinopsis, *Forbes.*											
undata, *Pennant*	...	...	*	*	*	...	*				

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Acephala (*continued*).											
Artemis, *Poli.*											
exoleta, *Lin.*	*	*	*	*	*	*	*				
lincta, *Pulteney*	*	*	*	*	*	*	*				
Cytherea, *Lam.*											
chione, *Lin.*	......	......	......	*	......	*	*	......	*	*	*
Venetiana, *Lam.*	......	......	......	......	......	*	*	......	*		
sp. ined.	......	......	......	......	......	......	*	......	*	*	
sp. ined.	......	......	......	......	......	......	......	......	*		
Venus, *Lin.*											
verrucosa, *Lin.*	......	......	......	*	*	*	*	......	*	*	
casina, *Lin.*	......	*	*	*	......	*	*	......	*	*	
striatula, *Don*	*	*	*	*	*	*	*	*			
gallina, *Lin.*	......	......	......	......	......	......	*				
fasciata, *Da Costa*	......	*	*	*	*	*	*				
ovata, *Pennant*	*	*	*	*	*	*	*				
sp. ined.	......	......	......	......	......	......	......	......	*		
sp. ined.	......	......	......	......	......	......	*	*			
Cardita, *Brug.*											
calyculata, *Brug*	......	......	......	......	......	......	*	*	*	*	*
trapezia, *Lin.*	......	......	......	......	......	*	*				
squamosa, *Lam.*	......	......	......	......	......	......	*				
sulcata, *Brug*	......	......	......	......	......	......	*				
corbis, *Phil.*	......	......	......	......	......	......	*				
Isocardia, *Lam.*											
cor, *Lin.*	......	......	*								
Astarte, *Sow.*											
arctica, *Gray*	*										
sulcata, *Da Costa*	*	*	*	*	*	......	*				
compressa, *Mont.*	*	*	*								
triangularis, *Mont.*	......	......	*	*	*	......	*	......	*		
incrassata, *Brocchi*	......	......	......	......	......	......	*	......	*		
fusca, *Desh.*	......	......	......	......	......	......	*				
crebricostata, *Forbes*	*										
elliptica, *Brown*	*	*	*								
bipartita, *Phil.*	......	......	......	......	......	......	*				
sp. ined.	......	......	......	......	......	......	*				
Circe, *Schumacher.*											
minima, *Mont.*	......	......	*	*	*	*	*	......	*	*	
Cyprina, *Lam.*											
Islandica, *Lin.*	*	*	*	*							
Galeomma, *Turton.*											
Turtoni, *Sow.*	......	......	......	*	*	......	*				
Lepton, *Turton.*											
squamosum, *Mont.*	......	......	*	*	*	......	*				
convexum, *Alder*	......	......	......	*							
Montacuta, *Turton.*											
substriata, *Mont.*	......	*	*	*	......	......	*				
ferruginosa, *Mont.*	......	......	*	*	......	......	*	*	*?	*?	
bidentata, *Mont.*	*	*	*	*	*	......	*				
Kellia, *Turton.*											
suborbicularis, *Mont.*	......	*	*	*	*	*	*	......	*		
corbuloides, *Phil.*	......	......	......	......	......	*	*	*			
complanata, *Phil.*	......	......	......	......	......	......	*	*			

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Acephala (*continued*).											
Kellia, *Turton.*											
rubra, *Mont.*	...	...	*	*	...	...	...	...	*	*	
Pythina, *Hinds.*											
sp. ined.	...	...	...	...	*	*	...	*			
Ungulina, *Daudin.*											
oblonga ?, *Daudin*	...	...	...	...	...	...	*				
Diplodonta, *Brown.*											
rotundata, *Mont.*	...	...	...	*	...	*	*	...	*	*	
apicalis, *Phil.*	...	...	...	...	...	...	*	...	*	*	
Lucina, *Bruguière.*											
borealis, *Lin.*	*	*	*	*	...	...	* ?	* ?			
spinifera, *Mont.*	...	*	*	*	*	*	*	*	*	*	
divaricata, *Lin.*	...	...	...	...	...	*	*	...	*	*	
flexuosa, *Mont.*	*	*	*	*	*	...	...	*	*		
leucoma, *Turton*	...	...	...	*	*	*	*	*	*		
Sarsii ?, *Phil.*	*	*									
ferruginosa, *Forbes*	*	*	*								
bullata, *Reeve*	...	...	...	...	...	...	*				
columbella, *Lam.*	...	...	...	...	...	...	...	...	*		
transversa, *Phil.*	...	...	...	...	...	...	...	...	*		
digitalis, *Lin.*	...	...	...	...	*	*	*				
pecten, *Lam.*	...	...	...	...	*	...	*	...	*	*	
sp. ined.	...	...	...	...	...	...	...	...	*		
sp. ined.	...	...	...	...	...	...	...	...	...	*	
sp. ined. ?	*										
Cardium, *Lin.*											
erinaceum, *Lam.*	...	...	...	...	...	...	*				
aculeatum, *Lin.*	...	...	...	*	...	*	*				
echinatum, *Lin.*	*	*	*	*	*	...	...	...	*	*	
rusticum, *Lin.*	...	...	...	*	*	*	*	...	*	*	
ciliare, *Penn.*	...	...	...	...	*	...	*				
edule, *Lin.*	*	*	*	*	*	*	*	*			
nodosum, *Turton*	*	*	*	*							
fasciatum, *Mont.*	*	*	*	*	*	*	*	*	*		
pygmæum, *Don.*	...	...	*	*	*	*	*				
Suecicum, *Reeve*	*	*	*								
Norvegicum, *Spengler*	...	...	*	*	...	...	*	...	*	*	
papillosum, *Poli*	...	...	...	...	* ?	*	*	*	*	*	*
punctatum, *Brocchi*	...	...	...	...	...	...	*	...	*	*	
minimum ?, *Phil.*	...	...	...	...	...	...	*				
elegantulum, *Müller*	*										
sp.	*										
Chama, *Lin.*											
gryphoides, *Lin.*	...	...	...	...	...	...	*	...	*		
Solemya, *Lam.*											
Mediterranea, *Lam.*	...	...	...	...	...	...	*	...	*		
Yoldia, *Möller.*											
pygmæa, *Munster*	*	*	*								
lucida, *Bland*	*	*									
limatula, *Say*	*										
Leda, *Schumacher.*											
caudata, *Don.*	*	*	*	*							
pernula, *Müller*	*	*									

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Acephala (*continued*).											
Leda, *Schum.*											
emarginata, *Lam.*	……	……	……	……	……	*	*				
striata, *Lam.*	……	……	……	……	……	……	*				
Nucula, *Lam.*											
nucleus, *Lin.*	*	*	*	*	*	*	*	*			
nitida, *Sow.*	……	……	*	*	*	*	*				
radiata, *Hanley*	……	……	……	*	*	*	*				
decussata, *Sow.*	……	……	*	*	……	……	*				
tenuis, *Mont.*	*	*	*								
corticata, *Möller*	*										
Limopsis, *Sassi.*											
pygmæa, *Phil.*	*										
Pectunculus, *Lam.*											
glycimeris, *Lin.*	……	……	*	*	*	*	*	……	*	*	
violascens, *Lam.*	……	……	……	……	……	……	*				
Siculus, *Reeve*	……	……	……	……	……	……	……	……	*	*	
pilosus, *Lam.*	……	……	……	……	……	……	*				
Arca, *Lin.*											
Noæ, *Lin.*	……	……	……	……	……	……	*				
tetragona, *Poli*	……	……	*	*	*	*	*	……	*	*	
barbata, *Lin.*	……	……	……	……	……	……	*				
antiquata, var. ?, *Poli*	……	……	……	……	……	……	*	……	*		
lactea, *Lin.*	……	……	……	*	*	*	*	*	*		
nodulosa, *Lovén*	……	*									
raridentata, *S. Wood*	*	*	*	……	……	……	*				
obliqua, *Phil.*	……	……	……	……	……	……	*				
navicularis, *Brug.*	……	……	……	……	……	……	*				
imbricata, *Brug.*	……	……	……	……	……	……	*	……	*		
diluvii ?, *Lam.*	……	……	……	……	……	……	*				
sp.	……	……	……	……	……	……	*				
Modiola, *Lam.*											
modiolus, *Lin.*	*	*	*	*							
tulipa, *Lam.*	……	……	*	*	*	……	*	……	*		
phaseolina, *Phil.*	*	*	*								
barbata, *Lin.*	……	……	……	*	……	*	*	*			
Petagnæ, *Scacchi*	……	……	……	……	……	……	*	……	*	*	
sp. ined.	*										
Crenella, *Brown.*											
discors, *Lin.*	*	*	*	*							
marmorata, *Forbes*	*	*	*	*	*	*	*	……	*		
nigra, *Gray*	*	*	*								
vestita, *Phil.*	……	……	……	……	……	……	*				
costulata, *Risso*	……	……	……	*	*	……	*	*			
rhombea, *Berkeley*	……	……	……	*	……	……	*	……	*		
decussata, *Mont.*	*	*	*								
Lithodomus, *Cuvier.*											
dactylus, *Cuvier*	……	……	……	……	……	……	*				
caudigerus, *Sow.*	……	……	……	……	*	*					
Mytilus, *Lin.*											
edulis, *Lin.*	*	*	*	*	*	*	*	*			
minimus, *Poli*	……	……	……	……	……	……	*				
Afer, *Gmel.*	……	……	……	……	……	……	*	*			

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Acephala (*continued*).											
Pinna, *Lin.*											
pectinata, *Lin.*	......	......	......	*							
muricata, *Poli*	......	......	......	......	......	......	*				
rudis, *Lin.*	......	......	......	......	......	......	......	......	*	*	
Avicula, *Brug.*											
Tarentina, *Lam.*	......	......	......	*	*	......	*	......	*	*	
Lima, *Brug.*											
subauriculata, *Mont.*	*	*	*	*	......	......	*	......	*		
sulculus, *Lovén*	*	*	* ?								
Loscombii, *Sow.*	*	*	*	*	......	......	*				
hians, *Gmel.*	*	*	*	*							
fragilis, *Scacchi*	......	......	......	......	*	......	*	......	*	*	*
squamosa, *Lam.*	......	......	......	......	......	......	*	......	*	*	
inflata, *Lam.*	......	......	......	......	......	......	*				
excavata, *J. C. Fab.*	*	*									
Pecten, *O. F. Müller.*											
varius, *Lin.*	......	......	*	*	*	*	*				
niveus, *Macg.*	......	......	*								
pusio, *Pennant*	......	*	*	*	*	*	*	*	*	*	*
striatus, *Müller*	*	*	*	......	*	......	*				
tigrinus, *Müller*	*	*	*	*	*	......	*				
Danicus, *Chem.*	*	*	*								
similis, *Laskey*	*	*	*	*	*	......	*	......	......	*	
maximus, *Lin.*	......	......	*	*	*	*	*	......	*	*	
Jacobæus, *Lin.*	......	......	......	......	......	......	*				
opercularis, *Lin.*	*	*	*	*	*	*	*	......	*	*	
Islandicus, *Müller*	*	*									
polymorphus, *Bronn*	......	......	......	......	......	*	*	......	......	*	
hyalinus, *Poli*	......	......	......	......	......	......	*				
sulcatus, *Lam.*	......	......	......	......	......	......	*				
glaber, *Lin.*	......	......	......	......	......	......	*				
testæ, *Bivon*	......	......	......	......	......	......	*				
pes-felis, *Lin.*	......	......	......	......	......	......	*	......	*	*	
gibbus ?, *Lin.*	......	......	......	......	......	......	*	......	*	*	
Grœnlandicus, *Sow.*	*										
corallinoides, *D'Orb.*	......	......	......	......	......	......	......	......	*	*	
sp. ined.	*										
sp. ined.	*										
sp. ined.	*										
Spondylus, *Lin.*											
gædaropus, *Lin.*	......	......	......	......	......	......	*	*	*		
Anomia, *Lin.*											
ephippium, *Lin.*	*	*	*	*	*	*	*	......	......	*	
patelliformis, *Lin.*	*	*	*	*	*	*	*				
striata, *Lovén*	......	*	*								
aculeata, *Müller*	*	*	*	*							
Ostrea, *Lin.*											
edulis, *Lin.*	......	......	*	*	*	......	*	* ?			
plicatula ?, *Phil.*	......	......	......	......	......	*	*	*	*	*	
Crania, *Retzius.*											
anomala, *Müller*	*	*	*	......	*						
Rhynchonella, *Fischer.*											
psittacea, *Chem.*	*										

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Acephala (*continued*).											
Argiope, *E. Deslongchamps.*											
decollata, *Chem.*	......	......	......	......	......	......	*	......	*	*	
Neapolitana, *Scacchi*	......	......	......	......	......	......	*	......	*		
cuneata, *Risso*	......	......	......	......	......	......	*	......	*		
cistellula, *Searles Wood*	......	......	*								
Megerlia, *King.*											
truncata, *Lin.*	......	......	......	......	......	......	*	......	*		
Terebratulina, *D'Orb.*											
caput-serpentis, *Lin.*	*	*	*	*							
Waldheimia, *King.*											
cranium, *Gmel.*	*										
Pteropoda.											
Spirialis, *Eydoux & Souleyet.*											
Flemingii, *Forbes*	......	......	*								
Macandrei, *Forbes & H.*	......	......	......	*							
sp.	......	......	......	......	......	......	......	......	*		
Cuvieria, *Rang.*											
columnella ?, *Rang*	......	......	......	......	......	......	......	......	*	*	
Creseis, *Rang.*											
recta, *Lesueur*	......	......	......	......	......	......	*	......	*		
striata, *Rang*	......	......	......	......	......	......	*	......	*		
subulata, *Quoy & Gaimard*	......	......	......	......	......	......	*	......	*		
Hyalea, *Lam.*											
tridentata, *Lam.*	......	......	......	......	......	......	*	......	*	*	
trispinosa, *Lesueur*	......	......	......	......	......	......	*	......	*	*	
vaginella, *Cantraine*	......	......	......	......	......	......	*	......	*	*	
sp.	......	......	......	......	......	......	......	......	......	*	
gibbosa, *Rang*	......	......	......	......	......	......	......	......	*	*	
Atlanta, *Peron.*											
Peronii, *Lesueur*	......	......	......	......	......	......	*				
Oxygyrus.											
Keraudrenii	......	......	......	......	......	......	......	......	*		
Gasteropoda.											
Umbrella, *Chem.*											
Mediterranea, *Lam.*	......	......	......	......	......	......	*				
Tylodina, *Rafinesque.*											
citrina	......	......	......	......	......	......	......	......	*		
Aplysia, *Gmel.*											
hybrida, *Sow.*	*	*	*	*	......	......	......	*	*		
Pattersoni	......	......	......	......	*						
ocellata	......	......	......	......	......	......	......	......	*		
Philine, *Ascanius.*											
aperta, *Lin.*	......	*	*	*	*	*	*	*	*	*	
quadrata, *Searles Wood*	*	*	*								
scabra, *O. Müller*	*	*	*	*	*	......	*				
catena, *Mont.*	......	......	......	*							
punctata, *Clark*	......	......	......	*							
pruinosa, *Clark*	......	......	*	*							
Smaragdinella, *A. Adams.*											
Algira, *Hanley*	......	......	......	......	......	......	*				

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Gasteropoda (*continued*).											
Scaphander, *Montfort.*											
lignarius, *Lin.*	......	*	*	*	*	......	*				
librarius, *Lovén*	*	*									
Amphisphyra, *Lovén.*											
hyalina, *Turton*	*	*	*	......	......	......	......	......	*	*	
Cylichna, *Lovén.*											
cylindracea, *Pen.*	*	*	*	*	*	......	*	*	*	*	
truncata, *Mont.*	* ?	......	*	*	*	*	*	*	*		
obtusa, *Mont.*	......	......	*	*							
mamillata, *Phil.*	......	......	......	*	......	......	*	......	*		
umbilicata, *Mont.*	*	*	*	*	*	......	*				
fragilis, *Jeffreys*	......	......	......	......	......	......	*	......	*		
alba, *Lovén*	*	*									
Akera, *O. F. Müller.*											
bullata, *Müll.*	......	......	*	*	*	*					
Hanleyi, *A. Ad.*	......	......	*								
Bulla, *Lin.*											
hydatis, *Lin.*	......	......	......	*	*	*	*				
Cranchii, *Leach*	......	......	*	*	......	......	*	......	*		
ovulata, *Phil.*	......	......	......	......	......	......	*				
sp. nov. ?	......	......	......	......	......	......	......	......	*		
sp. nov. ?	......	......	......	......	......	*					
sp. nov. ?	......	......	......	......	......	......	......	......	*	*	
striata, *Brug.*	......	......	......	......	......	*	*				
ampulla ?, *Lin.*	......	......	......	......	......	......	......	......	*	*	
Tornatella, *Lam.*											
fasciata, *Lam.*	*	*	*	*	*	*	*	*			
Auricula, *Lam.*											
alba, *Jeffreys*	......	......	*	*	......	......	......	......	......	......	*
denticulata, *Mont.*	......	......	*	*							
Ferminii, *Payr.*	......	......	......	......	......	......	......	......	*		
Pedipes, *Adanson.*											
sp.	......	......	......	......	......	......	......	......	*	......	*
Chiton, *Lin.*											
fascicularis, *Lin.* } discrepans, *Brown* }	......	......	*	*	*	*	*	*	*	*	*
Hanleyi, *Bean*	*	*	*								
ruber, *Lin.*	*	*	*								
cinereus, *Lin.*	*	*	*	*	*	......	......	*			
albus, *Lin.*	*	*	*								
asellus, *Chem.*	*	*	*	*	*						
cancellatus, *Sow.*	......	*	*	......	*						
lævis, *Pen.*	*	*	*	*	*	......	*				
marmoreus, *O. Fab.*	*	*	*								
fulvus, *Wood*	......	......	......	......	*	*					
Cajetanus, *Poli*	......	......	......	......	*	......	*				
Rissoi, *Payr.*	......	......	......	......	......	......	*				
siculus, *Gray*	......	......	......	......	......	......	*				
Poli, *Phil.*	......	......	......	......	......	......	*				
Canariensis, *Webb & Berth.*	......	......	......	......	......	......	......	......	*		
alveolus, *Sars*	*	*									
sp. ined	......	......	......	......	......	......	......	*	*		

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Gasteropoda (*continued*).											
Dentalium, *Lin.*											
entalis, *Lin.* } tarentinum, *Lam.* }	*	*	*	*	*	*	*	*			
dentalis, *Lin.*					*	*	*	*	*	*	
rubescens, *Desh.*							*		*	*	
sp. ined.					*						
sp. ined.	*										
Siphonaria, *Poli.*											
Algesira, *Quoy*							*	*			
Gadinia, *Gray.*											
Garnoti, *Payr.*							*				
Afer ?, *Gray*									*		
Acmæa, *Eschscholtz.*											
testudinalis, *Müller*	*	*	*								
virginea, *Müller*	*	*	*	*	*		*	*			
Lepeta, *Gray.*											
ancyloides, *Forbes*			*								
cæca, *Müller*	*	*									
Pilidium, *Forbes.*											
fulvum, *Müller*	*	*	*								
Patella, *Lin.*											
vulgata, *Lin.*	*	*	*	*	*	*	*	* ?			* ?
cærulea, *Lam.*							*				
athletica, *Bean*			*	*			* ?				
crenata, *D'Orb.*									*	*	
guttata, *D'Orb.*									*	*	
aspera, *Lam.*							*				
Lowei, *D'Orb.*								* ?	*	*	
scutellaris, *Lam.*							*				
Candei, *D'Orb.*									*	*	
tenuis, *Dillwynn*										*	
Gussonii, *Costa*									*	*	*
nigropunctata, *Lam.*							*				
pellucida, *Lin.*	*		*	*	*			*			
Pileopsis, *Lam.*											
Hungarica, *Lin.*	*	*	*	*	*		*				
Crepidula, *Lam.*											
unguiformis, *Lam.*							*				
gibbosa, *Defr.*							*				
Calyptræa, *Lam.*											
Sinensis, *Lin.*				*	*	*	*	*	*	*	
Emarginula, *Lam.*											
reticulata, *Sow.*	*	*	*	*	*	*	*		*	*	
rosea, *Bell*				*	*						
crassa, *J. Sow.*		*	*								
elongata, *Costa*							*		*		
pileolus, *Michaud*							*				
sp. ined.										*	*
Puncturella, *Lowe.*											
Noachina, *Lin.*	*	*	*								
Fissurella, *Lam.*											
reticulata, *Don.*			*	*	*	*	*	*	*	*	
rosea, *Lam.*							*	*			

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Gasteropoda (*continued*).											
Fissurella, *Lam.*											
gibba, *Phil.*					*	*	*		*		
Ianthina, *Lam.*											
communis, *Lam.*									*	*	*
prolongata, *Blainv.*							*			*	
exigua, *Lam.*									*	*	*
sp.?					*						
Scissurella, *D'Orb.*											
crispata, *Flem.*	*	*	*								
Bertheloti, *D'Orb.*									*		
angulata, *Lovén*	*										
Haliotis, *Lin.*											
tuberculata, *Lin.*				*	*	*	*	*	*?	*?	*?
lamellosa, *Lam.*							*				
sp.?									*		
Adeorbis, *Searles Wood.*											
subcarinatus, *Mont.*				*	*			*			
Margarita, *Leach.*											
helicina, *O. Fab.*	*	*	*								
undulata, *Sow.*	*	*	*								
alabastrum, *Beck*	*	*	*								
cinerea, *Couthouy*	*	*									
Trochus, *Lin.*											
zizyphinus, *Lin.*			*	*	*	*	*	*?	*	*	*
conulus, *Lin.*							*		*	*	
granulatus, *Born.*				*			*		*	*	
striatus, *Lin.*				*	*	*	*		*	*	*
Montagui, *Gray*			*	*	*	*	*				
millegranus, *Phil.*	*	*	*	*			*				
exiguus, *Pulteney*				*	*	*	*		*	*	
crenulatus, *Phil.*							*	*	*	*	
tumidus, *Mont.*	*	*	*	*	*						
cinerarius, *Lin.*	*	*	*	*	*						
umbilicatus, *Mont.*			*	*	*	*		*			
magus, *Lin.*			*	*	*		*		*	*	
lineatus, *Costa*				*	*			*			
canaliculatus, *Phil.*						*	*				
fanulum, *Gmel.*							*				
fragaroides, *Lam.*							*		*		
indecorus, *Phil.*									*		
Saulcyi, *Webb & Berth.*									*		
Richardi, *Payr.*							*				
Laugieri, *Payr.*					*	*	*				*
sp.					***						
Vieillotti, *Payr.*							*				
Jussieui, *Payr.*							*				
articulatus, *Lam.*						*	*				
divaricatus, *Lin.*							*				
dubius?, *Phil.*							*				
sanguineus, *Lin.*							*				
villicus, *Phil.*							*				
Bertheloti (Monodonta), *D'Orb.*									*	*	*

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Gasteropoda (*continued*).											
Phasianella, *Lam.*											
pullus, *Lin.*			*	*	*	*	*	*	*	*	*
intermedia, *Scacchi*						*	*				
Vieuxii, *Payr.*							*				
Turbo, *Lin.*											
rugosus, *Lin.*					*	*	*	*	*	*	*
sp. ined.								*			
Neritina, *Lam.*											
viridis, *Lin.*							*		*	*	
Truncatella, *Lowe.*											
truncatula, *Drap.*							*		*		
Skenea, *Flem.*											
planorbis, *O. Fab.*	*	*	*								
sp.	*	*									
sp.									*		
Rissoa, *Frem.*											
striatula, *Mont.*				*			*				
lactea, *Mich.*					*		*	*			
Zetlandica, *Mont.*			*								
crenulata, *Mich.*				*	*		*	*	*	*	*
Beanii, *Hanley*			*								
abyssicola, *Forbes*			*								
calathus, *Forbes & Hanley*		*	*	*	*						*
granulata, *Phil.*							*				*
sculpta, *Phil.*			*	*							
punctura, *Mont.*				*							
costata, *Adams*				*	*		*		*		
striata, *Mont.*	*	*	*	*	*						
parva, *Costa* interrupta, *Adams* }	*	*	*	*	*	*	*	*	*		
costulata, *Alder*				*	*		*				
rufilabrum, *Alder*			*	*							
labiosa, *Mont.*			*	*	*		*		*		
semistriata, *Mont.*				*							
rubra, *Alder*				*					*?		
cingillus, *Mont.*			*	*	*						*
vitrea, *Mont.*			*	*	*						
ulvæ, *Pennant*	*	*	*	*	*						
Barleei, *Jeffreys*			*								
violacea, *Desm.*					*		*		*	*	
monodonta, *Bivon*						*	*				
Bruguieri, *Payr.*							*				
auriscalpium, *Lin.*							*				
Montagui, *Payr.*							*				
Desmarestii, *Forbes*							*				
Canariensis, *Webb & Berth.*									*	*	
sp. ined.							***				
sp. ined.									*****		
sp. ined.										***	
Lacuna, *Turton.*											
pallidula, *Costa*		*	*	*							
puteolus, *Turton*			*	*	*						
vincta, *Mont.*	*	*	*	*							

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Gasteropoda (*continued*).											
Lacuna, *Turton.*											
labiosa, *Lovén*	*	*									
crassior, *Mont.*	......	......	*								
Solarium, *Lam.*											
luteum, *Lam.*	......	......	......	......	*	......	......	......	*		
stramineum, *Gmel.*	......	......	......	......	*	......	*	......	*	*	
pseudoperspectivum, *Brocc.*	......	......	......	......	......	......	*				
Bifrontia, *Desh.*											
zanclæa, *Phil.*	......	......	......	......	......	......	......	......	......	*	
Fossarus, *Philippi.*											
Adansoni, *Phil.*	......	......	......	......	......	......	......	*	*	*	*
Littorina, *Fér.*											
neritoides, *Lin.*	......	......	*	*	*	*	*	*	*	*	
littorea, *Lin.*	*	*	*	*	*	*					
littoralis, *Lin.*	*	*	*	*	*	*	*				
rudis, *Don.*	*	*	*	*	*						
tenebrosa, *Mont.*	*	*	*	*	*						
saxatilis, *Johnston*	*	*	*	*	*						
patula, *Jeffreys*	*	*	*	*	*						
Syriaca, *Phil.*	......	......	......	......	*	......	*				
striata	......	......	......	......	......	......	......	......	*	*	*
Scalaria, *Lam.*											
Turtonis, *Turton*	......	......	*	*	*	......	*	......	......	*	
communis, *Lam.*	......	......	......	*	*	......	*				
clathratula, *Mont*	......	......	......	*	*	*	*	*	*	......	*
Grœnlandica, *Chem.*	*	*	* ?								
Lovéni, *A. Ad.*	*	*									
Trevelliana, *Leach*	......	......	*	*							
crenata, *Lin.*	......	......	......	......	......	......	*	*	*		
pseudoscalaris, *Brocchi*	......	......	......	......	......	......	*	*	*		
cochlea, *Sow. Jun.*	......	......	......	......	......	......	......	......	*	*	
Webbii, *D'Orb.*	......	......	......	......	......	......	......	......	*		
Macandrei, *Forbes, MSS.*	......	......	......	......	......	......	......	......	*		
sp. ined.	......	......	......	......	......	......	*				
sp. ined.	......	......	......	......	......	......	......	......	****		
sp. ined.	......	......	......	......	......	......	......	......	......	**	
Vermetus, *Adanson.*											
gigas, *Bivon*	......	......	......	......	......	......	*				
glomeratus, *Lin.*	......	......	......	......	......	......	*				
corneus, *Forbes*	......	......	......	......	......	......	*				
Cæcum, *Fleming.*											
trachea, *Mont.*	......	......	......	*	*	......	*				
glabrum, *Mont.*	......	......	......	*	......	......	*				
elegantissimum, *Carpenter*	......	......	......	......	......	......	......	......	*		
Searles-Woodii, *Carpenter*	......	......	......	......	......	......	......	......	*		
vitreum, *Carpenter*	......	......	......	......	......	......	......	......	*		
Aclis, *Lovén.*											
ascaris, *Turton*	......	......	*	*	*	......	*				
supranitida, *Searles Wood*	......	......	......	*	*	......	*				
sp. ined.	......	......	......	......	......	......	......	......	*		
? Genus uncertain.											
sp. ined.	......	......	......	......	......	......	*				
sp. ined.	......	......	......	......	......	......	......	......	......	*	

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Gasteropoda (*continued*).											
Turritella, *Lam.*											
communis, *Risso*	*	*	*	*	*	*	*	*			
triplicata, *Brocchi*					*		*		*		
Mesalia, *Gray.*											
brevialis, *Lam.*						*	*	*			
striata, *A. Ad.*							*			*	
Aporrhais, *Aldrovandus.*											
pes-pelecani, *Lin.*	*	*	*	*	*	*	*				
pes-carbonis, *Brongniart*	*		*								
Triforis, *Deshayes.*											
adversa, *Mont.*			*	*							*
perversa, *Brug.*					*	*	*	*	*	*	
Macandrei, *A. Ad.*	*	*									
Cerithiopsis, *Forbes.*											
tubercularis, *Mont.*			*	*			*		*?		
Cerithium, *Brug.*											
reticulatum, *Costa*		*	*	*	*	*	*	*	*	*	*
metula, *Lovén*	*	*	*								
lacteum, *Phil.*							*				
angustinum, *Forbes*							*		*	*	
vulgatum, *Brug.*						*	*		*		
fuscatum, *Costa*							*		*		
Stylina, *Flem.*											
sp.									**?		
Eulima, *Risso.*											
polita, *Lin.*	*	*	*	*	*		*				
distorta, *Desh.*			*	*			*		*	*	*
subulata, *Donovan*				*	*	*	*			*	
bilineata, *Alder*	*	*	*								
nitida, *Lam.*							*		*	*	
sp. ined.									*	*	*
Chemnitzia, *D'Orb.*											
elegantissima, *Mont.*				*	*	*	*	*	*	*	*
rufa, *Phil.*						*	*		*	*	
formosa, *Jeff.*				*	*						
fenestrata, *Forbes & Jeff.*				*	*						
fulvocincta, *Thompson*			*	*	*	*					
scalaris, *Phil.*				*	*		*				
rufescens, *Forbes*		*	*								
indistincta, *Mont.*			*	*	*		*		*		
sp. ined.	*										
sp. ined.							***				
Eulimella, *Forbes.*											
acicula, *Phil.*			*	*			*				
affinis, *Phil.*	*	*	*								
Scillæ, *Phil.*		*	*				*		*	*	
Odostomia, *Flem.*											
conoidea, *Brocchi*			*	*	*	*	*	*	*		
acuta, *Jeff.*				*			*		*		
spiralis, *Mont.*			*	*			*				
interstincta, *Mont.*			*	*			*		*	*	
conspicua, *Alder*						*					
plicata, *Mont.*	*	*	*	*					*?	*	

Species.	Northern Scandinavia (Finmark and Nordland).	Drontheim.	Scotland.	British Channel.	North of Spain.	Portugal.	South of Spain and Mediterranean.	Mogador.	Canary Islands.	Madeira.	Azores.
Gasteropoda (*continued*).											
Odostomia, *Flem.*											
obliqua, *Alder*			*	*					*		
glabrata, *Muhlfeldt*				*					*		
unidentata, *Mont.*			*	*					*	*	
tricincta, *Jeff.*							*		*	*	
Velutina, *Flem.*											
lævigata, *Lin.*	*	*	*	*	*						
flexilis, *Mont.*	*	*	*								
Lamellaria, *Mont.*											
tentaculata, *Mont.*				*	*		*				
perspicua, *Lin.*			*	*			* ?		* ?	*	
prodita, *Lovén*	*										
sp. ined.									*		
Sigaretus, *Lam.*											
haliotideus, *Lin.*						*	*				
Natica, *Lam.*											
monilifera, *Lam.*			*	*	*						
nitida, *Don.*	*	*	*	*	*		*				
sordida, *Phil.*			*	*			*				
helicoides, *Johnston*	*	*	*								
pusilla, *Gould*	*	*	*								
Montagui, *Forbes*	*	*	*								
clausa, *Sow.*	*										
aperta, *Lovén*	*										
intricata, *Don.*						*	*				*?
textilis, *Reeve*							*				
olla, *M. De Serres*							*				
millepunctata, *Lam.*							*		*		
Guilleminii, *Payr.*						*	*				
macilenta, *Phil.*							*	*			
porcellana, *Webb & Berth.*									*	*	
Sagrana, *D'Orb.*						*	*		*		
sp. ined.									*		
sp. ined.									*	*	
Ovulum, *Lam.*											
patulum, *Pen.*				*							
spelta, *Lin.*							*		*		
carneum, *Lin.*							*				
? acuminatum, *Brug.*			*	*			*				
Erato, *Risso.*											
lævis, *Don.*			*	*	*		*				
Cypræa, *Lin.*											
Europea, *Mont.*		*	*	*	*	*	*				
pulex, *Solander*							*		*	*	*
candidula, *Gaskoin*									*	*	
spurca, *Lin.*							*		*		
pyrum, *Lin.*							*		*		
moneta, *Lin.*							* ?		* ?		
lurida, *Lin.*									*		
Marginella, *Lam.*											
miliacea, *Lam.*							*	*	*	*	
clandestina, *Brocchi*							*		*	*	
guancha, *D'Orb.*									*	*	

Species.	Northern Scandinavia (Finmark and Nordland).	Drontheim.	Scotland.	British Channel.	North of Spain.	Portugal.	South of Spain and Mediterranean.	Mogador.	Canary Islands.	Madeira.	Azores.
Gasteropoda (*continued*).											
Marginella, *Lam.*											
secalina ?, *Phil.*							*		*		
glabella, *Lin.*								*	*		
sp. ined.								*			
Mitra, *Lam.*											
columbellaria, *Scacchi*							*		*		
ebeneus, *Lam.*							*	*			
Savignii, *Payr.*							*				
fusca, *Swains.*									*	*	*
lutescens, *Lam.*							*				
zebrina, *D'Orb.*								*	*	*	*
sp. ined.									*	*	
sp.						*					
Cymba, *Brod.*											
olla, *Lin.*						*	*		*		
Lachesis, *Risso.*											
minima, *Mont.*				*	*		*	*		*	
Defrancia, *Millet.*											
pyramidalis, *Strom.*	*										
linearis, *Mont.*	*	*	*	*	*		*		*	*	
purpurea, *Mont.*			*	*	*		*	*		*	
Phileberti, *Michaud.*							*		*	*	
Lefroyii, *Mich.*			*				*		*		
reticulata, *Brown*							*				
Bela, *Leach.*											
turricula, *Mont.*	*	*	*	*							
Trevelliana, *Turton*	*	*	*								
mitrula, *Lovén*	*	*									
rosea, *Sars*	*										
rufa, *Mont.*	*	*	*	*							
septangularis, *Mont.*			*	*	*		*				* ?
Mangelia, *Leach.*											
?Holbollii, *Möller*	*	*									
?nana, *Lovén*	*	*	*								
teres, *Forbes*		*	*	*			*		*	*	
gracilis, *Mont.*			*	*			*		*	*	
nebula, *Mont.*			*	*			*		*	*	
lævigata, *Phil.*							*	*			
brachystoma, *Phil.*			*	*	*		*	*			
striolata, *Scacchi*				*	*	*	*		*	*	
costata, *Pen.*			*	*	*	*					
attenuata, *Mont.*				*	*	*	*				
elegans, *Scacchi*					*	*	*		*		
Vauquelina, *Payr.*							*		*	*	
secalina, *Phil.*							*			*	
grana, *Phil.*							*				
rugulosa, *Phil.*							*				
nana, *Scacchi*							*				
crispata, *Cristof.*							*				
rudis, *Phil.*							*				
sp. ined.							*				
sp. ined.									*	*	
sp. ined.									*		

Species.	Northern Scandinavia (Finmark and Nordland)	Drontheim.	Scotland.	British Channel.	North of Spain.	Portugal.	South of Spain and Mediterranean.	Mogador.	Canary Islands.	Madeira.	Azores.
Gasteropoda (*continued*).											
Mangelia, *Leach.*											
sp. ined										**	
nivalis, *Lovén*	*										
balteata, *Beck*							*		*		
Conus, *Lin.*											
Mediterraneus, *Brug.*						*	*		*		
papilionaceus, *Brug.*									*		
Columbella, *Lam.*											
rustica, *Lin.*						*	*		*	*	*
scripta, *Lin.*							*	*			
minor, *Scacchi*							*	*	*	*	
cribraria, *Lin.*									*	*	
Broderipii, *Sow.*								*	*		
sp. ined										**	
sp. ined											*
Dolium, *Lam.*											
galea, *Lin.*							*		*		
Cassidaria, *Lam.*											
echinophora, *Lin.*							*				
Cassis, *Lam.*											
sulcosa, *Lam.*							*		*	*	
saburon, *Lam.*					*	*					
Purpura, *Lam.*											
lapillus, *Lin.*	*	*	*	*	*						
hæmastoma, *Lin.*					*	*	*	*	*	*	*
viveratoides, *Webb & Berth.*									*		
Ringicula, *Desh.*											
auriculata, *Mont.*					*	*	*	*	*	*	
Nassa, *Lam.*											
reticulata, *Lin.*	*	*	*	*	*	*	*	*	*		
incrassata, *Müller*	*	*	*	*	*	*	*		*	*	*
pygmæa, *Lam.*				*	*	*	*				
variabilis, *Phil.*							*	*	*	*	
prismatica, *Brocchi*							*		*	*	
mutabilis, *Lin.*							*				
neritea, *Lin.*							*				
grana, *Lam.*							*				
trifasciata, *A. Ad.*					*	*	*	*			
glaberrima, *Gmel.*							*	*	*		
corniculum, *Olivi.*					*		*	*			
Terebra, *Lam.*											
sp.									*		
Buccinum, *Lin.*											
undatum, *Lin.*	*	*	*	*							
Dalei, *J. Sow.*	*										
Humphreysianum, *Bennet*	*		*								
fusiforme, *Brod.*	*	*									
cyaneum, *Müller*	*										
sp. ined								*	*		
Fusus, *Lam.*											
Islandicus, *Chem.*	*										
gracilis, *Costa*	*	*	*	*							
propinquus, *Alder*			*	*							

Species.	Northern Scandinavia (Finmark and Nordland).	Drontheim.	Scotland.	British Channel.	North of Spain.	Portugal.	South of Spain and Mediterranean.	Mogador.	Canary Islands.	Madeira.	Azores.
Gasteropoda (*continued*).											
Fusus, *Lam.*											
Berniciensis, *King*			*								
antiquus, *Lam.*	*	*	*	*							
Norvegicus, *Chem.*	*		*								
contrarius, *Lam.*					*						
Syracusanus, *Lin.*							*				
corneus, *Lin.*							*				
pulchellus, *Phil.*							*		*		
rostratus, *Olivi*							*		*		
craticulatus, *Phil.*							*				
moroccanus									*		
sp.							*				
Trophon, *De Montfort.*											
clathratus, *Lin.*	*	*	*								
muricatus, *Mont.*			*	*	*						
Barvicensis, *Johnston*	*	*	*								
Gunneri, *Lovén*	*	*									
craticulatus, *Fab.*	*										
Trichotropis, *Brod.*											
borealis, *Sow.*	*	*	*								
Cancellaria, *Lam.*											
cancellata, *Lam.*							*				
assimilis, *Sow.*							*				
sp. ined.							*		*	*	
sp. ined.									*	*	
viridula (Admete), *O'Fab.*	*										
Triton, *Lam.*											
nodiferus, *Lam.*					*	*	*		*		*
corrugatus, *Lam.*					*	*	*				
cutaceus, *Lam.*					*	*	*		*		
olearius ?, *Lin.*							*				
scrobiculatus, *Lam.*							*				*
pilearis, *Lam.*									*	*	
tuberosus, *Lam.*									*		*
Ranella, *Lam.*											
lævigata, *Lam.*									*		
Pisania, *Biron.*											
D'Orbignii, *Payr.*							*				
maculosa, *Lam.*							*				*
Typhis, *Montf.*											
Sowerbii, *Brod.*							*				
Murex, *Lin.*											
erinaceus, *Lin.*			*	*	*	*	*		*	*	
trunculus, *Lin.*						*	*				
brandaris, *Lin.*						*	*		*		
corallinus, *Scacchi*					*	*	*	*	*	*	*
Edwardsii, *Payr.*					*	*	*		*	*	
cristatus, *Brocchi*							*			*	
torosus, *Lam.*								*			
sp. ined.									*	*	
Cephalopoda.											
Spirula, *Lam.*											
Peronii, *Lam.*					*		*		*		*

Number of species enumerated :—

Acephala, 275 ; Pteropoda, 14 ; Gasteropoda, 460 : Total 750.

Number of species obtained in the most northern district (Finmark and Nordland) :—

88 Acephala, 100 Gasteropoda ; total 188 species, of which

72	Acephala,	88	Gasteropoda	=160,	were found as far	south as	North Drontheim.
64	,,	71	,,	=135	,,	,,	Scotland.
50	,,	43	,,	= 93	,,	,,	British Channel.
37	,,	36	,,	= 73	,,	,,	North of Spain.
35	,,	25	,,	= 60	,,	,,	Portugal.
35	,,	24	,,	= 59	,,	,,	S. of Spain & Mediterranean.
19	,,	15	,,	= 34	,,	,,	Mogador.
8	,,	8	,,	= 16	,,	,,	Canary Islands.
6	,,	4	,,	= 10	,,	,,	Madeira.

Of 83 Acephala and 93 Gasteropoda=176 species from the coast of North Drontheim—

77	Acephala and	80	Gasteropoda	=157	found as far south as	Scotland.
60	,,	51	,,	=111	,,	British Channel.
45	,,	43	,,	= 88	,,	North of Spain.
41	,,	30	,,	= 71	,,	Portugal.
41	,,	29	,,	= 70	,,	Mediterranean.
23	,,	18	,,	= 41	,,	Mogador.
16	,,	11	,,	= 27	,,	Canary Islands.
10	,,	8	,,	= 18	,,	Madeira.
69	,,	82	,,	=151	,, north as	Nordland and Finmark.

Of 117 Acephala, 1 Pteropod, and 142 Gasteropoda=260 species found on the coasts of Scotland—

97	Acephala,	103	Gasteropoda	=200,	extend south to the	British Channel.
81	,,	86	,,	=167	,,	North of Spain.
76	,,	69	,,	=145	,,	Portugal.
76	,,	65	,,	=141	,,	Mediterranean.
47	,,	46	,,	= 93	,,	Mogador.
36	,,	36	,,	= 72	,,	Canary Islands.
26	,,	25	,,	= 51	,,	Madeira.
70	,,	83	,,	=153	extend as far north as	Drontheim.
59	,,	72	,,	=138	,,	Nordland and Finmark.

Of 122 Acephala, 136 Gasteropoda=258 species from the south coast of England—

103	Acephala,	114	Gasteropoda	=227,	are found as far	south as the	North of Spain.
98	,,	94	,,	=192	,,	,,	Portugal.
98	,,	90	,,	=188	,,	,,	Mediterranean.
59	,,	59	,,	=118	,,	,,	Mogador.
45	,,	48	,,	= 93	,,	,,	Canary Islands.
30	,,	33	,,	= 63	,,	,,	Madeira.
91	,,	99	,,	=190	,,	north as	Scotland.
51	,,	49	,,	=107	,,	,,	Drontheim.
46	,,	42	,,	= 88	,,	,,	Nordland and Finmark.

Of 94 Acephala, 123 Gasteropoda=217 from the north coast of Spain, including Vigo—

88	Acephala,	95	Gasteropoda	=183,	are found as far	south as	Portugal.
86	,,	89	,,	=171	,,	,,	Mediterranean.
49	,,	61	,,	=110	,,	,,	Mogador.
35	,,	46	,,	= 81	,,	,,	Canary Islands.
22	,,	34	,,	= 56	,,	,,	Madeira.
81	,,	91	,,	=172	,,	north as	South of England.
62	,,	66	,,	=128	,,	,,	Scotland.
38	,,	38	,,	= 76	,,	,,	North Drontheim.
30	,,	33	,,	= 63	,,	,,	Nordland and Finmark.

Of 90 Acephala, 74 Gasteropoda = 164 species of Mollusca from the coast of Portugal—

88 Acephala,	65 Gasteropoda		= 153,	extend to the S. of Spain and Mediterranean.		
54	,,	47	,,	= 101	,,	as far south as Mogador.
37	,,	40	,,	= 77	,,	,, Canary Islands.
24	,,	27	,,	= 51	,,	,, Madeira.
75	,,	54	,,	= 129	,,	as far north as North of Spain.
67	,,	38	,,	= 105	,,	,, South of England.
45	,,	27	,,	= 72	,,	,, Scotland.
28	,,	14	,,	= 42	,,	,, North Drontheim.
21	,,	11	,,	= 32	,,	,, Nordland and Finmark.

Of 184 Acephala, 7 Pteropoda, 233 Gasteropoda, 1 Cephalopod = 425 species from south of Spain and Mediterranean—

91 Acephala,		6 Pteropoda,		116 Gasteropoda,		1 Cephalopod		= 214,	extend S. to	Mogador.
69	,,	6	,,	100	,,	1	,,	= 176	,,	Canary Islands.
46	,,	6	,,	64	,,	1	,,	= 117	,,	Madeira.
122	,,	..	,,	120	,,	1	,,	= 243	,, N. to	Portugal.
109	,,	..	,,	103	,,	1	,,	= 213	,,	North of Spain.
99	,,	..	,,	82	,,	..	,,	= 181	,,	S. of England.
73	,,	..	,,	57	,,	..	,,	= 130	,,	Scotland.
42	,,	..	,,	26	,,	..	,,	= 61	,,	North Drontheim.
33	,,	..	,,	20	,,	..	,,	= 53	,,	Nordland & Finmark.

Of 44 Acephala, 64 Gasteropoda = 108 species obtained at Mogador—

20 Acephala,		38 Gasteropoda		= 58	extend southward to the Canary Islands.	
10	,,	27	,,	= 37	are found in Madeira.	
43	,,	45	,,	= 80	extend North to the Mediterranean.	
36	,,	34	,,	= 70	,,	Portugal.
31	,,	32	,,	= 63	,,	North of Spain.
27	,,	24	,,	= 51	,,	South of England.
21	,,	16	,,	= 37	,,	Scotland.
14	,,	7	,,	= 21	,,	North Drontheim.
11	,,	5	,,	= 16	,,	Nordland and Finmark.

Of 78 Acephala, 9 Pteropoda, 179 Gasteropoda, and 1 Cephalapod = 267 species of Mollusca obtained in the Canary Islands—

48 Acephala,		5 Pteropoda,		86 Gasteropoda				= 139,	were found in	Madeira.
73	,,	6	,,	108	,,	1 Cephalapod		= 188	reach Nwd. to	Mogador.
73	,,	6	,,	104	,,	1	,,	= 184	,,	Mediterranean.
53	,,	..	,,	67	,,	1	,,	= 121	,,	Portugal.
49	,,	..	,,	60	,,	1	,,	= 110	,,	North of Spain.
45	,,	..	,,	46	,,	..	,,	= 91	,,	South of England.
33	,,	..	,,	32	,,	..	,,	= 65	,,	Scotland.
16	,,	..	,,	13	,,	..	,,	= 29	,,	North Drontheim.
10	,,	..	,,	9	,,	..	,,	= 19	,,	Nordland & Finmark.

Of 56 Acephala, 6 Pteropoda, 107 Gasteropoda = 169 species from Madeira—

48 Acephala,		5 Pteropoda,		86 Gasteropoda		= 139,	are found in	the Canary Islands.
10	,,	..	,,	27	,,	= 37	,,	Mogador.
46	,,	6	,,	64	,,	= 116	,,	Mediterranean.
24	,,	..	,,	27	,,	= 51	,,	Portugal.
22	,,	..	,,	34	,,	= 56	,,	North of Spain.
30	,,	..	,,	33	,,	= 63	,,	South of England.
26	,,	..	,,	25	,,	= 51	,,	Scotland.
10	,,	..	,,	8	,,	= 18	,,	North Drontheim.
6	,,	..	,,	4	,,	= 10	,,	Nordland and Finmark.

To judge of the marine Mollusca of the Azores from the few species received from thence, they appear to be generally identical with those of the Mediterranean, except a very few species not identified, and several littoral species, such as *Littorina striata*, *Mitra fusca*, *Mitra zebrina*, *Pedipes*, which are not European, but common to Madeira and the Canary Islands.

Concluding Observations.

The acephalous or bivalve Mollusca possess generally a capacity to exist through a greater bathymetrical range than univalves, several species of the former being to be found in all the zones of depth from the margin of the sea to a hundred or more fathoms, and it is these same species which are most widely distributed geographically, as might indeed be reasonably inferred, it being evident that the depths of the ocean can be comparatively but slightly affected by changes of temperature and of climate, and that, consequently, a species removed to a distance northward or southward from its most congenial habitat, would encounter less change in climatal conditions by seeking a greater depth.

Those species which inhabit a great vertical range, such as *Saxicava arctica*, *Venus striatula*, *Venus ovata*, *Lucina borealis*, &c., have generally their maximum of development and attain their greatest dimensions in shallow water; and I call the attention of geologists to this fact as it may occasionally be of service in determining the depth at which strata have been deposited. Another important point, deserving attention on account of its bearing on geology, *is the modifications of growth, incident to all the individuals taken from a great depth, as compared with individuals of the same species taken from a moderate depth.* Some of these vary in different species, but the general characteristics of deep-water specimens are deficiency of colour and of solidity, and smallness of size.

Northern species generally diminish greatly in size as they approach southern latitudes; but the converse of the rule cannot be so generally applied to southern species, for while some of these are smaller, others increase in dimensions as they approach the northern limit of their range. As examples of the latter, I may mention *Ringicula auriculata* and *Mactra rugosa*, which attain their maximum size in Vigo Bay, *Haliotis tuberculata* in Guernsey, and *Tellina balaustina* in the West of Ireland and the Hebrides.

To give an idea of the comparatively small number of species existing in high northern latitudes, I may mention that I obtained 50 per cent. more of species in the Canary Islands than in the northern provinces of Norway, although I bestowed at least thrice the amount of time and labour in dredging the latter, under more favourable circumstances, and through a greater range of latitude.

The correct division of the marine Mollusca into provinces, or as they are called "Faunas," is a subject deserving consideration, as it may be of assistance to us in our endeavours to become acquainted with the laws regulating the distribution of species.

The Arctic and Tropical faunas are tolerably well defined by the zones after which they are named, except that the former, on the European side of the Atlantic, recedes a few degrees within the Arctic Circle, in consequence of the current which sets northward along the coast of Norway. It is the division of the temperate zone into the Boreal, Celtic, and Lusitanian or Mediterranean provinces, which offers some difficulty, and I take the liberty of submitting the following suggestions with reference to it.

Two sets of Mollusca of very different type advance from the sub-arctic and sub-tropical regions towards each other. In the course of their progress each loses by the way many of its most characteristic members, which one after another become extinct, so that when they reach their point of contact, the species are comparatively few in number, and not the most characteristic of their northern or southern origin. In order to remedy this state of things and to accomplish an equable distribution of Mollusca throughout the temperate zone, it is necessary that there should exist an *intermediate* fauna, pervading more or less the ground occupied by both the others, and having its principal development at their point of meeting, and this I believe to be neither more nor less than what actually occurs. The point at which the north temperate or boreal, and the south temperate faunas meet, I conceive to be about lat. 50°, or at the British Channel, which marks the limit of some of the most characteristic northern forms, viz. *Buccinum undatum, Fusus antiquus, Cyprina Islandica*, &c., as well as of the genera *Haliotis, Lachesis, Calyptræa, Venerupis, Gastrochæna, Auricula*, and numerous species of southern type. Supposing my view to be correct, it is at once seen why there can be no *peculiar* species in the Celtic (or as I would rather call it), the *English* or *intermediate* fauna. It is difficult to lay down an exact line of division between one animal province and another, the transition being gradual; but I would consider the "intermediate" fauna to be contained between the 45th and 55th parallels of latitude, which will include the larger portion of the Bay of Biscay and a considerable part of the North Sea. All species which attain their maximum of development within these limits I would consider legitimately to belong to it, and among the most characteristic of these may be mentioned *Purpura lapillus, Natica monilifera* and *N. nitida, Trochus zizyphinus, Lacuna puteolus, L. pallidula*, all the British *Pholades, Mactra solida, Tellina crassa, Pecten opercularis, P. pusio*, and *Venus striatula*.

Although, as already stated, the transition from one fauna to another takes place gradually, the change is much greater at certain geographical points than at others, and the neighbourhood of Cape St. Vincent is remarkable as the northern limit on the Atlantic coast of about a hundred southern species, including the following genera:—

Solemya.	Siphonaria.	Ranella.	Conus and
Cardita.	Sigaretus.	Mitra.	Cypræa (except the
Chama.	Crepidula.	Columbella.	sub-genus *Trivia*).
Spondylus.	Cancellaria.	Pollia.	

Though *Cardita* and *Mitra* reappear in the Polar seas represented each by a single species, and *Cancellaria* under the form *Admete. Cymba* extends to the neighbourhood of the rock of Lisbon; *Ringicula* to Vigo; *Triton, Turbo, Cassis*, and *Lithodomus* to *Asturias*; *Adeorbis, Haliotis, Calyptræa, Lachesis, Gastrochæna, Venerupis, Galeomma*, and *Avicula* to the south coast of England.

The circumstance of so many characteristic forms disappearing at Cape St. Vincent, may perhaps be accounted for by the change which there takes place in the direction of the coast and consequent set of the current. It will be noticed that the disappearance of species is all in one direction, and that the point in question is not known to form the southern limit of a single species; also that nearly all the genera enumerated as not passing it are to be found six or seven degrees further north in the Mediterranean.

A circumstance analogous to what occurs at Cape St. Vincent takes place about the South of Scotland with reference to northern forms of Mollusca. Of 135 Norwegian species which extend to Scotland, no less than 42 are absent from the South of England; and this fact is, I conceive, to be explained by the change in the nature of the sea-bottom, which may also account for the circumstance that many species, and among them the peculiarly northern forms of *Trichotropis, Cemoria*, and *Pilidium*, are common to the coast of Norway and the Hebrides, and even extend as far south as the Clyde, while they are altogether absent from, or but very rarely found upon the east coast of Scotland.

The Mediterranean fauna may be considered a branch of the north temperate Atlantic, agreeing with it in its general character, though possessing some peculiarities, a natural result of its isolated condition.

Report on the present state of our knowledge with regard to the Mollusca of the West Coast of North America. By Philip P. Carpenter. Kref.

1. The duty of preparing a Report "On the present state of our knowledge of the Mollusca of California," was entrusted to the writer simply in consequence of an opportunity which accident had thrown in his way, of obtaining accurate information on the Mollusca of one spot only on the Pacific shores of N. America. Almost entirely destitute of technical knowledge, and living at a distance from collections and libraries, he would not have ventured to undertake it but for the promised aid of one, whose early death, just as he was entering on that field which seemed of all others most adapted to develop his peculiar powers, still leaves a most deeply-felt void in Malacological and Geological Science. This spot is neither politically nor conchologically in California, strictly so called, but belongs in its fauna to the province which culminates in the Bay of Panama and extends southwards to Peru; while many shells of the real Californian fauna extend northwards towards Behring's Straits, and are found on the Asiatic coasts in the Okhotsk Sea. This Report will therefore take cognizance of all that is known of the Mollusca of the West Coast of North America, from the Boreal shores to Panama.

Before results can be obtained of permanent value, and general deductions drawn from them that shall bear on the great questions of the condition of our globe in this and previous ages, it is necessary that the foundations should be laid by patient and accurate examination of every minute point in our inquiries: else, as the wrong measurement of a degree nearly prevented Newton's elimination of the great law of gravitation, so the deficiency or hasty examination of details respecting particular species and their abodes, may lead the great master-minds of science to erroneous conclusions, which, through their well-earned influence, retard rather than stimulate the progress of future research. It is proposed therefore—(1) to state the physical conditions, and the cautions to be observed in the inquiry; (2) to present the different sources of information in historical order; and (3), after tabulating these geographically and zoologically, to draw such inferences as the present state of our knowledge may warrant*.

* On receiving the request of the Association, I issued a circular seeking information as to—

1. What species are found on the north-east shores of the Pacific, especially at Vancouver's Island.
2. What near the mouth of the Columbia river, and in the Oregon territory.
3. What near San Francisco and Monterey.
4. What near San Diego.
5. What along the *Pacific* shores of the peninsula to Cape St. Lucas.
6. What at La Paz, Guaymas, and other stations *in* the Gulf of California.
7. What at Acapulco and other stations along the coast towards Panama.
8. What species of land and freshwater shells are found in different parts of Oregon, California, and West Mexico.

And, in order to compare with these, as to—

9. What species are found on the *eastern* (Atlantic) shores of Mexico.
10. What at the Galapagos.
11. What at the Sandwich Islands (distinguishing what are brought there from other places).
12. What in Polynesia.
13. What *fossil* species are found in the Tertiary deposits of the United States, which may throw light on the existing Pacific species.

This circular was sent to every accessible station on the West N. American coast, and to naturalists in this and foreign countries. The replies are on most points extremely meagre: but I have pleasure in recording great obligations to Hugh Cuming, Esq., for the most liberal

2. Perhaps no region in the world is so well adapted for the study of the geographical distribution of Mollusca as the W. coast of N. and S. America. Shut out from the vast Indo-Pacific province which reaches to the Sandwich and Marquesas Islands by an uninterrupted body of water almost equal in extent to the whole Atlantic Ocean, on the other side barred against all admixture with the Caribbean Sea by the mighty bulwark of Central America and Darien, it presents the least indented line of coast that the world can show, from the frozen ocean of the north to a southern promontory 20° south of the lowest extremity of the old world. Even the land fauna is separated from that of the bulk of the continent by the great chain of the Andes and the Rocky Mountains, and by the arid climate which prevails over a large portion of its extent. Here then we enter upon a new type of marine life, almost entirely distinct from those with which we have been familiar in the Atlantic, Indian and Polynesian waters; in which we can pass, on each side of the equator, from tropical to boreal conditions, with the most satisfactory regularity. All that we miss is the presence of more oceanic islands; the solitary group of the Galapagos presenting data of unusual interest, to be noticed afterwards.

3. The tropical region of marine life extends much further north than south of the equator. This is accounted for by the direction of the equatorial current, which, striking upon the swelling coast of Peru, sweeps round the great Bay of Panama and Central America, and following the north-westerly direction of the coast, is naturally driven up the narrow Gulf of California, where, even at Guaymas, in lat. 27°, are found the conditions of equatorial climate (*Gould*). The long promontory of Lower California, from lat. 23°–32°, offers a natural impediment to the further northward passage of mollusks; while the current which flows southwards, parallel to the shores of temperate America, seems to convey many boreal species below the latitude at which we should have expected them. The zoological temperate zone therefore is curtailed in the northern and extended in the southern hemisphere.

4. The following are recorded as the physical conditions of places which have been made the special seats of observation.—PANAMA. At the head of an extensive bay, with a reef consisting of "ledges of trachytic rocks, with flat and concave surfaces, and gently sloping, precipitous, or shelving sides." Each has its appropriate species, as have also the loose pieces of rock, according to their size, distance from each other, and amount of insertion in the sand. On the fine sand beaches, *Oliva, Tellina, Donax* and *Dosinia* abound. On trees a little above half-tide level are found *Purpuræ* and *Littorinæ*; with numerous *Veneridæ, Columbellæ, Neritina picta* and *Arca grandis* among the sticks and moss-like algæ beneath. On ledges of smooth basaltic rocks abound *Littorinæ, Fissurellæ*, and *Siphonariæ*. In a mangrove thicket at high-water mark occur *Cerithideæ, Cyrena, Arcæ, Potamomyæ, Melampi*, and "over head, *Littorina pulchra*, almost as rare as beautiful." The ordinary tides are 16–20 feet, very rarely 28 feet, leaving many square miles of sea-bed exposed at the ebb. The bay contains several

and unrestricted use of his unrivalled collections, and the benefit of his experience and judgment; to Dr. A. A. Gould, of Boston, U. S., for the transmission of the whole of his valuable materials, including lists and collections; to R. M'Andrew, Esq., F.R.S., for the use of his collections and library; to R. D. Darbishire, Esq., B.A., of Manchester, and Sylvanus Hanley, Esq., B.A., for aid in the identification of species; to Dr. J. E. Gray, Dr. Baird, and S. P. Woodward, Esq., of the British Museum, for their assistance throughout; to Prof. Dr. Dunker for special help in the Mytilidæ, W. Clark, Esq., in the Cæcidæ, and L. Reeve, Esq., in the Patellidæ; and generally to friends and naturalists who have freely contributed materials at their disposal.

steep islands, of which the best known is Taboga (C. B. Adams, *Pan. Shells*, pp. 19–21).—MAZATLAN. On the north side of the bay is a "long neck of narrow hills, [of primitive rock,] their sides exhibiting projecting crags and deep indentations which the ocean has been lashing for ages. On the south are rocky islands, but towards the south-west the harbour is open to the broad Pacific, whence at times the sea rolls in with great fury" (*Bartlett*). The harbour is in some places choked with shoals of large *Pinnæ*, whose sharp edges cut the boats (*Belcher*). Station has often much more to do with the distribution of species than mere latitude: *e.g. Venus gnidia* is found in muddy places from Peru to the Gulf of California, but is not found on the prolific sandy floor of Acapulco harbour, where it is replaced by the sand-loving *V. neglecta*. In some sandy situations, the dredge may be used for hours without the smallest success; while in others, where the floor is varied, a short search will procure more than fifty species (*Hinds*).—CALIFORNIA. Along the coast of Upper California are primitive rocks, chiefly granite and syenite. Near Santa Barbara are cliffs of shell limestone, perhaps 200 feet high; but their contents have not been recorded. Brooks with hot springs issue from the primitive rocks, and there are abundant traces of huge geological convulsions (*Nuttall*). The peninsula is of volcanic rock, and exhibits great diversity of climate. When, near Cape St. Lucas, the thermometer stands between 60° and 70°, it may be found, near the northern extremity, at the freezing point. The muddy marshes near San Diego, &c., appear to be very prolific in bivalves; as are the rocks in *Acmææ*, which seem to culminate on this coast, whence they were first described by Eschscholtz. "Observations on some points in the Physical Geography of Oregon and Upper California, by Jas. D. Dana," will be found in 'Silliman's American Journal of Science and Art,' series 2, no. 21, May 1849, p. 376.

5. The Gulf of California (often, even in books of great pretension, strangely called a bay) was discovered by a vessel detached from the expedition of Cortez in 1533 (*Dana*), (1534, teste *Hibbert*). It was the Sea of Cortez, and the Vermilion Sea of the early Spaniards. It is about 700 miles long and from 40–120 wide. About the year 1697* it was colonized by a party of Spanish Jesuits, who founded Loreto, La Paz, and San Jose on its shores. The earliest shell known from its waters was the pearl oyster (*Margaritiphora fimbriata*, Dkr.), to obtain which, about the seventeenth century, the Spaniards employed from 600 to 800 divers; the value of the pearls obtained annually being estimated at 60,000 dollars. So exhausting was this traffic, that the fishery is now almost entirely abandoned. Occasionally, however, a ship-load of pearl shell is sent to Liverpool, and sold for manufacturing purposes. Among the sweepings from one of these loads was found the finest specimen known of *Placunanomia pernoides*, remarkable for its reappearance on the Gambia coast. There appears to have been a treaty with Spain as far back as 1786, allowing of some trade between this country and the Mexican shores; but there is no trace of much intercourse before the Declaration of Independence in 1821. In 1826 a direct treaty was formed between England and Mexico, and from that time the Californian and W. Mexican coast has ceased to be a *terra incognita* to English naturalists. Still, however, our knowledge of the shores and deep waters of the Gulf (especially of its northern extremity), and of the peninsula of California, is most fragmentary. The present Report contains the first account at all verging towards accuracy and completeness, of the fauna at its mouth. The 117 species collected on the shores of Upper California by our country-

* *Hibbert*: 1642, Blackie, Imp. Gaz.

man Mr. Nuttall, incomplete as it is, remains the best list of that interesting district; and in spite of the old-established English settlement near the Columbia River, it was left to the United States' Exploring Expedition to make us even moderately acquainted with the shells of the Oregon district. Of the abyssopelagic species in Oregon and California, we have only the very limited collections of Belcher and Hinds; and of the minuter forms, which in the British fauna are 31 per cent., in the Panama fauna 13 p. c., and in the Mazatlan fauna no less than 39 p. c. of the whole number of species, we cannot reckon more than half-a-dozen names.

6. It might be thought that, in order to obtain suitable lists of the Mollusca inhabiting particular localities, all that was necessary would be that shells should be brought from that locality, and then described. But such is far from being the case. A few of the principal causes of error, both as regards habitat and description, will be noticed, in order that suitable caution may be observed in judging of the materials to be presented.

7. *Errors respecting habitat.*—A large part of the shells in collections have been brought from the seats of trade. Either persons at home, in their communications with friends at sea-ports, request that shells may be sent back; or sailors bring them as an article of commerce. In both cases, the greatest number of specimens is collected from all sources, and no dependence whatever can be placed on the results. Thus, well-known East Indian, Philippine, and Polynesian shells have been sent from Acapulco and Mazatlan; and coast shells from various latitudes, including the Sandwich Islands, occur in the Oregon collection of Lady K. Douglas. It is well if sailors and captains do not add to the confusion by mixing together shells picked up at different places on the voyage. Nor do the errors end here. When they pass into the hands of dealers, it is rarely that the least attention is paid to their locality. They are mixed in drawers in every possible confusion, and instances have not been rare of traders coining habitats to suit the supposed taste of their customers. Even when they have their eyes open to the importance of accuracy, such are the circumstances of confusion attendant on the management of their business, that correctness is rarely to be expected.

8. But even if collections have been made on a single spot by a traveller of ordinary and even of conchological attainments, errors may arise from shells imported in ballast, &c., and dropped on the shore. Adhering and burrowing littoral shells may thus be found alive in places foreign to their native seas. This may account for a specimen of *Acmæa pelta*, abundant at Oregon, being found with the Mazatlan Limpets; and for *Littorina aspera* being given by Prof. Forbes in his zoological map as the characteristic species of the Oregon instead of the Mexican fauna, specimens having probably reached the northern collectors in the same way. As an aid to detect these errors, it is very desirable that shells should be retained without being subjected to the usual acid treatment, as the accretions, or the minute shells among the dirt, will often decide a point that the shell itself will not determine. Thus, a small specimen of *Fissurella Barbadensis* was separated from a boxful of *F. virescens* (a variety of which in the young state it closely resembles) by a minute *Spiroglyphus* and coral which seem peculiar to the Atlantic Seas. Thus also specimens of *Ostrea iridescens* with their *Placunanomiæ* were confirmed in their African habitat, from the minute shells between the laminæ, which agreed with the African and differed from the Panamic types. How many of these ballast species have found their way into the well-searched British shores, is patent to the readers of Forbes and Hanley's Hist. Brit. Moll. It is said that even the great Mediterranean

Triton has been dredged with the animal in, off the coast of Guernsey*. It is therefore very desirable that collectors should have a general acquaintance with the shells of a variety of distinct provinces, in order that they may be prepared to detect errors when they arise. For this purpose also the formation of local collections in public museums is very greatly to be recommended †.

9. It might be thought that all sources of error would be avoided, when competent naturalists themselves collect shells in their original haunts. But when different places are visited, it is not always possible, in the confinement of a ship, or amid the confusions of land travelling, to pack and tabulate accurately the results of each branch of inquiry: or, supposing these errors guarded against, intermixings may still take place in the unpacking and distribution of specimens. Moreover, when shells are left loose in cabinets, and the information is supplied by ticket only, a variety of interchanges may very unexpectedly take place. Such errors are most serious when they take place in the collections of naturalists deservedly noted for their accuracy; because whatever appears in their cabinets is naturally regarded as of unquestionable authority. Thus, a Ceylon shell ran an imminent risk of being described as from Mazatlan; and specimens were found bearing one locality on the ticket affixed to them, and another on a ticket within. Thus, also, Prof. Adams notes‡ having received a *Pleurotoma zonulata* from Mr. Cuming, as from the Philippines. Indeed, after the vast collections made by that gentleman in so fruitful a locality, it was natural that shells should be often assigned to this habitat, unless a contrary were known. The "China Seas" or "Eastern Seas" of Lieut. Belcher are also supposed to have included many chance acquirements; among others, *Dosinia Dunkeri* from the Panamic, and *Semele rubro-lineata* (= *simplex*) from the Californian fauna.

10. All these errors, from whatever source derived, find their way into the monographs, sometimes with additions by the writers themselves, and so become perpetuated. Some authors, even in our own country as well as in France, are not strict in regard to geographical boundaries. "Central America" and "West Columbia" are used generally for the tropical portions of the W. American coast, and "California" for any stations north of Acapulco, either in the Panamic or the San Franciscan province. Mr. Reeve, indeed (under *Patella venosa*, pl. 10. f. 18), extends W. Columbia southwards to include the Isle of Chiloë, in lat. 43°, just as Valenciennes and Kiener extend Peru northwards to include Acapulco. By mistake, Mr. Sowerby, jun., refers a Panama shell to Jamaica, when he cites Prof. Adams's *Cerithium validum*, and gives as the habitat of *Ranella nana* and *albofasciata*, P. Z. S. 1841, p. 52, "ad *insulam* Panama, *Philippinarum*."

11. Another class of errors arises from confounding places which bear the same name. Thus St. Vincent's may be either the island in the West Indies or on the Guinea coast, according as it is used by Guilding or Tams. San Blas may be either the near neighbour of Mazatlan in the Gulf district, or it may be D'Orbigny's locality in Patagonia. And San Juan may be either the bay on the Gulf side of the Peninsula of California, in lat. 27°, or the Straits of San Juan de Fuca (or Fuaco), near Vancouver's Island. It is believed that in Kellett and Wood's collections, the words *de Fuca* have

* Some may attribute a solitary specimen of *Trochus conulus* found by Mr. Bean at Scarborough to a like importation.

† Prof. E. Forbes had been collecting materials for a series of such collections at the University of Edinburgh. It is hoped that they may yet be made available for the purposes for which they were designed.

‡ Pan. Shells, p. 144; so also *Omphalius Californicus*, ticketed "Moreton Bay," Mus. Cum.

been added to papers from the former place; *e.g.* in *Cypræa arabicula*, (Bristol Mus.) and *Planaxis nigritella*, both of which belong to the Gulf fauna. In Mr. Reeve's account of *Hinnites giganteus*, Gray, the shell is quoted from "California and the Straits of Juan *Fernandez*," pl. 1. sp. 2.

12. The errors of one collection, or of the author, are not confined to books, but are continually repeated in public and private collections. It is important, therefore, when shells are named from the monographs, that the copied locality should be distinguished, say by marks of quotation. When the locality of the actual specimen is known on authority, this may be underlined; and, where practicable, the authority should always be added.

13. *Errors of nomenclature.*—But supposing that the original materials have been collected with perfect accuracy (and for the reasons above stated, those collections are the most reliable which have been made by competent observers on single spots or unmixed districts), a vast variety of errors will probably arise before their nomenclature is suitably established.

First, the works in which shells are described are inaccessible to ordinary students. This arises in part from their being so expensive, that even public museums are often unable to procure them; and in part from species being described in local journals or loose tracts, which either do not find their way at all into general scientific literature, or do so with such tardiness that their effect is simply to introduce the confusion of synonymy, and, by appealing to an earlier date, to upset the labours of those who would most thankfully have been spared the responsibility of description. This almost limits the satisfactory production of original works to those who have frequent access to the capital.

14. Or, supposing the books obtained, the materials are found in so ill-assorted a state, that the student's time is frittered away in finding out where to look. It is customary with some writers to describe new species from any genera or any localities, without the least regard to order. Thus every student at work on the shells of any district is obliged to wade through the "centuries" of new shells described by Philippi in the 'Zeit. f. Mal.,' for fear of overlooking an already published species. Or even when the genera are monographed, the species are generally arranged either by accident or to suit the supposed elegance of the plate; instead of either grouping them zoologically, so as to exhibit allied species side by side, or else geographically so as to bring the species from each district together. For want of some such help, whole hours, which might have been spent in advancing science, may be wasted in hunting for a single *Conus*, a *Voluta*, a *Helix*, or a *Mitra*. As a help to the determination of species, the more minute division of large genera is by no means to be opposed; the Lamarckian genera being to our present knowledge of species and animals what the Linnæan groups were in the times of Lamarck. It is greatly to be regretted that many of the divisions proposed of late years have been named in utter defiance of the principles of nomenclature which the British Association recommend, and which are generally received by the naturalists of this and other countries.

15. But supposing the materials found, it then appears that most of them are in so unsatisfactory a state that allied species cannot be discriminated. Some writers recommend short descriptions to save time; but much more time is lost in the end by the errors to which they give rise. If any one will study the synonymy of the *Calyptræidæ* in the British Museum Mazatlan Catalogue, they will be able to form some idea, though a very partial one, of the labour that has been thus entailed. The consequence is that the same name is often quoted by different writers for very different shells,

which is a much greater evil than the giving of several names to one species. Until, therefore, existing species are tabulated in such a way as to be recognizable by students, it would appear a less evil in a doubtful case to describe a fresh species, than to run a probable risk of affiliating a different shell to a species already constituted.

16. Those identifications therefore are by far the most satisfactory which are made by a comparison of types. But even here the student must exercise caution. For if any one had searched last year for the types of Broderip's *Calyptræidæ* (so obscure to the many who have not access to the plates in the 'Transactions'), he would have found not only two of those species nameless, and in imminent peril of re-description, and that too as from different localities from those recorded in the 'Proceedings'; but he might have observed the same name of Broderip given to two distinct species, neither of which was the shell figured in the 'Transactions,' which still appears under another name. On searching also for the types of shells described in the 'Proceedings,' within a few weeks after they had been communicated, the names indeed were found, but fastened to very different shells from what the author had intended. All these errors had arisen from the number-tickets with the shells referring to the catalogues having been misplaced.

17. As human life is so short, and those who have the inclination for scientific pursuits have generally so little leisure, it is a serious evil when so large a proportion of that little has to be devoted to the labour of making out the errors of predecessors. We therefore venture to suggest some points which may be worthy of the consideration of the leaders in science. First, whether the Government, which often spends large sums in the production of important and expensive works, might not spend a portion of that sum in presenting copies, or selling them at a reduced rate, to the various free museums and libraries in the country. Secondly, whether the British Association (which has already catalogued the stars), or some other public body, might not undertake the work of cataloguing the existing species in different departments of natural history*. And thirdly, whether a general registry office could be agreed upon by naturalists of all nations, which might have branch stations in the various capitals, and to which Latin copies of all descriptions of new species should be sent, by every naturalist who wished to retain the rights of priority; to be accompanied by information where the type specimen was to be found.

18. But the foundation-point of all our inquiries must be the discrimination of species themselves as they exist in nature. And here those labour under great disadvantage who can only consult the "*espèces de cabinet*," in which, for the sake of saving room, single or very few specimens are exhibited; since, in the case of variable species, it is quite easy to pick out several extreme forms which shall apparently be even more distinct than those which all allow to be separate species. Every description therefore which is founded on single or extremely few specimens must be regarded as only provisional, till their circumstances of variation are known. And he, perhaps, is doing more useful work, who has obtained materials by which a full knowledge of the variable powers of mollusks may be attained, than he who only describes a number of single independent forms. Those

* Or if this should be regarded as too great a work, the preparation of cheap digests of species like Mr. Hanley's admirable 'Recent Bivalve Shells,' and figures intermediate between those of Wood and the Monographs, are greatly to be desired. Now that Mr. Woodward's text-book is making the study of Mollusks so popular, the need for such books of species is becoming extensively felt. The publication also of cheap abstracts of expensive books, such as are given in the 'Zeit. f. Mal.,' would be of great service to students.

who would study species in a comprehensive manner might advantageously consult the canons given in Dr. W. B. Carpenter's Researches on Orbitolites, 'Trans. Roy. Soc.' 1855, pp. 226–230. It must not be expected, however, that creatures (comparatively speaking) so highly organized as mollusks, should assume such abnormal forms as the lower animals and plants. Often indeed one species will greatly vary, while another, closely allied, is constant in its characters; or differences will be found between the shells of a single species, which in another tribe would justly entitle them to generic separation. No general rules therefore can be given to guide the student. But it is required of him that he should faithfully use all the materials at his command; not being satisfied with an examination of particular forms, but carefully working through those shells especially which many would cast aside simply because they were puzzling, or were not fine specimens. Those whose work lies mainly among picked collectors' shells are recommended to study the series of fossils arranged by Prof. E. Forbes in the Museum of Practical Geology, and the large suites illustrating particular species in the British Museum Mazatlan Collection.

19. It is, however, by no means recommended that we should abstain from describing new forms, because it may afterwards be discovered that they are conspecific with others previously found. The great point is, that we should be guided in those matters that are least known by the experience gained by studying carefully ascertained species in their varied developments; and that we should not desire the maintenance of species simply because they have once been published, when further light assigns to them a subordinate place. Those writers are therefore not to be blamed who have multiplied species simply from a want of sufficient materials. Thus when C. B. Adams described as five distinct species the *Cæcum pygmæum*, *diminutum*, *monstrosum*, *eburneum*, and *firmatum*, which seem only stages in the development of the same shell, he did carefully, according to the then state of knowledge, what a naturalist of less accuracy would have passed over as one shell, simply from not having found out the differences. But when the further discovery of many hundreds of individuals proves that they are identical, a higher point of knowledge is reached, according to which all examinations in the same group may be henceforth interpreted till some yet higher generalization is attained.

20. But when species are constituted or disregarded, simply in obedience to a theory, injury is done to the progress of science. Thus a recent author on the British Fauna appears unwilling to believe in the existence of species other than what occur on the South Devon coast; and accordingly unites together many which have been constituted by the most accurate naturalists, but which, from their northern station, he had not an opportunity of studying. And on the other hand, the principal American conchologists, having assumed a theory that no species can be found in two distinct provinces unless we can see a way by which they may have moved from one to the other, forthwith proceed to describe as new everything which makes its appearance on an unexpected side of the coast. Undoubtedly it is by far the most easy way of studying a fauna merely to consult those works which apply to that fauna, and to describe as new whatever is not found therein; but we must beware lest we be forcing Nature into our own form. Now, just as we give a species already constituted the benefit of a doubt, till we be fairly able to prove its identity with another, so we may suppose shells different from opposite coasts, till we can prove them the same. But, in the language of the late Dr. Binney*, "until the question of the identity of

* Terrestrial and Air-breathing Molluscs of the United States, edited by Dr. Gould, Boston, 1851, vol. i. chap. 3.

these closely allied species has been decided by their anatomy, we believe it to be perfectly safe to adopt this axiom,—that *species, whencesoever derived, possessing the same characters, are identical.* We view this to be a more rational course than to consider them to be the *analogues* of each other; a convenient but very indefinite mode of expression, which may be used to cover every degree of similitude, from a general analogy to a close affinity hardly admitting of distinction*."

21. As far as facts already ascertained justify us in drawing any conclusions, it would appear that while the shells in each of the great provinces throughout the world are in the main remarkably distinct from each other, there are in each fauna (1) many shells which are parallel with those from other seas; (2) some which are nearly ubiquitous, and often extend far back in geological age; and (3) others which, though by no means widely diffused, reappear very unexpectedly in far-distant seas. Thus Philippi and Hanley quote shells common to the Mediterranean and Australia; Mr. Cuming finds the British *Lucina borealis* and *Nassa incrassata* at the Philippines; and even Mr. Hinds can trace no difference between a *Neæra* of the China Seas and the European *N. costellata.* As to the line of demarcation between species and varieties, that must remain in many cases a matter of individual opinion. Those who, with Prof. Adams, can speak of the different species of Man (Conch. Contr. p. 87; a view more congenial to the "peculiar institution" of the stripe-flagged United States than to the readers of Pritchard's Physical History), may be expected to constitute species of shells on characters which to others will appear of secondary importance; while those who have been in the habit of examining large multitudes of specimens will take a larger view of the probable extent of specific variation. These differences will be taken into account in comparing the works of one naturalist with another.

22. Having thus shown the grounds of caution in using the materials by which a knowledge of local faunæ is to be derived, we proceed to examine, one by one, the sources of information which have been discovered with regard to the Mollusca of the two great divisions of the West N. American fauna. The localities to which they principally refer may be arranged as follows:—

I. BOREAL FAUNA. A. *Circumpolar.* Icy Cape, lat.† 70·5°. Behring's Straits, on the Arctic circle. "Behring Sea."
  B. *Asiatic.* Sea of Okhotsk, with the Schantar Is., 55°. Kurule Is., from Japan to Kamtschatka. Petropaulovski, 52·5°. Cape Lopatka, 51°: from which the Aleutian Is. extend to
  C. *American.* Prom. Aliaska. Those most explored are, Is. Kodiak, 57°; Oonalashka, 54°; Atcha, 53°. Norfolk Sound in King George's Archipelago. Sitcha, 58°, in the parallel of the Hebrides.

II. TEMPERATE FAUNA. A. *Oregon.* (Parallel of France.) Vancouver's Is. 49°–51°, with Nootka Is. and Sound; separated on the south from the mainland (of which the extreme point is Cape Classet) by the Straits of San Juan de Fuaco, at the S. end of which is Ft. Nisqually, 47°. At the mouth of Columbia River are Townsend and Discovery Harbour, 46°. Up the river is Ft. Walla Walla. R. Willamette flows upwards into the R. Columbia, near Ft. Vancouver, 46°.
  B. *Upper California.* (Parallel of the Mediterranean.) "Colonie Russe," or Bodegas, 38°. San Francisco and R. Sacramento, 37·5°. Monterey, 36·5°. Sta Barbara, 34°. Is. Catalina, 34°‡.

* *Vide* Prof. Agassiz on the "Geographical Distribution of Animals," in the 'Christian Examiner,' Boston, March and July 1850.

† The degrees are only given approximately.

‡ Another Is. Catalina is in the Gulf.

C. Peninsula of Old or *Lower California*, 23–32°, Pacific Shores. (Parallel of the Canaries.) San Pedro, near Is. Catalina. San Diego, 33°*. Bay of Magdalena, with Is. Margarita, 24·5°. Cape St. Lucas, 23°.

III. TROPICAL FAUNA. A. *Gulf District*. (Tropic —? 32°). *a*. Californian Coast. Cape Palma†, 23·5°. La Paz, 24°. Is. and Cape San Jose, 25°‡. Loretto and Bay of San Juan, 26·5°.§ Gulf San Miguel, 29°‖. *b*. Mexican Coast. Guaymas, 28°. Lobos Is. 27°¶. Mazatlan, 23° (with the Is. Crestin, Ciervo, Permano, Venado, &c.). Is. Tres Marias, 22°. Isabella Is., between these and San Blas, 21·5°.

B. *Mexican and Central American District*. (Parallel of Senegambia.) Revillagigedos Is. 18°, not yet searched, perhaps connected with the Gulf fauna. Acapulco, 17°. Gulf Tehuantepec, 16°. Sonsonati and Guacomayo (or Guayamoco), 14°. Gulf of Fonseca or Conchagua, 14°. Realejo or Real Llejos, 13°. Gulf of Papagayo, 11°. Gulf of Nicoya, 10°, with Punta Arenas within the Gulf, and Cape Blanco at the entrance. Gulf of Dulce**, or Bay of Costa Rica, with Is. of Caña and Pueblo Nuovo, 9°. Bay of Montijo and Bay of Honda, 8°. Is. of Quibo, 7°.

C. *Panama District*. (Parallel of Liberia.) The town is in lat. 8° 49′, and in the Bay are the Is. of Taboga, Rey, Perico, San Jose, and Saboga††.

D. *Ecuador District*. Atacamas, with Cape San Francisco‡‡, 1° N. Bay of Caraccas, ·5° S. Is. Plata, 1°. Gulf of Guayaquil, with Punta St. Elena, Punta Arenas and Is. Puna, 2°. Payta, 5°.

E. *Galapagos* or Tortoise Is., on the equator in long. 90°, consisting of six large and seven small islands; those most quoted are, Charles Is., James Is., Albemarle Is., Chatham Is., and Hood's Is.§§

23. Scarcely any mention is made of W. American shells by Linnæus, Chemnitz, and the older conchologists generally. A very few handsome species from the Panama province, such as *Oliva porphyria*, &c., had found their way into European collections and books, perhaps through the pearl oyster trade; or even, it may be, introduced indirectly through East Indian commerce. But our first direct acquaintance with the shells of the Panama

* The shells of this place rank somewhat better with Lower than with Upper California, with which it is locally and politically connected. It was the first settlement on the coast, having been founded by the Jesuits in 1769. There is another San Diego in the Gulf of Tehuantepec.

† Not to be confounded with Cape Palmar, on the equator, in long. 80°; nor with Cape Palmas on the Guinea coast, where are islands (St. Thomas and St. Vincent) liable to be associated with the Antilles.

‡ There is also a San Jose between the two capes at the end of the promontory, and another in the harbour of San Francisco. An island of the same name is in the Bay of Panama.

§ Besides this station and the Straits of De Fuca, there is a San Juan on the opposite shore near Guaymas; another near San Blas; a Point on the coast near Lake Nicaragua; and a little island between Is. Catalina and San Diego.

‖ There is another San Miguel near the Bay of Fonseca, in long. 88·5°; also a port in the Bay of Panama, lat. 8° 10′; and an island outside Sta Barbara.

¶ Not to be confounded with Lobos Is., Peru.

** Another Gulf of Dulce opens out of the Bay of Honduras.

†† This is quoted by Prof. Adams as a corruption of Taboga. It is, however, marked in the charts as a very small island, N.W. of San Jose and one-third of the distance between that and Taboga. A river Chiriqui is also quoted as in the Bay of Panama. Perhaps it is near the town of the same name in Veragua. There is another Chiriqui between Greytown and Chagres.

‡‡ There is a Bay of San Francisco in Lower California on the Pacific side, in lat. 30°, and another near San Miguel within the Gulf. Also a Bar of the same name in the Gulf of Tehuantepec.

§§ Another Hood's Is. is in lat. 21° S., long. 135° W. Which of these is the "Lord Hood's Is." often quoted in Mr. Cuming's Coll., is not known. It is possible that some species belonging to the Galapagos fauna have been passed over, from their being assigned to the Polynesian station.

province is due to the French botanist, Joseph Dombey. He arrived in Peru in 1778, and brought home several shells, of which eight species are described by Lamarck*. (*C. B. Adams.*)

24. The earliest authentic collections, however, made on the Pacific shores of N. America were obtained by the celebrated Baron Humboldt and his companion M. Bonpland. In 1803 they reached Peru, whence they sailed to Acapulco. It is to be regretted that they did not themselves describe the shells they brought. They were seen, indeed, by Lamarck, who described eleven species from them; but the detailed account was entrusted to M. Valenciennes, and was not published till 1833, the descriptions having been written in Nov. 1831†. In vol. ii. of "Recueil d'Observations de Zoologie et d'Anatomie Comparée, faites dans l'Océan Atlantique, dans l'Intérieur du Nouveau Continent, et dans la Mer du Sud pendant les années 1799–1803,

* An important aid in the understanding of the Lamarckian species was given by M. Delessert, who published a magnificent volume of plates entitled "Recueil de Coquilles décrites par Lamarck dans son Hist. Nat. des An. s. Vert. et non encore figurées. Paris, 1841." A copy may be seen in the library of the Linn. Soc., and a list of species is given by Menke in his 'Zeit. f. Mal.' June 1844, pp. 83–95.

† The following Table may aid the student in deciding questions of priority: the lists being given in the approximate order of collection; the order of publication being very different.

Precedence of Publication.	Date of Expedition.	Date of Publication.	Vessels.	Collectors.	Northern District.	California.	Mexico and C. America.	Panama and S. America.
1	1778	Lam. A.s.V.	...	Dombey				—
2 9	1803	Do. Voy. 1833	...	Humboldt and Bonpland..			—	—
3	1822–1825	1826–1830	Coquille	Lesson				—
5	1823–1826	1829–1833	...	Eschscholtz	—			
4 11	1825–28	1829 Z. J. 1839 Voy.	Blossom	Beechey and Belcher	—	—	—	—
12	1826–1836	1839	Adventure and Beagle	Capts. King and Darwin				Gal.
18	1826–1833	1847	...	D'Orbigny				—
8	1827–1830	1832–56	...	Cuming				—
6 7	....	1832 Blainv. 1833 Duclos	...	Botta			—	—
10	1834–1835	1836, 37	...	Nuttall	—	—		
21	1836–1837	1847–51	Bonite	Eydoux and Souleyet				—
13 16	1836–39	Desh. 1839–40 Voy. 1846	Venus	DuPetitThouars, Chiron, La Perouse	—	—	—	—
14	1836–1842	Z. P. 1843 Voy. 1844	Sulphur	Belcher and Hinds	—	—	—	—
17	1839–1842	1846–	U. S. Expl. Exp.	Wilkes, Couthouy	—	—		—
20	1843–1844	1847–51	...	Middendorff	—	—		
15	....	1846	....	(Philippi)			—	
25	1846–1848	1851–56	Mexic. war	Jewett, Green, and Rich...		—	—	—
19	....	1847	...	Melchers			—	
24	1848–1849	1850–51	...	Melchers			—	
23	....	1850	Pandora	Kellett and Wood		—	—	—
30	1848–1850	1856	...	Reigen			—	
22	....	1850	...	Wilson			—	—
26	1850	1852	...	C. B. Adams				—
29	1854	1856	...	(Sailor)			—	
27	....	1855	...	Blake and Webb	—	—		
28	1856	1856	...	Bridges				—

par Al. de Humboldt et A. Bonpland; Paris, 1833," will be found the "Mollusques, décrites par A. Valenciennes," pp. 217–339. Several of the shells are from the East Indies; and of those assigned to Acapulco, many appear to have crossed the Pacific by the agency of man. The list of Acapulco shells, however, as it appears, is as follows:—

Page.	Plate.	Fig.	
222	48	2*a*,*b*.	*Tellina petalum*, Val. Acapulco. Almost exactly like *T. solidula*.
221	50	3*a*,*b*,*c*, 4.	*Donax radiata*, Val. Pacific shores of equatorial America. This appears to be either *D. punctatostriatus*, Hanl. *var.*, or *D. Conradi*, Desh., probably the latter; but the description is not sufficiently accurate to claim priority.
219	48	1*a*,*b*,*c*.	*Venus succincta*, Val. Acapulco. Probably = *Anomalocardia subimbricata*, Sow. or *V. neglecta*, Gray.
236	50	2.	*Anodonta glauca*, Val. Acapulco. Appears exactly to accord with *Anodon ciconia*, Gould, except that it is said to be white within. Perhaps described from a single specimen.
245	55	1*a*, *b*.	*Bulimus undatus*, Lam. Mexico. =*Orthalicus zebra*, Müll.
247	56	1*a*, *b*.	*Bulimus Mexicanus*, Lam. Mexico. The shell described in B. M. Maz. Cat. p. 177. no. 234, may be the young of this species.
267	...	...	*Haliotis Californiana*, Val. California.
273	...	...	*Turbo pellis-serpentis*, [quasi] Val. Acapulco. =*Tegula p.*, Mawe.
263	...	...	*Nerita textilis*, Linn., Lam. Acapulco.
264	...	...	*Nerita papilionacea*, Val. Acapulco. Differs from the last in having fewer ribs, and granulations on the lip. Lat. ·83.
275	...	...	*Turritella gonostoma*, Val. Acapulco, [Jun.].
276	...	...	*Turritella leucostoma*, Val. Acapulco.
277	...	...	*Cerithium musica*, Val. Acapulco. Described from one sp. long. 1·25: said to resemble *C. literatum*, Brug. (not Born and Gualt.).
278	...	...	*Cerithium granosum*, Val. Acapulco. Probably a *Cerithidea*.
278	...	...	*Cerithium stercus-muscarum*, Val.* Acapulco.
279	...	...	*Cerithium fragaria*, Val.* "One sp. fished at Acapulco," plaited like *Fasciolaria*, resembles *C. lima*, long. 1· +. Comp. *Vertagus gemmatus*, Hds. jun.
282	...	...	*Cerithium varicosum*, [quasi] Val. Probably *Cerithidea varicosa*, Sow.†
252	56	2*a*, *b*.	*Paludina carinata*, Val. "Mexico:" on which side of the mountains is not stated.
271	...	...	*Tectarius coronatus*, Val. Acapulco.
334	...	...	*Cypræa radians*, Lam. Acapulco.
334	...	...	*Cypræa arabicula*, Lam. Acapulco.
334	...	...	*Cypræa Lamarckii*, Ducl. Acapulco.
307	...	...	*Strombus troglodytes*, Lam. Acapulco.
308	57	4*a*, *b*.	*Strombus cancellatus*, Lam. Acapulco.
336	...	...	*Conus regius*, Brug. & Lam. Acapulco. =*C. princeps*, Linn.
336	...	...	*Conus lineolatus*, Val. Acapulco. Like the last.
337	...	...	*Conus cinctus*, Val. Acapulco. Like *C. hyæna*.
338	...	...	*Conus scalaris*, Val. Acapulco. The recent analogue of *C. deperditus*, Lam.
269	...	...	*Solarium granulatum*, Lam. Acapulco.
269	...	...	*Solarium granosum*, Val. Acapulco. "The living analogue of the Italian fossil, *S. millegranum*."
270	...	...	*Solarium bicanaliculatum*. Val. Acapulco.
265	57	3*a*, *b*.	*Natica Bonplandi*, Val. Acapulco. =*N. patula*, Sow. teste Val.; but probably a distinct species, as it is described "callo subdiviso."

* These species are not noticed by Sow. jun. in his recent Monograph. His "*C. granosum*, Kien." is an Australian species, like *C. corallium*; and his "*C. musicum*, nob." is like *C. vulgatum*, but from the Cape de Verd Islands.

† *C. Humboldti*, Val. = *C. Pacificum*, Sow. teste Jay.

Page.	Plate.	Fig.	
332	...	...	*Mitra babea,* Val. Acapulco. Resembles *M. Vulpecula,* &c.
286	...	...	*Fasciolaria canaliculata,* Val. Acapulco. Resembles *F. tulipa.* Long. 2·33.
286	...	...	*Fasciolaria rugosa,* Val. Acapulco. Long. ·42. Probably a young *Latyrus.*
283	...	...	*Turbinella ardeola,* Val. Acapulco. =*T. cæstus,* Brod. According to Val. the *Leucozonia* (*Monoceros*) *cingulata* was not brought by Bonpland, as Lam. supposed.
334	...	...	*Oliva testacea,* Lam. Acapulco.
334	...	...	*Oliva volutella,* Lam. Acapulco.
334	...	...	*Oliva zonalis,* Lam. Acapulco.
310	...	...	*Cassis centiquadrata,* Val. Acapulco.
311	...	...	*Cassis doliata,* Val. Acapulco.
312	...	...	*Cassis testiculus,* Linn. Acapulco. (W. Indian.)
313	...	...	*Cassis coarctata,* Wood. "West shores of South America, near Acapulco." In p. 338, the author again refers to Acapulco as in South America. [=*Levenia c.*, Gray.]
323	...	...	*Harpa scriba,* Val. Acapulco.
325	...	...	*Malea* latilabris,* Val. Acapulco. "=*Buccinum ringens,* Wood."
327	...	...	*Malea crassilabris,* Val. Acapulco. Described from a single sp., and probably a var. of *Malea ringens.*
328	...	...	*Buccinum leiocheilos,* Val. Acapulco.
329	...	...	*Columbella,* allied to *rustica.* Acapulco. Doubtless *C. fuscata,* Sow.
330	...	...	*Columbella strombiformis,* Lam. Acapulco.
331	...	...	*Columbella gibbosa,* Val. Acapulco. "= *C. strombiformis,* pars, Sow. Gen. f. 1." Appears to be a variety of the last, and not *C. major,* as it is described with a yellow border to the aperture, and white spots on the back.
331	...	...	*Columbella costata,* Val. Acapulco. Possibly = *Anachis coronata,* Sow.
314	...	...	*Purpura patula,* Linn. Three individuals were labelled "South Sea" by Bonpland! Val. confesses that no difference can be traced between these and the W. Indian shells.
315	...	...	*Purpura undata,* Lam. Acapulco. =*P. biserialis,* Blainv. Val. says that he has compared this shell with the Lamarckian type, but confesses that his description (according to him, by a *lapsus calami*) does not agree. Kiener figures the *P. undata,* Lam. for a different W. Indian shell, and is probably right.
316	...	...	*Purpura speciosa,* Val. Acapulco. =*P. centiquadra,* Val. MS. = *P. triserialis,* Blainv.
316	...	...	*Purpura canaliculata,* Val. Acapulco. Long. ·66.
317	...	...	*Purpura semi-imbricata,* Lam. Acapulco.
318	...	...	*Purpura* (*Monoceros*) *crassilabrum,* Lam. Acapulco.
287	...	...	*Fusus turris,* Val. Acapulco. Like *F. colus.* Long. 6·.
288	...	...	*Fusus cancellatus,* Val. Acapulco. Like *Trophon fenestratus.* Long. 1·42.
290	...	...	*Fusus Magellanicus,* Gmel., Lam. (*Trophon*). "= *T. fimbriatum,* Mart. S. America and Acapulco." [?]
291	...	...	*Pyrula patula,* Brod. Acapulco.
292	...	...	*Pyrula vespertilio,* Gmel. (*Murex*). =*P. carnaria,* Enc. Acapulco.
294	...	...	*Pyrula* (*Ficula*) *reticulata,* Lam. "S. America."
295	...	...	*Pyrula* (*Ficula*) *ficoides,* Lam. "With the preceding at Acapulco."
296	...	...	*Pyrula spirata,* Lam. Acapulco (Bonpland).
304	...	...	*Tritonium hæmastoma,* Val. Acapulco. Very like *pileare,* Linn.
305	...	...	*Tritonium macrodon,* Val. Acapulco. Like the last.
306	...	...	*Tritonium decussatum,* Val. Acapulco. Like *Distortio anus.*
297	...	...	*Ranella crumenoides,* Blainv. "=*R. crumena,* Brod. Zool. Journ. Suppl. pl. 11. fig. 2."

* Although this genus is properly defined in Latin, Messrs. H. and A. Adams (Gen. vol. i. p. 196) lay it aside in order to introduce an unknown name, *Cadium,* previously given by Link.

Page.	Plate.	Fig.	
298	...	...	*Ranella granifera,* Lam. Acapulco.
299	...	...	*Murex radix,* Gmel. Acapulco.
300	...	...	*Murex tricolor,* Val. = *M. regius,* Swains. (*rectè*).
301	...	...	*Murex bicolor,* Val. = *M. regius,* Schub. & Wagn. (*malè*). "With the last at Acapulco."
302	...	...	*Murex erinaceoides,* Val. Acapulco.

This list, being the largest known from Acapulco, would have been extremely valuable, could it have been depended on for accuracy. But (1) the presence of several well-known E. Indian and other foreign shells (supposed by Prof. Adams to have been obtained from the inhabitants, the relics of former trade with the Philippines) endangers the authenticity of others, unless there be further confirmation. And (2) the description of the species, although set forth with not a little display, is performed in so loose a manner, that it is impossible to speak of them with confidence without an inspection of the types. It will be seen that the author adopts a course, too common among French naturalists, of changing the specific when he alters the generic name, appending his own authority for the species; and that when two authors have used the same name for a shell, instead of preserving the right and re-naming the wrong, he has given his own names to both species.

25. In the "Voyage autour du Monde sur la Coquille, pendant les années 1822–5, par L. I. Duperrey, Paris, 1826" (plates only), the following are the only two species connected with this province:—

"Moll. pl. 11. f. 1, 1′, *Natica glauca,* Humb. Peru:" = *N. patula,* Sow.

"Moll. pl. 15. f. 2, 2 A, *Calyptræa Adolphei,* Less.," has the animal represented in the reversed position: = *Crepidula dilatata,* Lam.

From the text (not seen) are quoted, among others—

P. 421. No. 198 (1830), *Patella scurra,* Less.
P. 419, *Patella clypeaster,* Less.

26. The earliest known collector on the North-west shores of America was the justly celebrated Dr. Johann Friedr. Eschscholtz, Professor and Director of the Zoological Museums in the University of Dorpat. He accompanied an expedition in the Russian ship Predpriaetiё, commanded by Capt. Kotzebue, during the years 1823–6, which, after sailing round Cape Horn, and visiting the Bay of Conception in Chili, proceeded by the Sandwich Islands to Kamtschatka, reaching Petropaulovski June 22, 1824. Thence they proceeded along the north-west coast of America to Sitcha, and in October and November to San Francisco and the Rio Sacramento. In the following year they again sailed by the Sandwich Islands to Norfolk Sound, Sitcha; thence to Manilla; and returned *viâ* St. Helena. During this time Eschscholtz collected 2400 species belonging to all divisions of the animal kingdom; including 10 sp. of Cephalopoda, 172 Gasteropoda, 45 Lamellibranchiata, and 28 Tunicata*. The description of the new species was commenced by Eschscholtz in the "Zoologischer Atlas, enthaltend Abbildungen und Beschreibungen neuer Thierarten, Berlin, May 1829;" but he died of nervous fever, May 7, 1831, at the early age of 37 years. The work was brought to a conclusion in the year 1833 (from the author's MSS.) by Dr. Martin Heinrich Rathke, who appears to have succeeded him in the chair at Dorpat†. The following is the brief list of the species bearing on

* The plants collected during the expedition appear to have been described by Eschscholtz immediately after his return, in the Mémoires de l'Acad. de St. Pétersbourg, vol. x. p. 281–292 (1826), "Descriptiones plantarum novæ Californiæ, adjectis florum exoticorum analysibus."

† An analysis of the Mollusca in this work is given by Menke in the Zeit. f. Mal. May 1844, pp. 70–76.

our present inquiry. The descriptions are in Latin, the localities accurately recorded, and the work illustrated with plates which are tolerably characteristic.

Part.	Page.	Plate.	Fig.	
2	10	9	1.	*Murex monodon*, Esch. Sitcha. = *M. foliatus*, Gmel. teste Rve. =*M. tripterus*, Lam. teste Sow.=*M. alata*, Chemn. teste Sow.
2	10	9	2.	*Murex ferrugineus*, Esch. Sitcha. = *M. lactuca*, var. (Midd.).
2	11	9	3.	*Murex lactuca*, Esch. Sitcha.
2	11	9	4.	*Murex multicostatus*, Esch. Sitcha. =*Trophon clathratus*, Linn. teste Midd.
3	16	15	1.	*Pleuropus pellucidus*, Esch. South Sea (Pacific), near Equator.
3	17	15	5.	*Creseis cornucopiæ*, Esch. South Sea, near the "niedern Inseln."
3	18	15	6.	*Creseis caligula*, Esch. South Sea, near Equator.
4	14	19	1.	*Eolidia pinnata*, Esch. Sitcha.
4	15	19	2.	*Cavolina crassicornis*, Esch. Sitcha.
4	15	19	3.	*Cavolina subrosacea*, Esch. Sitcha, on Fuci.
4	16	19	4.	*Glaucus Pacificus*, Esch. Intertropical Pacific.
4	16	19	5.	*Glaucus draco*, Esch. Equatorial Pacific.
4	17	19	6.	*Phylliroë Lichtensteinii*, Esch. Pacific, west of Sandwich Islands.
5	16			*Acmæa.* Animal and shell described.
5	18	23	4.	*Acmæa mitra*, Esch. = *Patella scurra*, Less. = *Scurria mitra*, Gray, Gen. = ? *Lottia pallida*, Gray, Zool. Beech. Voy. Sitcha. This shell is very abundant on the coasts of Chili (*Cuming*), and is also common near Monterey (*Nuttall*), but is not found in tropical America.
5	18	...	...	*Acmæa mammillata*, Esch. Sitcha. = *Scurria mitra*, var. teste Phil., Midd.
5	19	...	...	*Acmæa marmorea*, Esch. Sitcha. =*Scurria mitra*, var. teste Midd.
5	19	24	3.	*Acmæa cassis*, Esch. Sitcha. The northern analogue of *P. deaurata*, Gmel., from the Magellan Straits. Probably = *P. exarata*, (Nutt. MS.) Rve. Conch. Ic. pl. 19. sp. 47 : var. pl. 24. f. 62 *a*, *b*. Oregon, *Lieut. Baskerville*. ? =*P. Mazatlandica*, Gray.
5	19	...	...	*Acmæa pelta*, Esch. Sitcha. = *P. leucophæa*, (Nutt. MS.) Rve. Conch. Ic. 34. 101.+*P. monticola*, Nutt. MS. (= *P. monticolor*, Jay, Cat. 2844)+*P. strigillata*, (Nutt. MS.) Jay, Cat. 2881.
5	19	23	1–3.	*Acmæa scutum*, Esch. Sitcha. (Chili, Bolivia, Peru, *D'Orb.*), = *A. patina*, var. teste Phil., Midd.
5	19	24	7, 8.	*Acmæa patina*, Esch. Sitcha. =*P. mammillata* (Nutt. MS. non Esch.), Rve. Conch. Ic. 42. 140. + *P. tessellata*, (Nutt. MS.) Jay's Cat. 2885.+*P. fenestrata*, (Nutt. MS.) Rve. C. I. 38. 121. +*P. verriculata*, Rve. C. I. 31. 87. California.+*P. cinis*, Rve. C. I. 24. 60. Monterey, *Hartweg*. ?+*P. Nuttalliana*, Rve. C. I. 30. 81. Oregon. +*P. Cumingii*, Rve. C. I. 16. 37. Valparaiso, *Cuming*, teste *Rve.*: "never took it," *Cuming*, teste seipso. Monterey, *Hartweg*, teste Mus. Cuming. ?+ *P. diaphana* (Nutt. MS.) Jay, Cat. 28. 3, non Rve.+*Lottia pintadina*, pars, Gould, Exp. Sp. p. 9 : v. B.M. Maz. Cat. p. 207. no. 265.*

* The above extensive citation of synonyms is the result of (1) the study of Eschscholtz's diagnoses:—(2) The judgment of them by Philippi, after seeing the types, as recorded in *Zeit. f. Mal.* 1846, p. 106–8 :—(3) The fully recorded judgment of Middendorff in the *Mal. Ross.* and *Sib. Reise, in locis* :—(4) The careful and repeated examination of Mr. Nuttall's shells, (*a*) in his own collection, aided by his recollection, and with the full concurrence of his judgment; (*b*) in Dr. Jay's catalogue; (*c*) in Mr. Cuming's collection, as received from Nuttall, through Jay, and figured by Reeve :—(5) The comparison with these of Dr. Gould's specimens, collected on the same coast by the officers of the United States' Exploring Expedition and of the Mexican war :—(6) The examination of the types of Mr. Reeve's species in the Cumingian collection :—(7) The interpretation of all the above by the experience derived from the repeated and most careful examination of many thousand (at least 15,000) Limpets in the Mazatlan collection. It is offered as an approximation to the truth. It is a subject of great

Part.	Page.	Plate.	Fig.	
5	20	...	...	*Acmæa radiata*, Esch. Sitcha. =*A. persona*, jun. teste Midd., non Phil.
5	20	24	1, 2	*Acmæa persona*, Esch. Sitcha. = *P. Oregona*, (Nutt. MS.) Rve. Conch. Ic. pl. 36. sp. 112. + *P. umbonata*, (Nutt. MS.) Rve. C. I. 35. 107. + *P. pileata*, (Nutt. MS.) Jay, Cat. 2861. ?= *Lottia punctata*, Gray: teste Midd. (non Quoy & Gaim.)
5	20	24	4, 6	*Acmæa ancylus*, Esch. Sitcha. = *A. persona*, teste Midd., non Phil.*
5	20	23	7, 8	*Acmæa digitalis*, Esch.†
5	21	23	5	*Fissurella aspera*, Esch. Sitcha. ?= *F. densiclathrata*, Reeve.

Besides these, Philippi in Zeit. f. Mal. 1847, p. 113, describes *Modiola Californiensis*, Esch. from a specimen brought by Eschscholtz, and by an accident inscribed by him *Pholas Californiensis* in the Dorpat Museum. It is intermediate between *Lithophagus dactylus*, &c., and *L. cinnamomeus*.

27. The "Catalogue of the Shells contained in the Collection of the late Earl of Tankerville, with Appendix containing descriptions of many new species, by G. B. Sowerby, Lond. 1825," is a very interesting document, both as showing how few shells from the West N. American coast were then known, and also how early some of the most remarkable, as *Crepidula adunca*, *Lucapina crenulata*, and others, had found their way to this country. The following shells belong to our present subject of inquiry; those having page-references being properly described in the appendix.

Page.	No.	
iv.	226.	*Donax transversus.*
ii.	116.	*Mactra elegans* (figured).
,,	208.	*Lucina punctata.*
,,	284.	*Cytherea aurantia* (South Seas).
vi.	796.	*Fissurella crenulata.*
,,	808.	*Siphonaria gigas* (Panama).
,,	814.	*Calyptræa extinctorium* [non Lam.].
,,	815.	*Calyptræa spinosa.*
vii.	828.	*Crepidula adunca.*
,,	1213.	*Haliotis Cracherodii.*
,,	1214.	*Haliotis Californiensis*, and others.
xiii.	1418.	*Planaxis planicostatus* (Galapagos).
,,	1401.	*Turbo bicarinatus* (figured).
xvi.	1553.	*Fasciolaria princeps.*
,,	1672.	*Murex brassica.*
xix.	1703.	*Murex monodon*, Mart. iii. pl. 105. f. 980, 987.
,,	1673.	*Murex regius.*
,,	1675.	*Murex radix.*
xvi.	1614.	*Pyrula ventricosa.* "We believe it to be an extremely rare species, as we have never met with another specimen." Mart. iii. pl. 66. f. 733.
xvi.	1786.	*Strombus granulatus.*
xx.	1792.	*Strombus gracilior.*
xxi.	1826.	*Cassis coarctata.* "We believe it to be a New Zealand shell."
xxi.	1824.	*Cassis ringens.* "Forms a good genus, nearer in natural affinity to *Dolium*, to which *D. pomum* also should be referred."
,,	1843.	*Purpura columellaris.*
,,	1844.	*Purpura bicostalis.*
,,	1888.	*Monoceros cymatum.*
,,	2002.	*Columbella strombiformis.*
,,	2253.	*Cypræa pustulata.*
,,	2263.	*Cypræa radians.*
,,	2290.	*Oliva porphyria.*
,,	2295.	*Oliva angulata.*
xxiii.	1984.	*Terebra strigata.* "It is extremely rare, only a few specimens having been brought from the Panama."

regret that Mr. Reeve, in describing the Limpets of the West N. American coast, did not avail himself of the previous labours of Eschscholtz, Middendorff and Menke in the same direction. If an author professes that he cannot understand the labours of his predecessors, he is not bound to add to them; but if he builds on their foundation, without making that foundation his own, he cannot expect the stability of his edifice.

* Philippi regards *A. radiata*+*ancylus* as forming quite a distinct species from *A. persona*. He thinks that the locality-tickets have become misplaced, and that it is really from Chili. He affiliates, from type, *A. punctata*, D'Orb., which does not appear in the B.M. Cat., and was not seen in his collection. There is no reason why the species should not reappear on the Chili coast, as *A. patina* and *S. mitra* seem to do. Middendorff confirms the northern localities.

† Judging from the figures and descriptions of this shell, I should have regarded it as the

28. The next expedition furnishing results belonging to our present subject of inquiry was the "Voyage to the Pacific and Behring's Straits, performed in H.M.S. Blossom, under the command of Capt. F. W. Beechey, R.N., F.R.S. &c., in the years 1825–28." Capt. Beechey was principally assisted in the collection of Mollusca by Lieut. Belcher. Unfortunately it was not at that time thought necessary to mark the locality of specimens; and for a large proportion we have to depend on general notes or the memory of the collectors. Of several very interesting species, however, the locality was carefully preserved. A series of specimens having been presented to the Zoological Society, the new species were described at the request of the Society by Messrs. Broderip and Sowerby in the Zoological Journal, vol. iv. 1829, pp. 359–379, with Latin diagnoses and a plate. As this list is valuable, both from its not being mixed with other collections and from the known accuracy of the writers, it is here presented entire.

Page.			Page.	Pl.	Fig.
359.	*Nucula arctica*; a few sp. in Vatcha Bay, Kamtschatka. Pl. 9. f. 1.				
360.	*Mactra pallida*, San Blas.				
,,	*Mactra subglobosa*.				
361.	*Corbula rostrata*.				
,,	*Corbula gibbosa*; 1 sp. Icy Cape.				
,,	*Solen acutidens*, Chinese Sea (Loo Choo)	Z.B.V.	153	43	2
,,	*Solen tenuis*, Northern Ocean.				
362.	*Solen altus*, Northern Ocean.				
,,	*Tellina Burneti*, Mazatlan. Pl. 9. f. 2.				
363.	*Tellina edentula*, Behring's Straits	,,	154	41, 44	5, 7
,,	*Tellina alternidentata*, Icy Cape	,,	153	44	5
,,	*Tellina inconspicua*, Icy Cape. 2 sp. = *T. Grœnlandica*, Beck, MS.	,,	153	41	6
,,	*Tellinides purpureus*, Pacific. (Real Llejos, *Cuming*.)	,,	153	42	2
364.	*Cytherea rosea*, San Blas	,,	151	43	7
,,	*Venus gnidia*, San Blas	,,	151	41	3
,,	*Cyrena Mexicana*, Mazatlan. "In Mr. Sowerby's Coll." The type appears to have been lost.				
365.	*Astarte crassidens*, Icy Cape. 1 sp.				
,,	*Astarte lactea*, Icy Cape	,,	152	44	12
,,	*Arca grandis*.				
,,	*Arca gradata*, Mazatlan	,,	152	43	1
366.	*Cardium Belcheri*; 3 sp. taken north of Isabella Is. in the entrance of the Gulf of California, 15 fm. Pl. 9. f. 3.				
,,	*Cardium radula* (resembling *C. muricatum*).				
,,	*Cardium punctulatum*. 1 sp.				
367.	*Cardium Dionæum*, Is. in S. Pacific	,,	152	42	6
,,	*Cardium graniferum*, Mazatlan: 6 inches in mud.				
,,	*Cardium biangulatum*	,,	152	42	5
368.	*Cardium boreale*, Icy Cape.				
,,	*Chiton albolineatus*, Mazatlan	,,	149	40	4
,,	*Chiton Loochooanus*, Loo Choo.				
,,	*Chiton vestitus*, Arctic Ocean	,,	150	41	14
369.	*Vermetus pellucidus*. Probably the young of *V. eburneus*, Rve.				
,,	*Patella Mexicana*, Mazatlan. Long. 9 in.				
,,	*Dentalium semipolitum*. (Like *D. nebulosum*.)				
,,	*Bulla calyculata*, Pitcairn's Island.				
370.	*Crepidula incurvata*, Kamtschatka.				
,,	*Fissurella hians*, Valparaiso.				
,,	*Emarginula crenulata*.				

young of *A. persona*, which is sometimes deeply ribbed, sometimes nearly smooth. Both Philippi and Middendorff, however, regard it as a well-distinguished species.

Page.			Page.	Pl.	Fig.
370.	*Littorina squalida*, Northern Ocean. Resembles *L. littoreus*.				
371.	*Margarita umbilicalis*, Northern Ocean.				
,,	*Margarita striata*, Northern Ocean	Z.B.V.	143	34	11
,,	*Sigaretus coriaceus*, Northern Ocean: Cape Lisbon Bay.				
,,	*Neritina alata*, Taheite.				
372.	*Natica pallida*, Icy Cape............................	,,	136	34	15
,,	*Natica otis*, Mazatlan. Comp. *N. Galapagosa*.........	,,	136	{34 / 37	13 / 3
,,	*Natica clausa*, North Sea, *Sabine*....................	,,	136	{34 / 37	3 / 6
,,	*Mitra crassidens*.				
373.	*Harpa gracilis*.				
374.	*Trichotropis bicarinata*, 10–15 fms. Between Cape Lisbon Bay and Icy Cape. Pl. 9. f. 4–8.				
375.	*Trichotropis borealis*, Melville Is.: 1 sp. *Lieut. Belcher*, Icy Cape.				
,,	*Buccinum boreale*, Kamtschatka.				
376.	*Columbella costellata*. "Panama and Coast of Africa," *Gray*.	,,	129	36	9
,,	*Nassa luteostoma* = *N. Xanthostoma*, Gray	,,	127	36	3
,,	*Ricinula elegans*. (Very like *R. arachnoidea*.)				
,,	*Ranella nana*.				
377.	*Murex ducalis*, near Mazatlan. = *M. brassica*, Lam.	,,	108	33	1
,,	*Pyrula patula*, Pacific (= *T. melongena*, var. n. 1611, Tank. Cat. 62.)	,,	115	{34 / 35	10 / 1,3
378.	*Fusus lapillus*, Pacific. = *Buccinum subrostratum*, Gray, Wood Suppl. = *Pyrula s.*, Gray, Z. B. V............	,,	115	36	15
,,	*Fusus pallidus*, Mazatlan. "A *Fusus* from the Calcaire grossière near Paris presents no observable marks of difference."...................................	,,	117	36	14
,,	*Pleurotoma tuberculifera*, North of Isabella Is., entrance of Gulf of California.				
379.	*Conus arcuatus*, near Mazatlan. ? = *C. regularis*, var.....	,,	119	36	22
,,	*Conus interruptus*, near Mazatlan. Resembles *C. purpurascens*....................................	,,	119	33	2
,,	*Oliva gracilis*......................................	,,	130	36	21

In a continuation of this paper (Zool. Journ. vol. v. pp. 46–51) are found the following species:—

Page.			Page.	Pl.	Fig.
46.	*Chelyosoma MacLeayanum*. Arctic Seas, on stones. New genus (*Tunicata*), described.				
48.	*Cytherea planulata*. Near Mazatlan	Z.B.V.	151	43	6
49.	*Venus decorata*. Hab.? Mus. Sow. Brought home in the 'Blossom.' Pl. Suppl. 40. f. 3.				

The duty of describing the Mollusca of the 'Blossom' was undertaken by Mr. (now Dr.) J. E. Gray, who considered it a suitable occasion not only for introducing descriptions of Mollusca collected in the Pacific Ocean about the same time by Capt. Lord Byron, Mr. Fryer, and the Rev. — Hennah, and presented by them to the British Museum; but also for giving a complete account (so far as materials then served) of the animals of the various genera. This course delayed the completion of the work for nine years; and it was at last only by entrusting the revisal and completion of the MS. to Mr. Sowerby, that Capt. Beechey was enabled to publish the work in July, 1839. For the reasons above stated, the "Zoology of Captain Beechey's Voyage: Molluscous Animals and their Shells, by J. E. Gray, F.R.S. &c., London 1839," is more valuable as a contribution to general conchological and malacological knowledge than to the furtherance of geographical studies.

The following is a list of the additional species described, so far as they may be supposed to belong to the West N. American province; the references to the species already described by *Brod.* and *Sow.* being appended to the former list. The diagnoses are in English; the plates beautiful and accurate, sometimes, however, too highly coloured.

Page.	Plate.	Fig.	
108	33	4,6.	*Murex vitulinus* [? non Lam.] = *Vitularia salebrosa*, King, Zool. Journ. v. 347.
109	...	...	*Murex acanthopterus*, "Lam. 165 = *M. monodon*, Esch. = *M. phyllopterus*, Sow. Gen. non Lam. = *M. foliatus*, Wood = *M. purpura alata*, Chemn. Pacific, N. Zealand, &c. [!] + *M. trigonularis*, Cab. Lam. (filed down)."
109	...	...	*Murex monodon*, Sow. Tank. Cat. no. 1703.
109	...	...	*Murex regius*, Panama.
109	...	...	*Murex radix*, Panama.
109	...	...	*Murex radix*, "wide-variced var. further north." = *M. nigritus*, Phil. + *M. ambiguus*, Rve.
108, 109	33	1.	*Murex brassica*, Lam. "Further north still."
110	...	...	*Tritonium Chemnitzii*. " = *Murex argus*, var. Chemn."
112	...	...	*Pollia hæmastoma*. = *Pisania sanguinolenta*, Ducl.
113	...	...	*Turbinella rigida*, Gray in Wood Suppl.
114	...	...	*Turbinella castanea*, Pacific.
114	...	...	*Turbinella cerata*, Gray in Wood Suppl.
117	...	...	*Fusus angulatus*, North Sea.
117	...	...	*Fusus Sabini*, North Sea.
117	...	...	*Fusus ventricosus*.
117	...	...	*Fusus glacialis*, Arctic Ocean.
117	...	...	*Fusus fornicatus*, Gmel., Icy Cape.
118	36	13.	*Fusus lamellosus*, Icy Cape.
118	...	...	*Fusus multicostatus*, Esch. Northern Ocean.
119	...	...	*Conus Ximenes*, Panama.
122	34	5.	*Harpa rosea crenata*. = *H. crenata*, Swains., Pacific.
124	...	...	*Monoceros grande*, Pacific.
124	...	...	*Monoceros punctatum*, Pacific.
124	...	...	*Monoceros lugubre*, Sow. Gen. f. 3. = *M. cymatum*, (Soland.) Sow. Tank. Cat. = *Buccinum denticulatum*, + *B. amatum*, Wood Suppl. Pacific. (California, on rocks, teste Reeve.)
125	...	...	*Monoceros maculatum* = *Buccinum brevidentatum*, Gray in Wood Suppl. = *Purpura cornigera*, Blainv. Pacific. [Mr. Gray assigns no reason for changing his own previous name.]
127	36	6.	*Buccinum angulosum*, Icy Cape.
128	...	...	*Buccinum polaris*, Icy Cape.
128	36	19.	*Buccinum tenue*, Icy Cape.
129	...	...	*Columbella cribraria*, Lam. = *C. mitriformis*, Brod. and King.
131	36	25.	*Oliva zonalis*, Lam.
131	36	23, 27.	*Oliva undatella*, Lam.
131	...	...	*Oliva lineolata*, Gray. = *Voluta Dama*, Wood Suppl. 4; 37. ? Peru.
131	...	...	*Oliva volutella*, Lam.
132	...	...	*Aragonia hiatula*, [Gray, not] Lam. = *Oliva testacea*, Lam. S. Amer.
136	37	2.	*Natica borealis*, North Sea, *Sabine*.
136	37	4.	*Natica suturalis*, North Sea, *Sabine* and *Beechey*.
139	...	...	*Littorina fasciata*, ? Pacific.
143*	34	14.	*Trochiscus Norrisii*, Sow., Mag. Nat. Hist. 2nd series.
147	39	1.	? *Lottia pallida*, Pacific. = *Acmæa mitra*, Esch.†

* From this page to the end, the work is edited by Mr. G. B. Sowerby, principally from Mr. Gray's MS.

† As Mr. Gray quoted the Zool. Atl. in the earlier part of this work, it is remarkable that he did not adopt Eschscholtz's genus *Acmæa*, instead of *Lottia*, which, with others in the same work, appear only one step removed from the nonsense names of Adanson.

Page.	Plate.	Fig.	
148	39	12.	*Patella Mazatlandica,* Mazatlan. This species did not occur among the myriads of limpets lately sent from the same place. It closely resembles *Acmæa cassis,* Esch., and may really have come from the North.
150	41	15.	*Chiton tunicatus,* Wood. Sitcha (teste Reeve).
150	41	16.	*Chiton articulatus,* Sow. Proc. Zool. Soc. 1832. San Blas, under stones.
150	41	17.	*Chiton setosus,* Sow. P. Z. S. 1832. Guacomayo.
150	43	9.	*Chama echinata,* Brod. Trans. Zool. Soc. vol. i. p. 306. pl. 39. f. 5–7. The specimen figured in these books, and in Chén. Conch. Ill., as a very old individual of *Ch. echinata,* is proved by the series in the B.M. Mazatlan Coll. to be a comparatively young shell of *Chama frondosa,* var. *Mexicana.* V. Cat. p. 87. no. 121.
151	41	8.	*Venus neglecta.* Central America, in sandy mud.
151	43	5.	*Venus biradiata.* Found abundantly at San Blas and Mazatlan. = *C. squalida,* Sow. = *C. Chionæa,* Mke.
152	44	10.	*Astarte Banksii,* Northern Seas.
152	44	9.	*Astarte ? striata,* Northern Seas.
152	42	4.	*Cardita crassa,* Acapulco.
152	42	7.	*Cardium Panamense,* Sow. Proc. Zool. Soc. 1833, p. 85. Sandy mud at Panama. The specimen here figured can hardly be distinguished from the young of *C. procerum.*
152	42	3.	*Pectunculus inæqualis,* Sow. Proc. Zool. Soc. 1832, p. 196. Sandy mud at Panama and Real Llejos. This is not the shell usually known by this name, and is accordingly quoted by Krauss for a S. African species.
154	44	4.	*Tellina proxima,* Brown, MS. Arctic Ocean.
154	44	8.	*Mactra similis,* Gray, MS. Northern Seas.

The following species are added on the authority of Mr. Reeve, in his Conch. Icon.:—

Plate.	Spec.	
9	62.	*Fissurella Lincolni,* Gray, Conch. Ill. p. 7. no. 62. f. 40. Monterey, *Belcher.*
6	27.	*Turritella sanguinea,* Rve. California, *Mus. Belcher.*
11	42.	*Murex imperialis,* Swains. Zool. Ill. series 2. vol. ii. pl. 67. Mud banks, Isabella Is., Cal., *Belcher.*

29. In the "Supplement to the Index Testaceologicus, by W. Wood, F.R.S. &c., London, May 1828," are figured several shells (principally without habitats) which belong to the West N. American fauna, and which were probably collected by Capt. Lord Byron, Rev. — Hennah, &c. Those which are recognized are as follow:—

Plate.	Fig.	
2	1.	*Donax scalpellum,* B.M.
2	6.	*Venus subrugosa,* Mawe. Panama.
2	11.	*Arca pectiniformis,* B.M. Closely resembling *Pectunculus inæqualis.*
3	6.	*Conus gradatus,* Mawe. California.
3	7.	*Cypræa arabicula,* (Mawe) Lam. South Seas.
3	3.	*Bulla decussata,* Mawe. Panama. (*Ficula.*)
3	26.	*Voluta harpa,* Mawe.
4	36.	*Voluta cærulea,* Mawe. = *Oliva volutella,* Lam.
4	37.	*Voluta Dama,* Mawe. S. Sea. = *O. lineolata,* Gray.
4	1.	*Buccinum ringens,* B.M. = *Malea crassilabris,* Val.
4	5.	*Buccinum coarctatum,* Mawe. (*Cassis.*)
4	6.	*Buccinum Rudolphi,* Mawe. = *Purpura columellaris,* Lam.
4	10.	*Buccinum brevidentatum,* Mawe. (*Monoceros.*)
4	12.	*Buccinum armatum,* Mawe. ? = *Monoceros lugubre.*
4	13.	*Buccinum tectum,* Mawe. (*Cuma.*)
4	15.	*Buccinum Planaxis,* Mawe. = *Planaxis laticostata,* Sow.
4	18.	*Buccinum strombiforme,* B.M. = *Columbella strombiformis,* Lam.

Plate.	Fig.	
4	23.	*Buccinum roseum,* B.M. = *Harpa rosea.*
4	24.	*Buccinum minus,* B.M. = *Harpa minor.*
4	1.	*Strombus gracilior,* B.M.
4	13.	*Strombus galea,* B.M.
4	14.	*Strombus galea,* jun.
4	21.	*Strombus granulatus,* B.M.
5	3.	*Murex rigidus,* B.M. (*Lathirus.*)
5	13.	*Murex regius,* Swains. South Seas.
5	15.	*Murex ceratus,* Mawe. (*Lathirus.*)
5	19.	*Murex aculeatus,* Mawe. = *M. dubius.*
5	1.	*Trochus undosus,* Mawe. California. (*Pomaulax.*)
5	2.	*Trochus unguis,* Mawe. California. (*Uvanilla.*)
5	3.	*Trochus olivaceus,* Mawe. S. Sea. (*Uvanilla.*)
5	4.	*Trochus pellis-serpentis,* Mawe. Panama. (*Tegula.*)
5	17.	*Trochus Byronianus,* B.M. Sandwich Is. [?] (*Omphalius.*)
5	23.	*Trochus filosus,* B.M.
6	44.	*Turbo fluctuosus,* Mawe. (*Callopoma.*)
6	45.	*Turbo saxosus,* Mawe. (*Callopoma.*)
8	2.	*Nerita patula,* B.M. (*Natica.*) S. America.
8	4.	*Nerita ornata,* B.M. S. America. = *N. scabricosta,* Lam.
8	2.	*Patella poculum,* B.M. = *Trochita radians,* Lam.
8	3.	*Patella Peziza,* B.M. = *Crucibulum spinosum,* Sow.
8	4.	*Patella scutellata,* B.M. = *Crucibulum imbricatum,* Sow.

30. In the Voyage of the Astrolabe to the Australian and East Indian Seas during the years 1826–1829, of which the "Zoology" was published by MM. Quoy and Gaimard, Paris, 1830–35, there does not appear to have been a single species collected identical with any from N. America. A list of the Mollusca is given by Menke in the *Zeit. f. Mal.* for March 1844, pp. 38–48. The same result appears in East Indian and Polynesian voyages generally, which therefore have not been collated.

31. In the "Description of the Cirrhipeda, Conchifera, and Mollusca in a Collection formed by the Officers of H.M.S. Adventure and Beagle, employed between the years 1826–1830 in surveying the southern coasts of S. America, including the Straits of Magalhaens and the coast of Tierra del Fuego, by Capt. Philip P. King, R.N., F.R.S., assisted by W. J. Broderip, Esq., F.R.S.," given in the Zool. Journn. vol. v. 1832, pp. 332–349, occur very unexpectedly descriptions of the following species:—

No. 44. *Ampullaria Cumingii.* Is. Sabago, Bay of Panama, in a small hill stream. Received from Mr. Cuming. Mus. Brit., King, Brod.
„ 57. *Murex salebrosus.* Hab.? Mus. King, Sow.
„ 60. *Triton scaber.* Fished up with the anchor in Valparaiso Bay. Mus. King.

32. The most comprehensive and accurate materials for the knowledge of the tropical Pacific fauna, are to be found in the collections made by Hugh Cuming, Esq. In the year 1827 that gentleman set out on his first great conchological voyage, and remained till 1830, exploring the West coast of America, at various stations from Chili to the Gulf of Fonseca or Conchagua, in lat. about 13° N. He also visited various of the Pacific Islands, and especially the Galapagos group. Mr. Cuming is the first collector on record who took notes, as accurate as was thought necessary, of the results of his dredgings. It is cause for the greatest regret that a systematic account of this expedition has never been published. The new shells brought home have indeed been to a great extent described in the *Proc. Zool. Soc.* and figured in the Monographs of Sowerby and Reeve. Of these the particulars of station and habitat have been recorded. But not only has the student to

wade through a number of works, at the risk of overlooking what belongs to his purpose: he has also to find that many of the genera have never yet been examined; and that, while new species are tabulated, the localities of those before known are not given. If materials are yet accessible by which lists could be published of all the shells found by Mr. Cuming at different places, separately, with particulars as to their frequency, as well as station, such a work would be among the most valuable contributions to geographic zoology yet given to the world. All notes of habitat recorded in the *Proc. Zool. Soc.* 1832–1836, may be considered as very authentic*. After the interruption caused by the second and great expedition of Mr. Cuming to the Philippines, there is of course a possibility of error from the accidental interchange of tickets belonging to different species. It is right to state that the services rendered to malacological science by the researches of Mr. Cuming are only equalled by the urbanity and readiness with which he allows the use of them to scientific inquirers†, and to which the author is under very peculiar obligations.

The following are the species observed in the *Proc. Zool. Soc.* Wherever the localities or stations given in the illustrated Monographs differ from these, the statements in the *Proceedings* must be regarded as of most authority.

1832. Page.	Proc. Zool. Soc.—*Cuming.*	Station.	Depth in fms.	Locality.
25	Chiton‡ Goodallii, *Brod.* jun.	u. s. & rock-ledges	l. w.	James Island, Gallapagos.
	sen.	exposed situations	...	Ditto ditto.
25	—— Stokesii, *Brod.*	on stones	l. w.	Panama, St. Elena.
26	—— limaciformis, *Sow.*	....	...	Guacom., Inner Lobos Is.
27	—— Elenensis, *Sow.*	under stones	l. w.	Pan., St. Elen.
27	—— setosus, *Sow.*	exposed situations	...	Guacomayo.
28	—— scabriculus, *Sow.*	under stones	...	Guac., Puerto Portrero.
28	—— retusus, *Sow*.................	....	...	Ditto ditto.
29	Placunanomia Cumingii, *Brod.*	in mud, on dead bivalves & corals	11	Gulf of Dulce.
29	Dentalium tesseragonum, *Sow*...	sandy mud	10–16	G. Nocoiyo, P. Port., Xipix.
30	Carocolla quadridentata, *Brod*...	woods	...	G. Dulce.

* It is necessary, however, to use even these with caution; as, in the papers purporting to describe shells collected by Mr. Cuming, species are introduced from places which he never visited. All shells quoted from the Gulf of California, Acapulco, and stations north of the Bay of Fonseca, are of this class. These were *obtained*, but not *collected*, by Mr. Cuming, and are therefore liable to the errors of his informants. A remarkable instance of the way in which mistakes arise will be found in P. Z. S. 1833, p. 36, where Mr. Sowerby, in describing "shells collected by Mr. Cuming," states that "detached valves were picked up on the sands at Real Llejos and Mazatlan." In Mr. Reeve's Monograph, which is supposed to be of perfect accuracy in all matters relating to the Cumingian Museum, we read that "a few odd valves of this species were found *by Mr. Cuming* on the sands at Real Llejos and *Mazatlan*."

† Mr. Broderip, in commencing the description of the shells collected by Mr. Cuming in his great expedition to the Philippines, 1836–40, deservedly writes (Proc. Zool. Soc. 1840, p. 84),—"Mr. C., by his accurate notes, and the open publication of the places where every one of the multitudinous species and varieties collected by him was found, has mainly assisted in making a complete revolution in this department of the science, and has done more towards giving us data for the geographical distribution of the testaceous Mollusca than any person who has yet lived."

‡ Perhaps the first notice of Mr. Cuming's labours occurs in a "Description of several new species of Chitones found on the coast of Chili in 1825, with a few remarks on the method of taking and preserving them, by John Frembley, R.N." (Zool. Journ. vol. iii. 1828, pp. 193–205). Among others, the author describes *Chiton Cumingsii*, "after his friend Mr. Cumings of Valparaiso, whose zeal in the pursuit of this interesting science will, he is persuaded, soon make a large addition to our present stock." In connexion with this paper should be read another, by the Rev. Lansdown Guilding, B.A., in the Zool. Journ. vol. v. pp. 25–35, "Observations on the Chitonidæ: St. Vincent, May, 1829." In this paper, the genus *Acanthopleura* is properly characterized.

1832. Page.	Proc. Zool. Soc.—*Cuming*.	Station.	Depth in fms.	Locality.
31	Bulinus translucens, *Brod.*	on trees	...	Is. King & Saboga, B. Pan.
32	Fasciolaria granosa, *Brod.*........	mud banks	...	Pan.
33	Voluta Cumingii, *Brod.*......1 sp.	....	9	Gulf of Fonseca.
50	Cancellaria solida, *Sow.*	sand	8–10	Real Llejos, St. Elena.
51	—— bullata, *Sow.*	mud	12	Payta, G. Nocoiya.
51	—— mitriformis, *Sow.*......1 sp.	sandy mud	...	Pan.
51	—— goniostoma, *Sow.*......1 sp.	sand	8	Conchagua, San Salvador.
52	—— clavatula, *Sow.*..............	sandy mud	7	Pan., Pay.
52	—— obesa, *Sow.*	....	15	G. Dulce, P. Port.
53	—— cassidiformis, *Sow.*	sandy mud	16	Pan.
53	—— acuminata, *Sow.*	sandy mud	12	Guacom.
54	—— buccinoides, *Sow*...........	sandy mud	7–15	Rl.Lj., Iqui., Callao, P.Port.
54	—— indentata, *Sow*..............	....	...	Pan.
54	—— hæmastoma, *Sow*...........	sand	10–16	Gal.
54	—— chrysostoma, *Sow.*	sand	8–10	Pan., St. Elen.
55	—— gemmulata, *Sow.*	sandy mud	...	G. Nocoiya.
55	—— decussata, *Sow*.............	sandy mud	10–13	Pan., P. Port.
55	—— bulbulus, *Sow.* ...2 sp. jun.	sand	8–10	Real Llejos.
55	Scalaria diadema, *Sow*...........	....	...	James Is., Gal.
55	Cardita Cuvieri, *Brod.* ......1 sp.	sandy mud	11	G. Fonseca.
56	—— varia, *Brod.*.................	fine sand	6	Gal.
58	Chiton dispar, *Sow.*	under stones	shore	Is. Saboga.
58	—— Columbiensis, *Sow.*	under stones	l. w.	Pan.
59	—— hirundiformis, *Sow.*	under stones	l. w.	Chatham Is., Gal., Ancon, Lobos Is., Payta, Peru.
60	Stilifer Astericola, *Brod.*	in *Asterias solaris*	...	Ld. Hood's Is., Gal.
105	Bulinus vexillum, *Brod.* [= alternans, *Beck*, teste *Jay*]	trunks of large trees	...	Is. King and Saboga.
105	—— Panamensis, *Brod.*	ditto	...	Ditto ditto
113	Columbella pulcherrima, *Sow.* 1 sp.	sandy mud	10	G. Dulce.
113	—— harpiformis, *Sow.*	on dead shells	10	Pan.
113	—— bicanalifera, *Sow*...........	sandy mud	10	Gal.
114	—— coronata, *Sow*...............	under stones	...	Pan.
114	—— lyrata, *Sow.*	under stones	...	Pan., Chiriqui.
114	—— elegans, *Sow*................	sandy mud	...	Guacom.
115	—— turrita, *Sow*.................	coarse grav. & s.m.	10	B. Mont., St. El.
115	—— fulva, *Sow.*	under stones	...	Pan.
115	—— rugosa, *Sow*.................	under stones	...	Pan., Xipix.
115	—— fluctuata, *Sow*..............	under stones	...	G. Nocoiyo.
116	—— lanceolata, *Sow.*	fine coral sand	6–8	Gal.
116	—— maculosa, *Sow*..............	sandy mud	...	Guacom.
116	—— hæmastoma, *Sow*...........	under stones	...	Gal., Pan.
116	—— varia, *Sow.*	under stones	...	Pan.
116	—— scalarina, *Sow*..............	under stones	...	Pan., Chiriqui.
116	?—— pyrostoma, *Sow.*	under stones	...	Pan., Gal.
117	?—— maura, *Sow.*	under stones	...	Pan., Gal.
117	?—— livida, *Sow.*................	under stones	...	Pan.
117	—— fuscata, *Sow.*	under stones	...	Pan., St. Elen., M. Xti.
118	—— costellata, *Sow*........1 sp.	....	16	Pan.
118	—— guttata, *Sow.* "Long well known, but not aware that hitherto described." = Buccinum cribrarium, *Lam.*	under stones	...	Pan.
118	—— varians, *Sow.* "First brought by Capt. Cook, in Endeavour."	....	...	"Galapagos (Hood's Is.)."
118	—— angularis, *Sow*..............	....	...	Pan.
118	—— castanea, *Sow*...............	....	...	Real Llej.
119	—— major, *Sow.*	under stones	...	Is. Muerte.
119	—— procera, *Sow*..........1 sp.	....	...	Pan.
119	—— pygmæa, *Sow.*	on dead sh., sdy m.	10	St. El.
119	—— unicolor, *Sow.*	....	...	"Gal. (Hood's Is.)."
125	Bulinus nux, *Brod.*	on bushes	...	Charles Is., Gal.

1832. Page.	Proc. Zool. Soc.—*Cuming.*	Station.	Depth in fms.	Locality.
173	Cancellaria uniplicata, *Sow.* 2 sp.	sand	10	Pan.
173	Ovulum avena, *Sow.*	...	...	Conchagua.
173	—— inflexum, *Sow.* .... 1 sp.	...	...	G. Dulce.
174	—— æquale, *Sow.*	...	...	Pan.
174	Murex recurvirostris, *Brod.*	sandy mud	9	G. Nicoiyo.
174	—— erosus, *Brod.*	under stones	...	Pan.
175	—— pumilus, *Brod.*	under stones	...	Gal.
175	—— nucleus, *Brod.*	fine coral sand	8	Gal.
175	—— vibex, *Brod.*	sandy mud	6–12	St. Elen., Pan.
176	—— oxyacantha, *Brod.*	sandy mud	8	Real Lleijos.
176	—— nitidus, *Brod.* .... 1 sp.	cleft of rock	...	Real Lleijos.
176	—— horridus, *Brod.* = M. Boivinii, *Kien.*	sandy mud	8–12	St. Elen., Pan.
177	—— lappa, *Brod.*	rocky bed	12	St. Elen.
179	Ranella muriciformis, *Brod.*	loose gravel	7	B. Mont.
179	—— cælata, *Brod.*	under stones	...	Pan.
185	Cypræa Pacifica, *Gray*	under stones	...	Gal.
185	—— rubescens, *Gray.*	under stones	...	Gal.
185	—— Maugeri, *Gray.*	under stones	...	Gal.
194	Ranella pyramidalis, *Brod.* = Murex anceps, *Pfr.* ...	on reefs	...	Pan., Ulitea.
195	Cardita laticostata, *Sow.*	sand	6–12	Rl. Llej., Pan., St.El., Guac.
195	—— radiata, *Sow*	muddy sand	6–12	Pan., Salango.
195	—— affinis, *Sow.*	sandy mud	6–12	B. Mont., G. Nocoiya.
196	Pectunculus inæqualis, *Sow.*	sandy mud	10	Pan., Real Llej.
196	—— assimilis, *Sow.*	sandy mud & grav.	8–12	B. Guayaq., P. Port.
196	Capsa altior, *Sow.*	coarse gravel	12	G. Nocoiyo.
196	—— ——, var.	thin mud	5	Tumbez.
198	Nucula polita, *Sow.* .... 1 sp.	sand	7	Pan.
198	—— costellata, *Sow*	sandy mud	10	Pan.
198	—— gibbosa, *Sow*	soft mud	5	Tumbez.
198	—— ——, var.	mud	12	G. Nocoiyo.
199	Amphidesma rupium, *Sow*	coarse grav. in coral reefs, & in rocks	...	Ld. Hood's Is.
199	—— ——, var.		...	Gal.
200	—— punctatum, *Sow* ...... 1½ sp.	...	...	Gal.
200	Neritina latissima, *Brod.*	on rocks in river	...	Real Llej.
201	—— globosa, *Brod.* = N. intermedia, var. teste *Rve.* + N. tritonensis, *Guil.* teste *Sow.*	in river	...	Chiriqui (Nicoya, *Sow.*).
201	—— intermedia, *Sow*	on stones in mountain stream	...	Is. Lions, Bay Mont.
201	—— ——, var.	in rivulet	...	San Lucas, Gulf Nocoiya.
201	—— picta, *Sow*	mud bank partially overflowed with fr. water; abundant	...	Pan.
1833. 4	Spondylus dubius? = S. princeps, var. *Brod.*	on shells	10	Gulf of Tehuantepec.
5	Triton lignarius, *Brod.*	sandy mud	7–12	Porto Protrero & Panama.
5	—— tigrinus, *Brod.*	sandy mud	11	Guacomayo.
6	—— lineatus, *Brod.*	coral sand	6	Galapagos.
7	—— gibbosus, *Brod.*	coarse sand	7	Panama and Monte Xti.
7	—— scalariformis, *Brod.*	coarse sand	10	Bay of Montijo.
7	Turbinella tuberculata, *Brod.* ...	under stones	...	Galapagos.
7	—— armata, *Brod.*	on coral reef	...	Elizabeth Is.
52	Conus tiaratus, *Brod.* = C. minimus, *Linn.* var. teste *Rve.*	on sand in small ponds of sea water	...	Galapagos.
54	—— nux, *Brod.*	...	...	Galapagos.
54	—— Archon, *Brod.*	sandy mud	12	Bay of Montija.
54	—— purpurascens, *Brod.*	sandy mud in clefts of rocks.	...	Panama.
55	—— gladiator, *Brod.*		...	
55	—— Orion, *Brod.*	soft sand in ditto	...	Real Llejos.

1833. Page.	Proc. Zool. Soc.—*Cuming.*	Station.	Depth in fms.	Locality.
55	Conus princeps	soft mud in rocks sandy mud in ditto	... ...	Panama. St. Elena and Monte Xti.
82	Cardium Cumingii, *Brod.*	sandy mud	12	Gulf of Dulce.
83	—— procerum, *Sow.*	coarse sand	4–6	Real Llejos.
83	—— planicostatum, *Sow.*	fine sand	13	Guacomayo.
85	—— Panamense, *Sow.*	sandy mud	10	Panama.
124	Orbicula Cumingii, *Brod.*	on lower sides of stones in sandy m.	l. w. 6	Payta, St. Elena, Pan.
18	Byssoarca illota, *Sow.*	under stones	...	Gulf of Nocoiyo.
19	—— truncata, *Sow.*	on st. & *Aviculæ*	...	Galapagos, Ld. Hood's Is.
19	Arca tuberculosa, *Sow.*	roots of mangroves	l. w.	Real Llejos.
20	—— concinna, *Sow.*	coarse sand	12	Gulf of Nocoiyo.
20	—— emarginata, *Sow.*	...	...	Atacamas, Real Llej., Xip., Panama, and Gulf of Calif.
20	—— formosa, *Sow.*	...	...	Gulf of Tehuantepec.
21	—— multicostata, *Sow.*	...	12	Ditto.
22	—— quadrilatera, *Sow.* [=grandis jun.]	sandy mud	8	Real Llejos.
21	—— labiata, *Sow.*	sandy mud	7	Tumbez and Real Llejos.
34	Cumingia lamellosa, *Sow.*	in hard clay	l. w. deep w.	Payta. Panama.
35	Corbula nuciformis, *Sow.*	sandy mud	6	Real Llejos; also fossil near Guayaquil.
35	—— bicarinata, *Sow.*	sandy mud	7–17	Pan., Rl. Llej., Carac., St. El.
35	—— biradiata, *Sow.*	mud and sand	3–6 7	Chiriqui. Bay of Caraccas.
35	—— nasuta, *Sow.*	sandy mud	10	Xipix. *Jun.* G. Nocoiyo.
35	—— ovulata, *Sow.*	sandy mud	7–17	Xip., B. Mont., Carac., Rl. Lj.
36	—— tenuis, *Sow.*	sandy mud	12	Bay Montijo.
36	Bulinus rugiferus, *Sow.*	under scoriæ	...	James Is., Gal.
37	—— unifasciatus, *Sow.*	under lava	...	Charles Is., Gal.
37	—— corneus, *Sow.*	und. decayed grass	...	Real Llejos.
71	Triton reticulatus, *Sow.*	under stones	...	Gal.
72	Bulinus discrepans, *Sow.*	under bark	...	Conchagua.
72	—— calvus, *Sow.*	on dry grass-tufts	...	James Is., Gal.
72	—— ustulatus, *Sow.*	on pieces of lava	...	Charles Is., Gal.
73	—— unicolor, *Sow.*	on dead leaves	...	Is. Perico, Pan.
74	—— Jacobi, *Sow.*	under scoriæ	...	James Is., Gal.
134	Pleurotoma unimaculata, *Sow.*	sandy mud	8–16	Monte Xti, Guac., Salango
134	—— clavulus, *Sow.*	sandy mud	17	B. Montija.
135	—— oxytropis, *Sow.*	sandy mud	13–20	Pan., Port. Portrero.
135	—— albicostata, *Sow.*	fine coral sand	6	Gal.
135	—— bicolor, *Sow.*	under stones	...	Pan.
135	—— ——	sand	8	Gal.
135	—— splendidula, *Sow.*	fine coral sand	6	Gal.
136	—— bicanalifera, *Sow.*	sandy mud	10	B. Montija.
136	—— rugifera, *Sow.*	fine coral sand	6	Galap.
137	—— aterrima, *Sow.**	under stones	...	Monte Christi.
137	—— nigerrima, *Sow.*	sandy mud	6–10	Pan.
137	—— corrugata, *Sow.*	muddy sand	10	B. Mont., Port. Portrero.
138	—— excentrica, *Sow.*	coral sand	6	Galap.
138	—— incrassata, *Sow.*	sandy mud	6–10	Pan., Mte Xti.
138	—— duplicata, *Sow.*	sandy mud	10	Port. Portr., B. Mont.
138	—— unicolor, *Sow.*	sandy mud	6–10	Pan.
139	—— granulosa, *Sow.*	sand	8	B. Mont., Pan.
139	—— variculosa, *Sow.*	sandy mud	10	B. Mont.
139	—— nitida, *Sow.*	sandy mud	10	B. Mont.
139	—— hexagona, *Sow.* 1 sp.	sandy mud	13	Guacomayo.
1834.				
7	Eulima interrupta, *Sow.*	coarse sand	11–13	G. Nocoiyo.
8	—— acuta, *Sow.*	coarse sand	13	B. Montiji.

* N.B. Pl. rustica, *Sow.* = thiarella, *Val.* teste *Jay.*

1834. Page.	Proc. Zool. Soc.—*Cuming*.	Station.	Depth in fms.	Locality.
18	Conus Luzonicus, var.	clefts of rocks	l. w.	Gal.
18	—— brunneus, *Wood*	clefts of rocks	...	Gal., Puert. Portr., Pan.
19	—— diadema, *Sow.*	clefts of rocks	l. w.	Gal.
19	—— regalitatis, *Sow.*	sandy mud in do.	...	Real Llejos.
21	Gastrochæna ovata, *Sow.*	on *Spondyli* on coral rocks	... 17	Is. Perico. Is. Plata.
21	—— truncata, *Sow.*	on *Spondyli*	...	Is. Perico.
21	—— brevis, *Sow.*	in pearl oysters	3–7	Galap., Lord Hood's.
22	—— rugulosa, *Sow.*	in pearl oysters	3–7	Galap., Lord Hood's.
22	—— hyalina, *Sow.*	with the last	3–7	Lord Hood's Is.
35	Calyptræa rudis, *Brod.*	....	...	Pan., Real Llej.
35	—— corrugata, *Brod.*	under stones	14	Guacom.
35	—— varia, *Brod.*	....	...	Gal.,Ld.Hd'sIs.,Is.Muerte.
36	—— (Calypeopsis) imbricata, *Brod.* (*Sow.*)	on st. in sandy m.	6–10	Pan.
36	—— (——) lignaria, *Brod.*	under stones	...	Real Llejos.
36	—— (——) —— var.	on shells in s. m.	4	Chiloe.
36	—— (——) tenuis, *Brod.*	on liv.shells in m.s.	9	Samanco Bay.
37	—— (——) serrata, *Brod.*	on dead shls., mud	6–11	Real Llejos, Is. Muerte.
37	——(Syphopatella)sordida,*Brod.*	on stones, sand	12	Pan.
39	—— (Crepidula) unguiformis, *Lam.*	inside dead shells, sandy mud	4–10	Pan., Chiloe.
40	—— (——) excavata, *Brod.*	....	...	Real Llejos.
40	—— (——) arenata, *Brod.*	on sh. sandy mud	6–8	St. Elena.
40	—— (——) marginalis, *Brod.*	stones & shls. s. m.	6–10	Pan., Is. Muerte.
40	—— (——) squama, *Brod*	under stones	...	Pan.
47	Petricola robusta, *Sow.*	in rocks	6–11	Pan., Is. Muerte.
47	—— amygdalina, *Sow.*	in pearl oysters	3–6	Gal., Lord Hood's Is.
69	Pholas cruciger, *Sow.*	soft sandstone soft stone hard clay	½-tide l. w. 13	Is. Puna, Guayaq. Bay Caraccas. G. Nocoiyo.
69	—— calva, *Gray, MS.* adult jun.	.... hard stones	12 l. w.	Is. Perico.
70	—— ——, var. nana	hard stones	l. w.	Pan.
70	—— acuminata, *Sow.*	limestone	l. w.	Pan.
71	—— curta, *Sow.*	soft stone	l. w.	Is. Lions, Veragua.
72	—— cornea, *Sow.*	trunk of tree	l. w.	Chiriqui, Veragua.
88	Lyonsia picta, *Sow.*	attached to particles of sand	11	Is. Muerte.
125	Fissurella obscura, *Sow*	under stones	shore	Galap.
125	—— virescens, *Sow.* [non F. virescens, *Guild.* =Barbadensis, var. teste *Sow.*]	exposed situat.	l. w.	Pan.
125	—— nigropunctata, *Sow*	....	...	Galap., Lobos Is.
125	—— macrotrema, *Sow.*	under stones	shore	Gal., Lambeyeque, Lob. Is.
125	—— microtrema, *Sow.*	under stones	...	Real Llejos.
126	—— inæqualis, *Sow.*	under stones	shore	Gal., Guacom.
126	—— pica, *Sow.*	dead shells	6–8	St. Elena, Galap.
127	—— Panamensis, *Sow.*	dead shells	6–10	Panama.
128	—— crenifera, *Sow.*	under stones	shore	Real Llejos.
148	Chama frondosa, *Brod.*	on coral rock	17	Is. Plata.
148	—— ——, var. *b.*	on pearl oyst. s.m.	10	G. Tehuantepec.
149	—— imbricata, *Brod.*	on pearl oysters	3–7	Ld. Hood's Is., Pearl Is.
150	—— ——, var. *a.*	rocks and stones	l. w.	Galap.
150	—— producta, *Brod.*	on stones, s. mud	10	G. Tehuan.
150	—— corrugata, *Brod.*	stones	l. w.	Real Llej.
150	—— echinata, *Brod.**	on rocks	l. w.	Puert. Portr.
1835. 5	Hipponyx radiata, *Gray* (non *Desh.*) = H. Grayanus, *Mke.*	on rocks	...	Pan., Galap.

* The old sp. spoken of are the young of *Ch. frondosa*, var. The young are *Ch. coralloides*, Rve.

1835. Page.	Proc. Zool. Soc.—*Cuming.*	Station.	Depth in fms.	Locality.
6	Mouretia stellata, *Sow.* [comp. Gadinia pentegoniostoma] ...	on rocks	l. w.	Real Llej.
6	Siphonaria costata, *Sow.*	on rocks in exposed situations	l. w.	Guacom.
7	—— maura, *Sow.*	on rocks	...	Pan.
21	Venus Columbiensis, *Sow*	coarse sand	l. w.	St. Elena.
21	—— subimbricata, *Sow.*	fine sand	13	P.Portr.,Acap.[Calif.,*Sow.*]
22	—— multicostata, *Sow*	coarse sand	l. w.	G. Pan.
23	Cytherea unicolor, *Sow*	coarse sand	6	Real Llej. [Xipix., *Sow.*]
23	—— concinna, *Sow*	fine sand	10	Pan.
41	Venus histrionica, *Sow*	muddy sand	l. w.	Real Llej., St. Elena.
41	—— fuscolineata, *Sow*	sandy mud	13	Guacom.
42	—— discors, *Sow*	sandy mud	6–9	Guacom., St. Elena.
43	—— crenifera, *Sow*	sand	l. w.	Payta, St. Elena.
44	—— ornatissima, *Brod.* ... 1 sp.	sandy mud	10	Pan.
44	—— pulicaria, *Brod.* [=cingulata, *Lam.* teste *Sow.*]	sandy mud	3	Chiriqui and Tumaco.
45	Cytherea tortuosa, *Brod.*	sandy mud	6	Pan., Xipix.
45	—— affinis, *Brod*	sandy mud	10	Xipix.
46	—— Dione, var. β. = C. lupinaria	soft mud	5	Tumbez.
46	—— vulnerata, *Brod.*	sandy mud	6	Real Llej.
46	—— argentina, *Sow*	sand-banks	l. w.	G. Nocoiyo.
84	Pinna rugosa, *Sow.*	sand-banks	...	Is. Rey, B. Pan.
84	—— maura, *Sow*	muddy banks	...	Pan.
84	—— tuberculosa, *Sow*	muddy banks	...	Pan.
93	Pandora brevifrons, *Sow*	sand	10	Pan.
94	Buccinum modestum, *Powis* ...	muddy gravel	7–17	B. Mont.
95	Nassa nodifera, *Pow*	coral sand	6–10	Gal., Pan.
95	—— festiva, *Pow.*	sandy mud	6–10	Pan., St. Elen.
96	—— pallida, *Pow*	sandy mud	6	Pan.
96	—— scabriuscula, *Pow.*	sandy mud	12	Bay Mont.
109	Pecten subnodosus, *Sow.* { var. β. / var. γ.	sandy mud and coral sand	10–17	{ Is. Plata. / Gulf Tehuant.
109	—— magnificus, *Sow.* { 1 sp. / var. γ.	coral sand	6 / 17	Galap. / Is. Plata.
109	—— tumidus, *Sow.*	sandy mud	6–10	St. Elena, Salango.
194	Mitra tristis, *Swains*	sandy mud	6–10	St. Elena, Galap.
194	—— effusa, *Swains*	sandy mud	12	Guacom., Galap.
194	Tiara foraminata, *Swains.* = Voluta lens, *Wood*	sandy mud and gravel	6–14	St. Elena, Is. Plata, Pan.
194	—— muricata, *Swains*	sandy mud	6	Galap.
1840.				
139	Murex plicatus, *Sow. jun*	coarse sand	12	G. Nocoyo.
1841.				
51	Ranella nana, *Sow. jun.*	coarse sand	7	Panama. ["Ins. Philip."]
52	—— albofasciata, *Sow. jun*	coarse sand	10	Panama. Ditto.
1842.				
49	Siphonaria characteristica, *Rve.* .	....	...	Pan.
197	Vermetus eburneus, *Rve*	....	...	?
1843.				
23	Lima angulata, *Sow. jun*	sandy mud	12–20	Pan.
208	Natica Panamaënsis, *Récl.*	fine sand	10	Pan.
210	—— uberina, *Val. in Humb*	muddy sand	5	Casma, Peru.
213	—— Gallapagosa, *Récl.* [? = N. otis, *Z.B.V.*]	coral sand	...	Albemarle Is., Gal.
185	Pleurotoma cedo-nulli, *Rve*	sandy mud	10	Pan.
30	Cyclostoma giganteum, *Sow*	woods	...	Panama.
154	Terebra aspera, *Hinds*	sandy mud	6–10	Pan., Mte Xti., St. Elen.
156	—— elata, *Hinds*	coarse sand	15	Bay Mont.
160	—— ornata, *Gray* (P.Z.S. 1834, p. 62)	{ coral sand / (mud	5–7 / 7	Gal. / Panama, *Hinds.*)
166	—— aciculata, *Hds.* (quasi *Lam.*)	....	...	Xipix. (Acapulco, Sonsonati, *Hds.*)

1844. Page.	Proc. Zool. Soc.—*Cuming*.	Station.	Depth in fms.	Locality.
17	Lithodomus plumula, *Hanl.*	in Spondyli	...	Pan.
59	Tellina Cumingii, *Hanl.*	coral sand	...	Guacom.
60	—— rubescens, *Hanl.*	sandy mud	...	Pan., Tumbez.
61	—— regia, *Hanl.*	coarse sandy mud	7	Real Llej.
61	—— laceridens, *Hanl.* .... {	soft sandy mud	5	Tumbez.
		sandy mud	3	Chiriqui.
62	—— princeps, *Hanl.*	soft sandy mud	5	Tumbez.
70	—— insculpta, *Hanl.* ......1 sp.	sandy mud	3	Chiriqui.
71	—— felix, *Hanl.*	sandy mud	6–10	Pan.
142	—— gubernaculum, *Hanl.*	sandy mud	7	Real Llej. [*Thes.*)
144	—— elongata, *Hanl.*	sand	3	Chiquiqui (Chiriqui, *Sow.*
144	—— Dombei, *Hanl.*	sandy mud	12	Pan., *var.* Tumbez.
147	—— plebeia, *Hanl.*	sandy mud	7	Real Llej.
147	—— aurora, *Hanl.*	soft sandy mud	10	Pan.
148	—— hiberna, *Hanl.*	sandy mud	6–11	Pan., Guayaq.
121	Triton pagodus, *Rve.*	....	...	Bay Montija.
121	—— pictus, *Rve.*	under stones	l. w.	Galap.
12	Scalaria mitræformis, *Sow. jun.*	....	...	Guacom.
51	Columbella rugulosa, *Sow.*	....	...	Galap.
51	—— atramentaria, *Sow.*	....	...	Chatham Is., Galap.
52	—— nigricans, *Sow.*	....	...	Galap.
1845.				
11	Artemis simplex, *Hanl.* [=Dosinia Dunkeri, *Phil.*]	}	...	Pan., St. Elen.
11	—— subquadrata, *Hanl.*	....	...	St. Elena.
15	Donax navicula, *Hanl.*	....	...	Gulf Nicoya.
15	—— gracilis, *Hanl.* ...... {	....	...	Bay Guayaq.
	var. *b.*	....	...	Chiriqui.
	var. *c.*	....	...	Caraccas.
17	—— assimilis, *Hanl.*	....	...	Pan.
107	Ostrea Columbiensis, *Hanl.*	rocks	½-tide	St. Elena.
42	Glandina obtusa, *Pfr.*	leaves of bushes	...	Real Llej.
129	Helix spirulata, *Pfr.*	trunks of trees	...	Ditto.
130	—— Nystiana, *Pfr.*	....	...	Ditto.
139	Littorina aspera, *Phil.*	....	...	Conchagua.
139	—— porcata, *Phil.*	high exposed rocks	...	Galap.
142	?—— aberrans, *Phil.*	rocks	½-tide	Pan.
53	Mitra gratiosa, *Rve.*	coral sand	7	Gal.
59	—— gausapata, *Rve.*	....	10	Gal.
1846.				
117	Chama Panamensis, *Rve.*	on stones	...	Pan.
119	—— Janus, *Rve.*	on large *Aviculæ*	...	Gal.
1848.				
41	Planorbis Panamensis, *Dk.*	in streams	...	Pan.
97	Cypræa pulla, *Gask.* (described 1846, p. 24)	}	...	Gal., Guay.
49	Turbo saxosus, *Rve.*	....	...	W. Columb.
1849.				
116	Anomia fidenas, *Gray*	on *Pinnæ*	l. w.	Pan.
117	—— adamas, *Gray*	on *Av. marg.*	9	Gal., Lord Hood's Is.
134	Tornatellina Cumingiana, *Pfr.*	....	...	Real Llej.
1850.				
154	Phos turritus, *A. Ad.*	coral sand	6–10	Pan.
1851.				
109	Nassa angulifera, *A. Ad.*	....	10	Gal.
110	—— nodicincta, *A. Ad.*	....	7	Gal.
1855.				
173	Scintilla Cumingii, *Desh.*	....	...	Panama.
183	Erycina dubia, *Desh.*	....	...	Is. Muerte, Guayaq.

The following species occur in Reeve's *Conchologia Iconica*, from places visited by Mr. Cuming, and were probably collected by that gentleman.

Plate.	Sp.	Name.	Station.	Depth in fms.	Locality.
1	2	Lucina punctata	....	l. w.	Panama.
7	33	—— fibula	sandy mud	6 l. w.	St. Elena. Philippines.
8	49	—— eburnea	sandy mud	11	Pan., St. Elen.
9	25	—— cornea [Mysia, *H. & A. Ad.*]	coarse sand	10–13	G. Nicoya.
11	68	—— calculus	coarse sand	10–13	G. Nicoya.
6	29	Cardium biangulatum [=magnificum, *Desh.*]	coral sand	17	Is. Plata, St. Elena.
8	43	—— graniferum	....	......	G. Nicoya, Xipix.
17	86	—— consors	sandy mud	6–11	St. Elena, Guacom.
7	31	Fig. *a*, *b*. Pecten ventricosus, *Sow.* Thes. =P. tumidus, *Sow.* P. Z. S., non *Turt.*	....	......	St.Elen.,&c.,Philippines.
100	552	Helix uncigera, *Petit*, Guér. Mag. Zool. 1838, pl. 113.	....	......	Panama.
24	61	Fig. *a*, *b*. Patella diaphana, *Rve.*	....	......	Cent.Amer. (*Cum.*,*Kell.*)
33	99	Fig. *a*, *b*. —— striata, *Rve.* [as of *Quoy & Gaim.*, but quite distinct from their species, which is given afterwards under the same name.]	....	......	Galapagos.
37	117	Fig. *a*, *b*. Patella stipulata, *Rve*	....	......	Panama.
5	21	Turbo squamiger, *Rve.*	....	7	Gal.
3	3	Strombus galeatus=S. crenatus, *Sow.*	reefs	l. w.	G. Nicoy.
14	32	—— granulatus	sandy mud	6–8	St. Helena and Gal.
16	38	—— gracilior	sandy mud	6–12	St. Elena and Pan.
3	15	Chiton sulcatus	under stones	below l. w.	Ld. Hood's & Jas. I., Gal.
6	29	—— crenulatus	under stones	ditto	Pan.
10	54	Chiton hirundiniformis	....	......	Korean Archip., *Belcher*; teste *Rve.*, Gal.; and Peru, teste *Cum.*
4	11	Turritella nodulosa, *King*, Z. J. v. 347, =T. papillosa, *Kien.*	sandy mud	6–10	Gulf Dulce.
10	47	—— fascialis, *Rve.*	coarse sand	7	B. Mont.
11	63	—— rubescens, *Rve.*	coarse sand	7	B. Mont.
24	134	Cypræa fusca, *Gray*	....	......	Gal. (also B. Guayaquil,
13	59	—— nigropunctata, *Gray*, Z. J. iv. 11, =C. irina, *Kien.*	under stones	......	Gal. [teste *Sow.*)
41	58	Conus varius, *Linn.* 1170. [*Rve.* pl. 12, non 13, sp. 58.]	....	......	Philippines.
		Var. β. = C. pulchellus, *Sow.* not *Swains.* = C. interruptus, *Wood*, Suppl.	clefts of rocks	l. w.	Gal.
12	99	Pleurotoma cincta, *Rve.*=modesta, *Sow.*	sandy mud	8	Real Llej. and Is. Annaa.
12	49	Fig. *a*, *b*. Natica unifasciata, *Rve.* [? not *Lam.*]	mud banks	l. w.	Pan.
11	57	Purpura Carolensis, *Rve.* [=triangularis, *Blainv.*]	under stones	l. w.	Charles Is., Gal.
2	9	—— columellaris, *Lam.*	exposed rocks	l. w.	Gal.
3	14	—— planospira, *Lam.*	exposed rocks	......	James Is., Gal.
11	60	—— alveolata, *Rve.*	under stones	......	Pan.
9	43	—— undata, *Rve.* [=biserialis, *Blainv.* non *Rve.*, var. Non undata, *Lam.*=fasciata, *Rve.* pl. 9. f. 45.]	under stones	l. w.	St. Elena.
3	17	Ricinula heptagonalis, *Rve.* P. Z. S. 1846 [? ubi].	under stones	l. w.	Pan.
4	23	—— alveolata, *Kien.* [comp. Purp. alv.]	....	......	Pan.
5	32	—— contracta, *Rve.*	....	......	Pan., St. Elen.
5	33	—— zonata, *Rve.*	under stones	l. w.	Charles Is., Gal.

Plate.	Sp.	Name.	Station.	Depth in fms.	Locality.
6	13	Cassis tenuis, *Gray*, in *Wood*, pl. 8. f. 4, = C. Massenæ, *Kien.*	sandy mud	6	Gal.
6	14	—— coarctata, *Sow.*, *Wood*, f. 5	crev. of rocks	......	Gal.
1	5	Oniscia tuberculosa, *Sow.* Gen. p. 2	clefts of rocks	l. w.	Gal.
9	62	Buccinum Coromandelianum, *Lam.*	....	......	Coromandel, Panama.
10	71	—— biliratum, *Rve.*	....	......	Gal.
10	73	—— nigrocostatum, *Rve.*	under stones	l. w.	Pan.
11	80	—— pulchrum, *Rve.*	....	......	Gal.
11	84	—— cinis, *Rve.*	under stones	......	Gal.
11	89	—— pastinaca, *Rve.*	....	......	B. Mont.
2	6	Monoceros grande, *Gray*, Z. B. V. p. 124, = Purpura Grayii, *Kien.*	crev. of rocks	l. w.	James Is., Gal.
3	11	—— cingulatum, *Lam.* = Buc. pseudodon, *Burrows.* "Quite inseparable from the present group:" [except by the Lathyroid plaits, and the Turbinelloid operculum, which *Kien.* had already described.]	clefts of rocks	l. w.	Pan.
11	37	Triton Chemnitzii = Cassidaria setosa, *Hds.* [? ubi].	sandy mud	6	Pan.
16	65	—— Sowerbii = T. lineatus, *Sow.*	sandy mud	6	Gal.
17	72	—— reticulatus ? = Murex reticulatus, *Dillw.* = T. turriculatus, *Desh.* = Tritonium intertextum, *Pfr.* = T. reticulatus Mediterraneus, *Sow.*	....	6	Mediterranean, Gal. &c.
16	124	Mitra attenuata, *Swains.*	rocky bottom	28	Is. Caña, Centr. Am.
22	176	—— sulcata, *Swains.*	fine black sand	4	Mouth of Chiriqui, Veragua.
1	3	Voluta harpa	sandy mud	8	St. Elen.
6	40	Fissurella Mexicana	....	......	Real Llej.
8	56	—— rugosa	under stones	l. w.	Gal.
9	15	Oliva Julieta	sandy mud	6	Real Llej.
11	17	—— splendidula	sandy mud	l. w.	Is. Tobago, B. Pan.
14	29	—— polpasta, *Ducl.*	sandy mud	13	B. Mont., Veragua.
20	49	—— kaleontina	....	6–12	B. Guay., Gal.
2	6	Turbinella varicosa..........................	crev. of rocks	......	Gal.
5	27	—— nodata, *Mart.* = Murex rigidus, *Wd.*	....	l. w.	Pan.
3	7	Fasciolaria salmo, *Wood* [Pyrula, *Gray*], = F. Valenciennesii, *Kien.*	....	......	Real Llej.
32	157	Fig. 157, 163. Murex alveatus, *Kien.* p. 24. pl. 46. f. 2.	under stones	l. w.	Pan.

The following species, to which is appended the authority of Mr. Cuming, are figured in Sowerby's *Conchological Illustrations.*

No.	Fig.	Name.	Locality.
17	17	Fissurella gibberula, *Lam.*	Panama.
18		Bulinus princeps, *Brod.* Z. P. 1832 [? ubi. = zebra, var.]	Conchagua.
85		—— eschariferus, *Sow.*	Galapagos.
87		—— rugulosus, *Sow.*	Galapagos.
	45	—— Jacobi, *Sow.*	Galapagos.
	42	—— ustulatus, *Sow.*	Galapagos.
119	23	Murex dubius, *Sow.* = M. aculeatus, *Wood*	Panama.
126	41	Cypræa suffusa, *Gray* [= C. armadina, *Ducl.* teste *Kien.*]......	Galapagos.
31		Ovulum æquale, *Sow.*	Panama.
25		Conus tornatus, *Brod.* [Xipixapi, teste *Brod.* P. Z. S. 1833, p. 53.]	Panama.
2	2	Amphidesma pulchrum, *Sow.* [B. Caraccas, teste *Sow.* P. Z. S. 1832, p. 57.]	St. Elena: *var.* Panama.
	59	Neritina pulchra, *Sow.*	Panama.

The following species occur in Sowerby's *Thesaurus Conchyliorum*, on the authority of Mr. Cuming.

No.	Page.	Plate.	Fig.	Name.	Station.	D. in fms.	Locality.
12	86	22	39, 40	Lima angulata, *Sow.*	......	...	Panama.
15	86	22	41, 42	—— arcuata, *Sow.*	u. coral sdy. m.	... ...	Ld. Hood's Is. Panama.
51	129	37	112–13	Columbella cribraria, *Lam.*	u. s.	...	Pan., very common.
38	163	44	71	Terebra frigata, *Hds.* = T. gracilis, *Gray*.	cor. sd.	6	Galap.
118	284	57	42	Tellina virgo, *Hanl.* P. Z. S. 1844, p. 143	......	...	Chiriqui, W. Col.
36		77	153–5	Marginella cærulescens, *Lam.* = M. prunum, *Gmel.* [not M. sapotilla, *Hds.*]	......	...	Panama.
38	479	99	16–19	Ovulum gibbosum, *Lam.*	......	...	Panama.
76	529	112, 115	108–9 217–18	Neritina Michaudii, *Recl.* Rev. Zool. 1841, p. 315.	......	...	Panama.
48	576	123	71	Bulla Quoyii, *Gray*, MS.	cor. sd.	6–8	Galap.
52	577	123	76	—— rufolabris, *A. Ad.*	fine sd.	6	Galap.
53	577	123	77	—— punctata, *A. Ad.*	sdy. m.	10	Panama.
21	618	127	12	Cytherea undulata, *Sow. jun.* = C. planulata, var., *Sow. sen.*	sdy. m.	9	Salango.
69		179	59, 77	Cerithium ocellatum, *Sow.* [not *Brug.*] = C. irroratum [non] interruptum, *Gd.*	......	...	Gulf Cal., Galap.
71		179	60	—— nebulosum, *Sow.* = C. maculosum, *Kien.*	......	...	Galapagos.
70		178	48	—— adustum, *Sow.* non *Kien.* ? = C. maculosum, var.	......	...	Galapagos.
85	869	182	155–6	—— Gallapaginis, *A. Ad.* ? = interruptum, *Mke.*	......	...	Galapagos.
169	887	186	280–2	—— varicosum, *Sow.*	......	...	Real Llejos, at roots of mangroves.

33. At the very time that Mr. Cuming was prosecuting his researches on the West Coast of South America, the Chevalier Alcide D'Orbigny was engaged in a similar exploration of the continent generally, from the years 1826–1833. In July 1833, he reached the Pacific coast at Arica, whence he proceeded to Callao, stopping at Cobijo, Islay, and Arequipa. Thence he returned to Europe *viâ* Valparaiso. The result of his labours is described in the "Voyage dans l'Amérique Méridionale, le Brésil, la République Orientale d'Uruguay, la République Argentine, la Patagonie, la République du Chili, la République de Bolivia, la République de Perou, exécuté pendant les années 1826–1833, par Alcide D'Orbigny. Mollusca, Paris, 1847." Among the services rendered to malacological science by Dr. Gray*, it is not the least that he has obtained the type specimens described in this work for the British Museum, where they may be seen by students on application. The sea-shells are frequently by no means in good condition, in which respect they contrast most unfavourably with the magnificent specimens brought in such abundance by Mr. Cuming; nor is the identification of species always to be relied on. In the Calyptræidæ especially, M. D'Orbigny has added to the confusion which was before characteristic of the nomenclature in that interesting but unfortunate family. Both the specimens and the work, however, are extremely valuable, especially from the materials afforded for a comparison of the faunæ of the Atlantic and Pacific coasts; and the publication of a cheap catalogue of them by Dr. Gray, Oct. 1854, enables ordi-

* Perhaps the attention now given to the animals of Mollusca, and the reform of systems founded on the shells alone, are due to the labours of Dr. Gray more than to any other man living. It is a source of unfailing regret that the benefit of his works is very much overlooked, in consequence of his not conforming to the principles of nomenclature published under the auspices of the British Association (Reports, 1842, pp. 105–121).

nary students to make use of the information they afford. But in the part of South America to which our present inquiries are directed, which is mainly from Panama to the Bay of Guayaquil, it does not appear that M. D'Orbigny himself traveled. The shells quoted from this coast were principally collected by M. Fontaine, or copied from the descriptions of Mr. Cuming's stores. Those which are connected with the West North American province are as follow. The numbers refer to the "List of the Shells of South America in the Collection of the British Museum. 1854." Some notes are added on doubtful species, from a study of the specimens.

No.
279. Turritella Broderipiana, *D'Orb.* Peru, Payta.
= T. goniostoma, *Val.*
301. Natica glauca, *Val.* = N. patula, *Sow.* Peru, Payta.
320. Cypræa nigropunctata, *Gray.* Payta.
345. Columbella lanceolata, *Sow.* Peru, Payta.
356. Purpura hæmastoma, *Lam.* Brazils.
These specimens are of the *P. Floridana* type, punctured like the Mazatlan *P. biserialis,* but with the tubercles not developed. Some of the shells appear to be the true *P. undata,* Lam.
359. —— scalariformis, *Blainv.* Guayaquil.
= Cuma kiosquiformis, var.
365. —— bicostalis, *Lam.* Brazils.
Very like No. 364, which is probably the true *P. undata* of Lam., not of Val. and C. B. Ad. Whether the Lamarckian *P. bicostalis* be this shell, or an E. Indian species, as supposed by Blainv., is not known. Reeve assigns the name to the Mazatlan shell.
373. Cerithium varicosum, *Sow.* Guayaquil.
374. —— Montagnei, *D'Orb.* Guayaquil.
(Quite distinct from *Cerithidea varicosa.*)
407. Calyptræa (Calypeopsis) quiriquina, *D'Orb.* Chili; Conception.
=(Tablet 555) *C. rugosa,* Desh., var. Probably a form of *Crucibulum spinosum.*
408. —— (——) rugosa, *Desh.* Chili.
= *C. lignaria,* Brod., non *C. rugosa,* Less. Tablet 558 is the extreme form, *lignaria*; 557, intermediate between that and 555.
409. —— (——) imbricata, *Sow.* Peru; Payta.
=*C. rugosa,* Less., not Desh. Tablets 559, 560 are the true *Crucibulum imbricatum*: 561, ? do. var. *Broderipii*; 556, ?? do. var. *Cumingii.*
410. —— (——) auriculata, *D'Orb.* Peru; Payta.
=*Crucibulum spinosum,* Sow., not *P. auriculata,* Chemn.
411. —— (Trochatella) trochiformis, *D'Orb.*=T. radians, *Lam.* Chili and Peru.
412. —— (——) mammillaris, *D'Orb.* Peru; Payta—Guayaquil.
= *Galerus unguis,* Brod., not *G. mammillaris,* Brod.
415. Crepidula aculeata, *Gmel.* Brazils; Patagonia.
416. —— Patagonica, *D'Orb.* Patagonia.
Probably = *C. dilatata,* var. Some species are perhaps *C. nivea,* var.
417. —— protea, *D'Orb.* East coast; Patagonia; Brazils.
Tablet 573, probably dead specimens of *C. incurva,* or *onyx,* or both.
" 574 " " *C. nivea.*
419. —— foliacea, *Brod.* Bolivia.
Possibly a var. of *C. dilatata*; like *C. Lessonii* of *C. nivea.*
420. —— arcuata, *Brod.* Peru; Payta.
Probably = *C. dilatata,* var.
440. Acmæa scurra, *Less.* Chili, Arica (on Fucus).
= *Scurria mitra,* Gray, from Less. and Esch.
441. —— scutum, *Esch.* Chili; Bolivia; Peru.
=*A. patina,* var.
449. Patella maxima, *D'Orb.* Peru; Payta.
=*P. Mexicana.*

No.
482. Pholas curta, *Sow.* "Ecuador; Isle de los Leones."
This island is in Veragua, teste Cuming. The shell is probably copied.
545. Donax radiata, *Val.* [?] Peru; Arica.
587. Venus planulata, *Sow.* Chili; Coquimbo.
607. —— Solangensis, *D'Orb.* Ecuador; Xipixapi.
=*Cytherea radiata*, Sow.
608. —— Paytensis, *D'Orb.* Peru; Payta.
=*Cytherea affinis*, Brod.
610. —— neglecta, *Gray.* Peru; Payta.
611*.—— Californiensis, *Brod.* (non *Conr.*) Peru; Payta (*Fontaine*).
776. Ostrea æquatorialis, *D'Orb.* Ecuador; Guayaquil; Is. de la Luna.

34. M. Paul Emile Botta, who has since acquired such deserved reputation for his Assyrian researches, appears to have been a naval surgeon in early life, and is quoted by French writers for several shells belonging to the W. American faunas. The habitats assigned are in some instances correct, but error has evidently crept into others.

	p.	No.
Pyrula bezoar, *Lam.* China. "California, *Botta.*" Blainv. Ann. Nouv. du Mus.	234	68
Purpura chocolatta. [S. America.] California, *Botta*	240	80
—— cornigera [= Mon. brevidentatum, *Gray*]. Mazatlan, *Botta*, (fragment)	213	28
—— fusiformis. N. Guinea, *Lesson & Garnot.* Mazatlan, *Botta.* M. Botta's shell, if from Mazatlan, is probably the allied *Fusus pallidus.*	229	61
—— triangularis. Mazatlan, 1 sp.	223	466
—— triserialis. California, 1 sp.	226	53
—— spirata. Sandwich Islands	252	105
—— columellaris. Chili	220	40
—— costata. Mazatlan, 1 sp.	231	63
Pleurotoma maura. Mazatlan *Kiener*	59	37
—— Bottæ. Mazatlan, 1 sp. *Kiener*	26	33

35. M. Blainville, in his Monograph of *Purpura*, "Nouvelles Annales du Muséum," 1832, vol. i. pp. 189–263, besides the species brought by M. Botta, describes the two following, of which one, probably both, are from the West N. American coast. This accurate work, which does not seem to have been fully understood by recent English authors, or allowed priority by writers in his own country, contains a very interesting analysis of the geographical distribution of the tribe.

Page.	No.	Pl.	Fig.	
238	75	11	11.	Purpura biserialis = bicostalis, *Rve.*; not P. bicostalis, *Lam.* teste *Blainv.*
232	65	11	9.	—— costularis, *Lam.* closely resembles Murex nux, *Rve.*

36. In Guérin's Magasin de Zoologie for May 1833, appear figures and descriptions of the following shells, by M. Duclos.

Pl.	Fig.	
22	1.	Purpura sanguinolenta, *Ducl.* =Pollia hæmastoma, *Gray.*
22	2.	—— truncata, *Ducl.* =Monoceros muricatum. Chili. [!] (Voy. Ven. pl. 9. f. 2, 2*a.*)
†1	3.	—— nympha. [?=costata, *Blainv.*]
1	5.	—— kiosquiformis. N. Holland. [!]
1	6.	—— angulifera. [=Cuma tectum.]
2	8.	—— centiquadra, *Val. MS.*= speciosa, *Val.* Voy. Ven.= triserialis, *Blainv.*
20		Oliva polpaster, *Ducl.* [?=Cumingii, *Rve.* var.] Panama.

† This plate and the next are marked "Ann. Sc. Nat. vol. 26." The writer says that they are from the vol. for May 1832.

37. In the "Journal of Researches into the Geology and Natural History of the various countries visited by H.M.S. Beagle, under the command of Capt. Fitzroy, R.N., 1832–1836: by Ch. Darwin, M.A., F.R.S., London, 1839," chap. 19, pp. 453–478, is an extremely interesting account of the zoology of the Galapagos (which were visited in Sept. 1835), particularly of the reptiles; but no lists are given of the shells collected. The list of the Galapagos Mollusca, drawn out by Mr. Darwin with the assistance of Mr. Cuming, was unfortunately not preserved; and the collections were distributed without any catalogue having been made of them.

38. Perhaps the earliest specimens of U. Californian shells seen in this country were those sent from Oregon by Lady Katherine Douglas (now Lady K. Wigram). It would appear that that lady procured shells wherever she could, as some are well known to be from the Sandwich Islands, and many belong to the Gulf Fauna. The collection therefore needs careful sifting before it can be regarded as of any geographical authority. It contains, however, several very interesting and new shells, which have not even yet been found again by subsequent travelers. The following are the species that have been observed.

Lutraria maxima, Mid. Calif. and Columbia R. =*Tresus maximus*, Gray. =*Mactra maxima*, Rve. C. I. 1; 4.
Tellina nasuta, Conr. R. Col.
Tellina inquinata, Desh.
Tellina, like *Dombeyi*. R. Col.
Saxidomus squalidus, Desh. Cal. and R. Col. "Copiapo, Chili," Desh. in B. M. Ven. Cat. p. 188. no. 5.
Saxidomus Nuttalli, R. Col.
Chione neglecta, Gray. Cal. and R. Col.
Chione ruderata, Desh. Cal.
Trigona mactroides [?*radiata*, jun.]. Cal.
Mactra similis, Gray.
Cardium Nuttallianum. Fort Simpson.
Mytilus ? *edulis*. Cal. and R. Col.
Mytilus Californianus, Conr. [?].
Pectunculus Californicus.
Pectunculus, like *maculatus*.
Spondylus ?
Placunanomia cepio, Gray, Cat. Anom. B. M. p. 11. no. 6. "California, Lady Katherine Wigram."
Placunanomia alope, Gray, Cat. Anom. B. M. p. 12. no. 7. "California, Lady Katherine Wigram."
Anomia lampe, Gray, Cat. Anom. B. M. p. 19. no. 14. "California, Lady Katherine Wigram."
Chiton Sitkensis, Rve. (non Mid. =*Stelleri*, Mid.) Cal.
Katherina Douglasiæ, Gray =*Chiton tunicatus*, Sow. Cal.
Haliotis rufescens (and others).
Ziziphinus filosus.
Turbo fluctuatus.
Nerita ? *scabriuscula*.
Neritina picta.
Hipponyx, sp. ind.
Turritella goniostoma.
Cerithium maculosum.
Trivia suffusa. R. Col.
Trivia Solandri.
Torinia areola, Desh. [?] :=*T. variegata*, Maz. Cat. p. 407.
Natica bifasciata, Gray.
Natica, like *maroccana*.
Neverita, sp. ind.
Cancellaria reticulata, Lam. (appears a worn *C. urceolata*).
Oliva ? *venulata*.
Olivella lineolata.
Mitra, like *tristis*.
Columbella, like *fuscata*.
Columbella hæmastoma, Sow. Cal.
Columbella strombiformis. Sandw. Is. [?]
Columbella castanea.
Columbella pygmæa.
Purpura crispata, resembles *lapillus*.
Purpura crispata, varieties. Cal. & R. Col.
Purpura Conradi, Nutt. R. Col.
Purpura, n. s. (smooth, like *Buccinum*). Cal. The same species appears as "W. Coast America, Hinds."
Nassa tiarula, Kien. =*tegula*, Rve.
Fusus carinatus. "Labrador."
Fusus Dupetithouarsii.
Murex trialatus, Sow.

39. During the years 1834–5, Thomas Nuttall, Esq., for many years Professor of Natural History at Harvard University, Cambridge, U.S., visited the then almost unsearched shores of California, by a journey across the Rocky Mountains under the escort of a trading company. Although his

object was principally botanical, his love of natural science induced him to collect all the shells he could meet with; and with such good success, that many of his species have not to this day been again discovered. The peculiar interest attaching to his researches is, that he did not visit any part of the coast north of Oregon or south of San Diego. There is no danger, therefore, of any admixture with the shells of the Gulf district; and his collections may be regarded as the type of the Californian fauna strictly so called. Leaving the American shores, Mr. Nuttall visited the Sandwich Islands, whence he only brought one species belonging to the American fauna, viz. *Hipponyx Grayanus*, on a *Pinna*. On his return to the United States, *viâ* Cape Horn, the description of the marine shells was undertaken by Mr. T. A. Conrad, and of the land and freshwater species by Mr. Lea. The latter gentleman communicated his paper to the American Philosophical Society, where it will be found in the 'Transactions,' vol. vi.; Mr. Conrad read his paper before the Academy of Natural Sciences of Philadelphia, in Jan. and Feb. 1837. It is published in the second part of the 'Journal' of the Society, vol. vii. pp. 227–268*. Although headed "Descriptions of New Marine Shells, from Upper California, collected by Thomas Nuttall, Esq.," it also contains not only descriptions of several of Mr. Nuttall's Sandwich Island shells and *Hinnita Nuttalli*, from Fayal†, but also shells from places never visited by him, as *Lyonsia inflata*, Guayaquil, Dr. Burrough; *Vulsella Nuttalli*, from the Friendly Islands; and *Tellina lintea*, a fossil from Mobile Point, Alabama. The work bears the appearance of undue haste; the genera are grouped together without the least regard to arrangement; a large proportion of the species are named either *Californicus* or *Nuttalli*; the difficult genera, such as *Acmæa* and *Chiton*, are not touched; the localities cannot always be depended on, as *e. g.* when *Perna Californica* is said to inhabit the *Sandwich Islands*; and the descriptions being in English would not have been entitled to claim precedence were it not that they are accompanied by tolerably recognizable figures. The characteristic names and very elegant and accurate descriptions of plants from the pen of Mr. Nuttall in the same volume, make us greatly regret that he performed his conchological work by proxy. But the confusion does not end here. Mr. Nuttall, having reserved a small part of his collections for his own use, transferred the bulk of them to Dr. Jay, accompanied by MS. names for the shells passed over by Conrad. These have been printed in Jay's Catalogue, but without descriptions, with the addition of some not in the least remembered by Mr. Nuttall. Under these names they were sent to Mr. Cuming and others, and have taken their chance of admission into the monographs‡. Meanwhile Mr. Nuttall returned to England (where he now resides on his estate, Nut Grove, Rainhill, near Liverpool), and continued to distribute the shells under MS. names; but not having access to Conrad's work, the names of that author were often lost, and others substituted in their place. So little is Conrad's paper known, that M. Deshayes redescribed several of the most characteristic species; Dr. Dunker complained that he had never been able to see it;

* Part i. of the same volume bears date 1834.

† It is generally supposed that the *Hinnites Poulsoni*, which is described and figured by Conrad in the same volume of the Journal, and is the *H. giganteus*, Gray, is assigned to Fayal. The two species have been confounded, as the locality of *H. Poulsoni* was not known.

‡ Of the species only existing in Dr. Jay's Catalogue, and which therefore have no claim to priority, I am unable to give any information. I have requested that celebrated conchologist (through Dr. Gould) to furnish the public with either figures or descriptions of them, but have not yet received a reply. From the redescription of several of them by Dr. Gould, they would appear not to be well known even by the naturalists of his own country.

and Philippi states that it is not to be found even in the Royal libraries at Berlin or Gottingen. Having fortunately obtained access to a copy of the paper, and compared it with Mr. Nuttall's own shells*, and at the same time with those brought by the officers of the Mexican war, I offer the following as the best statement that present circumstances will permit. It should be premised that Mr. Conrad, in the 'Journal' for 1849, made several emendations of his paper which have been here incorporated. The new species are described in the 'Proc. Zool. Soc.' 1856, pp. 209–229.

No.	Page.	Plate.	Fig.	Name.	Locality.	Station.
1	236	18	5, 6	Parapholas† Californica, *Conr.* .... =*Pholas C.*, Conr. à pr. man.; Sow. Thes. =*Pholas Janellii*, Desh. Rev. 1839, p. 357; Guer. pl. 14–16; Chen. pl. 3. f. 5; Jay's Cat. No. 162.—Mus. Nutt., Cum., Brit.	Sta. Barbara.	clay rocks.
2	237	18	7	——† penita, *Conr.* .... =*Pholas p.*, Conr. à pr. man. =*Pholas concamerata*, Desh. Rev. 1839, p. 357; Guer. pl. 17; Chen. pl. 3. f. 4; Jay's Cat. 186.—Mus. Gould.	Sta. Barbara.	clay rocks.
3	236	18	2	Platyodon‡ cancellata, *Conr.*, *Jay's Cat.* 265. —Mus. Nutt., Brit.	Sta. Barbara.	muddy marshes and soft rocks.
4	235	18	1	Cryptodon§ Nuttallii, *Conr.* .... ?=*Cypricia Nuttallii*, quasi Conr.—B.M. Non *Mactra Nuttallii*, Rve. Conch. Ic. pl. 21. sp. 125.—Mus. Nutt., Brit.	Sta. Barbara.	salt marshes, bare at low w.
5	234	17	11	Sphænia Californica, *Conr.* .... =*Cryptomya Californica*, Conr. Journ. 1849, p. 208; Jay's Cat. 467.—Mus. Nutt.	Sta. Barbara.	salt marshes; rare.
6	248	19	8	Thracia curta, *Conr.*—Mus. Nutt............	Sta. Barbara.	one fine pair.
7	247	19	5	Mytilimeria¶ Nuttalli, *Conr.*, Jay's Cat. 2221.—Mus. Brit.	California.	in sponge, and thrown up attached to roots of fuci, in deep w.
8	248	19	20	Lyonsia Californica, *Conr.* .... ?=*L. hyalina*, Conr. This shell, which seems to have been lost, probably reappears as *L. nitida*, Gould: v. *infra*.	Sta. Barbara.	
9	238	18	8	Periploma argentaria, *Conr.* .... =*P. planiuscula*, Sow. 1834, teste Gld. non Cum.; Jay's Cat. 330.—Mus. Cum. Gld.	San Diego.	muddy marshes of sea-coast.
10	228	17	1	Pandora punctata, *Conr.*—Mus. Cum., Nutt.	Sta. Barbara.	single valves.

* Mr. Nuttall's silvery locks have not lessened his interest in Natural Science. His memory is singularly clear on all matters relating to his own collections; and has been allowed to turn the scale on doubtful points, in the few instances where no MS. had remained.

† It is difficult to know what Conrad means by this genus, which is described in Journ. 1849, p. 214. He afterwards calls *P. acuminata*, which is clearly congeneric, *Penitella Wilsonii*; while he applies the name *Parapholas* to *Pholadidea melanura*. It is here used according to the interpretation of Woodw. (Man. Moll. p. 329) for the *Pholadideæ* with tripartite valves, persistent cups, and large plates.

‡ *Platyodon* is described as a subgenus of *Mya*, with four testaceous valves on the ends of the tubes.

§ *Cryptodon* is described as a subgenus of *Lutraria*, with two corneous valves, which close the orifices of the tubes.

¶ *Mytilimeria*, as appears from type valves in the Brit. Mus., received from Conrad, is a subgenus of *Lyonsia* (not a synonym for it) with spiral umbos, regular rounded form, and very slight ligamental pit.

No.	Page.	Plate.	Fig.	Name.	Locality.	Station.
11	231	17	8	Solecurtus lucidus, *Conr.* .... =*S. radiatus*, Gld. non Linn. (teste Conr. 1849). =*Siliqua lucida*, Conr. Journ. Aug. 1849. *Machæra lucida*, Jay, 238.—Mus. Nutt., Br.	Sta. Barbara.	rare.
12	232	17	9	Solecurtus Nuttallii, *Conr.* .... =*Siliqua Nuttallii*, Conr. Aug. 1849. =*Solen splendens*, Chen. teste Conr. =*Machæra maxima*, Gould, Jay's Cat. 239; non Wood, teste Conr.—Mus. Nutt.	Columbia R.	salt marshes, near Pt. Adams.
13	233	17	10	Cultellus subteres, *Conr.* [Subg. described.] *Solecurtus subteres*, Jay, 236. — Mus. Nutt., Brit.	Sta. Barbara.	
14	233	18	3	—— Californianus, *Conr.* .... *Solecurtus Californianus*, Jay, 221.—Mus. Nutt., Brit.	Sta. Barbara.	muddy salt marshes: common.
15	241	18	13	Psammobia Pacifica, *Conr.*, Jay, 500 (Columbia R.). [*Sanguinolaria.*]—Mus. Br.	San Diego.	deepish water, sandy bottom.
16	230	17	6	Sanguinolaria Nuttallii, *Conr.*, Jay, 488, 489. —Mus. Nutt., Cum. =*Psammobia decora*, Hds.	San Diego.	marshes.
17	231	17	7	—— Californiana, *Conr.* .... Var. A. "May prove distinct."—Mus. Nutt.	Columbia R.	muddy marshes, brackish.
18				—— rubro-radiata, *Conr.*, *Nutt. MS.*—Mus. Nutt. Appears to have been overlooked. Allied to *Psammobia*.	California.	
19	239	18	11	Amphidesma rubrolineata, *Conr.* .... =*Semele simplex*, A. Ad. ?ubi. — Mus. Gld., Cuming.	San Diego.	deep water.
20	239	19	2	—— decisa, *Conr.* .... =*A. roseum*, Gld. [? non Brod. & Sow.); Jay, 443.—Mus. Nutt., Brit., Cum.	San Diego.	deep water.
21	234	17	12	Cumingia Californica, *Conr.*, Jay, 457.—Mus. Cum., Brit.	Sta. Barbara.	rare.
22	258			Tellina alta, *Conr.*, Jay, 520 .... ? =?*Scrobicularia biangulata*, Cpr.*—Mus. Nutt. P. Z. S. 1855, p. 230.	Sta. Barbara.	
23				—— edentula, *Brod. & Sow.* —Mus. Nutt., Cum. &c.	Columbia R.	"Grows very large, and is eaten by the Chinhooks."—*Nutt.*
24	258			—— nasuta, *Conr.*, Jay, 592. Columbia River. Jay's habitat is likely to be more correct than Conrad's, as this is one of the Okotsk species.	San Diego.	
25	257			Tellina secta, *Conr.*† .... =*T. ligamentina*, Desh. in Guer. Mag. 1843, pl. 81; Jay, 633.—Mus. Nutt.	San Diego.	muddy marshes.
26				Strigilla carnaria, *Linn.*‡	California.	not uncommon.
27	254	19	21	Donax Californica, *Conr.*, Jay, 699.—Mus. Nutt., Brit., Cum. &c. =*Donax obesa*, Phil. Zeit. f. Mal. 1851, p. 75. no. 2. (non Desh.)	Sta. Barbara.	sand.

* The *T. alta* is lost in this country. There is no figure in Conrad. In genera that are loosely defined, there is a danger of species reappearing under two heads, as in the case of *Psammobia decora*, Hds., which however was figured. The biangulate character assigned to *T. alta* makes the ?*Scrobicularia* suspected.

† There is a *Tellina Californica*, as of Conr., in the Brit. Mus., which is probably identical with one of these published species.

‡ This species has been overlooked in the Monograph, P. Z. S. *Vide* Br. Mus. Maz. Cat. *in loco*.

No.	Page.	Plate.	Fig.	Name.	Locality.	Station.
27	254	19	21	Donax Californica (*continued*). = *D. obesus*, Gld., quasi nov. sp. Non *D. Californicus*, Desh. in Mus. Cum. = *D. Conradi*, var. jun.		
28	240	18	12	Mactra Californica, *Conr.*—Mus. Gould ...	Sta. Barbara.	muddy marshes bare at low water: rare.
29	240			—— planulata, *Conr.* (Appears to be lost.)	Sta. Barbara.	
30	256	20	9	Petricola Californica, *Conr. Journ.* Aug. 1849; *Desh. Cat. Ven.* p. 208. no. 3. *Saxicava C.*, Conr. à prim. man.; Jay's Cat. 460.—Mus. Gould, Cum. = *Petricola arcuata*, Desh. Rev. Cuv. Dec. 1839, p. 358.	Sta. Barbara & San Diego.	
30*b*	255	20	8	—— carditoides, *Conr. Journ.* Aug. 1849. *Saxicava c.*, Conr. à pr. man.—Mus. Nutt., Gld. Non *Venerupis carditoides*, Lam. An. s. Vert. vol. vi. p. 164. no. 7; Desh. B.M. Cat. Ven. p. 192. no. 7. = *P. Californica*, var. teste Nutt. Comp. *Petricola cylindracea*, Desh. Rev. Cuv. 1839, p. 358; B.M. Cat. Ven. p. 208. no. 5. Comp. *Petricola gibba*, Mid. Mal. Ross. p. 57. pl. 18. f. 5–7.	Sta. Barbara.	one valve.
31	251	19	19	Venus lamellifera, *Conr.* [Rupellaria.] ...... = *Venerupis Cordieri*, var. β, Desh. Cat. Ven. p. 191. no. 1. = *Petricola Cordieri*, Desh. Rev. Cuv. 1839, p. 358.—Mus. Cum., Nutt., Gld.	San Diego.	one valve.
32				? Tapes tumida, *Conr*. .... *Mysia tumida*, Conr. teste Nutt. MS.—Mus. Nutt.	Sta. Barbara.	one sp.
33	250	19	14 (non 15)	Venus staminea, *Conr*. .... *Tapes straminea*, Sow. Thes. Conch. p. 699, pl. 151. f. 151. = *Venus dispar*, Gld. MS.—Mus. Brit., Nutt., Cum.	Sta. Barbara & San Diego.	
34	249	19	12	Saxidomus Nuttalli, *Conr.* [Genus described.] *Desh. Cat. Ven.* p. 188. no. 4. = *Venerupis gigantea*, Desh. Rev. Cuv. 1839, p. 359, teste Jay. = *Pullastra gigantea*, Catl. Conch. Nom. p. 41. = *Saxidomus giganteus*, Desh. Cat. Ven. p. 187. no. 2. Comp. *Saxidomus Petiti*, Desh. Cat. Ven. p. 189. no. 7; Jay, 481.—Mus. Nutt., Cum. [The species described from the Californian *Saxidomi* are unsatisfactorily made out; depending on differences in sculpture which appear variable.]	"California and San Diego."	"burrowing into soft claystone."
35	253	19	17	Trigonella crassatelloides, *Conr*. .... Subgenus indicated: described Journ. 1849, p. 213. *Trigona crassatelloides*, Desh. Cat. Ven. p. 46. no. 1. = *Cytherea solidissima*, Phil. Z. f. M. 1851, p. 74. no. 100. *Cytherea crassatelloides*, Jay, 847. Mus. Nutt., Gld., Brit., Cum.	San Diego and Sta. Barbara.	1 foot deep in the sand, common.

No.	Page.	Plate.	Fig.	Name.	Locality.	Station.
36	252			Cytherea callosa, *Conr.* [Dosinia.] .... Non *Chione callosa*, Desh. Cat. Ven. p. 135. no. 48. Non *Venus Stuchburyi*, Jay's Cat. 1080. —Mus. Nutt.	Sta. Barbara.	common: broken by gulls.
37	250	19	15 (non 14)	Venus Nuttalli, *Conr.*, Jay, 1037.—Mus. Brit., Nutt., Cum. *Chione Nuttallii*, Desh. Cat. Ven. p. 135. no. 47. + *Chione callosa*, Desh. no. 48, pars.	Sta. Barbara & San Diego.	
38	251	19	16 (non 15)	—— Californiana, *Conr.* [quasi *Sow.*] ...... = *Venus Californiensis*, Brod. P.Z.S. 1838. *Chione Californiensis*, Desh. no. 44. = *Venus leucodon*, Sow. teste Desh.—Mus. Brit., Cum., Nutt.	San Diego.	muddy marshes.
39				—— simillima, *Sow.*, *Desh. Cat. Ven.* p. 133. no. 43.—Mus. Nutt.	California.	one sp.
40				—— (Chione) excavata, *Cpr.*—Mus. Nutt.	San Diego.	one sp.
41	236	18	4	Cypricardia Californica, *Conr.** .... = *C. Duperryi*, Desh. Rev. Cuv. 1839, p. 359. teste Gld.—Mus. Nutt.	San Diego and Sta. Barbara.	soft clay rocks, bare at low water.
42	256			Chama exogyra, *Conr.*, Jay 2110.—Mus. Nutt., Cum., Brit., Gld.	Sta. Barbara & San Diego.	on rocks.
43				——? frondosa, var. Mexicana. — Mus. Nutt.	Sta. Barbara.	one young sp.
44				—— pellucida..................................	Sta. Barbara.	one very fine sp.
45	229	17	3	Cardium Nuttallii, *Conr.*, Jay, 1177.—Mus. Nutt., Brit.	Sp. San Juan di Fuca.	muddy marshes.
45*b*	229	17	4	—— Californianum, *Conr*..................... = *C. Nuttallii*, var. teste Midd. Mus.——? Non *C. Californiense*, Desh. teste Midd.	Sta. Barbara.	single valves, rare.
46	230	17	5	—— quadragenarium, *Conr.*, Jay, 1197–98. (Not known in England.) Comp. *C. xanthocheilum* = *luteolabrum*, Gld.	Sta. Barbara.	rare.
47	228	17	2	—— substriatum, *Conr.*, Jay, 1222.—Mus. Nutt.	San Diego.	muddy marshes, bare at low water.
48	254	19	11	Lucina bella, *Conr*........................... = *L. pecten*, var. teste Jay [?] Cat. 682.	San Diego.	muddy marshes, bare at l. w.: common.
49	255	20	1	—— Californica, *Conr.*, Jay, 662	San Diego.	ditto: rare.
50	255	20	2	—— Nuttalli, *Conr.*, Jay, 680.—Mus. Nutt.	San Diego.	muddy marshes, &c.
51				Diplodonta orbella, *Gld.* .... ? = *D. semiaspera*, var. — Mus. Nutt., Gld.	Sta. Barbara.	muddy æstuary, 1 sp.
52				Anodon Nuttalliana, *Lea*, Trans. Am. Phil. Soc. vol. vi. pl. 20. f. 62; Jay, 2059. —Mus. Nutt.	Wahlamat R., Oregon.	
53				—— Oregonensis, *Lea*, Trans. Am. Phil. Soc. vol. vi. pl. 21. f. 67; Jay, 2061.	Wahlamat R., Oregon.	
54				—— Wahlamatensis, *Lea*, Trans. Am. Phil. Soc. vol. vi. pl. 20. f. 64; Jay, 2084.	Wahlamat R., Oregon.	
55	242			Modiola capax, *Conr.*, Jay, 2153.—Mus. Cum., Gld., Brit.	Sta. Barbara.	marshes and muddy shores.
56	243	19	1	—— recta, *Conr.*—Mus. Gld..................	Sta. Barbara.	rare.
57				Mytilus edulis, *Linn.*, (*a*) normalis, (*b*) pellucidus, (*c*) latissimus.—Mus. Nutt.	U. California.	
58	242	18	15	Mytilus Californianus, *Conr.*, Jay, 2185.—Mus. Gld.	Sta. Barbara, Monterey, San Diego.	on rocks.

* Mr. Hanley thinks that this shell may be the *C. Guiniaca* of Lamarck. This is extremely unlikely, as there is no evidence that Lam. was acquainted with a single strictly Californian species.

No.	Page.	Plate.	Fig.	Name.	Locality.	Station.
59	241	18	14	Mytilus bifurcatus, *Conr.*, Jay, 2184......... No knowledge of the locality of this shell exists, except the statement of Conrad, which alone is not binding, and its appearance among the Mexican War shells, the collectors of which brought home nothing from the Sandwich Islands.	" Sandwich Is."	"on rocks, bare at low water."—*Conr.*
60	246			Perna costellata, *Conr.*, Jay, 2267.—Mus. Nutt. " Sta. Barbara." Conrad, who rightly assigns his *P. Californica* to the Sandwich Islands, appears to have made an error in assigning the Californian species to the same place.	"Sandwich Is."	"under stones." *Conr.*
61	238	18	9	Pecten latiauratus, *Conr.*, Jay, 2364.—Mus. Nutt., Cum.	San Diego and Sta. Barbara.	below efflux of tide.
61*b*	238	18	10	—— Monotimeris, *Conr*........................ =*P. latiauratus*, var. teste Nutt.; Jay, 2374.	San Diego and Sta. Barbara.	below efflux of tide. Young attached to Fuci by byssus.
62				Ostrea conchaphila, *B.M. Maz. Cat.* no. 214. —Mus. Nutt. &c.	Oreg., S. Diego.	
63				Bulla nebulosa, *Gld.*—Mus. Gould, Cuming, Nutt., Brit.	Sta. Barbara.	
64				Helix Californiensis, *Lea*, Trans. Am. Phil. Soc. vol. vi. p. 99. pl. 23. f. 79, 84. +*H. Nickliniana*, Lea, teste Jay, 3452.	Columbia River.	
65				—— Columbiana, *Lea*, Trans. Am. Phil. Soc. vol. vi. p. 89. pl. 23. f. 75; Jay, 3552.	Columbia River, Ft. Vancouver, Nootka Sd.	
66				—— Nuttalliana, *Lea*, Trans. Am. Phil. Soc. vol. vi. p. 89. pl. 23. f. 74. =*H. fidelis*, Gray, P.Z.S. 1834, p. 67; Jay, 3668.	Ft. Vancouver, Nootka Sd. Oregon.	
67				—— Oregonensis, *Lea*, Trans. Am. Phil. Soc. vol. vi. p. 89. pl. 23. f. 85; Jay, 4095.	Oregon.	
68				—— Vancouverensis, *Lea*, Trans. Am. Phil. Soc. vol. vi. p. 87. pl. 23. f. 72; Jay, 4524.—Mus. Nutt.	Oregon.	
69				—— Townsendiana, *Lea*, Trans. Am. Phil. Soc. vol. vi. p. 99. pl. 23. f. 80.—Mus. Gld., Cum.	Oregon.	
70				Succinea Oregonensis, *Lea*, Trans. &c. 1841, p. 32; Jay, 5734.	Oregon.	
71				Limnæa Nuttalliana, *Lea*, Trans. &c., 1841, p. 9; Jay, 6316.	Oregon.	
72				Physa, *sp. ind.*—Mus. Nutt.	Oregon.	
73				Planorbis subcrenatus, *Cpr.*—Mus. Nutt....	Oregon.	1 sp.
74				Chiton Nuttalli, *Cpr.**—Mus. Nutt., Cum., ?Br.	Monterey.	
75				—— acutus, *Cpr.**—Mus. Nutt.	Sta. Barbara.	
76				—— ornatus, *Nutt. MS.*—Mus. Nutt. ...... ?=*Ch. armatus*, Nutt. in Jay's Cat. 2678: =*Ch. muscosus*, Gld.	San Diego.	
77				Acmæa patina, *Esch.*—Mus. Nutt., Cum., Br., Gld. &c. =*Patella fenestrata*, Nutt. in Jay's Cat. 2815. +*P. mamillata*, Nutt. in Jay's Cat. 2839.	U. California.	

* In the Brit. Mus. appears an undescribed "*Chiton consimilis*, Nutt." It is probably one of these species, which were described from Mr. Nuttall's own specimens. There is also a *Chiton Californicus*, Nuttall, MS., in Rve. Conch. Ic. pl. 16. fig. 89.

No.	Page.	Plate.	Fig.	Name.	Locality.	Station.
77				Acmæa patina (*continued*). +*P. tessellata*, Nutt. in Jay's Cat. 2885. ?+*P. diaphana*, Nutt. in Jay's Cat. 2813 (? non *P. diaphana*, Rve.*).		
78				—— pelta, *Esch.*—Mus. Nutt., Cum. Brit., Gld. &c. =*Patella leucophæa*, Nutt. MS.; Rve. Conch. Ic. pl. 34. sp. 101; non *P. leucophæa*, Gmel., Jay's Cat. 2827. ?+*P. monticola*, Nutt. MS.=*P. monticolor*, Jay's Cat. 2844. +*P. strigillata*, Nutt. MS.; Jay, 2881.	U. California.	
79				—— persona, *Esch.*—Mus. Nutt., Cum., Br., Gld. &c. =*Patella Oregona*, Nutt. MS.=*P. Oregana*, Jay's Cat. 2852. +*P. umbonata*, Nutt. MS.; Jay, 2887. +*P. pileata*, Nutt. MS.; Jay, 2861.	Oregon.	
80				—— scabra, *Nutt. MS.*—Mus. Nutt., Cum., Brit., Gld. &c. *Lottia scabra*, Jay's Cat. 2907. *Patella scabra*, Rve. Conch. Ic. pl. 37. f. 119 *a, b*. Non *P. L. scabra*, Gld. Exp. Shells, p. 10.	San Diego, &c.	
81				—— spectrum, *Nutt. MS.*—Mus. Nutt., Cum., Brit., Gld. &c. *Patella spectrum*, Jay, 2877; Rve. Conch. Ic. pl. 29. f. 76 *a, b*. =*P. L. scabra*, Gld., non Nutt.†	California.	
82				Scurria mitra, *Esch. & Less.*—Mus. Nutt., Cum., Brit. Gld., &c. =*Patella scurra*, Less. Voy. Coq. 1830, p. 421. no. 198. =*Acmæa mitra*+*mammillata* [non Nutt.] +*marmorea*, Esch. =? *Lottia pallida*, Gray, Z. B. V. p. 147. pl. 39. f. 1.	Monterey.	common.
83				Fissurella ornata, *Nutt. MS.*—Mus. Nutt., Brit. Jay, 3003 (St. Helena, err.)	U. California.	
84				Glyphis aspera, *Esch.* .... =*Fissurella densiclathrata*, Rve. teste Cum.—Mus. Nutt., Cum. =*F. exarata*, Nutt. MS. =*F. cratitia*, Gld.	Sta. Barbara.	
85				Lucapina crenulata, *Sow.* Conch. Ill. no. 19. f. 31, 38; Tank. Cat. App. p. vi; Rve. Conch. Ic. pl. 3. sp. 18.—Mus. Jay, Nutt., Cum.	San Diego.	
86				Haliotis Californiensis, *Swains.* Zool. Ill. vol. ii. pl. 80.	San Diego.	
87				—— Cracherodii, *Leach*, Rve. Conch. Ic. pl. 7. f. 23.—Mus. Jay, Nutt. =*H. glaber*, Schub. and Wagn. pl. 224. f. 3086–7.	San Diego.	
88				—— splendens, *Rve.* Conch. Ic. pl. 3. f. 9...	San Diego.	
89				Pomaulax undosus, *Wood.* .... =*Trochus Californianus*, Nutt. MS.—Mus. Nutt., Cum., Brit.	Monterey.	

* For other references to this species, *v. supra*, p. 173.

† Of *Patella lævigata*, Nutt. MS. in Jay's Cat. 2825, Mr. Nuttall can give no information. It is probably one of the many forms of *A. patina*. The above arrangement is satisfactory to Mr. Nuttall, after a re-examination of his shells in connexion with the collections of Dr. Gould.

No.	Page.	Plate.	Fig.	Name.	Locality.	Station.
90				Trochiscus Norrisii, *Sow*. .... =*Turbo rotelliformis*, Jay.—Mus. Nutt., Brit., Cum.	Monterey.	
91				Trochus filosus, *Wood*, Suppl. pl. 5. f. 23 (malè). =*T. castaneus*, Nutt. MS.; Forbes, P.Z.S. 1850. =*T. ligatus*, Gould, Exp. Sh. p. 55. Var. =*T. doliarius*, Gld. MS. ? non Chemn. ? Var. =*T. virgineus*, Gld. MS.? non Chemn. =*Ziziphinus annulatus*, A. Ad. ? non Mart. in Lam. An. s. Vert. ix. 144. no. 51. —Mus. Nutt., Gld., Cum., Brit.	Monterey.	
92				Omphalius ater, *Less*.—Mus. Nutt., Cum., Brit. &c. ? Var. =*Trochus gallina*, Forbes.	California.	
93				—— fuscescens, *Phil.* .... =*Trochus luridus*, Nutt. MS.—Mus. Nutt., Brit., Cum.	Sta. Barbara.	
94				—— marginatus, *Nutt. MS.*, in P. Z. S. 1851, p. 181. no. 11*.—Mus. Nutt., Brit., Cum.	U. California.	
95				—— aureotinctus, *Forbes* .... ? =*Trochus pallidus*, Nutt. MS.—Mus. Nutt., Brit., Cum., Gld. =*T. cateniferus*, Potiez, teste Gld.	U. California.	
96				Crepidula rugosa, *Nutt. MS.;* Jay, 3036. —Mus. Nutt., Cum. =*C. onyx*, var. teste Jay [?].	U. California.	
97				——, *sp. ind.*—Mus. Nutt., Jay. .... =*Crepidula navicelloides*, Nutt. MS. ? Jun. =*Cr. minuta*, Mid. Mal. Ros. p. 101. pl. 11. f. 6, 7. ? Var. =*Cr. nummaria*, Gld., Exp. Sh. p. 15; Jay, 3035.—Mus. Cum., Gld.	U. California.	
98				—— *explanata*, Gld. .... =*Crepidula exuviata*, Nutt. in Jay's Cat. 3027. =*Cr. perforans*, Val.—Mus. Jay, Cum., Gld. ? =*Cr. navicelloides*, var.	U. California.	
99				—— aculeata, *var*. .... =*Crepidula Californica*, Nutt. MS.—Mus. Nutt., Brit., Warrington, &c.	Sta. Barbara.	common.
100				Crucibulum spinosum, *Sow*.—Mus. Nutt....	Monterey.	very rare.
101				Hipponyx Grayanus, *Mke*. .... =*H. radiatus*, Gray.—Mus. Nutt.	California.	very rare.
102				Spiroglyphus, *sp. ind.*—Mus. Nutt.	Sta. Barbara.	1 young sp. On *Crep. aculeata.*
103				Aletes squamigerus, *Cpr.*—Mus. Nutt., Gld.	Sta. Barbara.	
104				Petaloconchus macrophragma, *Cpr.*—Mus. Nutt.	San Diego.	on *Euraphia Hembeli.*
105				Cerithidea sacrata, *Gld*. .... =*Pirena Californica*, Nutt. MS.—Mus. Nutt., Brit., Gld.	Monterey, Sta. Barbara, &c.	in æstuaries.
106				Litorina planaxis, *Phil.* .... =*Littorina tenebrata*, Gld.—Mus. Nutt., Brit., Cum.	California.	

* Mr. Adams in his Monograph of the family has omitted to describe this species. It may, however, be the *Turbo marginatus* of Rve. Conch. Ic. pl. 12. f. 57.

No.	Page.	Plate.	Fig.	Name.	Locality.	Station.
107				Natica ?maroccana, *var.* Californica*.—Mus. Nutt., Brit.	U. California.	
108				Ranella triquetra, *Rve.* Conch. Ic. pl. 7. f. 41.—Mus. Nutt., Cum. Extremely like a young *Vitularia salebrosa.* Also resembles *R. muriciformis.*	San Diego.	
109				Mitra maura, *teste Nutt. MS.*—Mus. Nutt.	U. California.	
110				Olivella glandinaria, *Nutt.*—Mus. Nutt.	California.	
111				"Buccinum Poulsoni," *Nutt. MS.*—Mus. Nutt. N.B. The *Purpura dumosa,* Conr. p. 267. pl. 20. f. 20 = *porphyrostoma,* Rve. teste Jay, is not from California, as given by Jay, Cat. 8781, (Conrad being silent), but from Wahoo, Sandw. Is. teste Nutt.	U. California.	
112	267			Purpura macrostoma, *Conr.* .... =*P. aperta,* Blainv. var., teste Jay's Cat. 8942 :—Museo suo.	Sta. Barbara.	
113	266	20	25	—— harpa, *Conr.*—Mus. Nutt. Jay, 8980...	Sta. Barbara.	
114				—— emarginata, *Desh.* .... =*P. Conradi,* Nutt. MS. teste Jay's Cat. 8972.—Mus. Brit., Cum.	California.	
115	264	20	17	Monoceros engonatum, *Conr*.................. =*M. unicarinatum,* Rve. Conch. Ic. sp. 1; non pl. 1. f. 1. nec syn. plur.: non Sow. nec Desh. Comp. *Purpura spirata,* Blainv. Nouv. Ann. Mus. i. 1832, pl. 12. f. 8. p. 252. no. 105; Kien. Ic. Conch. p. 121. no. 76. pl. 38. f. 90. = *M. unicarinatum,* pars, Desh. in Lam. An. s. Vert. x. p. 124. no. 10, syn. Angl. exci.—Mus. Nutt., Brit., Jay, 9067.	Sta. Barbara.	
116	264			—— brevidens, *Conr*.......................... =*M. unicarinatum,* Sow. Conch. Ill. no. 14. p. 4. f. 5, non Rve. nec Desh. =*Monoceros,* pl. 1. f. 2 (non sp. 2), Rve. Conch. Ic. Non *M. brevidentatum,* Gray = *M. maculatum,* Gray = *Purpura cornigera,* Blainv. Jay, 9045.—Mus. Nutt., Cum.	Sta. Barbara.	
117	265	20	18	—— lapilloides, *Nutt.* .... =*M. punctulatum,* Sow. Conch. Ill. p. 4. no. 13. f. 3. =*M. punctatum,* Gray, Z. B. V. 1839, p. 124 :—Rve. Conch. Ic. sp. 2. pl. 1. f. 1 (non f. 2).—Mus. Jay 9065, Nutt., Brit., Cum. Possibly these three species are varieties of the same.	Sta. Barbara.	
118	264	20	22	Murex (Cerostoma) Nuttalli, *Conr.* [s. g. described]. Jay, 8298.—Mus. Nutt. ? = *Murex monoceros,* Sow. jun. P. Z. S. 1840, p. 143; Rve. pl. 2. f. 7.	Sta. Barbara.	

40. In the "Voyage autour du Monde, pendant les années 1836–37, sur la Bonite: Zoologie, par MM. Eydoux et Souleyet;" published without date at Paris between the years 1847 and 1851, are to be found beautiful illustrations of Cephalopoda and Pteropoda, and various plates of shells without

* Mr. Reeve figures a "*Natica plicatula,* Nutt." pl. 23. f. 107, without locality. It closely resembles No. 107, but has a straight umbilicus.

descriptions. The original types of most of these are deposited separately in the British Museum; of which the Trustees published a Catalogue in January 1855. The following are all that have been observed which enter the West N. American province; having been collected probably on the W. coast of S. America, as far north as Guayaquil, whence the vessel sailed for the Sandwich Islands.

Plate.	Fig.	
35	1–3.	*Natica glauca,* Humb. =*N. patula,* Sow.
35	4, 5.	*Natica Chemnitzii,* Récl. (non *N. Chemnitzii,* Pfr. =*N. maroccana,* Chemn. var.)
36 37	1–5. 25–31.	} *Modulus trochiformis,* Eyd. & Soul. =*M. disculus,* Phil.
39	17–19.	*Purpura undata,* Lam. var. This is not the West Indian shell, which is probably the true *P. undata.* It is doubtful whether it is a variety of the Pacific species, *P. biserialis,* Blainv.

In the British Museum Collection there also appear—

Tablet 195.	*Scurria mitra,* Less. & Esch.
„ 248.	*Cytherea ?petichialis,* Touranne.
„ 395.	"*Purpura hæmastoma,*" punctured like the *P. biserialis,* and probably identical with it. (? =*P. undata,* figured as above.)

41. In the year 1836, the Venus sailed from France under the command of M. du Petit Thouars, on a voyage of discovery round the world. The second in command was M. Chiron, who, aided by his friend M. de La Perouse, collected a large number of shells. The ship visited Callao, Payta, the Galapagos, the Bay of Magdalena, Mazatlan, San Blas, and various stations northwards as far as Kamtschatka.

After the return of the expedition in 1839, M. Chiron furnished M. Deshayes with a large number of specimens, who makes this characteristic announcement. "MM. les officiers de marine, qui ont le désir d'être utiles à l'histoire naturelle, reconnaîtront qu'en mettant les riches matériaux qu'ils rapportent entre les mains de naturalistes vraiment travailleurs, ils en font profiter de suite la science; *ce qui n'a jamais lieu* lorsqu'ils les donnent, sans discernement et en totalité, à des établissemens publics." In this country we should desire to reverse the recommendation; and consider that collectors were showing their discernment by giving the first choice of their materials, *en totalité,* to public museums where they can be consulted by students.

In the "Revue Zoologique par la Société Cuvierienne, Paris, Decembre 1839," pp. 356–361, appear Latin diagnoses of 30 "Nouvelles Espèces de Mollusques, provenant des côtes de la Californie, du Mexique, du Kamtschatka, et de la Nouvelle Zélande, décrites par M. Deshayes." As several of the species figured by Conrad are redescribed, it is to be presumed that he wrote in ignorance of his labours. The following are the shells belonging to the West N. American faunas, with the habitats when recorded.

P. 357. *Chironia Laperousii.* [Monterey, *Hartweg.*] Mag. Zool. 1840, pl. 12.

Pholas Janellii, California. =*P. Californica,* Conr. M. Z. pl. 14–16.

Pholas concamerata, California. =*P. penita,* Conr. M. Z. pl. 17.

P. 358. *Arca trapezia,* "Semblas au Mexique." ? San Blas. M. Z. pl. 21. Probably a deformed *A. tuberculosa.*

P. 358. *Cytherea æquilatera,* California. =*Trigona argentina,* Sow. M. Z. pl. 22.

Saxicava pholadis, Lam. An. s. Vert. iv. 152. no. 3. Kamtschatka.

Saxicava legumen, California. M. Z. pl. 29. Probably the long form of the common species: also found at Mazatlan.

P. 358. *Petricola Cordieri*, California. =*Venus lamellifera*, Conr. M. Z. pl. 18.

Petricola arcuata, California. M. Z. pl. 19.

Petricola cylindracea, California. (Probably *P. arcuata*, var.) M. Z. pl. 20.

P. 359. *Venerupis gigantea*, California. =*Saxidomus Nuttalli*, Conr.

Venerupis Petiti, California. =*Tapes diversa*, Sow. jun.

Anomia macrochisma, Kamtschatka. M. Z. pl. 34. =*Placunanomia m.*, Gray.

Cypricardia Duperreyi, California. M. Z. pl. 27.

Modiola cultellus, Kamtschatka.

P. 360. *Cardium Laperousii*, California*. M. Z. pl. 48.

P. 360. *Cardium Californiense*, California. M. Z. pl. 47. = *C. Nuttallii*, Conr.: not *C. Californianum*, Conr.

Siphonaria scutellum, "Ile Chatam." ? Galapagos.

Purpura Freycinetii, Kamtschatka. M. Z. pl. 26. Much more like *P. lapillus* than Middendorff's figures.

Murex macropterus.

Helix Dupetithouarsi, Monterey. M. Z. pl. 30, as "......*rsii*."

P. 361. *Velutina Mulleri*, Kamtschatka.

Turbo digitatus, Acapulco. = *Uvanilla unguis*, Wood. M. Z. pl. 36.

Natica Recluziana, California. M. Z. pl. 37.

Natica ianthostoma, Kamtschatka.

Natica sanguinolenta.

To the above must probably be added *Purpura emarginata*, p. 360, M. Z. pl. 25, described by Deshayes as from New Zealand, but quoted in Jay's Cat. no. 8972, = *P. Conradi*, Nutt. MS., from California; and from the same locality in Mus. Cuming, on the authority of Mr. Hartweg. Many of these shells were figured in the following year in Guérin's Magasin de Zoologie, between plates 14 and 48, of which references are given above. In the same works are described, *Lucina cristata*, Recl. Rev. Cuv. 1842, p. 270, Guér. Mag. pl. 60, found "sur le banc de Campêche" by M. J. Cosmao, Commander of the Naval Station of Mexico, = *Tellina Burneti*, Brod. & Sow.: and *Lucina corrugata*, Desh., Guér. Mag. pl. 82, as from California, which Mr. Cuming found himself at Singapore.

The official description of the shells of the Venus, however, was intrusted to M. Valenciennes, under whose auspices was published "Voyage autour du Monde sur la Vénus, pendant les années 1836–39, par M. du Petit Thouars. Paris, 1846." Of this work plates only have been seen, of which the following are species connected with the West N. American coast.

Plate.	Fig.	
1	2.	*Helix vincta*, Val. (California, Rve.)
24	4, 4*a*.	*Pholas rostrata*, Val. Almost certainly the young of one of the following species.
24	1, 1*a*, *b*.	*Penitella Conradi*, Val. (*Pholadidea*, with long, inflated cup, without divisions.)
24	2.	*Penitella xilophaga*, Val. (*Pholadidea*, with long, narrow cup.)
24	3, 3*a*, *b*, *c*.	*Penitella tubigera*, Val. Probably a variety of the last; the tube being simply the lining of the old cavity, as in *P. calva*.
24	7*a*, *b*.	*Bornia luticola*, Val. (Closely approaches *Chironia Laperousii*, Desh.)
24	8, 8*a*.	*Saxicava clava*, Val. (Probably *S. legumen*, Desh.)
16	2, 2*a*.	*Venus perdix*, Val. ? = *Chione neglecta*, Sow., represented without pallial sinus.
16	3, 3*a*.	*Venus pectunculoides*, Val. = *Tapes histrionica*, Sow.
2	2, 2*a*.	*Trochus amictus*, Val. = *Uvanilla unguis*, Mawe. = *Turbo digitatus*, Desh.

* Described from a single shell which appears worn. It has much the aspect of a *Tellina*, with concentric ridges and no internal crenations; but is figured without pallial sinus.

Plate.	Fig.	
2	3, 3*a–c.*	*Trochus brevispinosus,* Val. = *Uvanilla olivacea,* Mawe.
3	1, 1 *a–c.*	*Trochus balænarum,* Val. ?=*Pomaulax undosus,* Mawe, var. Vide B. M. Maz. Cat. p. 230, note.
14	1.	*Calyptræa rugosa* (? *cujus*). = *Crucibulum imbricatum,* Sow.
14	2.	*Calyptræa tubifera,* Less. = *Cr. spinosum,* Sow.
15	2.	*Calyptræa gemmacea,* Val. Shell as figured, not recognized: it may be a worn and stunted *Cr. imbricatum.*
15	3.	*Calyptræa amygdalus,* Val. = *Crepidula onyx,* Sow.
24	9, 9 *a, b.*	*Calyptræa perforans,* Val. = *Crepidula explanata,* Gould. (The prior name of Val. must be abandoned, as representing an untruth. The form of the shell is due to its inhabiting the burrows of Lithophagi, &c.)
11	1, 1*a*, 1*a,bis.*	*Vermetus centiquadrus,* Val. (Subg. *Aletes.*)
11	3, 3*a.*	*Vermetus Peronii,* on *Strombus galea.* A variety of *V. centiquadrus.*
11	2.	*Vermetus margaritarum,* Val.
5	1 *a, b.*	*Fusus Petit-thouarsii.* = *F. Dupetit-Thouarsii,* Kien.
6	1, 1 *a–c.*	*Buccinum Janelii,* Val. = *Pisania sanguinolenta,* Ducl.
6	2, 2 *a–c.*	*Buccinum mutabile,* Val. = *Pisania insignis,* Rve.
6	2 *e, f.*	*Buccinum mutabile,* jun. = *Pisania gemmata,* Rve.
6	2 *α, β.*	*Buccinum mutabile,* operculum. (Extremely incorrectly drawn.)
8	4, 4*a.*	*Purpura saxicola,* Val. Resembles *P. lapillus* and *Freycinettii.*
8	3, 3*a.*	*Purpura hæmatura,* Val. ? = *P. biserialis,* Blainv. var.
9	3, 3*a–c.*	*Purpura Grayii,* Kien. = *Monoceros grande,* Gray.

It will be observed that the author has, in several instances, not only overlooked the writings of English naturalists, but even disregarded the descriptions by Deshayes of the shells of this very expedition.

42. During the period that Mr. Cuming was absent on his Philippine expedition, explorations of great value were being made by a gentleman, whose few published writings only show how much science has lost by his early death. In the year 1836, the 'Sulphur,' under Lieut. Com. Kellett, visited Callao and Payta in Peru, and explored the coast from the Bay of Guayaquil to Panama. Here Commander (now Capt. Sir E.) Belcher took the first place, a gentleman whose conchological labours during the voyage of the 'Blossom' have already been recorded. Mr. Hinds, the surgeon of the expedition, not only showed the greatest industry in dredging and otherwise collecting specimens, but made the products of his labours tenfold more valuable by the accurate notes which he took of their localities and stations, guided by a comprehensive view of the subjects which it was his endeavour to illustrate. The west coast of Central America and Mexico was searched as far as San Blas, and afterwards explorations were made from Acapulco to Cerro Azul. On the return of Messrs. Hinds and Cuming from their respective expeditions, they compared their collections and notes together. Here were abundant materials for geographical and stational lists of the very greatest value; but, most unfortunately, the usual plan was followed of only publishing the new species. This was done by Mr. Hinds in several most accurate and valuable papers communicated to the Zool. Soc. and to the Annals of Nat. Hist.; and, in a collective form, in the "Zoology of the Voyage of H.M.S. Sulphur, commanded by Capt. Sir E. Belcher, during the years 1836–1842; by Richard Brinsley Hinds, Esq., Surgeon R.N. London, Smith, Elder and Co., 1844. Vol. ii. Mollusca." The preface to this work contains a masterly digest of the results of his experience on the distribution of Mollusca, especially on those of the W. American coast as compared with the Pacific Islands; the influence of station, depth, temperature, and other causes, both on genera and on particular species; and the comparative effect

of similar differences on the flora and distribution of land shells in the same latitudes. The work therefore is extremely disappointing from its very excellence, as it shows how prepared the author was to fill up the gaps which are to us the most perplexing; but which his early death has left to be supplied by other, we fear less trustworthy hands.

Several valuable donations of shells, with the localities added by Mr. Hinds, are preserved in the British Museum. The new species described are as follow, so far as relates to the fauna of West N. America. The pages and numbers, with the plates and figures, refer to the Zool. Sulph.; but the references are also added to the Proc. Zool. Soc. and the Ann. Nat. Hist.

Page.	No.	Plate.	Fig.	Name.	Station.	Depth in fms.	Locality.
7	5	1	1, 2	Conus Patricius, *Hds.* A.N.H. xi. 256	sandy mud	7	G. Nicoya.
7	6	...	...	—— cœlebs, *Hds.* ,, ,, ,, =C. terebellum, jun., teste *Rve.*			
7	7	1	3–5	—— Californicus, *Hds.*	sand	7	B. Magdalena.
8	8	2	1–3	Murex Belcheri, *Hds.* P.Z.S. 1843, 127 = Pyrula B., *Rve.*	{ mud-bank at head of harbr.	}...	San Diego.
8	9	3	7, 8	—— centrifuga, *Hds.* ,, ,, 126	sand	52	W. C. Veragua.
8	10	3	9, 10	—— Californicus, *Hds.* ,, ,, 128	....	......	California.
8	11	3	11, 12	—— hamatus, *Hds.* ,, ,, ,, = Cerastoma, *Conr.*	mud	21	B. Guayaquil.
9	12	3	13, 14	—— festivus, *Hds.* ,, ,, 127	sand	7	B. Magdalena.
9	13	3	15, 16	—— foveolatus, *Hds.* ,, ,, 127	sand	7	B. Magdalena.
9	16	3	21, 22	—— radicatus, *Hds.* ,, ,, 128	mud	11	San Blas.
9	17	3	23, 24	—— peritus, *Hds.* ,, ,, 129	sand	7	B. Magdalena.
10	18	3	3, 4	Typhis quadratus, *Hds.* ,, ,, 18	mud	7–18	G. Nicoya, B. Guayaq.
11	22	4	1, 2	Triton vestitus, *Hds.* ,, 1844, 21	rocks	shore	Rl. Lj., G. Nic., B. Honda
12	28	4	13, 14	—— anomalus, *Hds.* ,, ,, ,,	sandy shore	l. w.	Is. Quibo, Veragua.
12	29	4	15, 16	—— lignarius, *Brod.* ,, 1833, 5	sandy mud	7	Monte Christi.
12	30	2	4, 5	Ranella Californica, *Hds.* A.N.H. xi. 255	....	......	San Diego.
13	31	4	17, 18	—— pectinata, *Hds.*	mud	7	San Blas.
14	36	1	16, 17	Trophon muricatus, *Hds.* [The name being preoccupied by Montagu, this species may be called *Troph. Hindsii.*]	mud	19	Panama.
15	37	5	1, 2	Pleurotoma nobilis, *Hds.* P.Z.S. 1843, 37	mud	7	San Blas.
15	39	5	4	—— gemmata, *Hds.* ,, ,, ,,	mud	7	Gulf Magdalena.
16	42	5	7	—— inermis, *Hds.* ,, ,, ,,	mud	7	Gulf Magdalena.
16	45	5	10	Clavatula militaris, *Hds.* ,, ,, 38	mud	8–30	Veragua.
17	50	5	15	—— ericea, *Hds.* ,, ,, 39	mud	26	Magnetic Is., Veragua.
17	52	5	17	—— sculpta, *Hds.* ,, ,, ,,	mud	7	Panama.
17	53	5	18	—— rava, *Hds.* ,, ,, ,,	mud	18	G. Nicoya.
18	58	6	4	—— luctuosa, *Hds.* ,, ,, 40	....	5–22	G. Magdal., B. Guayaq.
19	59	6	7, 8	—— aspera, *Hds.* ,, ,, ,,	mud	5	B. Guayaquil.
19	60	6	5	—— quisqualis, *Hds.* ,, ,, 44	mud	8–14	G. Papagayo.
19	61	6	9	—— plumbea, *Hds.* ,, ,, 41	....	5	B. Magdalena.
19	62	6	10	—— occata, *Hds.* ,, ,, ,,	....	......	Magnetic Is., Veragua.
19	63	6	13	—— bella, *Hds.* ,, ,, ,,	{ mud mud	30 8–14	W. C. Veragua. G. Papagayo.
20	64	6	11, 12	—— pudica, *Hds.* ,, ,, ,,	mud	8–14	G. Papagayo.
20	65	6	14	—— neglecta, *Hds.* ,, ,, 45	under stones	l. w.	G. Nicoya.
20	68	6	18	—— candida, *Hds.* ,, ,, 42	....	......	Magnetic Is., Veragua.
21	70	6	20	—— merita, *Hds.* ,, ,, ,,	under stones	l. w.	G. Nicoya.
21	73	6	23, 24	—— impressa, *Hds.* ,, ,, 44	mud	8–14	G. Papagayo.
22	77	7	1	—— pardalis, *Hds.* ,, ,, 42	under stones	l. w.	G. Nicoya.
22	78	7	6	—— cælata, *Hds.* ,, ,, ,,	mud	20	G. Fonseca.
23	83	7	11	—— micans, *Hds.* ,, ,, 43	mud	14	G. Papagayo.
24	92	7	18	—— rigida, *Hds.* ,, ,, 45	....	......	Panama.
25	95	7	20	Daphnella casta, *Hds.*	mud	23	G. Nicoya.
27	104	11	5, 6	Cerithium gemmatum, *Hds.*	sandy mud	2–7+	Panama.

Page.	No.	Plate.	Fig.	Name.	Station.	Depth in fms.	Locality.
31	127	16	13, 14	? Buccinum metula, *Hds*.	mud	few	W. C. Veragua.
32	128	...	...	Terebra robusta, *Hds*. P.Z.S. 1843, p. 149	sandy mud	4–18	8° 57′–21° 32′. Pan. S. Blas, G. Papag., G. Nic.
32	132	...	...	—— varicosa, *Hds*. „ „ 152	mud	23	G. Papagayo.
33	133	...	...	—— lingualis, *Hds*. „ „ 153	sandy mud	10–17	G. Papagayo, B. Montijo.
34	139	...	...	—— armillata, *Hds*. „ „ 154	....	5–13	Abundant in various localities between Pan. and B. Magd., also imbedded in fossiliferous cliffs which surround part of the Bay of M.
34	140	...	...	—— tuberculosa, *Hds*. „ „ 155	....	4–11	Pan., San Blas, G. Papag.
34	141	...	...	—— specillata, *Hds*. „ „ „ The Pacific analogue of *T. textilis*, from Str. Macassar, No. 142.	sandy mud	7	San Blas.
35	144	...	...	—— luctuosa, *Hds*. P.Z.S. 1843, p. 157	coral sand	12	G. Nicoya, P. Portr.
36	150	9	12, 13	Nassa perpinguis, *Hds*.	....	......	B. Magdalena.
36	153	9	18, 19	—— mœsta, *Hds*.	mud	8–14	G. Papagayo.
37	155	10	1, 2	Phos crassus, *Hds*. A.N.H. xi. p. 257	mud, solitary	3–14	Pan., G. Fonseca.
37	158	10	13, 14	—— Veraguensis, *Hds*. „ „ „ Pacific analogue of *Ph. senticosus*.	mud, gregarious	26	Pueblo Nueva, W. C. Veragua.
38	159	10	7, 8	—— articulatus, *Hds*.	....	......	Panama.
38	161	10	5, 6	—— gaudens, *Hds*.	....	13	G. Tehuantepec.
38	162	10	17, 18	Columbella fusiformis, *Hds*.	sand	24	Veragua.
39	163	10	19, 20	—— pavonina, *Hds*.	....	......	(Most prob. American.)
39	164	10	15, 16	—— carinata, *Hds*.	....	7 and under	Bodegas, San Diego.
39	165	10	21, 22	—— lentiginosa, *Hds*.	u. stones with *C. pygmæa*, com.	beach	G. Nicoya.
39	166	11	11, 12	Trichotropis cancellata, *Hds*. P.Z.S. 1843, p. 17.	sand	5–7	Sitka Harbour.
40	167	11	13, 14	—— inermis, *Hds*. P.Z.S. 1843, p. 18	sand	5–7	Sitka Harbour.
40	168	11	1, 2	Mitra Belcheri, *Hds*. A.N.H. xi. 255	mud	17	G. Papagayo, G. Nicoya.
41	170	12	11, 12	Cancellaria ventricosa, *Hds*. P.Z.S. 1843, p. 47	sandy mud	7 60–70	G. Magdalena 12° 28′– Rl. Lj., San Bl. 24° 38′.
41	171	12	7, 8	—— urceolata, *Hds*. P.Z.S. 1843, p. 47	....	8–14 7	G. Papagayo 12° 2′– San Blas 21° 32′.
42	172	12	9, 10	—— albida, *Hds*. „ „ „	....	7–23	B. Guayaq., Pan., Verag. 2° 47′ S.–9° 55′ N.
42	173	...	...	—— cremata, *Hds*. „ „ p. 48 (=f. 9. Conch. Ill., as *C. indentata*.)	mud	4–10	Pan.
42	174	12	1, 2	—— corrugata, *Hds*. P.Z.S. 1843, p. 48	mud	7	B. Guayaquil.
42	175	12	3, 4	—— elata, *Hds*. „ „ „	....	30	Pan., 1 sp.
43	176	12	5, 6	—— funiculata, *Hds*. „ „ „	sandy mud	7	G. Magd., 1 sp.
45	185	13	10, 11	Marginella sapotilla, *Hds*. „ 1844, p. 74 Pacific analogue of *M. prunum*.	sandy mud	5–13	Pan.
46	190	13	22, 23	Erato vitellina, *Hds*.	sand	7	B. Magdalena.
48	196	...	...	Scalaria Dianæ, *Hds*. P.Z.S. 1843, p. 125	mud	36	G. Nicoya.
49	202	...	...	—— vulpina, *Hds*. „ „ 126 The temperature below being 58°, and at the surface 82°.	mud	30	Is. Quibo, Veragua.
50	205	14	5, 6	Solarium placentale, *Hds*. P.Z.S. 1844, 22	sand	7	B. Magdalena.
50	206	14	7, 8	—— quadriceps, *Hds*. „ „ 23	mud	5	Pan.
53	216	...	...	Patella incessa, *Hds*. A.N.H. x. p. 82	on sea-weed	......	San Diego.
53	217	...	...	Patelloida depicta, *Hds*. „ „	on surface of a Zostera, common	...	San Diego.
53	218	16	7, 8	Crepidula solida, *Hds*. =C. adunca, *Sow*.	on dead & living shells & on each other.	6–10	Bodegas.
54	219	19	1	Chiton Magdalensis, *Hds*.	on rocks, common	......	B. Magdalena.
56	231	15	5	Melania occata, *Hds*. A.N.H. xiv. p. 9	....	......	River Sacramento, Calif.
59	241	16	22	Paludina seminalis, *Hds*. „ x. 83	....	......	Ditto.
59	...	...	...	Anodon angulatus	abundant	......	Ditto.

Page.	No.	Plate.	Fig.	Name.	Station.	Depth in fms.	Locality.
59	...	...	...	Paludina nuclea, *Lea*.	....	......	"Neighbouring locality."
60	245	17	1	Pecten sericeus, *Hds*. ......1 sp.	mud	53	B. Panama.
60	246	17	6	—— floridus, *Hds*.	mud	5	San Diego.
61	248	17	5	—— rubidus, *Hds*. ......4 sp.	....	33	Alashka, N. W. A.
61	249	17	2	—— digitatus, *Hds*.	mud	23	B. Guayaquil.
61	250	17	4	—— fasciculatus, *Hds*.	sandy mud	17	W. Veragua.
63	256	18	5	Nucula castrensis, *Hds*. P.Z.S. 1843, p. 98 Resembles the fossil *N. Cobboldiæ*, and *N. divaricata*, China Sea, 84 fms.	1 sp., sand	7	Sitka.
64	263	18	13	—— cælata, *Hds*. P.Z.S. 1843, p. 99	....	6–10	[Barb. 38° 18′–34 °24′. Bodegas, San Franc., Sta
64	266	18	17	—— excavata, *Hds*. „ „ 100	mud	30	Pan.
64	267	18	12	—— lyrata, *Hds*. „ „ „	....	30	Pan.
64	269	18	14	—— crispa, *Hds*. „ „ „	....	36	G. Nicoya.
65	271	19	5	Venus Kellettii, *Hds*.	adhesive mud, low temp.	30–34	Is. Quibo, W. C. Veragua.
65	272	21	1	Cytherea (Trigonella) crassatelloides, *Conr*.	mud-bank in the harbour.	......	San Diego.
66	275	19	2	Lucina fenestrata, *Hds*.	....	7–14	Monte Christi, San Blas.
66	276	19	6, 7	Psammobia decora, *Hds*. A.N.H. x. 81 =Sanguinolaria Nuttallii, *Conr*.	....	......	San Diego.
67	277	21	4	Tellina fucata, *Hds*.	....	......	B. Magdalena.
67	278	21	2	—— Bodegensis, *Hds*.	sand	7	Bodegas.
68	283	20	11	Corbula fragilis, *Hds*. P.Z.S. 1843, p. 56	mud	18	W. Veragua.
68	285	20	12	—— obesa, *Hds*. „ „ 57	mud	22–33	Pan., Verag., San Blas.
68	286	20	7, 8	—— speciosa, *Hds*. „ „ „ (=C. radiata, *Sow*. P.Z.S. 1833, p. 36, non *Desh*.)	mud	6	Pan., G. Nicoya.
69	289	20	13	—— marmorata, *Hds*. „ 1843, p. 58	mud	26	W. Veragua.
70	295	20	19	Neæra didyma, *Hds*. „ „ 78	mud	26	W. Veragua.
70	...	...	...	—— costata,	mud	26	W. Veragua.
71	298	19	4	Lingula albida, *Hds*.	sandy mud	7	B. Magdalena.

Besides these, the following are recorded in the Proc. Zool. Soc. as having been collected by Mr. Hinds:—

1843.	Name.	Station.	Locality.
p. 32	Pleurotoma arcuata, *Rve*.	....	Veragua.
32	—— picta, *Beck*	....	Pan., San Blas, G. Nicoya
77	Neæra costata (Anatina c., *Sow*., P.Z.S. 1834, p. 87), *Hds*.	....	St. Elen. 6 fm. sandy mud Magnetic Is., 22 fm. Veragua, 26 fm., mud.
125	Scalaria aciculina, *Hds*.	....	W.C. intertropical Amer.
160	Terebra strigata, *Sow. Tank. Cat*. =T. elongata, *Wood, Ind. Suppl*. =T. flammea, *Less. Ill. Zool*. =T. zebra, *Kien*.	common	Pan., *Hds*.
160	—— ornata, *Gray*......*Hds*. 7 fm.	mud	Pan.
1844,	[*Cum*. 5–7 fm.	coral sand	Galapagos.]
181	Mitra Hindsii, *Rve*......*Hds*. 17 fm.	mud	Gulf Nicoya.

In Mr. Cuming's collection appears *Corbula obesa*, Hinds, San Blas.

The following shells occur in Reeve's *Conchologia Iconica,* as having been collected by Mr. Hinds.

Plate.	Sp.	Name.	Station.	Depth in fms.	Locality.
1	3	Natica Recluziana	....	......	California.
24	61	Fig. *a, b.* Patella diaphana, *Rve.* = Acmæa mesoleuca, *Mke.*	....	......	Central America.
5	24	Cardita Cuvieri, *Brod.*	....	......	Acapulco.
8	44	Pectunculus pectenoides, *Desh., Cuv. R. A.* pl. 87. f. 8.	soft mud	7	Panama.
1	4	Arca grandis, *Brod. & Sow.*	....	......	Real Llej., B. Guayqu. (*Cuming & Hinds*).
21	165	Mitra Hindsii, *Rve.*	mud	17	G. Nicoya.
4	2	Fissurella volcano, *Rve.*	....	......	Sta. Barbara.
7	33	Chiton lineatus, *Wood*	....	......	Sitka.
22*	149	—— insignis, *Rve.*..........................	....	......	Sitka.
3	15	Pleurotoma arcuata, *Rve.*	....	......	Veragua.
3	16	—— picta, *Beck*............................	....	......	Pan., San Blas, G. Nic.
4	27	—— olivacea, *Sow.* (comp. P. funiculata)	mud	......	Pan., W. Mex., G. Nic. (Also Salango, and St. Elena, *Cum.*)
7	55	—— militaris, *Hinds*	mud	18	Veragua.
9	71	—— stromboides, *Sow.*	mud	7	B. Panama.
6	35	Conus Archon, *Brod.*	sandy mud	12–18	G. Nicoya.
20	48	Oliva biplicata, *Sow.*	sands	l. w.	Monterey.

Specimens of the following shells appear in the Brit. Mus. as having been presented by Mr. Hinds; and were doubtless collected by him during the Voyage of the Sulphur.

Tellina rufescens. Guayaquil.
Donax carinatus. Tumaco.
Venus neglecta (? *crenifera*). Acapulco.
Mactra exoleta. Guayaquil.
Kellia suborbicularis. Panama.
Pectunculus maculatus, Brod. = *giganteus,* Rve. W. Columbia.
Pinna lanceolata. Guayaquil.
Perna flexuosa. Conchagua.
Chama spinosa. Acapulco.
Anomia lampe. Guayaquil.
Chiton lineatus. Sitcha Sound.
—— *Simpsonii,* Gray. San Francisco.
Bulla nebulosa. San Pedro.
Siphonaria lecanium. St. Elena, Guayaq.
Cerithidea varicosa. Real Llejos, San Blas.
Litorina conspersa. Real Llejos.
—— ? *fasciata.* San Pedro.
Helix levis. California.
—— *areolata,* Sow., Pfr. Z. f. M. 1845, p. 154. California, near Columbia R.
Neverita helicoides (= *patula*). Acapulco.
Natica (like *canrena*). Acapulco.
Ranella nana. San Blas.
Fusus pallidus. Callao.
—— *Dupetithouarsii* (with operc.). Acapulco.
Murex incisus, Brod. Acapulco.
—— *oxyacantha,* Brod. Acapulco.
—— *humilis,* Brod. Bay Guayaquil.
—— *hamatus,* Brod. Bay Guayaquil.

43. During the years 1838–1842, the United States Exploring Expedition was engaged in its circumnavigation of the globe. In 1839 it touched at Callao, where 30 species of shells were collected; but it did not visit any other part of the Panama province. In 1841, however, the Vincennes and Porpoise were early on the coast of Oregon. The Peacock and Flying Fish arrived there in July; but the Peacock was lost on the bar of the Columbia River. The Expedition proceeded as far as San Francisco, and left in November of the same year. The conchologist to the Expedition was Mr. J. P. Couthouy, who, assisted by his companions, collected about 2000 species of shells (of which about 250 were considered new), and made drawings of the

* 22. 149 (text) 148 (fig.).

animals of about 500. The description of the collections was entrusted to Dr. A. A. Gould of Boston, the well-known author of the 'Report of the Invertebrata of Massachusetts.' In 1846 the descriptions of part of the species were issued in a pamphlet form, to which additions have been made from time to time, as they have appeared in the 'Proc. Bost. Soc. Nat. Hist.' In this work are the following descriptions of species from the Californian and Oregon districts.

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3. *Chiton lignosus*, Gld., Puget Sound. (= *C. lignarius*, G. MS.)
6. *Chiton dentiens*, G., Puget Sound.
,, *Chiton muscosus*, G., Puget Sound.
7. *Patella fimbriata*, G., Straits of De Fuca.
9. *Patella instabilis*, G., Puget Sound.
,, *Patella conica*, G., Puget Sound. = *Scurria mitra*, Esch.
,, *Lottia pintadina*, G., Straits of De Fuca, Puget Sound, and Columbia River (San Francisco).
  Max. pars = A. patina, var.: pars = A. mesoleuca, var.: teste sp. typ.
10. *Patella* (? *Lottia*) *textilis*, G., Straits of De Fuca and Killimook.
,, *Patella* (? *Lottia*) *scabra*, G., San Francisco. "Perhaps a variety of *P. textilis*." =*P. spectrum*, Nutt., Rve., not *P. scabra*, Nutt., Rve.
13. *Fissurella cratitia*, G., Puget Sound. ? = *F. aspera*, Esch.
14. *Rimula cucullata*, G., Puget Sound. (? *Puncturella*.)
,, *Rimula galeata*, G. (Classet), Puget Sound. (? *Puncturella*.)
,, *Crepidula rostriformis*, G., Straits of De Fuca. = *C. adunca*, Sow.
15. *Crepidula lingulata*, G., Puget Sound. "Like *C. Capensis*, Quoy," 1 sp.
,, *Crepidula nummaria*, G., Classet. [Probably a var. of *C. lingulata*.]
,, *Calyptræa fastigiata*, G., Puget Sound. [*Galerus*.]
16. *Helix labiosa*, G., Astoria, Oregon.
17. *Helix loricata*, G., California (Sacramento River).
,, *Helix devia*, G., ? Oregon.
18. *Helix strigosa*, G., interior of Oregon.
,, *Helix sportella*, G., Puget Sound.
31. *Succinea rusticana*, G., Oregon.
41. *Limnea lepida*, G., Lake Vancouver, Oregon.
42. *Planorbis opercularis*, G., Rio Sacramento, U. Cal.
,, *Planorbis vermicularis*, G., interior of Oregon.
43. *Physa virginea*, G., Rio Sacramento.
46. *Melania silicula*, G., Nisqually, Oregon. (= *M. siliqua*, G. MS.)

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46. *Melania bulbosa*, G., Columbia River.
49. *Natica Lewisii*, G., Puget Sound and Columbia River.
50. *Natica caurina*, G., Straits of De Fuca. "Nearly the same as *N. impervia*, Phil., from Cape Horn."
52. *Lacuna carinata*, G., Puget Sound.
,, *Littorina patula*, G., San Francisco. = *L. planaxis*, Phil.
,, *Littorina lepida*, G., Puget Sound.
53. *Littorina scutulata*, G., Puget Sound.
,, *Littorina plena*, G., San Francisco.
55. *Trochus ligatus*, G., Puget Sound. = *T. filosus*, Wood.
60. *Cerithium* (*Potamis*) *sacratum*, G., Sacramento River. = *Pirena Californica*, Nutt. MS.
61. *Cerithium irroratum*, Gould. Hab. ? [It is difficult to say how this got among the Expedition shells, as it belongs to the Mazatlan, not the Californian fauna. It may have been procured at Callao, or by the accidents of ballast.] = *C. stercus-muscarum*, Val.
62. *Cerithium filosum*, G., Puget Sound.
64. *Fusus fidicula*, G., Puget Sound. Closely resembles *F. turricula*.
65. *Fusus orpheus*, G., Puget Sound. Resembles *F. Bamffius*.
67. *Buccinum fossatum*, G., Puget Sound and mouth of Columbia River. (San Diego.) (= *Nassa fossata*, G., postea.) Of the same group as *N. trivittata*, Say.
70. *Nassa mendica*, G., Puget Sound, Nisqually, &c. Pacific analogue of *N. trivittata*, Say.
74. *Solen sicarius*, G., Straits of De Fuca, Oregon.
75. *Panopæa generosa*, G., Puget Sound, Oregon. Like *P. Aldrovandi*.
,, *Mya præcisa*, G., Puget Sound. Like *M. truncata*.
76. *Mactra falcata*, G., Puget Sound.
,, *Lutraria capax*, G., Puget Sound. (Afterwards changed to *L. maxima*, Midd.)
77. *Osteodesma bracteata*, G., Puget Sd. "Closely resembles *O. hyalina*."
83. *Cardita ventricosa*, G., Puget Sound.

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83. *Cardium blandum*, G., Puget Sound.
85. *Venus rigida*, G., Puget Sound, Straits of De Fuca.
86. *Cyclas patella*, G., Oregon. Resembles *C. cornea*.
87. *Anodon feminalis*, G., Oregon.
,, *Anodon cognata*, G., Nisqually and Fort Vancouver.
,, *Alasmodon falcata*, G., Wallawalla, Oregon; Sacramento River. = *A. margaritifera*, var. teste Lea and others.
88. *Unio famelicus*, G., Wallawalla, Oregon.

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93. *Mytilus* (*Modiola*) *flabellatus*, G., Puget Sound, Oregon (Townsend Harbour, San Francisco, and species from G. Calif.). Apparently = *Modiola Brasiliensis*.
94. *Mytilus trossulus*, G., Killimook, Puget Sound, Oregon. Appears a var. of *M. edulis*.
95. *Pecten caurinus*, G., Port Townsend, Admiralty Inlet, Oregon.
,, *Pecten hericeus*, G., Straits of De Fuca, Oregon.

The localities included in the ( ) are added from the standard work, for which that above quoted was but a preparation, entitled "United States Exploring Expedition during the years 1835–42, under the command of Charles Wilks, U.S.N. Philadelphia 1852– ." The plates have not yet found their way to this country. Besides the species already enumerated, are found the following:—

2. *Arion foliolatus*, G., Puget Sound.
3. *Limax Columbianus*, G., Puget Sd. and Oregon.
36. *Helix Vancouverensis*, Lea, Oregon.
66. *Helix Nuttalliana*, Lea, Puget Sd. and Oregon.
,, *Helix Townsendiana*, Lea, Oregon.
70. *Helix germana*, G., Oregon.
113. *Planorbis corpulentus*, G., Oregon.
122. *Lymnæa apicina*, G., Oregon.
,, *Lymnæa umbrosa*, Say (Astoria), Oregon, and Sacramento River.
143. *Melania plicifera*, G., Oregon.
353. *Lottia viridula*. "Mr. Nuttall brought home several specimens, which he described under the name of *monticula*" [*monticola*].
436. *Anodonta angulata*, G., Sacramento River.
206. *Scalaria* ? *australis*, Puget Sound. This species is from the opposite side of the equator from *S. australis*. Dr. Gould thinks it will prove distinct, but cannot yet see any differences.
214. *Natica algida*, G., Oregon.
219. *Trichotropis cancellata*, Hinds, Oregon.
241. *Triton Oregonense*, Jay, Oregon. = *Fusus Oregonensis* + *cancellatus*, Rve.
244. *Purpura ostrina*, G., Oregon.
247. *Columbella gausapata*, G.*, Oregon.
322. *Chiton interstinctus*, G., Oregon.
323. *Chiton vespertinus*, G., Oregon.
399. *Saxidomus Nuttalli*, Conr., Oregon.
467. *Terebratula pulvinata*, G., Oregon.
468. *Terebratula caurina*, G., Oregon.

And the following Nudibranchs:—*Chiorœra leonina*, G.; 310. ? *Dendronotus*; 311. ? *Goniodoris*; 29. ? *Doris*; ? *Æolis*.

In the Preface to this work, Dr. Gould states his views as to the geographical distribution of species, and gives the following interesting lists of parallel species from different seas:—

Oregon District.	Atlantic Coast.
Mya præcisa.	*M. truncata*.
Osteodesma bracteatum.	*O. hyalinum*.
Cardita ventricosa.	*C. borealis*.
Cardium blandum.	*C. Icelandicum*.
Venus calcarea.	*V. mercenaria*.

* Dr. Gould remarks (p. 270), that "there is a minute operculum to *Mitra*, while there is none to *Columbella*." Of the shells called *Columbellæ*, the typical species, *C. strombiformis*, *major*, and *fuscata*, have a broad oval operculum, with the apex at the anterior end of the outside margin; *Nitidella cribraria* has a distinctly Purpuroid operculum; and *Anachis costellata*, &c. have a Pisanoid ungulate operculum. *Vide* B.M. Maz. Cat. *in loco*.

Oregon District.	Atlantic Coast.
Alasmodonta falcata.	*A. arcuata.*
Helix Vancouverensis.	*H. concava.*
Helix loricata.	*H. inflecta.*
Helix germana.	*H. fraterna.*
Planorbis vermicularis.	*Pl. deflectus.*
Planorbis opercularis.	*Pl. exacutus.*
Lacuna carinata.	*L. vincta.*
Natica Lewisii.	*N. heros.*
Trichotropis cancellata.	*Tr. borealis.*
Fusus fidicula.	*F. turricula.*
Lottia pintadina.	*L. testudinalis,* &c.

To which we may add (from California),—

Solecurtus lucidus.	*S. radiatus.*

The following are quoted as parallel types between the Gulf of California and the Caribbæan Sea:—

Gulf of California.	Caribbæan Sea.
Lutraria undulata.	*L. canaliculata.*
Mactra nasuta.	*M. Brasiliana.*
Lutraria ventricosa [*Mactra exoleta*].	*L. carinata.*
Cytherea biradiata.	*C. Chione.* } Mediterranean.
Natica Chemnitzii, Pfr.	*N. maroccana.* } Mediterranean.

The following species have also been examined and determined by Dr. Gould, from the same collection:—

Helix tudiculata, Binney, Oregon.
Acmæa cribraria, G., Columbia River, San Francisco, De Fuca.
Modiola elongata, G., Puget Sound.
Solen maximus, Mouth of Columbia R.
Tellina nasuta, Conr., Mouth of Columbia River.
Tellina secta, Conr., De Fuca.
Tellina Californica, Conr., De Fuca.
Tellina Bodegensis, Hinds, Classet.
Anodonta Nuttalliana, Lea, Wallawalla, San Francisco.
Buccinum corrugatum, Rve., Puget Sound.
Purpura septentrionalis, Rve., Puget Sd.
Melania plicata, Lea, Oregon.
Melania Wahlamatensis, Lea, Sacramento River.
(*Cryptomya*) *Sphænia Californica,* Conr., Sacramento River.
Melania occata, Hds., Sacramento River.
Triton tigrinum, Brod., Puget Sound.
Modiola discrepans, Mont., Puget S. [!!]
Modiola ? vulgaris, Puget Sound.
Pecten Fabricii, Phil., Puget Sound.
Fusus cancellinus, Phil., De Fuca.
Pholas (*concamerata,* Desh. =) *penita,* Conr., San Francisco.
Paludina seminalis, Hds., Sacramento.

In the MS. list of the shells collected in the Oregon and Californian district during the U.S. Exploring Expedition, sent by Dr. Gould, and including the above, there appear 70 species from Oregon, a district before so little known, that only 23 of them have been identified with previous names, the rest having been described by Dr. Gould.

Through the great kindness of Dr. Gould, who showed his desire to make the materials for this Report as complete as possible, by copying out all the valuable information which was in his possession, we are enabled to present the materials from which the foregoing lists were drawn up, in the shape in which they first made their appearance. They are the only documents approaching the authority of "dredging papers," which have been made public, in the whole history of the coast, from Behring's Straits to Panama. They are the memoranda made by Dr. Charles Pickering of the U.S. Expl. Exp.; the specific names having been for the most part added by Dr. Gould on identification.

Box I. Oregon Tour.

Anodon cognata, G., Lake near Nisqually.
Alasmodon falcata, G., Columbia, Spokan, common.
Anodon feminalis, G., Wallawalla.
Helix strigosa, G., Interior of Oregon.
Lymnæa (long spire).
Succinea (spreading mantle).

Box IV. Puget Sound.

Venus (perhaps a fourth species), Classet.
Tellina (middle size, smooth, not polished, smaller, and a little deflected), common, sandy places.
Tellina secta, Conr. (or allied: larger, truncate at one end; ligament narrow, but elongate), common, sandy places.
Mytilus (size of *edulis,* with a few large costæ); [probably *M. Californianus,* Conr.;] among rocks, low-water mark, Classet.
Fissurella cratitia, G., Classet.
Cardium blandum, G., dredged at Dungeness.
Acmæa ? mitra, Esch., Classet.
Acmæa instabilis, G., Classet.
Acmæa (costate and tuberculate), common.
Acmæa (larger, apex more medial), Classet.
Acmæa (finely striate), rocks, Classet.
Pecten hericeus, G., Classet.
Pecten (young, costæ smooth), Classet.
Scalaria ? borealis, Classet.
Scalaria (large, much elongated, solid), Classet.
Tellina (elongate, concentric striæ), Classet.
Oliva, Classet, dead.
Haliotis (fragment of large species), Classet.
Modiola (one valve, young).
Triton tigrinum.
Crepidula (Capuloid); [probably *C. adunca.*]
Crepidula nummaria, G., Classet.
? *Anomia,* Classet, dead.
Mytilus (common, like *edulis*).
? *Saxicava* (very short and ventricose), Classet.
Natica algida, G., Classet.
Nassa mendica, G., Classet.
Purpura lagena, G., Classet.
Cerithium filosum, G., Classet.
Calyptræa ? pileiformis.
Mya (very small), Dungeness.
Cardium, Dungeness (dredged).

Box V. Puget Sound.

Cardium (largest, used for food).
Pecten hericeus, G., Dungeness.
Purpura septentrionalis, Dungeness.

Box VI. Puget Sound.

Solen sicarius, G., Dungeness (dredged).
Solen maximus, Classet.
Helix Vancouverensis, Lea.
Helix labiosa, G.

Box VIII. San Francisco.

Cardium ? Californianum (same as Oregon).
Mytilus (very large, a few shallow ribs, like Classet).
Mytilus trossulus, G. (see *M. edulis,* De Fuca).
Tellina secta, Conr.
Mactra (a thin *Mya*-shaped species: perhaps *Lutraria*).
Mya (*Sphænia,* $\frac{3}{4}$ in.; see Straits of De Fuca).
Tellina (small, like *balthica*).
Fissurella ? cratitia (like Classet).
Acmæa (nearly smooth).
Helix Nickliniana, Lea.
Purpura emarginata, Ducl.
Trochus mœstus.
Littorina planaxis, Nutt. (= *L. patula*).
Acmæa (angulated), Yerba Buena.

Box IX. San Francisco.

Pholas (small, enlarged, rounded end).
Pholas (smaller, obliquely truncate).
Ostrea (small), Carquiñez.
Amnicola, Sacramento.
Helix Californiensis, Lea.
Planorbis (form of *campanulatus*), Sacramento.

Box X. San Francisco.

Anodon (winged), Sacramento.
Alasmodon falcata, G., Upper Sacramento.
Purpura emarginata, Ducl.
Anodon cognata, G., near the Presidio.

Jar 184. Sacramento Trip.

Tellina (small, roundish), Carquiñez.
Mytilus glomeratus, G.
Helix Nickliniana, Lea.
Cerithium (*Potamis*) *Californianum.*
Anodon angulatum, Lea.
Planorbis (like *campanulatus*), up Sacramento.
Planorbis (like *trivolvis*), up Sacramento.
Acmæa (smoothish), mouth of harbour.
Acmæa (smaller, more pointed).

Jar 185. San Francisco.

Physa virginea, G.
Purpura emarginata.
Littorina patula, G.
Acmæa scabra, G. (ridged and nodulate) [= *A. spectrum*, Nutt.]
Trochus (like Puget Sound).
Physa (with truncate spire).
Physa (elongate), from behind Presidio.
Nassa (small, like Puget Sound).
Planorbis (flat and rather fine).
Succinea (small).
Littorina plena, G.

Oregon, by Drayton.

Tellina secta, Conr., below mouth of Columbia.
Anodon feminalis, G., Wallawalla.
Anodon Oregonensis, Lea, Wallawalla.
Alasmodon falcata, G., Wallawalla.
Melania plicifera, Lea, mill-dam above Vancouver.
Tellina, F. George, stomach of sturgeon.
Limnæa (small), Lake at Vancouver.
Solen sicarius, G.
Melania, Chester River.
Unio famelicus, G., Wallawalla.
Helix labiosa.
Pecten, dredged at Baker's Bay.
Limax Columbianus, G., Nisqually.
Natica Lewisii, G., Puget Sound.
Modiola flabellata, G., Port Discovery.
Pecten Townsendi, Nisqually.
Panopæa generosa, Nisqually.

Oregon Tour.

Helix strigosa, G.
Planorbis vermiculatus, G., Wallawalla.
Helix Townsendiana, Lea.
Helix devia, G.

Jar 166. De Fuca to Nisqually.

Lymnæa (elongated).
Physa (decollate).

Puget Sound.

Fusus fidicula, G.
Pecten (young).
Calyptræa (bis).
Fusus (or *Columbella*, small, smooth).
Venus (very small and smooth).
Chiton (very small).
Modiola (like *discors*).
Trochus virgineus, Wood.
Cardita ventricosa, G.
Fusus Orpheus, G.
Cardium Californianum, Conr.
Trichotropis cancellata, Hds.
Goniodoris.
Bullæoid [species].
Crepidula (small, white, on young *Purpura*).
Doris (like).
Terebratula pulvilla, G.
Terebratula (*septentrionalis*-like).
Natica caurina, G.
Oliva (small).

Brought up on Anchor.

Chiton (very small and narrow).
Rimula cucullata, G.
Lacuna carinata, G.
Acmæa mitra.
Littorina scutellata, G.
Acmæa textilina, G.
Solen maximus, (mouth of Columbia).
Helix Vancouverensis, Lea.
Limnea (much like *Paludina*), Columbia River.
Physa (bis).

Jar, going up to Puget Sound.

Limax Columbianus, G.
Limax foliolatus, G.

Dredged at Port Townsend.

Chioræra leonina, G.
Trochus (bis).
Acmæa (smooth, with *Balanus*).

Jar 1881. Oregon.

Planorbis corpulentus, Say, Fort George.
Limnæa (*ventricosa*), near Fort George.
Helix Vancouverensis, Lea.
Helix Townsendiana, Lea.
Unio famelicus, Wallawalla.
Cyclas egregia, Vancouver.
Bulla (small, very thin), Puget Sound.
Littorina lepida, Classet.
Buccinum.

Discovery Harbour.

Helix, 5 or 6 species.
Cardium blandum, G.
Lutraria capax, G.
Venus ampliata, G.
Mytilus trossulus.
Chiton (shell not appearing externally).

Townsend Harbour.

Solen sicarius, G.
Mytilus trossulus, G.
Modiola flabellata, G.
Cardium Nuttallii, Conr.
Natica Lewisii, G.
Bullæoid [species].
Trochus.
Columbella.
Purpura.
Calyptræa.

44. All existing information with regard to the Mollusca of the Boreal districts of North America and the corresponding portion of North-Eastern Asia, will be found embodied in the two following works:—"Beiträge zu einer Malacozoologia Rossica, von Dr. A. Th. von Middendorff. St. Petersburg, 1847:" and "Reise in den Aussersten Norden und Osten Sibiriens, während der Jahre 1843 und 1844, von Dr. A. Th. v. Middendorff. Band II. Zoologie. Theil I. Wirbellose Thiere. St. Petersburg, 1851. Mollusken, pp. 163–464." The author not only describes the results of his own travels, but arranges the discoveries of Eschscholtz (to whose specimens he had access), Mertens, Wosnessenski, and others. The descriptions are very minute and complex, the remarks extremely diffuse, and the references tabulated with consummate learning. Unfortunately, in his comparisons with the British Fauna, he had no better manual than Thorpe's Marine Conchology; the invaluable work of Messrs. Forbes and Hanley not having been then completed. The first part of the 'Malacozoologia Rossica,' entitled "Beschreibung und Anatomie ganz neuer, oder für Russland neuer CHITONEN," containing 151 quarto pages, with 14 plates, consists of an account of 21 species, of which 17 inhabit the Pacific shores. To an account of the principal form, *Chiton Stelleri*, 59 pages are devoted. All who study or describe species in this very interesting and difficult group, will do well to consult as much as their time allows of this comprehensive treatise. It is to be regretted that in the principles which have directed his classification, he has confined his attention to so limited a number of types; and, however burdensome to the memory may be the very numerous genera of modern writers, the subgenera, sections, subsections and divisions found necessary to accommodate only twenty-one out of the many hundreds of known species, by no means lessen the inconvenience. Thus to descend from *genus* Chiton to *species* Pallasii, the Middendorffian student has to master the following phraseology: "Chiton-Phænochiton-Dichachiton-Symmetrogephyrus (B. Apori) Pallasii." The following are the Pacific species; the synonyms being those of Middendorff, unless enclosed in [ ].

PART I.

Page.	No.	Plate.	Fig.	Name.	Locality.
37, 93	1	1–9	......	Chiton Stelleri, *Midd. Bull. Ac. Sc. St. Petersburg*, vii. 8. p. 116. =*C. amiculatus*, Sow. Conch. Ill. f. 80. =*C. Sitkensis*, Rve. Conch. Ic. pl. 10. sp. 55. ?=*C. chlamys*, Rve. Conch. Ic. pl. 11. sp. 60.	Abundant near Petropaulowski and the promontory of Lopatka. The Kamtschatkians call it *Keru*, and eat it.—*Steller.*
96	2	......	......	—— amiculatus, *Pallas, Nov. Act. Acad. Petrop.* ii. 235–7. pl. 7. f. 26–30.	Kurule Is.
98	3	......	......	—— Pallasii, *Midd. Bull. Ac. St. Pet.* vi. 117.	Tugurbusen, Ochotsk Sea.
98	4	......	......	—— submarmoreus, *Midd.*	Ditto, and Schantar Is.
98	5	10	1–5	—— tunicatus, *Wood*	Sitcha, Kadjak, Atcha.
101	6	11	1, 2	—— Wosnessenskii, *Midd. Bull. Ac. St. Pet.* vi. 119. Comp. *Ch. setiger*, King [Southern analogue]. Comp. *Ch. setosus*, Sow.	N. California, Sitcha, Atcha.
109	8	12	8, 9	—— lineatus, *Wood* .... ?=*Ch. insignis*, Rve. Conch. Ic. pl. 22. sp. 149. f. 148.	N. Calif., Sitcha, Unalaschka.
112	9	13	1, 2	—— Sitkensis, *Midd. Bull. St. Pet.* vi. 121 [non *Rve.*].	Sitcha.
114	10	11	4	—— Eschscholtzii, *Midd.* ,, ,, ,, 118	Sitcha.

Page.	No.	Plate.	Fig.	Name.	Locality.
115	11	11	5, 6	Chiton Merckii, *Midd. Bull. St. Pet.* vi. 20	Sitcha.
124	15	13	3, 4	—— lividus, *Midd.* ,, ,, ,, 120	Sitcha.
125	16	14	1–3	—— Mertensii, *Midd.* ,, ,, ,, 118	Colonie Russ. = Bodejas, Cal.
127	17	14	4, 5	—— scrobiculatus, *Midd.* ,, ,, ,, 121	Colonie Russ. = Bodejas, Cal.
128	18	......	......	—— Brandtii, *Midd.* ,, ,, ,, 117	S. coast, Ochotsk; large Schantar Is.
128	19	......	......	??—— giganteus, *Tilesius, Mem. Ac. St. Pet.* vol. ix. 1824, p. 473. pl. 16. f. 1, 2. pl. 17. f. 3 *bis*, 8.	? Kamtschatka.
129	20	......	......	??—— setosus, *Tilesius, Mem. Ac. St. Pet.* vol. ix. 1824, p. 484.	? Kamtschatka.
130	21	......	......	??—— muricatus, *Tilesius, Mem. Ac. St. Pet.* vol. ix. 1824, p. 483. pl. 16. f. 3.	? Kamtschatka and Kurule Is.

The last three are quoted on the authority of Tilesius. The second and third Parts bear date 1849, and contain the general descriptions of shells. The following are from the Pacific.

Part II.

32	4	......	......	Patella (Acmæa) cæca, v. *Reisewerk*	
32	5	......	......	—— —— cassis, *Esch.* (Represents *P. deaurata*, Gmel. Str. of Magellan.)	Sitcha.
33	6	......	......	—— —— patina, *Esch.*, v. *Reise.*	
34	7	1	6	—— —— scurra, *Less.* .... = *Acmæa scurra*, D'Orb. = *A. mitra*, Esch. + *A. mammillata*, Esch. [not Nutt.] + *A. marmorea*, Esch. =? *Lottia pallida*, Gray, Beech. Voy.	Sitcha.
35	8	......	......	—— —— digitalis, *Esch.*	Sitcha.
36	9	1	3	—— —— persona, *Esch.* .... + *A. radiata*, Esch. + *A. ancylus*, Esch. + *A. scutum*, D'Orb. (syn. excl.) ? = *Lottia punctata*, Gray; non *Patelloidea punctata*, Quoy and Gaim. Voy. Astr. pl. 71. f. 40, 42.	Sitcha.
37	10	1	2	—— ?—— personoides, *Midd.* .... = *A. ancyloides*, Midd. Bull. St. Peters. vi. 20, non Forbes.	Kenai Bay.
38	11	1	1	—— ?—— æruginosa, *Midd.*	Bodejas.
38	12	1	4	—— ?—— pileolus, *Midd.*	Sitcha.
39	13	1	5	—— —— Asmi, *Midd.*	Sitcha.
39	1	......	......	Fissurella violacea, *Esch.* 1829 = latimarginata, *Sow.* 1834. This well-known S. American species was found by Eschscholtz in the Bay of Conception: Wosnessenski's quotation from Sitcha is probably incorrect.	?Sitcha.
40	2	......	......	—— aspera, *Esch.*	?Sitcha, *Mertens*; Norfolk Sd., *Esch.*
46	1	......	......	Paludinella stagnalis, *Linn.*, v. *Reise*......	Ochotsk, Black Sea, Caspian.
46	2	......	......	—— aculeus, *Gould*	Ochotsk, Lapland.
47	3	10	11–15	—— castanea, *Möll.*	Ochotsk, Lapland.
48	4	......	......	—— cingulata, *Midd.*, v. *Reise*...........	Schantar Is.
54	3	......	......	Lacuna glacialis, *Möll.*	Ochotsk, Sitcha.
57	3	......	......	Littorina grandis, *Midd.*, v. *Reise.*	Ochotsk, Schantar, Kamtsch.
64	6	......	......	—— subtenebrosa, *Midd.*	Isl. Urup, Sea Ochotsk.
64	7	......	......	—— Kurila, *Midd.*	Isl. Urup, Schantar, Kenai.

Page.	No.	Plate.	Fig.	Name.	Locality.
64	8	8	13–15	Littorina Sitchana, *Phil.*	Sitcha, New Albion, Kenai.
66	9	......	......	—— modesta, *Phil.*	Sitcha, New Albion.
66	10	......	......	—— aspera, *Phil.*	Sitcha, [?] New Albion, *Barclay*.
68	1	11	1	Turritella Eschrichtii, *Midd.*	Sitcha.
69	1	......	......	Margarita arctica, *Leach*, var. major	Sitcha, Ochotsk, Schantar.
				+*M. vulgaris*, Leach.	
				? = *Turbo margarita*, Lowe.	
				= *M. Grœnlandica*, Beck.	
				= *M. helicina*, Möll., Fabr.	
73	3	8	45–6	—— sulcata, *Sow.*	Unalaschka.
74	4	......	......	—— striata, *Brod. & Sow*	Sitcha, Lapland.
				= *Turbo carneus*, Lowe.	
				= *T. cinereus*, Couth.	
				= *Margarita sordida*, Hancock.	
83	8	......	......	Trochus ater, *Less.*, *Phil. Abbild.* p. 188. no. 3. pl. 5, 8. f. 6.	Sitcha, *Wosn.*
84	9	......	......	—— euryomphalus, *Jonas, Abbild.* p. 15. no. 4. pl. 6. f. 4.	Sitcha, *Esch.*
84	10	......	......	—— mœstus, *Jon. Abbild.* p. 15. no. 5. pl. 6. f. 5; *Mke. in Zeit. f. Mal.* 1844, p. 113.	Sitcha, *Wosn.*
85	11	10	16–18	—— modestus, *Midd.*	Sitcha, *Wosn.*
85	12	......	......	—— Schantaricus, *Midd.*, v. *Reise.*	
86	13	......	......	—— (Turbo) Fokkesii, *Jonas*	Sitcha, *Wosn.*
91	2	......	......	Natica aperta, *Lov.*	Ochotsk, Schantar.
91	3	......	......	—— clausa, *Brod. & Sow.*	Sitcha, Ochotsk, Schantar, Kadjak, Kamtsch., Lapland, N. Zembl.
				= *N. consolidata*, Couth. & Phil.	
				= *N. septentrionalis*, Beck, Möll.	
				= *N. ianthostoma*, Desh., Guér. Mag. 1841.	
93	4	......	......	—— pallida, *Br. & Sow*	White Sea, Ochotsk.
				= *N. borealis*, Gray, Beech. pl. 37. f. 2.	
				= *N. Gouldii*, Phil. Zeit. f. Mal. 1845, p. 77, from type.	
				= *N. suturalis*, Gray, Beech. Voy. p. 136. pl. 37. f. 4.	
94	5	......	......	—— flava, *Gld. Am. Jl. Sc. Art*, vol. 38. 1840, p. 196.	N. Zembla, Is. Paul in Behr. Sea.
				= *N. lactea*, Lov., Phil.	
				= *N. Grœnlandica*, Beck, Möll. & Thorpe.	
				? = *N. suturalis*, Gray.	
				= *N. pusilla*, Say, teste Phil.	
96	6	......	......	—— herculæa, *Midd.*	Bodejas.
				? = *N. Lewesii*, Gld.	
97	1	......	......	Scalaria Grœnlandica, *Chemn.*, *Sow.*, *Gld.*	Behring Straits.
				= *S. planicosta*, Kien.	
				= *S. subulata*, Couth., De Kay.	
98	2	......	......	—— Ochotensis, *Midd.*, v. *Reise*	S. coast Ochotsk.
99	1	......	......	Pilidium commodum, *Midd.*, v. *Reise.*	Schantar Is.
100	1	......	......	Crepidula solida, *Hds.*	Bodegas.
100	2	11	3–5	—— Sitchana, *Midd.*	Sitcha, *Wosn.*
101	3	11	6, 7	—— minuta, *Midd.*	Sitcha, *Wosn.*
101	4	11	8–10	—— grandis, *Midd.*	Is. Paul, Behring Sea.
103	1	......	......	Haliotis Kamtschatkana, *Jonas*, *Z. f. M.* 1845, p. 168.	Kamtsch., Unalaschka.
104	2	......	......	—— aquatilis, *Rve*	Kurule Is., *Rve.*
104	1	......	......	Velutina haliotoidea, *O. Fabr.*	Lapl., *Midd.*; Kamtsch., Chiron, *Desh.*
				= *V. lævigata*, L., Gld., Rve., Donov.	
				= *Bulla velutina*, Müll.	
				= *V. Mülleri*, Desh., Guér. Mag. 1841.	
				= ?*Sigaretus coriaceus*, Br. & Sow.	
106	3	......	......	—— coriacea, *Pallas*	Kurile, *Pallas*; Kamt., *Steller.*
106*a*	4	......	......	—— cryptospira, *Midd.*, v. *Reise*	Schantar Is., Ochotsk.

Page.	No.	Plate.	Fig.	Name.	Locality.
107	1	......	......	Trichotropis bicarinata, *Sow*.	Behring, Schantar Is., Ochotsk.
107	2	10	7–9	—— insignis, *Midd.*	Behring.
108	3	......	......	—— borealis, *Br. & Sow.* =*T. costellatus*, Couth. =*T. Atlantica*, Beck. =*T. cancellata*, Hds. =*T. umbilicatus*, Macgil.	Sitcha, *Wosn.*, *Hds.*
109	4	......	......	—— inermis, *Hds.*	Sitcha, *Hds.*
110	1	......	......	Cancellaria (Tritonium [!]) viridula, *O. Fabr.* =*Admete crispa*, Möll. =*Canc. Couthoyi*, Jay. =*C. buccinoides*, Couth. =*C. costellifera*, Hanc.	Lapl., Behring Sea.
112	2	......	......	?—— arctica, *Midd.*	Behr. Str., *Wosn.*
113	1	......	......	Purpura lapillus, *Linn.* +*imbricata*+*bizonalis*, Lam.	Sitcha & Urup, Ochot., White S.
116	2	9	1–3	—— decemcostata, *Midd.*	Behr. Straits.
117	3	......	......	—— Freycinetii, *Desh.*, v. *Reise.*	Sitch., Och., Kamt., Behr., Aleut.
117	4	......	......	—— septentrionalis, *Rve.*	Sitcha.
118	2	......	......	Pleurotoma Schantaricum, *Midd.*, v. *Reise.*	Ochotsk, Schantar.
119	3	......	......	—— simplex, *Midd.*	Ochotsk.
119	1	......	......	Murex monodon, *Esch.*	Sitcha.
120	2	7	1, 2	—— lactuca, *Esch.* +*M. ferrugineus*, Esch.	Sitcha, Kadjak.
125	2	......	......	Tritonium (Trophon) clathratum, *Linn.* =*T. Gunneri*, Lov., Rve. =*Fusus lamellosus*, Gray, Z. B. V. pl. 36. f. 13. =*F. scalariformis*, Gld. =*Murex multicostatus*, Esch. =*M. clathratus*, Phil. Z. f. M. 1845, p. 78. =*Trophon Bamffii*, Fabr.	Sitcha, Lapland.
128	3	......	......	—— (Fusus) antiquum, *Linn.* (non *Lam.*) +*T. canaliculatum*, Pallas. +*F. fornicatus*, Gray, Z. B. V. p. 117; Rve. f. 63.	Kamt., Behr., Schan., Ochotsk, Lapl., N. Zembl.
138	5	......	......	—— —— decemcostatum, *Say*, *Gld.*	Kadj., Kenai.
140	6	......	......	—— —— contrarium, *Linn.*	Lapl., Ochotsk.
140	7	......	......	—— —— deforme, *Rve.*	Behr. Sea.
141	8	......	......	—— —— Islandicum, *Chem.* =*F. pygmæus*, Gld., Phil. ?=*F. Holboellii*, Möll. =*Trit. gracile*, Da Cost., Lov. =*Murex corneus*, Donov. =*Fusus Sabini*, Hanc.	Behr. Sea, Lapl.
145	9	......	......	—— —— Sabinii, *Gray* (nec *auct.*) =*Buccinum S.*, Gray, Parry's Voy. p. 240. =*F. Berniciensis*, King, 1846. =*F. Sabinii*, Gray, Z. B. V. p. 117.	Kenai, Lapl.
146	10	......	......	—— —— Schantaricum, *Midd.*, v. *Reise.*	Schant., Is. Paul.
147	11	......	......	—— —— Norvegicum, *Chemn.*	Tugur B., Ochotsk.
147	12	3	5, 6	—— —— Behringii, *Midd.*	Behr. Sea.
148	13	6	7, 8	—— —— Baerii, *Midd.*	Behr. Sea.
149	14	2	5–8	—— —— Sitchense, *Midd.*	Sitcha.
150	15	4	4, 5	—— luridum, *Midd.*	Sitcha.
151	16	......	......	—— (Buccinum) undatum, *Linn.*	Lapland.
156	...	......	......	—— .... *var.* Schantarica	Schantar Is.
157	17	......	......	—— —— tenebrosum, *Hanc.* =*B. cyaneum*, Möll. +*B. undulatum*, Hanc.	Sitcha, Lapl.

Page.	No.	Plate.	Fig.	Name.	Locality.
157	17	......	......	Tritonium (Buccinum) tenebrosum, *Hanc.* (*continued.*)	
				+*B. sericatum*, Hanc. An. N. H. 1846, p. 328.	
				+*B. hydrophanum*, Hanc.	
				=*B. boreale*, Br. & Sow.	
163	18	......	......	—— —— simplex, *Midd.*, v. *Reise*.......	Schant.
163	19	......	......	—— —— Ochotense, *Midd.*, v. *Reise*....	Ochotsk.
164	21	3	1–4	—— —— cancellatum, *Lam.*	Unalaschka, Kadjak, Kamtsch.
				=*Triton c.*, A. s. V. ix. 638.	
				+*F. Oregonensis*, Rve.	
167	22	......	......	—— —— (Pollia) scabrum, *King**	Kadjak, *Wosn.*; [S. Am., *King.*]
				Pollia scabra, Gray, Z. B. V. pl. 36. f. 16.	
168	23	4	11	—— —— glaciale, *Linn.*	Lapl., Ochotsk, Kamtsch.
				=*B. Grœnlandicum*, Hanc.	
				?=*B. polaris*, Gray, Z. B. V. p. 128.	
174	26	{4 6	12 1–4}	—— —— ovum, *Turt.*	Lapl., Behr.
				=*B. ventricosum*, Kr.	
				?+*B. fusiforme*, Kr.	
				=*Tr. ciliatum*, O. Fabr.	
175	27	......	......	—— —— ooides, *Midd.*, v. *Reise.*	Tugur, Ochotsk.
179	1	......	......	Bullia ampullacea, *Midd.*	Sitcha, Schantar.
183	1	......	......	Limacina arctica, *Fabr.*, v. *Reise.*	Schantar.
184	1	10	19–22	Tritonia [Dendronotus] arborescens, *Müll.*	Sitcha, Ochotsk, Lapl., N. Zem.
				=*T. Reynoldsii*, Couth.	
186	1	12	1–6	Onychotheutis Kamtschatica, *Midd.*......	Kurile.
187	2	......	......	—— Bergii, *Licht*............................	Behr. Sea.
187	...	......	......	?Octopus, sp. ind.	Behr. Sea.

Part III.

Page.	No.	Plate.	Fig.	Name.	Locality.
1	1	11	11–17	Terebratula psittacea, *Gmel.*	Sitcha, Lapl.
2	2	......	......	—— frontalis, *Midd.*, v. *Reise.*	Ochotsk.
5	4	......	......	[Placun-]Anomia patelliformis, *Linn.* ...	Sitcha, *Esch.*
6	5	......	......	—— macrochisma, *Desh.*, v. *Reise.*	Aleut., Kamt., Ochotsk.
10	2	12	7, 8	Pecten Islandicus, *Chemn.*	N. Zemb., Lapl., ? Behr., ? Kamt.
				=*P. Fabricii*, Phil.	
				=*P. Pealii*, Conr.	
12	3	{12 13	9, 10 1–6}	—— rubidus, *Hds.*............................	Sitcha, *Wosn.*; Aljaska, *Hds.*
17	2	......	......	Modiolaria nigra, *Gray*	Ochotsk, Lapl., N. Zem.
				=*M. lævigata*, Lov., Hanc.	
				=*M. lævis*, Beck.	
				=*M. discors*, Beck, Gld., Fabr., Chemn., Phil., Rve.	
20	3	......	......	—— vernicosa, *Midd.*, v. *Reise.*	Ochotsk, Is. Kadj.
21	1	......	......	Modiola modiolus, *Linn.*	Sitcha, Lapl., Behr.
				+*Mytilus barbatus*, Linn.	
				+*Mod. papuana*, Lam.	
				+*M. Gibbsii*, Leach.	
				+*M. grandis*, Phil.	

* This shell is introduced under the title "*Tritonium* (*Buccinum*, Subg. *Pollia*, Gray) *scabrum*, King et Broderip," which reminds us of the pre-Linnæan times, and almost destroys the good of binomial nomenclature. Dr. Middendorff may show his philosophical knowledge by uniting *Trophon*, *Chrysodomus*, *Buccinum*, *Pisania* and *Nassa* into one genus; but he has scarcely a right to compel us to use six words (besides the authority for the specific name) in citing his shell. Its presence in the N. Boreal fauna is extraordinary. It is generally regarded as one of the characteristic species of temperate or even tropical South America. It has occurred, however, in pseudo-Mazatlan collections, and was brought by Kellett and Wood. It has the aspect of a deep-water shell, and may therefore have a wide range.

Page.	No.	Plate.	Fig.	Name.	Locality.
25	3	13, 14	7–10, 1–8	Mytilus edulis, *Linn.*	Sitcha, Ochotsk, Kamt., Lapl., Is. Paul, Kadj., Kenai, Behr.
				+*M. borealis, abbreviatus, retusus, incurvatus*, Lam.	
				+*M. pellucidus*, Penn.	
				+*M. notatus*, De Kay.	
				+*M. subsaxatilis*, Williamson.	
28	2	......	......	Nucula castrensis, *Hds.*	Sitcha, *Hds.*
28	3	......	......	—— arctica, *Br. & Sow.*	Kamtsch., *Beechey.*
29	1	......	......	Cardita borealis, *Conr.*	Ochotsk.
39	9	16	1–5	Cardium Nuttallii, *Conr.*	Sitcha, Kenai B., Is. Paul.
				+*C. Californianum*, Conr.	
40	10	15	23–25	—— Californiense, *Desh.*, v. *Reise.*	Sitcha, Ochot., Unal., Behr. Sea.
44	1	16, 17	10–12, 1, 2	Astarte Scotica, *Mat. & Rack.*	Ochotsk, N. Zem., Lapl.
46	5	......	......	—— corrugata, *Brown*	Aljaska, Behr., N. Zem., Lapl.
				=*A. semisulcata*, Hanc.	
				=*A. borealis*, Phil., Forbes.	
				=*A. lactea*, Br. & Sow. Z. B. V, p. 152.	
				=*Tellina atra*, Pallas.	
51	2	17	11–13	Venerupis Petitii, *Desh.*	Sitcha, Behr. Sea.
52	3	18	1–3	—— gigantea, *Desh.*	Sitcha, Kamtsch.
56	5	......	......	Venus astartoides, *Beck*, v. *Reise.*	Ochotsk, Behr.
56	1	18	4	Petricola cylindracea, *Desh.*	Sitcha.
57	2	18	5–7	—— gibba, *Midd.*	Sitcha, *Esch.*
58	1	......	......	Saxicava pholadis, *Linn.*	Sitc., Och., Kamt., N. Zem., Lapl.
61	6	......	......	Tellina solidula, *Pult.*	Tugurb., Ochotsk, Behr., Kamt., N. Zem., Lapl., Black Sea.
61	7	......	......	—— nasuta, *Conr.*	Sitcha, Behr., Ochotsk.
62	8	17	8–10	—— lata, *Gmel.*, v. *Reise.*	Behr., Ochotsk, Tugurb., Lapl.
62	9	......	......	—— lutea, *Gray*, v. *Reise.*	Behr., Schant., St. Paul.
62	10	......	......	—— edentula, *Br. & Sow.*, v. *Reise.*	Ochotsk, Unal., Behr.
62	11	......	......	—— Bodegensis, *Hds.*	Bodegas.
66	2	......	......	Mactra ovalis, *Gld.*, v. *Reise.*	Ochotsk, Behr., Kenai.
66	1	19	1–4	Lutraria maxima, *Midd.*	Sitcha, *Wosn.*
				[?=*L. capax*, Gld.]	
67	1	21	1–3	Pectunculus septentrionalis, *Midd.*	Is. Ukamok, N.W. coast.
68	1	......	......	Lyonsia Norwegica, *Chemn.*, v. *Reise.*	Ochotsk.
69	1	19	13–15	Mya truncata, *Linn.*	Ochotsk, Lapl., Kamt.
				[?=*M. præcisa*, Gld.]	
70	2	20	1–3	—— arenaria, *Linn.*	Sitcha, Ochotsk, Lapl., N. Zem.
78	1	21	4–10	Machæra costata, *Say*, v. *Reise.*	Sitcha, Ochotsk, Behr., Kamt.

In the *Sibiriens Reise*, additional particulars are given with regard to the following species.

163	1	13, 14	1–9, 1–6	Chiton Pallasii, *Midd.*	Tugur.
174	2	15	1–6	—— Brandtii, *Midd.*	Sitcha, Tugur, Schantar.
178	3	14, 15	7–10, 7, 8	—— submarmoreus, *Midd.*	Sitcha, Tugur, Schantar.
183	4	16	6 *a–c*	Patella (Cryptobranchia) cæca, *Müll.*	Tugur, Schantar.
				+*P. cerea*, Möll.	
				+*C. candida*, Couth. Some varieties resemble *Acmæa testudinalis*.	
186	5	16	4*a–d*, 5*b, c*	—— (Acmæa) pelta, *Esch.*	Sitcha, Tugur, Schantar, Unalaschka.
187	6	16	1*a–d*, 2*a–c*, 3	—— —— patina, *Esch.*	Sitcha, Tugur, Schantar, Unalaschka, Aleut., Kenai.
				+*A. scutum*, Esch.	
				+*A. scutum*, D'Orb. p. 479, excl. f. 8–10. A white var. from the Ochotsk Sea.	

Page.	No.	Plate.	Fig.	Name.	Locality.
192	7	...	......	Paludinella stagnalis, *Linn.*	S. coast Ochotsk Sea, on *Algæ.*
				=*Paludina stagnalis*, Mke. Z. f. M. Jan. 1845, p. 37.	
				=*P. muriatica*+ *thermalis*, Phil. Sic.	
193	...	...	......	A. forma normalis	Ochotsk Sea.
				=*Turbo ulvæ*, Pen.	
				=*Paludina ulvæ*, Lov.	
				=*P. pusilla*, Eichwald.	
				=*Cingula lævis*, De Kay.	
193	...	...	......	A[1]. forma elatior.	
				=*Paludina octona*, Nilsson.	
				=*P. stagnalis*, var. *b*, Mke.	
				=*Cyclostoma acutum*, Drap.	
				=*Turbo ventrosus*, Mont. [?]	
				=*Rissoa saxatilis*, Möll.	
194	7	25	3, 4	A[2]. forma ventricosior.	
				=*Paludina balthica*, Nilss., Lov.	
				=*Cyclostoma anatinum*, Drap.	
				=*Turbo muriaticus*, Beudant.	
				=*Cingula minuta*, Gld., De Kay.	
				=*Rissoa glabra*, Alder.	
				=*Paludina ? ulva*, Lyell.	
195	8	......	......	Paludinella aculeus, *Gld.*	S. coast Ochotsk.
				=*Cingula striata*, Thorpe.	
				=?*Rissoa arctica*, Lov.	
196	9	25	5–7	—— cingulata, *Midd.*	Schan.
197	10	10	10, 11	Lacuna glacialis, *Möll.*	Schan., S. Ochotsk.
198	11	11	4–10	Littorina grandis, *Midd. Bull. Class. Phys. Math. Ac. St. Petersb.* vii. no. 16.	Schan., S. Ochotsk.
201	12	11	13, 14	—— Kurila, *Midd. Bull. Class. Phys. Math. Ac. St. Petersb.* vii. no. 16.	Schan., S. Ochotsk, Kurile.
202	13	11	11, 12	—— subtenebrosa, *Midd. Bull. Class. Phys. Math. Ac. St. Petersb.* vii. no. 16.	S. Ochotsk (Is. Segneka).
203	14	17	13–16	Margarita arctica, *Leach, var.* major, *Midd.*	Schan., S. Ochotsk.
204	15	18	1–7	Trochus Schantaricus, *Midd.*	Schan., S. Ochotsk.
206	16	11	1–3	Natica aperta, *Lov*..........................	Schan., S. Ochotsk, Jakshina.
208	17	......	......	—— clausa, *Br. & Sow.*	Schan., S. Ochotsk.
				=*N. consolidata*, Couth., Phil.	
				=*N. septentrionalis*, Beck, Möll.	
210	18	......	......	—— pallida, *Br. & Sow.*	Schan., S. Ochotsk.
				=*N. borealis*, Gray, Z. B. V. pl. 37. f. 2.	
				=*N. Gouldii*, Phil. Z. f. M. 1845, p. 77.	
213	19	12	12–14	Scalaria Ochotensis, *Midd.* [This most remarkable shell has the appearance of an enormous *Chemnitzia*; and reminds one of the Oolitic forms which go by that name.]	S. Ochotsk (Bay Nichta).
214	20	17	4–11	Pilidium commodum, *Midd.*	S. Ochotsk.
216	21	25	8–10	Velutina cryptospira, *Midd.*	Schan.
218	22	......	......	Trichotropis bicarinata, *Br. & Sow.*	Schan., S. Ochotsk, Tugur.
				+*T. Sowerbiensis*, Less.	
219	23	12	1–9	Purpura Freycinettii, *Desh.*	S. Ochotsk.
				+*P. attenuata*, Rve.	
222	24	12	10, 11	—— lapillus, *Linn.*	S. Ochotsk.
223	25	12	17–19	Pleurotoma Schantaricum, *Midd.*	Schan., S. Ochotsk.
223	26	12	15, 16	—— simplex, *Midd.*	S. Ochotsk.
224	27	......	......	Tritonium (Fusus) antiquum, *Linn.*	
		10	3	Var. 1. *Behringiana*	Behring Sea.
				Var. 2. *communis*, +*fornicatus*, Rve.	
229	28	......	......	—— —— contrarium, *Linn.*	S. Ochotsk, Tugur.
230	29	10	7–9	—— Schantaricum, *Midd*.................	Schan.
231	30	......	......	—— (Fusus) Norvegicum, *Chemn*.........	Tugur.

Page.	No.	Plate.	Fig.	Name.	Locality.
233	31	10	4–6	Tritonium (Buccinum) undatum, *var.* Schantarica.	Schan.
234	32	......	......	—— —— simplex, *Midd. Bull. &c.* vii. no. 16	Schan.
235	33	{10, 9}	{1, 2; 5}	—— —— Ochotense, *Midd.*......do......	Tugur.
236	34	8	7, 8	—— —— ovoides, *Midd.* ....do......	Tugur.
237	35	8	5, 6	—— tenebrosum, *Hanc.* [pl. 9, err. typ.]	
237	36	8	3, 4	Bullia ampullacea, *Midd.* [pl. 17. fig. 1–3, err. typ.]	Schan., Tugur.
240	37	......	......	Limacina arctica, *Fabr.* .... =*L. helicialis*, Lam., Rve.	Schan.
241	38	18	9–14	Terebratula frontalis, *Midd.*	S. Ochotsk.
242	39	19	1–5	Anomia macroschisma, *Desh.*...............	Schan.
244	40	......	......	Modiolaria vernicosa, *Midd.*	S. Ochotsk.
245	41	......	......	—— nigra, *Gray*	Schan., S. Ochotsk.
245	42	......	......	Mytilus edulis, *Linn.*	S. Ochotsk.
247	44	......	......	Cardita borealis, *Conr.* .... ? *Cardita spurca*, Sow.	S. Ochotsk.
248	45	19	6–11	Cardium Californiense, *Desh.* (nec *Conr.*)	Schan., S. Ochotsk, Tugur.
250	46	20	1–4	Astarte Scotica, *Maton & Rack*............ =*A. semisulcata*, Lov., Phil., Möll. =*A. Garensis*, ?var. Lyell. =*A. lactea*, Gld. =*Venus sulcata*, Mont.	S. Ochotsk.
252	48	20	5–13	Venus Astartoides, *Beck*, n. sp............	S. Ochotsk, Tugur.
253	49	24	1–7	Saxicava pholadis, *Linn*..................... =*S. gallicana*, Lam. =*S. rugosa*, Lam. =*Mytilus rugosus*, Penn. =*S. Grœnlandica*, Pot. & Mich. =*S. distorta*, Say, Gld. =*Mya byssifera*, Fabr. =*Solen minutus*, Wood. +*Hiatella oblonga*, Turt.	S. Ochotsk.
256	50	23	6–11	Tellina nasuta, *Conr.*	S. Ochotsk, Tugur.
257	51	23	1–5	—— lata, *Gmel.* (nec *Quoy & Gaim.*).... =*T. calcarea*, Hanl., Lyell, Möll. +*T. proxima*, Bronn, Hanl., Gray. =*T. triangularis*, Lyell. =*T. sordida*, Couth. =*Sanguinolaria s.*, Gould. =*Macroma tenera*, Leach.	S. Ochotsk.
258	52	21	2, 3	—— lutea, *Gray* .... =*T. alternidentata*, Br. & Sow. =*T. Guildfordiæ*, Gray.	Schantar Is.
259	53	21	1	—— edentula, *Br. & Sow*....................	S. Ochotsk, Tugur.
260	54	22	3–6	—— solidula, *Pult.*, *Hanl.*, *Wood*, *Lam.*, *Kryn.* =*Loripes roseus*, Andrj. =*T. carnaria*, Penn., not Linn. =*T. balthica*, Phil., Lyell. =*T. grœnlandica*, Lyell. =*T. fusca*, Say=*Psammobia f.*=*Sanguinolaria f.* =*T. frigida*, Hanl. =*T. Fabricii*, Hanl. =*T. inconspica*, Br. & Sow. [Comp. *Sanguinolaria Californica*, Conr.]	S. Ochotsk.
363	55	......	......	Mactra ovalis, *Gld.* [p. 263, err. typ.] ... =*M. ponderosa*, Phil. =*M. similis*, Gray, Z. B. V. p. 154. pl. 44. f. 8.	S. Ochotsk, Tugur.

Page.	No.	Plate.	Fig.	Name.	Locality.
264	56	24	8–11	Lyonsia Norvegica, *Chemn.*	Schant., S. Ochotsk, Tugur.
				=*L. striata*, Turt. (*Mya str.*, Mont.)	
				=*L. gibbosa*, Hanc.	
				=*Mya hyalina*, Conr. teste Couth.	
				=*Pandorina arenosa*, Möll.	
				=*Amphidesma corbuloides*, Lam.	
				=*Osteodesma corbuloides*, Desh.	
				=*O. hyalina*, Couth., Gld., De Kay.	
266	57	25	11–14	Mya truncata, *Linn.*	S. Ochotsk.
				+*M. Uddevalensis*, Hanc.	
268	58	......	......	—— arenaria, *Linn.*	S. Ochotsk.
269	59	......	......	Panopæa Norvegica, *Spengler*	S. Ochotsk, Tugur.
269	60	......	......	Machæra costata, *Say*	S. Ochotsk (Lebashja).
				=*Solecurtus Nuttallii*, Conr.	
				=*Solen nitidus*, Chen.	
				=*S. splendens*, Chen.	
				=*S. Americanus*, Chen.	
				=*S. medius*, Gray, Z. B. V. p. 153. pl. 44. f. 2.	
				=*S. maximus*, Wood (nec Chemn.) p. 129. pl. 31. f. 3.	
				?=*S. tenuis*, Brod. & Sow.	
				?=*S. altus*, Brod. & Sow.	

The freshwater and land shells described in this work, pp. 273–308, appear to belong exclusively, either to the general North temperate fauna of the old world, or to the local fauna of the district. They are distributed by Middendorff under three heads, pp. 389 *et seq.* (1) *Circumpolar Fauna*: Unio margaritifera, Planorbis albus, Limnæus stagnalis and palustris, Physa hypnorum, Succinea putris, Helix pulchella, pura and fulva, Achatina lubrica, Vitrina pellucida. (2) *Boreal Fauna*: Unio pictorum and batavus, Anodonta cellensis and anatina, Pisidium obliquum, Cyclas cornea and calyculata, Planorbis corneus, complanatus, contortus, leucostoma and vortex, Limnæus auricularius, truncatulus, leucostomus, Physa fontinalis, Paludina Kikxii and tentaculata, Valvata piscinalis, Helix ruderata, Schrenkii, carthusiana and hispida, and Bulimus obscurus. (3) *Central Asiatic Fauna*: Unio Dahuricus and Mongolicus, Anodonta herculea, and Limnæus Gebleri.

The author enters at considerable length, pp. 351–389, into the influence of Zones, Depths, Temperature and Saltness on the distribution and changes of mollusks; and gives full details of the peculiarities of several specific and generic forms, pp. 330–342. In pp. 309–463, the author distributes the Russian shells into their various Zoological provinces. With the Aral-Kaspian, the Black Sea* and the very limited Baltic faunas, we have now no concern. The Polar fauna (p. 318 *et seq.*) is divided into three sections:—A. The Atlantic species, 30 in number. B. Those of the Behring Sea, 26; and C. the Circumpolar species, 54. To this list are added 50 species, which have not yet been found in the Russian dominions.

* Middendorff gives the following species as common to the temperate latitudes on both sides of the Atlantic:—*Littorina rudis, Fusus muricatus, Crepidula unguiformis, Dentalium dentalis, Anomia ephippium, Solen ensis, Pecten varius, Lima squamosa.* Also the following as common to the Mediterranean and the West Indies:—*Conus Mediterraneus, Columbella mercatoria, Nassa crenulata, Littorina muricata* and *neritoides, Cerithium lima, Tellina carnaria,* and *Rotella lineata.* Pp. 346–7.

B. *Polar Fauna of the Behring Sea.*

Chiton submarmoreus, tunicatus and vestitus.
Patella patina, pelta.
Paludinella ? cingulata.
Littorina subtenebrosa, Sitchana, grandis.
Margarita sulcata.
Scalaria Ochotensis.
Crepidula grandis.
Trichotropis insignis.
Cancellaria arctica.
Purpura Freycinetii, decemcostata.
Pleurotoma Schantaricum, simplex.
Tritonium (Fusus) Behringii, Baerii.
Bullia ampullacea.
[Placun-]Anomia macrochisma.
Modiola vernicosa.
Nucula arctica.
Tellina edentula, lutea.

C. *Circumpolar Species*, p. 319.

Patella cæca.
Paludinella stagnalis, aculeus.
Lacuna glacialis.
Margarita striata, arctica.
Natica pallida, clausa, aperta, flava, helicoides.
Scalaria grœnlandica.
Velutina haliotoidea.
Trichotropis borealis, bicarinata.
Purpura lapillus.
Tritonium (Trophon) clathratum.
T. (Fusus) antiquum, contrarium, Islandicum, Sabinii, Norvegicum, 10-costatum.
T. (Buccinum) undatum, tenebrosum, ovum.
Limacina arctica.
Onychotheutis Bergii, Kamtschatica.
Terebratula psittacea.
[Placun-]Anomia patelliformis.
Pecten Islandicus.
Modiola modiolus, nigra.
Mytilus edulis.
Nucula pygmæa.
Cardita borealis.
Cardium Nuttallii. [Probably belongs to B.]
Astarte Danmoniensis, Scotica, corrugata, compressa.
Venus Astartoides.
Saxicava pholadis.
Tellina solidula, lata.
Mactra ovalis.
Lyonsia Norvegica.
Mya truncata, arenaria.
Panopæa Norvegica.
Machæra costata.

An analysis of the species belonging to the Pacific waters is given in pp. 349 *et seq*. The following are as yet only known from the Asiatic coast:—

Chiton Pallasii and amiculatus.
Trochus Schantaricus.
Pilidium commodum.
Tritonium Schantaricum, simplex, Ochotense, ooides, cancellatum.
Terebratula frontalis.

The following have been found both on the east and west sides of the Pacific:—

Chiton Stelleri, Brandtii, lineatus.
Littorina Kurila.
Velutina coriacea, spongiosa.
Haliotis Kamtschatkana, aquatilis.
Modiola cultellus.
Cardium Nuttallii, Californiense.
Venerupis gigantea, Petitii.
Tellina nasuta.

Of the species (so far as we yet know) peculiar to the American shores, the following are recorded by Middendorff as not having been found below Sitcha; the list, however, will have to be materially modified:—

Chiton Sitchensis, lividus, Eschscholzii, Merckii.
Patella digitalis, persona, personoides, pileolus, Asmi.
Turritella Eschrichtii.
Trochus modestus.
Dentalium politum.
Crepidula Sitchana, minuta.
Trichotropis insignis.
Purpura septentrionalis.
Tritonium Sitchense, luridum.
Murex lactuca, monodon.
Pecten rubidus.
Petricola gibba.
Nucula castrensis.
Pectunculus septentrionalis.

The following list of species common to Sitcha and California will have to be considerably extended:—

Fissurella violacea, aspera.
Patella scurra.
Littorina modesta and aspera.
Trochus ater, mœstus, Fokkesii, euryomphalus.
Tritonium scabrum.
Petricola cylindracea.
Lutraria maxima.

The following are regarded by Middendorff as peculiar to the Californian province:—

Chiton Mertensii, scrobiculatus.
Patella æruginosa.
Natica herculæa.
Crepidula solida.
Tellina Bodegensis.

The very abnormal appearance of the tropical *Litorina aspera* and *Callopoma fluctuosum*, in these Northern lists, awaits confirmation. The *L. aspera* of Barclay may be founded on ballast specimens; or it may be a misnomer for the *L. planaxis* of Nutt., as ordinary coarse specimens of the two might easily be mistaken. The *Callopoma*, which appears to extend along the Californian coast, may also have reached Sitcha through human instrumentality. Another circumstance pointed out by Middendorff is remarkable: that two of the largest species of *Crepidulæ* known, are found on the northern shores of America; one on the Pacific, the other on the Atlantic side.

45. In the years 1843–46, H.M.S. Samarang sailed under the command of Capt. Sir E. Belcher to the East Indies. Although the expedition did not touch upon the western coast of America, there appear in the "Zoology: Mollusca, by A. Adams and L. Reeve; London 1850," the two following species:—

"P. 70. pl. 9. f. 7 *a, b*. *Calyptræa trigonalis*. China Sea." This scarcely differs in any essential particular from *Crucibulum lignarium*, Brod., and its varieties from South America. The trigonal form may be an accident of growth.

"P. 78. pl. 21. f. 17. *Artemis Dunkeri*, Phil. Eastern Seas." This is the abundant and characteristic species of the Mazatlan district, extending along the coast of Peru. The habitat is probably erroneous.

In all other respects, as might be expected, the species described in this beautiful and most instructive work are entirely distinct from those of the W. American coast.

46. In the "Zeitschrift für Malakozoologie, von Dr. Karl Theodor Menke und Dr. Louis Pfeiffer, Cassel, 1846," pp. 19–21, 51–55, Dr. R. A. Philippi describes the following species from Mazatlan, on the authority of one of his own family:—

Page.	No.	
19	1.	*Corbula alba*, Phil. Resembles the Italian fossil *C. carinata*. Perhaps it is the *C. bicarinata*, Sow.
19	2.	*Tellina cicercula*, Phil. Perhaps=*Strigilla carnaria*, jun. *Vide* B. M. Maz. Cat. p. 41. no. 66.
19	3.	*T. lenticula*, Phil. (*Strigilla*).
20	4.	*T. dichotoma*, Phil. (*Strigilla*).
20	5.	*T. ervilia*, Phil. (*Strigilla*). In his Abbild. &c. Aug. 1846, p. 24, he quotes *Tellina* (*Strigilla*) *pisiformis* and *Diplodonta semiaspera*, as common to Mazatlan and the Caribbæan Sea.
20	6.	*Diplodonta obliqua*, Phil.
21	7.	*Lucina cancellaris*, Phil.
21	8.	*Patella pediculus*, Phil.

Page.	No.	
51	18.	*Siphonaria Lecanium*, Phil.
51	19.	*Trochus disculus*, Phil. (*Modulus*).
52	20.	*Buccinum nucleolus*, Phil. ? An *Anachis*. Described as a miniature edition of *B. prismaticum*. Comp. *B. Antoni*, Dkr., Zeit. f. Mal. 1847, p. 61. no. 6, "Mexico, *Hegewisch*," described as resembling the same shell.
53	23.	*Terebra fulgurata*, Phil.
53	24.	*Columbella pallida*, Phil. Resembles *Anachis azora*, Ducl.
54	25.	*C. spadicea*, Phil. ?Resembles *A. costulata*, Brod. & Sow.
54	26.	*C. tæniata*, Phil.
55	27.	*Dentalium hyalinum*, Phil.

47. The Mexican War, carried on by the United States, 1846–1848, against their sister republic*, ending in the extension of slavery, was indirectly the means of adding to our knowledge of the Californian and Mexican faunas. Three of the officers, viz. Col. E. Jewett (of Utica, N.Y.) and Major William Rich (of Washington) of the army, and Lieut. T. P. Green of the navy, made collections at different stations from Panama to San Francisco, the whole of which have passed through the hands of Dr. Gould for examination. The number of species collected by Col. Jewett was about 221; by Major Rich, 130; by Lieut. Green, about 172; in all, perhaps 440 species. Many of them were collected alive, and of a large part the localities were noted at the time. It is too much to expect that gentlemen engaged in so fearful and exciting a trade should be able to exercise the calm, patient accuracy needed for scientific pursuits. On doubtful points, therefore, the evidence may need confirmation: still it speaks much for the care and interest for science which these gentlemen manifested, that the supposed errors are few and comparatively unimportant. Several species thought to be new were described by Dr. Gould in the 'Proc. Bost. Soc. Nat. Hist.' Nov. 1851; and have been since reprinted, with additional descriptions and three plates, under the title "Descriptions of Shells from the Gulf of California and the Pacific Coasts of Mexico and California, by Augustus A. Gould, M.D." There is no date, but the work was received last year in this country. In order to promote harmony of nomenclature between the writers in England and America, Dr. Gould ventured to entrust the whole of his valuable collections from the west coast of N. America to the writer, although unknown to him; by whom they were carefully collated with the specimens in the British Museum and the cabinets of Mr. Cuming and Mr. Nuttall†. The result, so far as the new species are concerned, is embodied in a paper laid before the Zoological Society last June; and, so far as relates to the identification of previous species, in the following lists. Of many, however, the specimens had only been lent to Dr. Gould for examination, and have therefore not been seen in this country. When the identifications of species are erroneous, according to English interpretations, the name assigned by Dr. Gould is retained as his own, with the supposed correct one added; in order that the meaning of the species as used by that author may be understood in his other writings. The very interesting locality-notes of Messrs. Jewett and Green contain several entirely unexpected statements, Panama and Mazatlan species being quoted from Sta. Barbara, and *vice versâ*. Some few well-known W. Indian forms also appear from Acapulco and Panama; which it is more natural to regard as importations than as "representative species." The same may be said of the remarkable appearance of *Livona pica* at Sta. Barbara. When we remember the errors that have

* *Vide* A. A. Livermore's War with Mexico Reviewed. Boston, 1850.

† A large part of the shells in the following lists, however, were not sent to this country; having probably only passed through Dr. Gould's hands for examination.

crept into the works of the most experienced writers, it is not passing the least reflection on the statements of these scientific officers, when we claim liberty to suspend our judgment till the unexpected results have been verified. The principal value of Major Rich's collection (as of those made by Capt. Kellett and Lieut. Wood), appears to be the accumulation of rare and interesting specimens: for geographical purposes, as most of the habitats are simply divided between Upper and Lower California, it cannot be regarded as of much authority.

Of the following species, sent with the others, the name of the collector is not given.

Sanguinolaria Nuttallii, Conr. =*decora*, Hds. San Diego.
Donax bella, Desh. Lower California.
—— *sulcatus*, Phil. Zeit. f. Mal. 1847, p. 76. no. 12. ?—
Dione chionæa, Mke. ?—
Mytilus bifurcatus, Conr. "Calif. coast somewhere." Sandw. Is., teste Conr.
Crenella coarctata, Dkr.
Arca ?lurida (or *vespertilio*). ?Mazatlan.
—— *solida*, Sow. California.
Ostrea Columbiensis, Hanl., on *Arca grandis*. Lower California.
—— *rufa*. Of two specimens thus named, the larger appears =*O. Virginica*, jun.; the smaller may be the young of the elongated form of *O. iridescens*. Calif.
Helix Nuttalliana, Lea, =*fidelis*, Gray. Oregon.
—— *Townsendiana*, Lea. Oregon.
—— *devia*, Gld.=*Baskervillii*, Pfr. Oreg.
—— *Nickliniana*, Lea, =*vincta*, Val. (not =*Californica*, Rve.) Upper California.
—— *æruginosa*, Gld. =*Townsendiana*, var. Pfr. San Francisco.
Helix sportella (384, young shell). ?—
Haliotis ?Kamtschatkana: dead. ?—
Hipponyx serratus, Cpr. ?—
—— *mitrula*, Lam. ?—
Modulus dorsuosus, Gld. =*duplicatus*, var. A. Ad. =*disculus*, Phil. ?—
Modulus ?lenticularis, Chemn. Acapulco. [Probably the W. Indian sp. imported.]
Cerithium interruptum, Mke. ?—
Ovulum secale. ?—
" —— ? *avena*, Sow. =*simile*, Rve. =*variabilis*, C. B. Ad." ?—
Pleurotoma funiculata, Sow. Lower Calif.
Drillia albovallosa, Cpr. ?—
Terebra albocincta, Cpr. (three dead sp.).
Marginella imbricata, Hds. Sta. Barbara.
Oliva gracilis, Brod. & Sow. ?Panama. [This appears exactly the W. I. species.]
"*Columbella terpsichore* and *pygmæa*, Jamaica."
Pisania ?articulata, =*P. pusio*, W. I. teste Cuming. ?Panama.
Trophon crassilabrum, Gray. ?Jamaica.
Murex armatus [not *hexagonus*], Ad. ?—

The following is a list of the new species described by Dr. Gould in the "Mexican and Californian Shells," and by the writer in the 'Proceedings of the Zoological Society,' July 8th, 1856; the numbers referring to the latter—the page, plate and figure to the former.

No.	Page.	Plate.	Fig.	Name.	Locality.
1	15	15	1	Pholas (Pholadidea) ovoidea, *Gld.*	San Diego, *Green.*
2	16	15	5	Petricola bulbosa, *Gld.* =*P. robusta*, Sow.=*P. sinuosa*, Conr.	Guaymas, *Green.*
3	...	...	...	Corbula polychroma, *Cpr.*	Sta. Barbara, *Jewett*; Gulf Calif., *Lieut. Shipley.*
4	17	15	6	Osteodesma nitidum, *Gld.* Probably =*Lyonsia Californica*, Conr. jun.	Sta. Barbara, *Lieut. Green.*
5	19	...	...	Amphidesma flavescens, *Gld.* =*Semele proxima*, B. M. Maz. Cat. p. 28. no. 40, non C. B. Ad.	San Diego, *Lieut. Green.*
6	24	16	1	Tellina miniata, *Gld.* Proc. B. N. H. S. Nov. 1851. =*Sanguinolaria purpurea*, Desh. P. Z. S. 1854, p. 346. no. 137; B. M. Maz. Cat. p. 31. no. 46.	San Juan, *Lieut. Green.*
7	25	16	2	—— tersa, *Gld.*	Panama, *Col. Jewett.*

No.	Page.	Plate.	Fig.	Name.	Locality.
8	25	16	3	Tellina pura, *Gld.*	Panama, *Col. Jewett*, teste Gld. Imp., San Diego & Mazatlan, *Lieut. Green*, teste Gld. MS.
9	26	16	5	—— gemma, *Gld.*	San Juan, *Lieut. Green.*
10	26	16	4	—— (Strigilla) fucata, *Gld.* Proc. B.S.N.H. 1851, p. 91. =*Strigilla carnaria*, B. M. Maz. Cat. p. 39. no. 66.	Mazatlan, *Col. Jewett.*
11	21	15	8	Donax flexuosus, *Gld.*	Sta. Barbara, *Col. Jewett.*
12	21	15	9	—— obesus, *Gld.* Proc. B. S. N. H. 1851, p. 90. =*D. Californicus*, Conr., non Desh. =*D. lævigatus*, Desh.	San Diego, *Lieut. Green.*
13	20	15	4	Mactra mendica, *Gld.* Proc. B. S. N. H. 1851, p. 88. =*Gnathodon trigona*, Petit, B. M. Maz. Cat. p. 52. no. 81.	Mazatlan, *Lieut. Green.*
14	17	...	...	Lutraria ventricosa, *Gld.* Proc. B. S. N. H. 1851, p. 89. =*Mactra exoleta*, Gray.	Mazatlan, *Lieut. Green.*
15	18	15	7	—— undulata, *Gld.* Proc. B. S. N. H. 1851, p. 89. Probably=*Mactra elegans*, Sow. Tank. Cat. App.	La Paz, *Lieut. Green.*
16	...	...	...	Tapes gracilis, *Gld.* MS.	San Pedro, *W. P. Blake.*
17	...	...	...	—— tenerrima, *Cpr.*	Panama, *Col. Jewett.*
18	33	15	10	Venus tantilla, *Gld.* [Trigona]	Sta. Barbara, *Col. Jewett.*
19	23	15	2	Arthemis saccata, *Gld.* Proc. B. S. N. H. 1851, p. 91. =*Cyclina subquadrata*, Hanl.	Mazatlan, *Lieut. Green.*
20	28	...	...	Cardium luteolabrum, *Gld.* Proc. B. S. N. H. 1851, p. 91 ?=*C. xanthocheilum*, Gld. MS. Cat.	San Diego, *Lieut. Green.*
21	...	...	...	—— cruentatum, *Gld.* MS.	San Pedro, *W. P. Blake.*
22	...	...	...	Lucina Artemidis, *Cpr.*	? Acapulco.—Mus. Gld.
23	22	15	3	—— orbella, *Gld.* Proc. B. S. N. H. 1851, p. 90. ?=*Diplodonta semiaspera*, var.	San Diego, *Lieut. Green*; Sta. Barbara, *Col. Jewett*, and *Nuttall.*
24	27	16	5	Cyrena altilis, *Gld.* =*Cyrena Mexicana*, var.	? Mazatlan, *Col. Jewett.*
25	29	...	...	Anodon ciconia, *Gld.* ?=*Anodon glauca*, Val.	? Mexico, *Lieut. Green.*
26	29	16	8	Mytilus glomeratus, *Gld.* Proc. B. S. N. H. 1851, p. 92	San Francisco, *Maj. Rich.*
27	...	...	...	Modiola nitens, *Cpr.*	California.
28	30	16	9	Lithodomus falcatus, *Gld.* Proc. B. S.N. H. 1851, p. 92 =*Lithophagus Gruneri*, Phil. (N. Zeal. Mus. Cum.)*	Monterey, *Maj. Rich.* In hard marly clay.
29	...	...	...	Byssoarca pernoides, *Cpr.*	San Diego, *Webb.*
30	31	16	7	Avicula sterna, *Gld.* Proc. B. S. N. H. 1851, p. 93 =*A. Atlantica*, Mke. not Lam.	Panama, *C. B. Ad.*; ? Mazatlan, *Lieut. Green.*
31	32	16	6	Lima tetrica, *Gld.* Proc. B. S. N. H. 1851, p. 93.	La Paz, *Maj. Rich.*
32	2	14	2	Bulimus vegetus, *Gld.* =*B. pallidior*, Sow. teste Cum.	San Juan, *Lieut. Green.*
33	2	14	1	—— vesicalis, *Gld.*	Lower Calif., *Maj. Rich.*
34	3	14	3	—— excelsus, *Gld.*	California, *Maj. Rich.*
35	6	14	4	Physa elata, *Gld.*	Lower California, *Maj. Rich.*
36	4	14	8	Bulla (Akera) culcitella, *Gld.* [Tornatina]	Sta. Barbara, *Col. Jewett.*
37	5	14	9	—— (Tornatina) cerealis, *Gld.*	Sta. Barbara, *Col. Jewett.*
38	...	...	...	—— —— inculta, *Gld.* MS.	San Diego, teste *Gld.*
39	...	...	...	—— (Haminea) vesicula, *Gld.*	San Diego, *W. P. Blake.*
40	3	14	5	Acmæa paleacea, *Gld.* =*Nacella depicta*, Hds.	Sta. Barbara, *Col. Jewett.* On kelp or Zoophytes.
41	8	14	11	Trochus marcidus, *Gld.* =*Omphalius Pfeifferi*, Phil. teste Cum. =*Chlorostoma maculosum*, A. Ad. Dr. Gould's shell is perhaps that of Adams; while his *T. Montereyi*, Rve., appears to be the *O. Pfeifferi*, Phil.	Monterey, *Lieut. Green.*

* This appears absolutely identical with the [?] New Zealand shell. It has no incrustation outside the epidermis. One of Mr. Cuming's species has an internal hinge-lamina.

No.	Page.	Plate.	Fig.	Name.	Locality.
42	9	...	...	Trochus (Monodonta) pyriformis, *Gld.* =*Osilinus gallina*, Forbes, var.	San Diego, *Lieut. Green.*
43	8	...	...	—— picoides, *Gld.* =*Livona pica*, teste Cuming, &c.	Sta. Barbara, *Col. Jewett*; 5 sp. (part living).
44	...	...	...	Phasianella compta, *Gld.* MS.	Sta. Barbara, *Col. Jewett*; San Diego, *Dr. Webb*, & *W. P. Blake.*
45	...	...	...	Crucibulum Jewettii, *Cpr.*	Mazatlan, *Col. Jewett*, 1 sp.
46	4	14	7	Crepidula explanata, *Gld.* =*C. exuviata*, Nutt. Jay's Cat. 3027. =*C. perforans*, Val.	Monterey, *Lieut. Green*; Lower Cal., *Maj. Rich.*
47	10	14	12	Modulus dorsuosus, *Gld.*	Acapulco, *Col. Jewett.*
48	7	14	10	Narica ovoidea, *Gld.* This shell belongs to *Isapis*, H. & A. Ad., which is a *Fossarus*, with a columellar callosity, like *Purpura columellaris.*	"Purchased at Mazatlan," *Col. Jewett.*
49	...	...	...	?Lacuna unifasciata, *Cpr.*	Sta. Barbara, *Col. Jewett.*
50	...	...	...	Cerithidea albonodosa, *Cpr.*	San Diego, *Dr. Webb.*
51	...	...	...	—— fuscata, *Gld.* MS. Probably = *C. sacrata*, var.	San Diego, *W. P. Blake.*
52	13	14	20	Erato leucophæa, *Gld.* =(probably) *E. columbella*, Mke.	Sta. Barbara, *Col. Jewett.*
53	7	14	19	Terebra arguta, *Gld.* =*T. fulgurata*, Phil.	San Juan, *Lieut. Green.*
54	13	14	21	Conus ravus, *Gld.*	Sta. Barbara, *Col. Jewett.*
55	14	14	23	—— comptus, *Gld.* =*C. purpurascens*, jun., rubbed, teste Cuming. =*C. achatinus*, Mke. non Chemn.	Sta. Barbara, *Col. Jewett.*
56	15	14	22	—— pusillus, *Gld.*	Mazatlan, *Col. Jewett.*
57	12	14	13	Odostomia achates, *Gld.* [Obeliscus] Comp. *O. clavulus*, A. Ad.	Mazatlan, *Col. Jewett.*
58	11	14	14	—— gravida, *Gld.* Closely resembles *O. conoidea.*	Sta. Barbara, *Col. Jewett.*
59	10	14	15	Chemnitzia tenuicula, *Gld.*	Sta. Barbara, *Col. Jewett.*
60	11	14	16	—— torquata, *Gld.*	"Obtained at Sta. Barb."
61	6	14	17	Sigaretus debilis, *Gld.*	La Paz, *Lieut. Green.*
62	...	...	...	Fasciolaria bistriata, *Cpr.*	Panama, teste Gld.
63	...	...	...	Olivella intorta, *Cpr.*	San Juan, *Lieut. Green.*
64	...	...	...	Marginella Jewettii, *Cpr.*	Sta. Barbara, *Col. Jewett.*
65	...	...	...	Columbella Santa-Barbarensis, *Cpr.*	Sta. Barbara, *Col. Jewett.*
66	...	...	...	?Nitidella Gouldii, *Cpr.*	Sta. Barbara, *Col. Jewett.*
67	12	14	18	Fusus ambustus, *Gld.*	Mazatlan, *Lieut. Green.*
68	33	...	...	Purpura pansa, *Gld.* =*Purpura patula*, auct.	W. coast America.

Collected by Col. Jewett.

N.B.—The Numbers refer to Dr. Gould's MS. lists. The habitats in *italics* claim most authority.

Pholas concamerata, Desh. 85. *Monterey.*

Osteodesma nitida, Gld. (San Blas: Mus. Cum.) 181. Sta. Barbara.

Corbula bicarinata, Sow. (dead valves). 9. Sta. Barbara.

—— *polychroma*, Sow. [Gulf Calif. *Lieut. Shipley.*] 8. Sta. Barbara.

—— *ovulata*, Gld. =*nasuta*, Sow. 10. Sta. Barbara. (Dead valves.)

Corbula tenuis, Sow. "?=*alba*, Phil." 79. *Mazatlan.*

Sanguinolaria grandis, Gmel., Hds. 211. San Francisco.

Amphidesma roseum, Gld. (not Sow.) = *decisa*, Conr. 3. *Sta. Barbara.*

Tellina tersa, Gld. 71*. *Panama* ("not Maz.").

"*Strigilla fucata*, Gld. =*Tellina felix*, Ad." (=*S. carnaria.*) 194. Panama.

Donax navicula, Hanl. 74. *Panama.*
—— *rostratus*, C. B. Ad. = *culminatus*, B.M. Cat. 37. *Sta. Barbara*, "very plentiful." [?] Non Nutt.
—— *Californicus*, Conr. 37*. *Sta.Barb.*
—— *gracilis*, Hanl. 183. *Sta. Barbara.*
—— *flexuosus*, Gld. Sta. Barbara.
Mactra Californica, Conr. 71*. *Pan.* [?]
—— *angulata*, Gray. 109. *Panama.*
Petricola lamellifera, Conr. = *Cordieri*, Desh. 88, 107. *Monterey* (do. Hartweg). (Young shell has radiating ribs like *Venus gnidia*, &c.)
—— *lamellifera*, var. = *Cordieri*, Desh. 88. *Monterey.*
—— *carditoides*, Conr. ?= *cylindracea*, Desh. 84. Monterey, with Bryozoon. ? + *P. Californica*, Conr. = *arcuata*, Desh.
Venus discors, Sow. 228, 229. Panama.
—— ——, Gld. =*grata*, Say. 28. *Guaymas.*
—— *amathusia*, Phil. 231. Panama.
—— *gnidia*, Sow. 227. Panama.
Anomalocardia subrugosa, Sow. 230. Pan.
Tapes tenerrima, Cpr. 187. Panama.
Cytherea lupinaria, Less. 117. *Mazatlan.*
—— *affinis*, Gld. =*tortuosa*, Brod. 111. *Panama.*
—— *aurantia*, Hanl. 124. Mazatlan.
—— ——. 1. Sta. Barbara. [?]
Trigona crassatelloides, Conr. 2. Sta. Barbara.
—— ——. 113. *Mazatlan.* [?]
—— ? *radiata*, var. *Hindsii*, but more resembles the *Tr. mactroides*. Dead valves. 189. Acapulco.
—— *planulata*, Sow. 94. Mazatlan.
—— *tantillus*, Gld. 14. *Sta. Barbara.*
Dosinia Dunkeri, Phil. 112. *Panama.*
Cardita volucris, Gld. =*affinis*, Rve. ?
Cardium biangulatum, Sow. 78. *Panama.*
—— *obovale*, Sow. 184. Panama.
—— *graniferum*, Brod.& Sow. 191. Maz.
—— *gemmatum*, 55.
—— *maculosum*, Kien. 153. "Panama" *à prima manu*, and probably correct; afterwards altered to "San Francisco."
Lucina orbella, Gld. ?=*Diplodonta semiaspera*, var. 83. Sta. Barbara.
Modiola recta, Conr. 87. Sta. Barbara.
Lithophagus falcatus, Gld. =*L. Gruneri*, Phil. 86. *Monterey.*
Arca gradata, Brod. & Sow. 84. ? Mazatlan.
—— ——, Brod. & Sow. 8. Monterey.
—— *concinna*, Gld. = *similis*, C. B. Ad. =*tuberculosa*, var. 82. ? Mazatlan.
—— *tuberculosa*, Sow. 236. Lower Cal.
—— *grandis*, Sow. 186. Panama.
Arca nux, Sow. 186 *bis*. Panama.
—— *Pacifica*, Sow. Panama.
—— *alternata*, Sow. 81. ? Mazatlan.
——, *sp. ind.* Dead valves. 185. ?
Pectunculus inæqualis, Gld. = *assimilis*, teste Cum. 4. Sta. Barbara. [?]
—— ? *tessellatus*. (Dead valves.) 190. ? Mazatlan.
—— *parcipictus*, Sow. 77. *Mazatlan.*
Nucula polita. 223. Sta. Barbara.
Avicula sterna, Gld. 93. Panama.
Lima angulata, Sow. 180. Acapulco.
Pecten monotimeris, Conr. + *latiauritus*, teste Nutt. 179. Sta. Barbara.
Bulla cerealis, Gld. 20. Sta. Barbara.
—— *punctulata*, A. Ad. 56. *Acapulco.*
—— *culcitella*, Gld. 62. *Sta. Barbara.*
Siphonaria gigantea. 206. Acapulco.
Chiton ornatus, Nutt. 197. Sta. Barbara.
—— *lineatus*, Wood. 198. *Panama.*
—— "*muscosus*, G. = *Collei*, Rve." = *Hindsii*, Sow. 199. Panama.
—— *Stokesii*, Brod. 200. San Francisco.
—— *Californicus*, Gld. = *scaber*, Rve. 201. Sta. Barbara.
—— *Sitkensis*, Rve. = *Stelleri*, Midd. 202. Monterey [?].
Acmæa paliacea, Gld. =*Nacella depicta*, Hds. 8. *Sta. Barbara.*
Nacella incessa, Hds. (from kelp). 6. Sta. Barbara.
Acmæa patina, var. Esch. (= *tessellata*, Nutt.) 7. Sta. Barbara.
—— *gigantea*, = *Kochii*, Phil. 98. *Monterey.*
—— *pintadina*, Gld. = *verriculata*, Rve. =*patina*, var. Esch. 207. *San Franc.*
—— *scabra*, Gld. = *spectrum*, Nutt. 210. San Francisco.
—— *scabra*, Nutt. 209. Monterey.
—— ——, Nutt. 211. Sta. Barbara.
—— *persona*, Esch. = *Oregona*, Nutt. 211 *bis*.
—— *mesoleuca*, var. 214. Acapulco.
Haliotis Cracherodii, Leach. 183. *Monterey.*
—— *rufescens*, Swains. 182. *Monterey.*
Trochus picoides, Gld. 203. "? Sta. Barbara."
—— *Buschii*, Phil. ? = *inermis*, Gmel. 115. *Panama.*
——, sp. ind. 216. Mazatlan.
—— (*Omphalius dentatus*, Gmel.) 216 *bis*. Acapulco. This appears to be the common small smooth W. Indian species; probably imported.
—— *Panamensis*, Phil. 217. Panama.
—— *reticulatus*, Gld. =*Omphalius viridulus*, Gmel. =*Byronianus*, Gray. 219. Mazatlan.

Trochus Antonii, var. 9. Sta. Barbara, from kelp.
—— *mœstus*. 129. Sta. Barbara.
—— *ligatus*, Gld. =*filosus*, Nutt. (*closely* resembles *dolarius*). 11. Monterey.
—— *dolarius*. 10. Sta. Barbara.
—— *Norrisii*, Sow. 120. *Sta. Barbara.*
—— *ater*, Less. =*gallina*, Forbes. 116. Monterey.
Turbo saxosus, Wood. 226. Panama.
—— *pustulatus*, Gld. (may be *tessellatus* or *saxosus*, jun. Cum.) 46. *Acapulco.*
—— *squamigera*, Rve. (Galapagos, *Cum.*) 218. Panama.
Phasianella compta, Gld. 12,25. *S. Barb.*
Nerita elegans (probably *scabricosta*, var.). 234. Panama.
"*Neritina harpæformis*:" probably a *lapsus* for *Columbella h.* Taboga.
Capulus. 213. Sta. Barbara.
Hipponyx Grayanus, Mke. = *radiatus*, Gray. 205. Panama.
——, sp. ind. 203. Taboga.
—— ? *subrufa*, Sow. (white, rubbed). 213. ? Sta. Barbara.
Calyptræa regularis, C.B.Ad. =*Galerus mammillaris*, Brod. 148. Sta. Barbara.
—— *mammillaris*, Brod. 215. Acapulco.
——, sp. ind. ?—
Crucibulum spinosum, Sow. (dead). 148 *bis*. Sta. Barbara.
—— *Jewettii*. 150. Mazatlan.
—— ? *imbricatum*, Sow. 212. Acapulco.
Crepidula excavata, Brod. 225. Sta. Barb.
—— (like *squama*; apex gone). 151. Sta. Barbara.
—— (? *hepatica* =) *onyx*, Sow. Mazatlan [teste list, probably correct: *Sta. Barbara*, ticket].
—— *rostriformis*, Gld. = *adunca*, Sow. 149. Sta. Barbara.
—— —— = *incurva*, Brod. 149. Sta Barbara.
Turritella goniostoma, Val. 235. Panama.
Modulus dorsuosus, Gld. =*disculus*, Phil. 47. *Acapulco.*
—— *catenulatus*, Phil. 48. *Acapulco.*
Narica ovoidea, Gld. =*Isapis o.*, H. and A. Ad. 17. Mazatlan.
Lacuna. 47. Sta. Barbara.
Litorina (? *Lacuna*) *unifasciata*, Cpr. 23, 172. Sta. Barbara.
—— *puncticulata*, Phil. =*conspersa*, var. 174. ? Panama.
—— ? *pusillus*, Phil. 50. *Panama.*
—— *planaxis*, Nutt., Phil. = *tenebrata*, Nutt. 100. *San Francisco.*
—— *aspera*, Phil. 173. Panama.
Rissoina ambigua, Gld. 14. "*Valpaireiso*, Mex."
Planaxis planicostata (called *sulcata*, Lam.). 53, 58. *Panama.*
Vertagus gemmatus, Hds. 55. ?—
Cerithium maculosum, Kien. 153. Pan. (à pr. man. *bene*, postea San Francisco).
Cerithidea sacrata, Gld. = *Pirena Californica*, Nutt. 102. *San Francisco.*
—— *Montagnei*, D'Orb. 13. Panama.
—— *solida*, Gld. = *valida*, C. B. Ad. = *varicosa*, Sow. 68. *Panama.*
Bittium (rubbed). 31. Sta. Barbara.
Ovulum variabile, C.B.Ad. = *Californicum*, Mus. Cum. No. 34 on kelp thrown up after storm. 32–34. Sta. Barbara.
Erato scabriuscula, Gray. 26. ? Mazatlan.
—— *leucophæa*, Gld. [Mazatlan, *Rev.* — *Steele.*] 28. Sta. Barbara.
—— ——. Comp. *E. columbella*, Mke. 27*, 30. ? Mazatlan.
? —— *Jewettii*, Cpr. 30. *Sta. Barbara.*
Cypræa radians, Lam. 136. *Panama.*
—— *spadicea*, Swains. 118. Sta. Barb.
—— *punctulata*, Gray. 108. *Panama.*
—— *pustulata*, Lam. 130. *Panama.*
—— *pediculus*, Linn. (dead). 131. Acapulco [? imported].
—— *Pacifica*, Gray. 131*. Acapulco.
—— *suffusa*, Gray. 132. Acapulco.
—— *Californica*, Gray. 133. Sta. Barb.
—— *sanguinea*, Sow. 134. Panama.
—— *Solandri*, Gray. 135. *Panama.*
Cancellaria brevis, Sow. Acapulco.
—— *clavatula*, Sow. 4. *Taboga.*
Strombus granulatus, Sow. 47, 70. *Pan.*
Terebra, sp. ind. 17. Sta. Barbara.
—— *robusta*, Hds. 119. Panama.
Defrancia bella, Hds. 18. Sta. Barbara, on zoophytes.
? *Mangelia*. [Perhaps this is the *Drillia albovallosa*.] 223. Panama.
Conus ravus, Gld. 5. Sta. Barbara.
—— ——. 160. Acapulco.
—— *comptus*, Gld. =worn *purpurascens*, jun., teste Cuming. 121. *Sta. Barb.* [?]
—— *pusillus*, Gld. 122. Mazatlan.
—— (young, worn). 29. Sta. Barbara.
Odostomia achates, Gld. =*Obeliscus*. 17. Mazatlan.
—— *gravida*, Gld. 24. *Sta. Barbara.*
Chemnitzia tenuicola, Gld. 19. Sta. Barb.
—— *torquata*, Gld. 22. *Sta. Barbara.*
Scalaria statuminata, Sow. (very fine). 240. Taboga.
Scalaria (like *venosa*, W. I.). ? Panama.
Natica Souleyetana, Recl. 166. Panama.
—— *maroccana*, jun. 165. Panama.
—— *unifasciata* (= *maroccana*, var.). 163. Panama.
—— *Haneti*, Recl. 169. Panama.
——, sp. ind. (rubbed). 167. Panama.

Natica zonaria, Lam. (Acapulco, on the sands, Mus. Cum.) 167 pars. Panama.
——, sp. ind. 164. ?—
—— *uber*, Val.=300+302, C.B.Ad. Pan. Shells, teste Gld. 168. ?—
Ficula decussata, Wood. 178. Taboga.
Dolium ringens, Swains. 204. Panama.
Voluta harpa, Barnes. 154. Mazatlan.
Marginella sapotilla, Hds. 110. *Panama.*
——, sp. ind. 27. ? Mazatlan.
Mitra lens, Wood, =*foraminata*, Swains. =*Dupontii*, Kien. 61, 69. *Panama.*
—— "*auriculoides?*" Probably =*pica*, Rve. 42. *Panama.*
Fasciolaria bistriata, Cpr. 175. Panama.
Leucozonia cingulata, Lam. 90. *Panama.*
Triton, sp. ind. Taboga.
—— *constrictus*, Gld. =*Persona ridens*, Rve. (St. John's, *Hartweg.*) 176. Acapulco.
? *Ranella convoluta*, Brod. 6. Taboga.
—— *nitida*, Brod. 89. *Panama.*
—— *cœlata*, Brod. 91. *Panama.*
Oliva ? eburnea. 159. ? Panama.
—— *petiolita*, Gld., ?=*rufifasciata*, teste Cum. 15. *Sta. Barbara* (dead).
—— *plumbea*=*testacea*, Lam. 99. Pan.
—— *angulata*, Wood. 107. *Taboga.*
—— *biplicata*, Sow. 157. Sta. Barbara.
—— *volutella*, Lam. 158,161,162. Pan.
Nassa luteostoma, Brod. 52. *Panama.*
—— *versicolor*, C. B. Ad. 117. Acapulco.
—— *complanata*, Powys. 44. *Panama.*
—— *collaria*, Gld. 49. Panama.
—— *corpulenta*, C. B. Ad. 51. *Panama.*
—— *perpinguis*, Hds. 114. Sta. Barbara.
Tritonidea pagodus, Rve. 95. *Panama.*
Purpura columellaris, Lam. 65. Acapulco.
—— *emarginata*, Desh.=*Conradi*, Nutt. 104. San Francisco.
—— "*undata* (? *bicostalis*)"=*biserialis*, Blainv. 238. Panama.
——, sp. ind. 104. ? Mazatlan.
Purpura sanguinolenta, Desh. = *Pisania hæmastoma*, Gray. 224. Panama.
—— *kiosquiformis*, Ducl. 105. Panama.
—— *septentrionalis* (appears =*lapillus*, var.). 97. San Francisco (also *Nutt.*).
—— *melones*, Ducl. 106. Panama.
Ricinula ? carbonaria. 67. Panama.
Monoceros punctatum, Sow.=*lapilloides*, Conr. 101. San Francisco.
—— *brevidentatum*, Brod. [?]. 103. *San Francisco.*
—— *unicarinatum.* 101. *San Francisco.*
Columbella gibberula, Sow. (on anchor). Sta. Barbara.
—— *gibberula*, Sow. 16. Taboga.
—— *carinata*, Hds. 35. Sta. Barbara.
—— *Gouldii*, Cpr. 36. *Sta. Barbara.*
—— *Santa-Barbarensis*, Cpr. 172. *Sta. Barbara.*
—— *bicanalifera*, Sow. 38. *Taboga.*
—— *nigricans*, Sow. 39, 40. *Taboga.*
—— *guttata*, Sow. (à pr. man.=*cribraria*, Lam.) 43. *Mazatlan.*
—— (*worn*). 49*. *Acapulco.*
—— *festiva*, Rve. 281. Acapulco.
—— *major*, Sow. 54. *Panama.*
—— ——. 102. *Mazatlan.*
—— *hæmastoma*, Sow. 57, 155. ? Pan.
—— *rugosa*, and var. 221. Panama.
—— *harpæformis*, Sow. Taboga.
—— ? *parva*, Sow. 96. ? Panama.
—— *maculosa*, Sow. ?—
Truncaria modesta, Pow. 152. Panama.
—— ——. 72. Sta. Barbara [?].
Engina ferruginosa. 41. [? W. I. imported.]
—— *crocostoma*, Rve. 67. Panama. [Galap. *Cuming.*]
Concholepas Peruviana, Lam. 139. *Panama* [surely imported].
Fusus, sp. ind. 175. Panama.
Cyrtulus distortus, Gray. 75. Panama.
Murex Nuttalli, Conr. 92. Panama [?].

Collected by Lieut. Green.

Pholas ovoidea, Gld. 181. *San Diego.*
—— *Californica*, Conr.=*Janellii*, Desh. 182. *San Diego.*
—— *penita*, Conr. 184. *San Diego.*
Platyodon cancellata, Conr. 162. *San Diego.*
Osteodesma Californica, Conr. 192. San Diego.
"*Anatina argentaria*, Conr.=*Periploma planiuscula*, Sow."=*Periploma Leana*, teste Cuming. 27. *Guaymas.*
Thracia granulosa, Gld.=*plicata*, Desh. 10. *La Paz.*
Solen maximus, Wood=*Nuttalli*, Conr. 21. *San Francisco.*
Solecurtus Californianus, Gld.=*subteres*, Conr. 188, 189. *San Diego.*
"*Sanguinolaria miniata*," Gld. =*purpurea*, Desh. 37. *San Juan.*
Psammobia decora, Hds.=*Sanguinolaria Nuttalli*, Conr. 140. *San Diego.*
Cumingia Californica, Conr. 171, 195, 196. *San Diego.*
Semele decisa, Conr. 134. *San Diego.*
—— *flavicans*, Gld.=*S. proxima*, B. M. Cat., not C. B. Ad. 191. *San Diego.*

Semele rubrolineata, Conr. = *S. simplex*, A. Ad. teste Cum.* 141. *San Diego.*
Tellina [resembling *Suënsoni*, Mörch, Brazil, and *T. calcarea*]. 142. San Diego.
—— *gemma*, Gld. 198. *San Juan.*
—— *pura*, Gld. 197. *San Diego.*
—— ——. 57. *Mazatlan.*
—— *secta*, Conr. 139. *San Diego.*
—— *nasuta*, Conr. 147. San Diego.
—— *vicina*, C. B. Ad. 130. ? Mazatlan.
—— ——, C. B. Ad. 188. Acapulco.
—— *regia*, Hanl. 52. *Mazatlan.*
Donax punctatostriatus, Hanl. 55. *Mazatlan.*
—— *carinatus*, Hanl. 93. *Mazatlan.*
—— *Californicus*, Conr. = *lævigatus*, Desh. 159. San Diego.
—— *abruptus*, Gld. = *Californicus*, Conr. var. 160. San Diego.
—— *Californicus*, Conr. var. 161. San Diego.
—— ——, var. 199. *San Juan.*
Mactra (*Lutraria*) *nasuta*, Gld. [? = *falcata*]. 49. ? Mazatlan; San Pedro.
—— *Californica*, Conr. 100. ? Mazatlan.
Lutraria ventricosa, Gld. = *Mactra exoleta*, Gray. 50. ? Mazatlan.
—— *undulata*, Gld. 9. *La Paz.*
Gnathodon mendicus, Gld. = *Rangia trigona*, Petit. 95. ? Mazatlan.
"*Saxidomus Nuttalli*, Conr. = *Venerupis Petitii*, Desh." = *Tapes maxima*, Phil. 156. Monterey.
Saxicava carditoides, Conr. 110, 111. ? Monterey.
—— *Cordieri*, Desh. = *Venus lamellifera*, Conr. 107. Monterey.
——, sp. ind. 11. *La Paz.*
—— *pholadis* (Desh., Guér. Mag. 1841, pl. 40). 29. San Diego.
Petricola bulbosa, Gld. = *robusta*, Sow. 31. *Guaymas.*
—— *dactylus*, Sow. (very rare). 11. *La Paz.*
Venus, sp. ind. 124. ? Mazatlan.
—— *amathusia*, Phil. 83, 59. *Mazatlan.*
—— ——. 53. Mazatlan.
—— *Columbiensis.* 85, 87. *Guaymas.*
—— *gnidia*, Sow. 63. *Mazatlan.*
—— *straminea*, Conr. 22. *Guaymas.*
—— *reticulata.* 17. *La Paz.*
—— *simillima*, Sow. 172. *San Diego.*
—— *Californiensis*, Brod. (not Conr.), Mus. Cum. 146. *San Diego.*
Venus Petitii, var. = *straminea*, var. teste Nutt. 185. *San Diego.*
—— *Californicus*, jun., Conr. = *compta*, Mus. Cum. 171. *San Diego.*
—— ——, = *compta*, Mus. Cum. 61. *Mazatlan.*
—— *fluctifraga*, Gld. = *Nuttalli*, Conr. (non Desh.)†. 145. *San Diego.*
Anomalocardia subrugosa, Sow. 58. *Maz.*
Dione circinata (Mazatlan, *Rev.*—*Steele*). 73. ? Mazatlan.
—— *rosea.* 62. *Mazatlan.*
—— *dione*, Gld. = *lupinaria*, Less. 129. Is. 3 Marias.
—— *biradiata*, Gray = *D. Chionæa.* 7. *La Paz.*
Dosinia Dunkeri, Phil. 56. ? Mazatlan.
—— *gigantea*, Sow. 19. *La Paz.*
—— *saccata*, Gld. = *Cyclina subquadrata*, Hanl. 99. Mazatlan.
Trigona crassatelloides, Conr. 153. *San Diego.*
—— ——. 94. *Mazatlan.* [?]
—— *corbicula*, Gld. = *radiata*, Sow. 122. ? Mazatlan.
Chama Pacifica, Gld. = *C. frondosa*, var. *Mexicana.* On *Vermetus.* 24. *Guaym.*
—— *exogyra*, Conr. San Pedro.
—— ——, with *C. venosa.* 150. *San Diego.*
—— *pellucida.* 176. *San Diego.*
Cardita affinis, Gld. = *Californica*, Desh. 26. *Guaymas.*
Cardium Panamense, Sow. 84. ? Maz.
—— *xanthocheilum*, Gld. = *luteolabrum*, Gld. 132. San Diego.
—— *Nuttalli*, Conr. = *Californiense*, Desh. 138. *San Diego.*
—— *substriatum*, Conr. 158. San Diego.
—— *elatum*, Sow. 194. *San Diego.*
Diplodonta orbella, Gld. [do. Nutt.] 137, 138. *San Diego.*
Lucina punctata, Linn. 16. *La Paz.*
—— ——, Linn. 136. *San Diego.*
Cyrena altilis, Gld. = *Mexicana*, var. 79. ? Mazatlan.
Anodon ciconia, Gld. 48. ? Mexico.
Mytilus, sp. ind. 47. *San Francisco.*
Modiola, sp. ind. 20. *San Francisco.*
—— *capax*, jun. 173. *San Diego.*
—— ——, Conr., very large valve. 4. *La Paz.*
Lithophagus falcatus, Gld. = *Gruneri*, Phil. 117. *Monterey.*

* The locality given to *S. simplex* by Lieut. Belcher is "China Seas;" but, as in the case of *Dosinia simplex*, is almost certainly erroneous.

† This is the *V. callosa* (quasi Conr.) of Deshayes. The specimen is marked "? Stutchburyi;" which is a closely allied species from the Pacific Islands, with differently shaped teeth, no posterior crenations, and displaying a few *Cardium*-like intercalations at the margin.

Lithophagus attenuatus, Desh. 180. *San Diego.*
—— ——, sp. ind. 183. *San Diego.*
Pectunculus giganteus, Rve. 32. *Guaymas.*
—— *assimilis,* Sow. 86. ? Mazatlan.
Avicula sterna, Gld. 60. ? Mazatlan.
Meleagrina, sp. 80. ? Mazatlan.
Perna flexuosa, Sow. = *Chemnitziana,* D'Orb. 81. *Mazatlan.*
—— ——, = *Chemnitziana.* 103. *La Paz.*
Pecten ? purpuratus = *ventricosus,* Sow., with *Bivonia indentata.* 144. ? San Diego.
—— *latiauritus,* Conr. + *monotimeris,* teste Nutt. 131. *San Diego.*
—— *nodosus.* 3. *La Paz.*
—— *dentatus,* Sow. 6. *La Paz.*
Hinnites gigantea, Gray = *H. Poulsoni,* Conr. 1834. 149. *San Diego.*
Spondylus "varians, Sow." 1. La Paz.
—— "*pictorum,* Chem. = *crassisquama,* Lam." 2. La Paz.
Ostrea Cumingiana, Dkr. 5. *La Paz.*
—— *palmula,* Cpr. 147. *San Diego.*
—— *conchaphila,* Cpr., 1·5 in. long; very thin; (*Oregon,* San Diego, *Nutt.*), no tendency to crenations; striped. 174. *San Diego.*
Bulla nebulosa, Gld. 175. *San Diego.*
Bulimus vegetus, Gld. = *pallidior,* Sow. San Juan.
Helix tudiculata, Binney. 151. *San Diego.*
—— *Kellettii,* Forbes. 152. San Diego.
Melampus olivaceus, Cpr. 193. San Diego.
Chiton articulatus, Br. 74. *Mazatlan.*
—— *Blainvillei,* Br. 133. *San Diego.*
—— *Magdalenensis,* Hds. 72. *Mazatlan.*
Patella Mexicana, Lam. 67. *Mazatlan.*
—— *discors,* Phil. 125. *Mazatlan.*
Acmæa? 125. ? Mazatlan.
—— *gigantea* = *Kochii,* Phil. 166. *San Diego.*
—— *pintadina,* Gld. = *verriculata,* Rve. = *patina,* var. 66. Mazatlan [?].
—— ——, = *mesoleuca,* Mke. 65. Mazatlan.
—— ——, = *leucophæa,* Nutt. = *pelta,* Esch. 75. Mazatlan [?].
—— ——, = *fascicularis,* Mke. 164, 177. *San Diego.*
—— ——? 167. *San Diego.*
—— ——, = *scabra,* Nutt., var. 168, 178. *San Diego.*
—— ——, = *Oregona,* var. Nutt. = *persona,* Esch. 169. *San Diego.*
—— *scabra,* Gld. = *spectrum,* Nutt. 179. San Diego.
—— ? *spectrum,* var. [May be an *araucana,* D'Orb., imported from Valparaiso]. 64. Mazatlan [?].

Acmæa patina, var. *cinis,* Rve. 116. Mont.
—— ——, var. *tessellata,* Nutt. 165. *San Diego.*
? *Fissurella.* 163. *San Diego.*
—— *virescens,* Sow. 70. *Mazatlan.*
—— *volcano,* Sow. 163. *San Diego.*
Turbo fluctuosus, Wood = *Fokkesii,* Jonas. 148. San Diego.
—— ——. 120. *Mazatlan.*
Trochus unguis, Wood = *digitatus.* 108. ? Mazatlan.
—— *filosus.* 157. *San Diego.*
—— *dolarius.* 115. *Monterey.*
—— *virgineus.* 114. *Monterey.*
—— *olivaceus,* Wd. 92. ? Mazatlan. (A specimen, no. 388, marked "Sandwich Is." must have been imported there.)
—— *Montereyi,* Kien. = *Pfeifferi,* Phil. 113. *Monterey.*
—— (*Omphalius*) *fuscescens,* Phil. 123. ? Mazatlan. (The *O. Californicus,* A. Ad., appears to be only a flattened var. of this shell.)
—— "*aureotinctus,* Fbs. = *cateniferus,* Pot." 186. *San Diego.*
—— *striatulus,* Kien. = *brunneus,* Phil. Mus. Cum. 187. *San Diego.*
—— *pyriformis,* Gld. = *gallina,* var. M. Cum. 155. *San Diego.*
Nerita multijugis, Mke. = *scabricosta,* Lam. 118. Panama.
—— *Bernhardi,* Recl. Guaymas.
Neritina picta, Sow. 126. *St. Michael.*
Calyptræa regularis, C. B. Ad. = *Galerus mamillaris,* Brod. 51. *Mazatlan.*
Crucibulum spinosum, Sow. 190. *S. Diego.*
Crepidula explanata, Gld. = *exuviata,* Nutt. = *perforans,* Val. 112. *Monterey.*
Aletes squamigerus, Cpr. San Pedro.
Modulus "? disculus, Phil." (perhaps *catenulatus,* Phil.). 82. *Mazatlan.*
Cerithium irroratum, Gld. = *stercusmuscarum,* Val. 78. *Mazatlan.*
Cerithidea fuscata, Gld. = *sacrata,* var. teste Nutt. San Diego.
Potamis Hegewischii, Gld. = *Cerithidea varicosa,* var. *Mazatlanica.* 71. *Mazatlan.*
Ovulum variabile, C. B. Ad. = *Californicum,* Mus. Cum. 36. *San Juan.*
Cypræa radians, Lam. 68. *Mazatlan.*
Cancellaria goniostoma, Sow. 56. *Mazatlan.*
Strombus gracilior, Sow. 8. *La Paz.*
Terebra arguta, Gld. = *fulgurata,* Phil. 35*. *San Juan.*
Conus regularis, Sow. 23, 25. *Guaymas.*
—— *princeps,* Linn. 90. *San Juan.*
——, sp. ind. 33. *Guaymas.*
——, sp. ind. 35. *Guaymas.*

Solarium ? quadriceps, Hds. (dead). 106. *Mazatlan.*
Natica patula, Sow. 77. *Mazatlan.*
—— *maroccana=Pritchardi*, Forbes. 96. ? Guaymas. Specimens exactly like, are in Mus. Cum. from Soc. Is.
—— *bifasciata.* 97. *? Guaymas.*
—— *Recluziana.* 154. *San Diego.*
Sigaretus debilis, Gld. 98. *La Paz.*
Ficula ventricosa, Sow.=*decussata.* 121. ? Mazatlan.
Cassis coarctata (dead). 89. *San Juan.*
Oniscia tuberculosa, Sow. 38. *San Juan.*
Oliva porphyria, Linn. 14. *La Paz.*
—— *? eburnea.* 34. *San Juan.*
——, sp. ind. 41. *San Juan.*
—— *tergina*, Ducl. 42, 43. *San Juan.*
—— *intorta.* 44. *San Juan.*
—— *splendidula*, Sow. 104. *La Paz.*
Purpura patula, Linn. 40. *La Paz* (list). San Juan (ticket).
—— *emarginata.* 12. *La Paz.*
—— *biserialis*, Blainv. 101. *La Paz.*
—— *kiosquiformis*, Ducl. 88. *La Paz.*
——, sp. ind. 13. *La Paz.*
Monoceros muricatum, Brod. ? St. Juan.
—— *tuberculatum*, Gray. 39, 91. *S. Juan.*
Columbella (*gibbosa* =) *strombiformis*, Lam. 102. Mazatlan.
Buccinum ? 33*. *San Juan.*
Fusus ambustus, Gld. [exactly resembles the Mediterranean sp.] 128. ? Mazatl.
—— *pallidus*, Gray. 119. *Guaymas.*
Pyrula patula, Br. & Sow. 69. *Mazatlan.*
—— *lignaria*, Gray. 119. *Guaymas.*
Murex bicolor, Val. 15. *La Paz.*
—— *brassica*, Lam. 76. *Mazatlan.*
—— *plicatus*, Sow. 109. ? San Juan.

Collected by Major Rich.

Pholas ovoidea, Gld. Upper Cal.
—— *Californica*, Conr. Upper Cal.
Sanguinolaria Nuttalli, Conr. *San Pedro.*
Solecurtus subteres, Conr. Monterey.
Tellina secta, Conr. Monterey.
—— *nasuta*, Conr. Lower Cal.
—— *Cumingii*, Sow. ?—
—— *Bodegensis*, Hds. *Monterey.*
Tellidora Burneti, Brod. Lower Cal.
Cumingia Californica, Conr. Monterey.
Lutraria ? Lower Cal.
Platyodon cancellata, Conr. Upper Cal.
Saxidomus Nuttalli, Conr. ?—
Saxicava carditoides, Conr. Lower Cal.
—— *lamellifera*, Conr. Upper Cal.
Petricola robusta, Sow. ?—
Dosinia gigantea, Sow. Gulf Calif.
Dione chionæa, Mke. Lower Cal.
—— *rosea*, Brod.=*lepida*, Chen. Lower California.
Trigona planulata, Sow. Lower Cal.
—— *crassatelloides*, Conr. Lower Cal.
—— *corbicula*, Gld. = *radiata*, Sow. Lower Calif.
—— *argentina*, Sow. Upper California [?].
Venus amathusia, Phil. Lower Cal.
—— *gnidia*, Brod. Lower Cal.
—— *straminea*, Conr. Lower Cal.
—— *Californiensis*, Brod., not Conr. Lower Cal. & San Pedro.
Chama rugosa. Lower Cal.
—— *echinata.* Lower Cal.
Cardita affinis, Gld.=*Californica*, Desh. Lower Cal.
Cardium Panamense, Sow. Lower Cal.
—— *Californiense*, Conr. Upper Cal.
—— *consors*, Br. & Low. Lower Cal.
Lucina "*? bella* (see *tigrina*)." Lower Cal.
—— *Californica.* Lower Cal.
Alasmodon falcata, Gld. Upper Cal.
Mytilus Californianus, Conr. Upper Cal.
—— *glomeratus*, Gld. *San Francisco.*
Modiola flabellum, Gld. ?—
—— *divaricata*, Gld. ? =*Crenella coarctata*, Dkr. Upper Cal. [?]
Lithophagus falcatus, Gld. Upper Cal.
—— *? cinnamomea.* ?—
Arca grandis, Sow. Lower Cal.
—— *formosa.* Lower Cal.
—— *tuberculosa*, Sow. Lower Cal.
—— *multicostata*, Sow. Lower Cal.
—— *reversa*, Gray=*hemicardium*, Koch. Lower Cal.
—— (large rhomboid), probably *grandis*, var. Gulf Cal.
Perna ? Californica, Conr. Lower Cal. [?]
Pecten ventricosus, Sow. Lower Cal.
—— *latiauritus*, Conr. + *monotimeris*, Conr. Upper Cal.
—— *nodosus.* Lower Cal.
Lima tetrica, Gld. Lower Cal.
Spondylus "*pictorum*, Chem." Lower Cal.
Placunanomia macroschisma, Desh. Monterey.
Bulla nebulosa, Gld. Lower Cal.
Bulimus vesicalis, Gld. (probably young, *Cuming*). Lower Cal.
—— *excelsus*, Gld. Lower Cal.
Helix Californiensis, Lea. Upper Cal.
Scurria mitra, Esch. & Less. Upper Cal.
Fissurella virescens, Sow. Upper Cal. [?]
—— *crenulata*, Sow. Monterey.
Pomaulax undosus, Wood. Upper Cal.
Trochus mœstus. Lower Cal.
—— *filosus.* Upper Cal.
—— *dolarius.* Upper Cal.
—— *virgineus.* Upper Cal.

Trochus ater, Less. [?=] *gallina* Up. Cal.
Trochiscus Norrisii, Sow. Upper Cal.
Uvanilla olivacea, Wood. Lower Cal.
Neritina picta, Sow. Lower Cal.
Crucibulum spinosum, Sow. San Pedro, Lower Cal.
—— *tenue*, Brod.=*spinosum*, var. Lower Cal.
—— *rude*, Brod. Lower Cal.
—— *dentatum*, Mke. Lower Cal.
—— *imbricatum* [? *cujus*]. ?—
Calyptræa (like *equestris*), probably *cepacea*. Lower Cal.
Galerus conicus, Brod. ?—
—— *mammillaris*, Brod. ?—
Crepidula onyx, Sow. Lower Cal.
—— *excavata*, Brod. Lower Cal.
—— *aculeata* (teste Gld.). Lower Cal.
—— (like) *dilatata*. Lower Cal.
—— ? *squama*. Lower Cal.
Litorina planaxis, Nutt. Upper Cal.
Planaxis planicostata. ?—
Cypræa spadicea, Gray. Monterey.
—— *zonata*, Gray = *Sowerbyi*, Rve. Lower Cal.
—— *arabicula*. Lower Cal.
Cancellaria obesa, Sow., ? =*urceolata*, Hds. *La Paz*.
—— *solida*, Sow. *La Paz*.
—— *cassidiformis*, Sow. *La Paz*.
—— *candida*, Sow. Gulf Cal.
—— *goniostoma*, Sow. Gulf Cal.
Strombus gracilior, Sow. Lower Cal.
—— *granulatus*, Sow. Lower Cal.
Terebra variegata, Gray. (Guaymas, Mus. Cum.) Lower Cal.
Pleurotoma maculosa, Sow. Lower Cal.
Conus trochulus, Rve. Upper Cal.
—— *interruptus*, Brod. & Sow. Lower California.
Solarium quadriceps, Hds. Lower Cal.
Natica Chemnitzii, Phil. Lower Cal.
—— *bifasciata*. Lower Cal.
Mitra lens, Wood. Lower Cal.
—— *inermis*. ?—
Cassis coarctata, Sow. Lower Cal.
Leucozonia cingulata, Sow. Lower Cal.
Ranella ventricosa. ?—
Triton Chemnitzii, Gld. (*lapsu*) = *siphonatus*, Rve. Lower Cal.
Tritonidea pagodus, Rve. Lower Cal.
Nassa luteostoma, Brod. Lower Cal.
Oliva splendidula, Sow. Lower Cal.
—— *testacea*, Lam. Lower Cal.
—— *biplicata*, Sow. Lower Cal.
—— *volutella*, Lam. Lower Cal.
—— ? *tigrina*. Lower Cal.
Columbella fuscata, Sow. Lower Cal.
—— *coniformis*. Lower Cal.
Purpura columellaris, Lam. Lower Cal.
—— *biserialis*, Blainv. Lower Cal.
—— *emarginata*, Desh. Lower Cal.
—— *kiosquiformis*, Ducl. ?—
—— *muricata*, Gray. Lower Cal.
Monoceros punctatum, Sow. Upper Cal.
—— *brevidentatum*, Wood. ?—
—— *cymatum*, Sow. ?—
—— *crassilabrum*, Sow. Upper Cal. [?]
—— *unicarinatum*. ?—
—— *globulus*, [? cujus]. ?—
Vitularia salebrosa, King=*vitulina*, Gray. Lower Cal.
Murex bicolor, Val. Lower Cal.
—— *foliatus*=*pinniger*, Brod. ?—

48. The first important contribution to the local fauna of the Gulf of California was made by Dr. Menke; who, having received from his friend M. Heinrich Melchers, of Bremen, a number of shells which he had himself collected at Mazatlan, proceeded to catalogue and describe them in the "Zeitschrift für Malacozoologie," Dec. 1847, pp. 177–191. Here, for the first time in the history of West N. American Mollusca, we have an attempt to present a complete geographical list, of known as well as supposed new species, collected in a particular district. For the example thus set, and for the record of the labours of M. Melchers, Dr. Menke deserves well of science; but it does not appear that his identification of species is always sound; nor is it in every case easy to make out his descriptions of new forms. The paper is entitled "Verzeichniss einer Sendung von Conchylien von Mazatlan, mit einigen Kritischen Bemerkungen," and contains notes on the following species:—

No.

1. *Siphonaria lecanium*, Phil.
2. *Litorina aspera*, Phil.
3. *Turritella imbricata*, [Mke. quasi] Lam.=*T. tigrina*, Kien.
4. *Vermetus glomeratus*, [Mke. quasi] (Rouss.), Linn. ?=*Bivonia contorta*.
5. *Natica iostoma*, Mke. "Resembles *N. canrena*." ?=*N. maroccana*, var.

No.

6. *Natica maroccana*, Chemn. (Koch) = *N. Chemnitzii*, Pfr.
7. *Nerita multijugis*, Mke. = *N. scabricosta*, Lam., teste Mke. postea.
8. *Turbo fluctuosus*, Wood.
9. *Solarium granulatum*, [Mke. quasi] Lam.
10. *Cerithium ocellatum*, [Mke. quasi] Brug. = *C. stercusmuscarum*, Val.
11. *Buccinum sanguinolentum*, Ducl. = *Pollia hæmastoma*, Gray.
12. —— *gemmulatum*, Rve. non Lam. nec Kien. = *Pisania gemmata*.
13. —— *gilvum*, Mke. Appears to be an *Anachis*, possibly *coronata*.
14. *Terebra fulgurata*, Phil.
15. *Purpura hæmastoma*, [Mke. quasi] Lam. = *P. biserialis*, Blainv. var.
16. —— *bicostalis*, Rve. = *P. biserialis*, Blainv.
17. —— *atromarginata*, "Blainv., Desh. = *P. cancellata*, Kien." (New Hebrides.)
18. *Columbella strombiformis*, Lam.
19. —— *major*, Sow.
20. —— *harpæformis*, Sow.
21. *Murex brassica*, Lam. = *M. ducalis*, Brod.
22. *Ficula decussata* = *Pyrula ventricosa*, Sow.
23. *Conus achatinus*, [Mke. quasi] Brug. = *C. purpureus* or *regalitatis*.
24. *Oliva tergina*, Ducl.
25. —— *zonalis*, Lam.
26. *Erato columbella*, Mke.
27. *Cypræa arabicula*, Lam.
28. —— *Sowerbyi*, "Rve. = *C. zonata*, Gray, not Chemn."
29. —— *sanguinea*, Gray.
30. —— *Solandri*, Gray.
31. —— *pustulata*, Lam.
32. *Crepidula costata*, [Mke. quasi] Sow. = *C. aculeata*, var.
33. —— *hepatica*, [Mke. quasi] Desh. = *C. incurva*, Brod., not *C. hepatica*, C. B. Ad.
34. —— *uncata*, Mke. = *C. adunca*, Sow.

No.

35. *Calyptræa dentata*, Mke. "= *C. rugosa*, Less. in Guér. Mag. non Desh. = *C. extinctorium*, Sow. non Lam." = *Crucibulum imbricatum*, var. B. M. Maz. Cat. p. 287. no. 343.
36. —— *imbricata*, Sow.
37. —— *Lamarckii*, Desh. (Australia).
38. *Hipponyx australis*, [Mke. quasi] Lam. = *H. serratus*.
39. *Fissurella pica*, Sow.
40. —— *chlorotrema*, Mke. = *F. rugosa*, Sow.
41. —— *humilis*, Mke. = *F. rugosa*, var.
42. —— *gemmata*, Mke. ? = *F. alba*, jun.
43. *Acmæa mitella*, Mke.
44. *Pecten adspersus*, Sow. (Tumbez, Peru.)
45. *Avicula Atlantica*, [Mke. quasi] Lam. = *A. sterna*, Gld.
46. *Arca ? ovata*, Rve.
47. *Mytilus* = *M. spatula*, Mke. in Zeit. f. Mal. 1848, p. 2. Possibly = *Modiola capax*, jun.
48. *Modiola* = *M. semilævis*, Mke. in Zeit. f. Mal. 1848, p. 5.
49. *Cardita affinis*, [Mke. quasi] Sow. = *C. Californica*.
50. *Cardium muricatum*, [Mke. quasi] Linn. ? = *C. radula*, Brod. & Sow.
51. —— *procerum*, Sow.
52. *Donax ? compressus*, [Mke. quasi] Lam. ? = *D. assimilis*, Hanl.
53. *Tellina cicercula*, Phil.
54. *Cytherea corbicula* [Mke. quasi] Lam. = *Trigona radiata*.
55. —— *argentina*, Sow.
56. —— *semifulva*, Mke. ? = *Trigona radiata*, var.
57. —— *chionæa*, Mke. = *Dione squalida*, Sow. + *biradiata*, Gray. ? + *D. elegans*, Koch.
58. *Venus cancellata*, [Mke. quasi] Linn. ? = *Chione amathusia*: but v. B. M. Maz. Cat. p. 80. no. 113.
59. *Corbula ? ustulata*, Rve. One rubbed valve.

Of the 45 species here quoted from other authors, the following 15 do not belong to the fauna:—Nos. 3, 4, 9, 10, 15, 17, 23, 32, 37, 38, 45, 50, 52, 54, 58. It is fair to suppose, either that the writer has erred in his diagnoses, or that shells have been imported. In most cases, as very similar species really are found at Mazatlan, it is natural to adopt the former alternative. In other cases, as in nos. 20 and 44, the species inhabit the coast, but their presence at Mazatlan wants the confirmation of the Reigen collection. Of the shells intended by nos. 17, 28, 37, 46, 48, & 59, no information can be given. Of the entire 59 species, accepting the altered nomenclature, which would reduce the number to 55, 40 are certainly, and five probably, members of the fauna: of the remaining ten, it is unsafe to hazard a conjecture.

The above analysis has been attempted, partly in order to show the difficulties attendant upon all inquiries of this kind. Here is a collection made on a single spot by a competent gentleman*, and described by a conchologist of acknowledged superiority, the editor of one of the very few strictly Conchological Journals; and yet only 32 can be accepted in the state in which they are presented, the remaining 27 containing errors either of collection or of description. If such is the work of a master, the readers of this Report will accept with due caution the labours of a mere student.

49. But if there is so much doubt attaching to Menke's first list, there is still more in the principal list which follows. In the *Zeit. f. Mal.* 1850, no. 11, Dr. Menke informs us that since his last paper, M. Melchers had again visited Mazatlan, and had investigated the shells of that region with great zeal and perseverance, and no little sacrifice of money. He returned to Bremen in the summer of 1849, and generously presented Dr. Menke with a selection in the autumn of 1850. So far all is extremely satisfactory; but he goes on to state that he received at the same time, from the same ship, *a box obtained at Mazatlan by purchase.* This fact invalidates the soundness of all that follows; except in those few instances in which we are informed that M. Melchers collected the shells himself. The following list therefore must be received with great caution, except where the shells are confirmed by other authority. Occasionally Dr. Menke gives particulars as to the number of individuals from which he describes; as when he tells us, p. 188, that, as he has had an opportunity of examining no fewer than eight specimens of *Murex ambiguus*, Rve., he can speak with authority as to its being distinct from *M. nigritus*, Phil. If he had examined the many hundreds in the Reigen collection, he would probably have come to a different conclusion. The second (mixed) list is as follows:—

1850, pp. 161–173.

1. *Bulla Adamsi*, Mke.
2. —— *nebulosa*, Gld.
3. —— (*Tornatina*) *gracilis*, [Mke. quasi] A. Ad. = ?*B. infrequens*, C. B. Ad.
4. *Bulimus zebra*, Desh.
5. *Planorbis tenagophilus*, [Mke. q.] D'Orb. =*P. tumens*, Cpr.
6. *Physa Peruviana*, [Mke. q.] Gray, =*Ph. aurantia*, Cpr.
7. *Litorina fasciata*, Gray.
8. —— *aspera*, Phil.
9. —— *modesta*, [Mke. q.] Phil. ?= *L. conspersa*, Phil. var.
10. *Turritella tigrina*, Kien. "=No. 3 of first list."
11. —— *goniostoma*, Val.
12. —— *Hookeri*, [Mke. q.] Rve.
13. *Vermetus Panamensis*, Rouss. The figure quoted represents *Le Vermet* of Adanson. The name has not been found. ?=*Bivonia contorta*, var.
14. *Vermetus glomeratus*,[Mke.q.]Rous. ?=*Bivonia contorta*, Cpr.
15. *Natica Récluziana*, Desh.
16. —— *glauca*, [?] Humb.=*N. patula*, Sow.
17. —— *maroccana*, (Chemn.) Koch.
18. —— *ovum*, Mke.
19. *Neritina cassiculum*, Sow.
20. —— *picta*, Sow,
21. *Nerita ornata*, Sow. "=*N. multijugis*, Mke." =*N. scabriuscula*, Lam.
22. —— *funiculata*, Mke. = *N. Bernhardi*, Récl.
23. *Planaxis acutus*, Mke. =*P. nigritella*, Forbes.
24. —— *obsoletus*, Mke. =*P. nigritella*, var.
25. *Turbo fluctuosus*, Wood.
26. *Solarium granulatum*,[Mke.q.]Lam.

* As M. Melchers is quoted for a shell from Vera Cruz, on the Gulf of Mexico, Zeit. f. Mal. 1848, p. 3, it speaks much for his accuracy as a collector that no W. Indian species are quoted in Menke's lists, except such as have analogues on the Pacific coast, for which they have probably been mistaken.

27. *Euomphalus radiatus*, Mke. =*Trochus perspectiviunculus variegatus*, Chemn., ?=*Torinia v.* Lam.
28. *Trochus* (*Calcar*) *olivaceus*, Wood.
29. —— —— *Melchersi*, Mke.
30. —— —— *stellaris*, [Mke. q.] Lam.
31. —— ? *minutus*, Chemn.
32. —— *versicolor*, Mke.
33. —— (*Monodonta*) *catenulatus*, Phil.
34. —— *ligulatus*, Mke.
35. —— *glomus*, [Mke. q.] Phil.

1850, pp. 177–190.

36. *Scalaria crassilabris*, Sow.
37. *Rissoa stricta*, Mke.
38. *Cerithium* (*Potamides*) *Montagnei*, D'Orb.
39. —— *maculosum*, Kien.
40. —— *ocellatum*, [Mke. q.] Brug.= *C. stercusmuscarum*, Val.
41. —— *interruptum*, Mke.
42. *Buccinum gemmatum*, Rve. "=*B. gemmulatum*, first list, No. 12."
43. —— *pristis*, Desh.=*serratum*, Dufr.
44. —— (*Nassa*) *luteostoma*, Kien.
45. *Monoceros muricatus*, Brod.
46. —— *cingulatus*, Lam.
47. *Purpura patula*, Lam.
48. —— *consul*, [Mke. q.] Lam. =*P. biserialis*, var.
49. —— *biserialis*, Blainv.
50. —— *bicostalis*, [Mke. q.?] Lam.= *P. biserialis*, var.
51. *Cancellaria ovata*, [Mke. q.] Sow. ?=*C. urceolata*, Hds.
52. —— *cassidiformis*, Sow.
53. —— *goniostoma*, Lam.
54. *Dolium dentatum*, Barnes, = *Malea ringens*, Swains.
55. —— *crassilabre*, (Mke.) Val. = *M. ringens*, var.
   =*Cassis ringens*, Swains., Bligh Cat. App. p. 4. 1822.
   =*Dolium dentatum*, Barnes, An. Lyc. N. Y. 1824.
   =*Buccinum ringens*, Wood, Suppl. 1828.
   =*Dolium personatum*, Mke. Syn. p. 62. 1830.
   =*Malea latilabris*, + *crassilabris*, Val. 1833.
   =*Dolium latilabre*, Kien. 1835.
   =*D. plicosum*, Mke. Zeit. f. M. p. 138. 1845.
   =*D. ringens*, Rve. 1848.
   =*Cadium dentatum* + *C. ringens*, H. & A. Ad. Gen. i. 197.
56. *Harpa crenata*, Gray, =*H. Rivoliana*, Less.
57. *Cassis coarctata*, Wood.
58. *Cassis inflata*, (Shaw) Rve.=*C. granosa*, Lam.
59. —— *abbreviata*, Lam.
60. *Columbella harpæformis*, Sow.=*C. citharula*, Ducl.
61. —— *fuscata*, Sow.
62. —— *nasuta*, Mke.
63. —— *fulva*, Sow.
64. —— *Terpsichore*, [Mke. q.] Sow.
65. *Murex messorius*, [Mke. q.] Sow.
66. —— *unidentatus*, [Mke. q.] Sow.
67. —— *ternispina*, [Mke. q.] Lam.
68. —— *salebrosus*, King.
69. —— *brassica*, Lam. = *M. ducalis*, Brod.
70. —— *bicolor*, Val.=*M. erythrostoma*, Swains.
71. —— *lappa*, Brod.
72. —— *dubius*, Sow. = *M. aculeatus*, Wood, not Lam.
73. —— *nigrita*, Phil.
74. —— *ambiguus*, Rve.=*nigritus*, var.
75. *Ranella nana*, Sow.
76. —— *muriciformis*, Brod.
77. —— *anceps*, Lam.=*R. pyramidalis*, Brod.
78. *Tritonium nodosum*, (Chemn.) Mke. =*Triton Chemnitzii*, Gray.
79. —— *lignarium*, Brod.
80. —— *scalariforme*, Brod.

1851, pp. 17–25.

81. *Turbinella cæstus*, Brod.
82. *Fasciolaria princeps*, Sow.
83. *Ficula decussata*, Rve.
84. *Pyrula patula*, Brod. & Sow.
85. —— *subrostrata*, Gray, = *Fusus lapillus*, Brod. & Sow.
86. —— *anomala*, Rve.
87. *Fusus rheuma*, Mart.=*F. torheuma*, Desh.
88. *Pleurotoma funiculata*, Val.
89. —— *maculosa*, Sow.
90. —— *incrassata*, Sow. = *P. Bottæ*, Val.
91. —— *Melchersi*, Mke.
92. *Strombus galeatus*, Swains.
93. —— *granulatus*, Wood.
94. —— *lentiginosus*, Linn.
95. —— *gracilior*, Sow.
96. *Conus princeps*, Linn.
97. —— *regularis*, Sow.
98. —— *puncticulatus*, Hwass.
99. —— *omaria*, Hwass.
100. *Oliva porphyrea*, Lam.
101. —— *angulata*, Lam.
102. —— *Julieta*, Ducl.=*O. Pantherina*, Phil.
103. —— *venulata*, Lam.
104. —— *Melchersi*, Mke.

105. *Oliva undatella*, Lam.
106. —— *anazore*, Ducl.
107. —— *tergina*, Ducl.
108. —— *testacea*, Lam.

1851, pp. 33–38.
109. *Ovula emarginata*, Sow.
110. —— *deflexa*, Sow.
111. *Cypræa Arabica*, Linn.
112. —— *arabicula*, Lam.
113. —— (*Trivia*) *pustulata*, Lam.
114. —— —— *sanguinea*, Gray.
115. —— —— *fusca*, Gray.
116. —— —— *subrostrata*, Gray.
117. *Terebra variegata*, Gray.
118. —— *armillata*, [Mke. q.] Hinds.
119. —— *luctuosa*, Hinds.
120. *Mitra lens*, Wood, = *M. Dupontii*, Kien.
121. *Crepidula contorta*, [Mke. q.] Quoy & Gaim.
122. —— *costata*, [Mke. q.] Sow.
123. *Crepidula striolata*, Mke. = *C. nivea*, var.
124. —— *Goreensis*, Desh.? = *C. nivea*, var.
125. *Calyptræa* (*Trochatella*) *Lamarckii*, [Mke. q.] Desh.
126. —— —— *conica*, Brod.
127. —— (*Dyspotæa*) *spinosa*, Sow.
128. —— *cepacea*, Brod.
129. *Hipponyx foliaceus*, [Mke. q.] Quoy & Gaim. ? = *H. serratus*.
130. *Fissurella virescens*, Sow.
131. —— *viminea*, [Mke. q.] Rve. ? = *F. rugosa*, var.
132. *Patella Mexicana*, Brod. & Sow.
133. *Acmæa mutabilis*, Mke. ? = *fascicularis* + *mesoleuca*, pars.
134. —— *fascicularis*, Mke.
135. —— *mesoleuca*, Mke. = *Patella diaphana*, Rve. not Nutt.
136. *Siphonaria denticulata*, [Mke. q.] Quoy & Gaim. Probably *S. lecanium*, var.

50. Among the many wasted opportunities of obtaining very valuable information on geographical distribution, must unfortunately be recorded the Surveying Voyages of the 'Herald' and 'Pandora,' by Capt. Kellett, R.N., C.B., and Lieut. Wood, R.N. The former of these gentlemen commanded the 'Starling' during the Sulphur Expedition. Their zeal for science is shown not only by the large number of fine and valuable shells which they brought back, but especially by the extreme liberality with which they have presented them to public museums wherever they thought that they could be made useful. The shells were deposited in the Museum of Practical Geology in Jermyn Street, London, then presided over by Prof. E. Forbes. He writes that "they were chiefly collected on the coast of Southern California, from San Diego to Magdalena, and the shores of Mazatlan." This is precisely the very district of all others on which we are in want of accurate information. San Diego belongs mainly to the Californian Province, Mazatlan to that of Panama; the question yet to be settled is, ? where and how do they separate. Here was an exploration in competent hands on the very *terra incognita* itself; and yet, alas! Prof. E. Forbes further states that "unfortunately the precise locality of many of the individual specimens had not been noted at the time; and a quantity of Polynesian shells mingled with them, have tended to render the value of the collection, as illustrative of distribution, less exact than it might have been." Such information as was accessible at the time was embodied by Prof. E. Forbes in two communications to the Zoological Society, 1850; the first on the Land Shells, collected during the Expedition, *Proc.* pp. 53–56; the second on the Marine Mollusca, pp. 270–274. The following abstract includes what may be supposed to relate to our present subject of inquiry.

From Oregon, *Helix Townsendiana*, *H. Nuttalliana*, and *H. Columbiana*.

Helix Pandoræ, Forbes, p. 55. pl. 9. f. 3 *a, b*. Sta. Barbara, as per box label: San Juan del Fuaco, teste Forbes.
—— *Kellettii*, Fbs. p. 55. pl. 9. f. 2 *a, b*. Allied to *H. Californiensis*, Lea. Same locality.
—— *labyrinthus*, var. *sipunculata*, p. 53. pl. 9. f. 4 *a, b*. Panama.
—— *vellicata*, Forbes, p. 55. pl. 9. f. 1 *a, b, c*. "? Panama."
—— *aspersa*, marked Sta. Barbara; probably imported, p. 53.

Bulimus nux, B. calvus, B. eschariferus, B. unifasciatus, and *B. rugulosus,* from Chatham Is., Gelepagos, p. 54. Also, from the same island,
—— *Chemnitzioides,* Forbes, p. 55. pl. 9. f. 6 *a, b*: and
—— *Achatinellinus,* Forbes, p. 56. pl. 9. f. 5 *a, b.* (In text *Achatellinus,* err. typ.)
—— *fimbriatus,* Forbes, p. 56. pl. 9. f. 7 *a, b.* Box labeled Panama.
—— *alternatus,* Panama, p. 54.
Succinea cingulata, Forbes, p. 56. pl. 9. f. 8 *a, b,* "said to come from Mazatlan."

"Out of 307 species of shells collected by the voyagers, 217 are marine Gasteropoda, 1 is a Cephalopod, and 58 marine bivalves. The new species are all from the American shores. There are no products of deep-sea dredging. A few specimens of considerable interest were taken by the 'Herald' at Cape Krusenstern." The following species are described by Prof. Forbes:—

Page.	Plate.	Fig.	
271	11	1 *a, b.*	*Trochita spirata,* Forbes. Massaniello, Gulf of California.
271	11	9	*Trochus castaneus,* Nutt. MS. Sta. Barbara, &c. *Nuttall.*
271	11	8 *a, b.*	—— (*Monodonta*) *gallina,* Forbes. "Probably from the Mazatlan coast." San Diego, *Lieut. Green.*
271	11	7 *a, b.*	—— —— *aureotinctus,* Forbes. "With the last." San Diego, *Lieut. Green.*=*T. cateniferus,* Potiez, teste Gould.
272	11	11 *a, b.*	—— (*Margarita*) *purpuratus,* Forbes, "? W. coast of N. A."
272	11	10 *a, b.*	—— —— *Hillii,* Forbes. "? N.W. coast of N. A."
272	11	2 *a, b, c.*	*Natica Pritchardi,* Forbes. Mazatlan, abundant.=*N. Chemnitzii,* Pfr. non Recl.=*N. maroccana,* var. teste Koch.
273	11	6	*Planaxis nigritella,* Forbes. "Straits of San Juan del Fuaco." =*P. acuta*+*P. obsoleta,* Mke. As this species is found in extreme profusion at Mazatlan, and was not found by Mr. Nuttall, it is in the highest degree improbable that it should occur in abundance so far north in Oregon. It was probably from San Juan in the Gulf of California.
273	11	12	*Purpura analoga,* Forbes. Probably from the Oregon district.
274	...	...	—— *decemcostata,* Midd., var. approaching *P. Freycinetii.*
274	...	...	—— *planospira, columellaris,* and *Carolensis*; "probably from the Galapagos." The two latter occur also at Mazatlan.
274	9	10	*Fusus Kelletii,* Forbes. One sp. from the Californian coast.
274	...	...	—— *Oregonensis.* Californian coast.
274	...	...	—— *salebrosus.* Mazatlan.

The types of the described species, and numerous most beautiful and interesting specimens have been presented to the British Museum. The remainder may be seen by students in the drawers of the Mus. Pract. Geol.: but the condition of the labels is not such that any dependence can be placed on them unless confirmed from other sources. In the only list that remains, it is said that there were the following shells from the Galapagos: 18. Eight species of small shells; 19. *Nerita*; 20–22. *Purpuræ*; 23–25. *Buccina*; 26. *Arcæ*; 27. *Bulimus.* Of the bulk of the collection, 95 species are known from other sources to occur at Mazatlan, and 35 species have been taken in other parts of the province between Mazatlan and Panama. Of the remainder, several are known to belong to Ecuador and Peru, and some, as *Pomaulax undosus* and *Acmæa Oregona,* to the Californian coast. But so large a number, even of those placed with the Mazatlan shells, and perhaps obtained by commerce from that spot, are known to be inhabitants of the Pacific Islands and the East Indies, that a list of them would be entirely useless for our present object.

Among the specimens collected by Messrs. Kellett and Wood during their voyage, which have been by them presented to the British Museum, have been observed the following species:—

Cardium Nuttalli. California.
Trigonia radiata, var. *Hindsii.*
Modiola capax. "S. America." [?]
Pinna rudis. Gulf of California.
Fissurella ornata.
Haliotis Cracherodii, Leach.
Purpura Carolensis. Is. Plata.
Murex foliatus. San Juan de Fuaco.

51. But the largest collection ever brought to Europe from one locality (with the single exception of Mr. Cuming's stores) was made at Mazatlan during the years 1848–50 by a Belgian gentleman of the name of Frederick Reigen. He did not live to enjoy the fruits of his almost unparalleled labours; and after his death in 1850, the collection was sent for sale, partly to Messrs. F. de Lizardi and Co. at Liverpool, and partly to Havre. The Liverpool portion measured about 14 tons of 40 cubic feet each. It was bought by Mr. G. Hulse, wholesale naturalist in Dale Street; but before it passed into his hands, it received such an examination as time allowed from Mr. F. Archer, in whose collection, and in that of the Royal Institution, the first unmixed fruits will be found. Unfortunately the geographical value of these selections is greatly injured by trusting to memory and loose tickets; and the localities of the Institution specimens have simply been added from the monographs, as 'Galapagos,' 'Panama,' 'St. Elena,' &c. Mr. Hulse fortunately deposited the bulk of the collection under lock and key in a chamber by itself; but to save room, he immediately disposed of most of the large shells, such as *Spondylus calcifer*, *Patella Mexicana*, *Strombus galea*, and the *Pinnæ*, to a publican near Manchester, where they may be seen in his "Museum." Circumstances enabled me to make a searching examination of Mr. Hulse's stores, and to form a geographical collection from their contents*. Finding that in a small manufacturing town this could not be made available for the purposes of science, I acceded to the request of Dr. Gray that it should be deposited in the British Museum; it being stipulated (1) that I should be allowed to arrange it in its permanent abode, where it should remain intact as a separate collection; and (2) that a descriptive catalogue should be published of its contents. The duty of preparing this was entrusted to me by Dr. Gray. The work is already written, and most of it printed. When completed, it will be found to contain descriptions of 222 new species; in addition to several which had been previously described from the same collection in the 'Proc. Zool. Soc.' and other works. Numerous details are added on species already known, especially on the variations of growth, geographical range, frequency, and synonymy.

Being desirous of making the permanent collection of the British Museum as complete as possible, and finding that the original stores were in danger of being dispersed, and so rendered useless for science, I obtained possession of the remainder of the vast collection, and subjected it to a renewed and more rigid scrutiny. There will, therefore, be preserved in the B.M. drawers, not only the type specimens of the described species; but what will perhaps be of more service to inland students, because less often accessible, large series illustrating particular species, and displaying both their normal and their abnormal variations. Thus, of *Donax punctatostriatus* will be found 192; of *D. Conradi* [+*culter*, Hanl. + *contusus*, Rve. + *Californicus*, Desh.], 292; of *Anomalocardia subrugosa*, 130; of *Venus gnidia*, 59; of *Anomia lampe*, 97; of *Neritina picta*, 607; and of *Acmæa mesoleuca*, 301 specimens; every one of which exhibits an appreciable difference from its neighbours. The latter

* Of this collection, amounting then to 440 species, an account was laid before the British Association at Liverpool: *v.* Reports, 1854, p. 107. The list was examined by Prof. Forbes, and much assistance obtained from his experience. That assistance was promised during the course of the present inquiry, and would have prevented many of the errors attendant on it; but within a week after he had written to recommend the transfer of the collection to the British Museum, he had passed to the scenes where human aid is no longer needed, and where human errors find no place.

series was obtained by repeated processes of elimination, from the examination of about 11,000 specimens. The whole number of shells passed under review probably exceeded 100,000. The following was found to be the most satisfactory plan for the determination of specific limits:—(1) to spread out the entire mass in somewhat of order before the view, in order that the general *idea* of the species (so to speak) might be received by the mind; (2) to examine the specimens one by one, in comparison with an ordinary shell selected as a standard, putting to one side all that for any cause attracted attention; (3) from the hundreds thus selected out of the thousands, or the scores out of the hundreds, to arrange series according to observed differences; (4) to subject these to a rigid scrutiny with each other and with neighbouring species; (5) to make a selection that should exhibit not extremes only, but intermediate grades; and (6) to write the description while the result of the previous processes was fresh in the recollection. No observations, indeed, can compare for accuracy with those made on living animals in their native haunts; but the next best process is the examination of large numbers of specimens, such as the almost exhaustive diligence of M. Reigen has placed at our disposal. The process may require considerable time and no small amount of patience; but results thus obtained are far more satisfactory than the plan too often followed, of picking out a few specimens of leading forms, which alone are available to naturalists for description. So marvelous indeed are the variations of growth thus traced to the same specific source, that we may well accept with doubt species that are constituted from very limited materials. This caution is by no means to be overlooked in using the very catalogue in question; as the only materials for a knowledge of the small species (which amount to no fewer than 314 out of 691) were the dirt obtained from the washings of the shells, which had most fortunately been sent "in the rough;" and the fragments obtained in ransacking the backs of a few *Spondyli*, which were most obligingly placed at my disposal by R. D. Darbishire, Esq., of Manchester, who had succeeded in rescuing them from the publican's "museum."*

It would of course have been far more satisfactory, for the purposes of science, had the collection never passed through a dealer's hands. The fortunate circumstance, however, of its size and value requiring a room to be emptied and kept looked for its custody, has prevented the chances of error which would otherwise have crept in. No species are inserted in the catalogue but what were obtained from the boxes in this room, and from the large shells about the parasites of which there can be no mistake; except *Ficula decussata*, of which Mr. Hanley distinctly remembers the appearance of a very few specimens in the Havre collection. This, which, though comparatively small, filled twenty-eight boxes, after lying some time in France without a purchaser, was in the main sent to London, and disposed of in lots at the auctions, mixed with other shells, and without any knowledge being communicated as to their history. They have been freely distributed as though from Panama; and several of them appear in the British Museum, labelled "Australia, presented by — Metcalf, Esq." Several freshwater shells, *Cyrenæ* and *Ampullariæ*, are believed to have come from this source; but there was no trace of them in the Liverpool collection. In general, the two sets so far agreed as to make it probable that the species were divided. Messrs. Lizardi received a list, in which the exact localities of all the shells

* I am under the greatest obligations to Mr. Darbishire for his valuable aid from the commencement of the work. We alone were admitted by Mr. Hulse into his secret chamber, filled with the unmixed spoils of the Mazatlan waters; nor should I have ventured to pursue this inquiry, which would have been conducted far better under his auspices, had not professional engagements entirely prevented his devoting the time necessary for such a purpose.

were recorded; this invaluable document, however, was thrown to one side as useless, and has not since been found.

The best evidence of the authenticity of the collection is in the shells themselves. These were, with very few exceptions, taken alive, and treated with evident care. Every single bivalve was separately wrapped up and ticketed; the mouths of the univalves were papered to preserve the opercula; and in many of the smaller species the animal was not extracted. The absence, from so vast a collection, of attractive shells known to be found in neighbouring places, such as *Oliva porphyria*, *Terebra variegata*, *Malea ringens*, *Cassis coarctata*, *Pectens* and *Pectunculi*, generally seen in collections from "that coast," shows that M. Reigen made little use even of the facilities of the coasting trade to extend his stores. Nor are there to be seen the Pacific Strombs, Cowries, Terebræ, &c., some of which even Menke allows to appear in his catalogue. In one respect a town of limited trade is more favourably situated for scientific purposes than a port of extensive commerce. Singapore, the Sandwich Is., Acapulco, &c., to say nothing of places on our own coast, are well known to be "hotbeds of spurious species." But among the many myriads in the Liverpool collection, not a dozen individual shells were found which can fairly be set down as strangers. The principal of these are—

Arca fusca (living), which is quoted from the West Indies, and may linger in the Gulf Seas; or it may have come from the East Indies on a ship bottom.
Conus arenatus. One very rubbed specimen; probably from ballast.
Crepidula Peruviana. Two worn specimens; probably from ballast.
Fissurella Barbadensis. One young fresh sp.; probably brought over on a pebble.

With regard to *Lucina tigerrina* and *Mactra fragilis*, of each of which one fresh specimen was sent papered and ticketed with nearly related shells, we have no right to deny their authenticity merely because they oppose our theories; as unexpected facts are continually making their appearance, to the confusion of the mere systematizer and the corresponding delight of searchers after truth. All shells of this class are included in the list, in order that persons may see the bad as well as the good, and judge of its authority accordingly. No attempt has been made (except with the small shells) to state the number of specimens, because of the abstractions which had previously been made by purchasers; but the following notes will give a tolerably correct idea of their comparative frequency, after these abstractions had been deducted.

e.r. extremely rare; under a score.
v.r. very rare; under a hundred.
r. rare; under two hundred.
n.c. not common; or } under 300.
n.u. not uncommon; }
c. common; up to 400 or 500.
a. abundant; 600 or 700.
e.c. extremely common; 1000.
e.a. extremely abundant; more than 1000.

List of the Reigen Collection of Mazatlan Mollusca.

No.	Name.	Freq.	Other Localities.
	Class BRYOZOA.		
	Membraniporidæ.		
1	Membranipora denticulata, *Busk*, n.s.	r.	
2	—— Gothica, *Rylands, MS.*, n. s.	r.	? Persian Gulf.
3	Lepralia atrofusca, *Rylands, MS.*, n. s.	r.	
4	—— trispinosa, *Johnst.*	1 sp.	Britain.
5	—— Mazatlanica, *Busk*, n. s.	r.	
6	—— rostrata, *Busk*, n. s.	r.	

No.	Name.	Freq.	Other Localities.
7	Lepralia marginipora, *Reuss*	r.	Fossil tertiary, Vienna.
8	—— hippocrepis, *Busk*, n. s.	r.	
9	—— humilis, *Busk*, n. s.	r.	
10	—— adpressa, *Busk*	n. u.	Chiloe, 96 fms., *Darwin*.
677	——, sp. ind.	v. r.	
	Celleporidæ.		
11	Cellepora papillæformis, *Busk*, n. s.	r.	
12	—— cyclostoma, *Busk*, n. s.	r.	
678	Cellepora, sp. ind., resembling pumicosa, *Linn.*	v. r.	
	Discoporidæ.		
13	Defrancia intricata, *Busk*, n. s.	r.	
679	Tubulipora, sp. ind.	v. r.	
	Class TUNICATA. Unknown.		
	Cl. PALLIOBRANCHIATA, *Blain.*		
14	Discina Cumingii, *Brod.*	r.	Payta and St. Elena; Panama.
	Class LAMELLIBRANCHIATA.		
	Pholadidæ.		
15	Pholadidea melanura, *Sow.*	c. r.	Monte Christi.
16	—— ? curta, *Sow.*	2 sp.	Veragua.
17	Parapholas calva, *Gray, MS.*	n. u.	Panama.
18	—— acuminata, *Sow.*	n. u.	Panama.
19	Martesia intercalata, n. s.	2 sp.	
20	(Fragment) somewhat resembling *Panopæa.* Perhaps *Corbula tenuis.*	1	
	Gastrochænidæ.		
21	Gastrochæna truncata, *Sow.*	n. u.	Panama, West Indies.
22	—— ovata, *Sow.*	v. r.	Pan., Is. Perico, West Indies.
	Saxicavidæ.		
23	Saxicava arctica, *Linn.*	v. r.	ubiquitous, p. 17; Fossil, Crag.
	Petricolidæ.		
24	Petricola robusta, *Sow.*	n. u.	Panama, Island of Muerte.
	= *P. bulbosa*, Gld. = *P. sinuosa*, Conr.		
	? = *Choristodon typicum*, Jonas	....	West Indies.
25	—— ventricosa, *Desh.*	e. r.	Gulf of California.
	? = *P. denticulata*, Sow.	....	Peru.
26	——, sp. ind.	2	
27	Rupellaria lingua-felis, n. s.	v. r.	
28	—— exarata, n. s.	e. r.	
29	——, sp. ind.	1	
680	?Naranio scobina, n. s.	e. r.	
220	——, sp. ind.	1	
	Myidæ.		
681	?Mya, sp. ind.	1	
	Corbulidæ.		
30	Corbula bicarinata, *Sow.*	e. r.	Pan., R. Llejos, Carac., St. Elena.
	? = *C. alba*, Phil.		
31	—— biradiata, *Sow.*	1	Panama, Chiriqui, Caraccas.
32	—— pustulosa, n. s.	2	Panama, St. Blas, 33 fms.
33	—— ? ovulata, *Sow.*	1	Panama, Xipix., Montijo, Carac.
34	——, sp. ind. *a.* (allied to *C. scaphoides*, Hds.)	2	
682	——, sp. ind. *b.*	1	
35	Sphænia fragilis, n. s.	n. u.	
683	——, sp. ind.	1	
684	?——, sp. ind.	1	

No.	Name.	Freq.	Other Localities.
	Pandoridæ.		
685	Tyleria fragilis, *H. & A. Ad.*	1	
36	Lyonsia picta, *Sow.*	e. r.	Is. Muerte, Vancouver's Island.
	Solecurtidæ.		
37	Solecurtus affinis, *C. B. Ad.*	n. c.	Panama.
38	—— politus, n. s.	4	
39	——, sp. ind.	1	
	Tellinidæ.		
40	Semele flavescens, *Gld.*	c.	San Diego.
	=*S. proxima*, [quasi] *C. B. Ad.*		
41	—— ? venusta, *A. Ad.*	2	W. Columbia.
42	Cumingia lamellosa, *Sow.*	v. r.	?Panama, Payta.
42*b*	—— ——, ? var. coarctata	e. r.	Panama, Caraccas.
43	—— trigonularis, *Sow.*	v. r.	Panama, St. Elena.
44	—— Californica, *Conr.*	v. r.	Monterey, &c.
45	——, sp. ind. (like *C. striata*)	e. r.	
46	Sanguinolaria miniata, *Gld.*	e. r.	San Juan.
	=*S. purpurea*, Desh.		
47	Tellina rufescens, *Chemn.*	v. r.	Tumbez, West Indies.
	=*T. operculata*, Gmel.		
48	—— Broderipii, *Desh.*	3	
49	—— ??Mazatlanica, *Desh.*	1	
50	—— Dombei, *Hanl.*	2	Panama.
51	—— felix, *Hanl.*	e. r.	Panama.
52	—— straminea, *Desh.*	e. r.	
53	—— donacilla, n. s.	1	
686	——, sp. ind. (*c*)	1	
54	—— punicea, Born.	v. r.	Pan., Guayaquil, W. I., Xipix.
	=*Donax Martinicensis*, Lam. teste Gray.		
	=*Tellina alternata*, Sow. teste Gray.		
	=*T. angulosa*, Gmel. teste Desh.		
	=*T. simulans*, C. B. Ad.		
55	—— Cumingii, *Hanl.*	1	Panama, Guacomayo.
56	—— ?eburnea, *Hanl.*	1	Tumbez.
57	?—— regularis, n. s.	1	
58	—— lamellata, n. s.	e. r.	
59	—— ?? puella, *C. B. Ad.*	1	Panama.
60	—— ?? delicatula, *Desh.*	1	
61	—— brevirostris, *Desh.*	2	Central America.
62	—— ? denticulata, *Desh.*	1	
63	——, sp. ind. (*a*)	1	
64	——, sp. ind. (*b*)	2	
65	Tellidora Burneti, *Brod. & Sow.*	n. u.	Salango, St. Elena.
	=*Lucina cristata*, Récl.		
66	Strigilla carnaria, *Linn.*	n. c.	W. I., ? Medit., Sta. Barbara.
	=*Lucina carnaria*, Lam.		
	=*Strigilla miniata*, Gld.=*S. fucata*, Gld.		
67	—— lenticula, *Phil.*	1	
68	??Psammabia, sp. ind.	1	
	Donacidæ.		
69	Iphigenia altior, *Sow.*	v. c.	Gulf Nicoya, Tumbez, Panama.
70	—— lævigata, ?	2	
71	Donax carinatus, *Hanl.*	v. r.	San Blas, Tumaco.
72	—— rostratus, *C. B. Ad.*	1	Sta. Barbara, Panama.
	=*D. carinatus*, var. Hanl.		
	=*D. culminatus*, Cat. Prov.		
73	—— transversus, *Sow.*	1	
74	—— assimilis, *Hanl.*	1	Panama.

No.	Name.	Freq.	Other Localities.
75	Donax punctatostriatus, *Hanl.*	e. c.	
75*b*	—— ?punctatostriatus, var. cælatus	v. r.	
76	—— Conradi, *Desh.*	c.	Acapulco.
	+*D. culter*, Hanl.		
	+*D. Californicus*, Desh. non Conr.		
	+*D. contusus*, Rve.		
	?+*D. radiata*, Val.		
77	—— navicula, *Hanl.*	n. u.	Gulf of Nicoya, Panama.
	Mactridæ.		
78	Mactra exoleta, *Gray*	n. u.	Panama, Guayaquil.
	=*Lutraria ventricosa*, Gld.		
	=*Mulinia ventricosa*, C. B. Ad.		
79	—— fragilis, *Chemn.*	1	West Indies.
	=*M. ovalina*, Lam. teste Gray.		
	=*M. Braziliana*, Lam. teste Desh.		
	=*M. oblonga*, Say, teste Rve.		
80	—— (Mulinia) angulata, *Gray*	e. r.	S.W. Mexico, Panama.
	?=*M. donaciformis*, C. B. Ad.		
81	Gnathodon mendicus, *Gld.*	r.	
	=*Rangia trigona*, Petit.		
	Veneridæ.		
82	?Clementia gracillima, n. s.	e. r.	
83	Trigona radiata, *Sow.*	v. c.	Salango, Xipix., Guayaq., Pan.
	=*Venus Solangensis*, D'Orb.		
	=*Trigona Byronensis*, Gray.		
	=*Cytherea corbicula*, Mke. (non Lam.)		
	+*C. semifulva*, Mke.		
	+*C. gracilior*, Sow.		
	+*C. Hindsii*, Hanl.		
	?+*C. intermedia*, Sow.		
84	—— humilis, n. s.	r.	
85	—— argentina, *Sow.*	v. r.	Gulf of Nicoya.
	=*Cytherea æquilatera*, Desh.		
86	—— ?? crassatelloides, jun.	2 valv.	Upper California.
87	—— planulata, *Brod. & Sow.*	n. c.	Pan., Salango: Chili, Coquimbo, *D'Orb.*
	+*Cytherea undulata*, Sow.		
	=*Donax Lessoni*, Desh.		
	=*Cytherea mactroides*, Lam. teste Desh.		
88	Dosinia ponderosa, *Gray*	1	Payta.
	=*Cytherea gigantea*, Phil.		
	=*Venus cycloides*, D'Orb.		
89	—— Annæ, *Darb.*	v. r.	
90	—— Dunkeri, *Phil.*	v. c.	Panama, St. Elena, "Eastern Seas," *Ad. & Rve.*
	=*Artemis simplex*, Hanl.		
	=*Cytherea Pacifica*, Trosch.		
91	Cyclina subquadrata, *Hanl.*	3	St. Elena, Panama.
	=*Artemis saccata*, Gld.		
92	Dione aurantia, *Hanl.*	n. c.	S.W. Mex., Gulf Nicoya, Taboga.
	=*Cytherea aurantiaca*, Sow.		
93	—— chionæa, *Mke.*	c.	San Blas, S.W. Mexico, La Paz, Taboga, St. Elena, ?Philippines, Swan River.
	+*Cytherea squalida*, Sow.		
	+*C. biradiata*, Gray.		
	?+*C. elegans*, Koch.		
94	—— rosea, *Brod. & Sow.*	c.	San Blas, Panama.
	=*Cytherea lepida*, Chen.		
95	—— lupinaria, *Less.*	e. c.	San Blas, Salango, Tumbez, Payta.
	=*D. lupanaria*, Gray.		
	=*Cytherea Dione*, var. Brod.		
	=*C. semilamellosa*, Gaud.		
96	—— ? vulnerata, *Brod.*	1	Real Llejos.

No.	Name.	Freq.	Other Localities.
97	Dione brevispinosa, *Sow.*	1	
98	—— circinata, *Born.*	2	West Indies, Monte Christi.
	= *Venus Guineensis*, Gmel.		
	= *Cytherea alternata*, Brod.		
99	—— concinna, *Sow.*	1	Panama.
	?+ *Cytherea affinis*, Brod.		
	?+ *C. tortuosa*, Brod.		
100	Cytherea petechialis, *Lam.*	v. r.	Japan.
101	Venus (Chione) gnidia, *Brod. & Sow.*	e. c.	Payta, Panama, San Blas.
102	—— —— amathusia, *Phil.*	c.	S.W. Mexico, Panama.
	= *Chione gnidia*, var. Desh.		
103	—— ——, sp. ind. (*a*)	e. r.	
104	—— —— distans, *Phil.*	1	Panama.
105	—— —— crenifera, *Sow.*	3	St. Elena, Payta.
	= *V. Portesiana*, D'Orb.		
106	—— —— ?undatella, *Sow.*	1	Island 3 Marias, G. of Calif.
107	—— —— Columbiensis, *Sow.*	e. c.	St. Elena, S.W. Mexico.
108	—— ——, sp. ind. (*b*)	3	
109	Tapes histrionica, *Brod. & Sow.*	e. c.	Real Llejos, St. Elena.
	= *Chione histrionica*, Desh.		
110	—— grata, *Say*	3	S.W. Mex., Pan., St. Elena and Guacomayo, Puerto Portrero, Guaymas.
	= *Venus tricolor*, Sow. teste Desh.		
	= *V. discors*, Sow. teste Jay.		
	? = *V. neglecta*, Phil. (non Gray).		
111	—— squamosa, n. s.	3	
112	Anomalocardia subrugosa, *Sow.*	e. c.	S.W. Mexico, Panama, Peru.
	= *Cytherea subsulcata*, Mke.		
113	—— subimbricata, *Sow.*	e. r.	Acapulco, Puerto Portrero.
	Astartidæ.		
114	Circe margarita, n. s.	v. r.	
115	—— subtrigona, n. s.	v. r.	
116	Gouldia Pacifica, *C. B. Ad.*	v. r.	Panama.
117	—— varians, n. s.	c.	
118	Cardita Californica, *Desh.*	e. r.	
	= *C. affinis*, Mke. non Sow.		
119	Venericardia, sp. ind.	1	
120	Trapezium, sp. ind.	1	
	Chamidæ.		
121	Chama frondosa, var. Mexicana	n. c.	Gulf of Tehuantepec.
	+ *Chama echinata*, fig. pars.		
121*b*	—— ? frondosa, var. fornicata	v. r.	
	? = *C. Buddiana*, C. B. Ad.		
122	—— spinosa, *Sow.*	4	Lord Hood's Island.
123	—— exogyra, *Conr.*	2	San Diego.
	Cardiadæ.		
124	Cardium (Lævicardium) elatum, *Sow.*	n. u.	Guaymas, San Diego.
125	—— procerum, *Sow.*	c.	S.W. Mexico, Panama, Payta, Real Llejos.
	?+ *C. laticostatum*, Sow.		
126	—— ? senticosum, *Sow.*	e. r.	Taboga, St. Elena.
	= *C. rastrum*, Rve.		
	? = *C. muricatum*, Mke.		
127	——, sp. ind. (*a*) (like C. punctulatum)	3	
128	——, —— (*b*) (like C. triangulatum)	1	
129	——, —— (*c*) (like C. pseudofossile)	1	
130	——, —— (*d*)	1	
131	——, —— (*e*)	2	
132	——, —— (*f*)	2	
133	—— alabastrum, n. s.	e. r.	
687	—— rotundatum, n. s.	1	

No.	Name.	Freq.	Other Localities.
134	Cardium graniferum, *Brod. & Sow.*	e. r.	Pan., Gulf Nicoya and Xipix.
135	——, sp. ind. (*g*), (lucinoides, *nom. prov.*)	1	
	Lucinidæ.		
136	Lucina (Codakia) tigerina, *Linn.*	1	S.W. Mexico, West Indies.
137	—— ?? punctata, *Linn.*	2	Panama.
138	—— annulata, *Rve.*	1	
139	—— ? muricata, *Chemn.*	1	
140	—— excavata, n. s.	e. r.	
141	——, sp. ind. (*a*)	1	
142	—— pectinata, n. s.	1	
143	—— cancellaris, *Phil.*	e. r.	
144	—— Mazatlanica, n. s.	c.	
145	—— prolongata, n. s.	v. r.	
146	——, sp. ind. (*b*)	1	
147	—— ? eburnea, *Rve.*	1	Panama, St. Elena.
148	—— sp. ind. (*c*)	2	
149	?Fimbria, sp. ind.	2	
150	Diplodonta semiaspera	v. r.	West Indies.
	? = *Lucina cælata*, Rve.		
	? = *L. semireticulata*, D'Orb.		
	Comp. *L. orbella*, Gld.	...	San Diego.
150*b*	—— ——, var. discrepans	1	
151	—— obliqua, *Phil.*	1	
152	?—— serricata, *Rve.*	n. u.	
	Kelliadæ.		
153	Kellia suborbicularis, *Mont.*	c.	Atlantic: Britain, — Canaries: Fossil Crag; Panama.
154	Lasea ? rubra, *Mont.*	e. r.	Atlantic: ?ubiquitous.
155	—— trigonalis, n. s.	e. r.	
156	?—— oblonga, n. s.	1	
688	——, sp. ind.	1	
157	Lepton Clementinum, n. s.	2	
158	—— Dionæum, n. s.	1	
159	—— umbonatum, n. s.	2	
160	Pythina sublævis, n. s.	4	
161	Montacuta elliptica, n. s.	3	
162	?—— subquadrata, n. s.	3	
163	——, sp. ind.	1	
	Cycladidæ.		
164	Cyrena olivacea, n. s.	n. c.	
	= *C. Fontainei*, Desh. non D'Orb.		
165	—— Mexicana, *Brod. & Sow.*	n. u.	
	Comp. *C. Floridana*, Conr.		
	Var. = *C. altilis*, Gld.		
	Unionidæ.		
166	Anodon ciconia, *Gld.*	n. u.	
	Comp. *A. glauca*, Val.		
	Mytilidæ.		
167	Mytilus palliopunctatus, *Dkr.*	c.	S.W. Mexico.
168	—— multiformis, n. s.	c.	
169	Septifer Cumingianus, *Récl.*	e. r.	Panama.
170	Modiola capax, *Conr.*	r.	S. Diego, La Paz, Gal., S.W. Mex.
171	—— Braziliensis, *Chemn.*	r.	Guiana, Venezuela, Bay Guayaquil, Panama.
	= *M. Guyanensis*, Lam.		
	= *M. semifusca*, Sow. (not Lam.)		
171*b*	—— ——, var. mutabilis	n. c.	? New Zealand.
172	Crenella coarctata, *Dkr.*	e. r.	Galapagos.
173	Lithophagus attenuatus, *Desh.*	e. r.	Peru, ?Chili.

No.	Name.	Freq.	Other Localities.
174	Lithophagus calyculatus, n. s.	1	
175	—— plumula, *Hanl.*	r.	Panama.
176	—— aristatus, *Sol.*	c.	Senegal, West Indies.
	=*Modiola caudigera*, Lam.		
	=*Mytilus ropan*, Desh.		
176*b*	—— ——, var. gracilior	v. r.	
176*c*	—— ——, var. tumidior	e. r.	
177	—— cinnamomeus, *Chemn.*	1	Mauritius, Philippines, Cuba, Venezuela, Central America.
178	Leiosolenus spatiosus, n. s.	e. r.	
179	——, sp. ind.	1	
	Arcadæ.		
180	Arca grandis, *Brod. & Sow.*	v. c.	Pan., Real Llejos, Bay Guayaq.
181	—— multicostata, *Sow.*	2	Gulf Tehuantepec.
182	—— ? labiata, *Sow.*	2	Real Llejos, Tumbez, W. Indies.
	?=*A. labiosa*, Sow.		
	?=*A. incongrua*, Say.		
183	—— bifrons, n. s.	e. r.	
184	—— tuberculosa, *Sow.*	v. c.	Panama, Real Llejos.
	?+*A. trapezia*, Desh.		
	+*A. similis*, C. B. Ad.		
185	—— reversa, *Gray*	2	Panama, Tumbez.
	=*A. hemicardium*, Koch.		
186	—— ? brevifrons, *Sow.*	1	Tumbez.
187	—— emarginata, *Sow.*	e. r.	Atacamas, Rl. Llej., Xipix., Pan.
188	——, sp. ind. (*a*)	2	
689	——, —— (*b*)	1	
189	Byssoarca Pacifica, *Sow.*	r.	St. Elena, Bijooga Island.
190	—— mutabilis, *Sow.*	r.	Island of Plata, Panama.
	Comp. *Arca Americana*, D'Orb. = *imbricata*, Brug.		
191	—— fusca, *Brug.*	1	East and West Indies.
192	—— vespertilio, n. s.	1	
193	—— illota, *Sow.*	e. r.	Gulf Nicoya.
	Comp. *A. Tabogensis*, C. B. Ad.		
194	—— gradata, *Brod. & Sow.*	v. r.	St. Elena, Taboga, West Indies, and Fossil.
	? = *A. squamosa*, Lam. = *A. Domingensis*, Lam.		
	=*Arca clathrata*, Defr.		
	Comp. *B. divaricata*, Sow.		
	Comp. *B. pusilla*, Sow.		
	Comp. *A. donaciformis*, Rve.		
195	—— solida, *Sow.*	n. u.	Panama, Payta.
196	Pectunculus inæqualis, *Sow.* (non *Gray*)	3	Panama, Real Llejos, Puerto Portrero, Guayaquil.
	=*P. pectiniformis*, Wood (non Lam.)		
	?+*P. assimilis*, Sow.		
197	—— ? multicostatus, *Sow.*	1	Ecuador, Guayaquil.
	Nuculidæ.		
198	Nucula exigua, *Sow.*	1	Panama, Bay of Caraccas.
199	Leda Elenensis, *Sow.*	2	Panama, St. Elena.
	Aviculidæ.		
200	Pinna maura, *Sow.*	com.	Panama.
201	—— lanceolata, *Sow.*	n. u.	Puerto Portrero.
202	—— ? rugosa, *Sow.*	v. r.	Panama.
203	Avicula sterna, *Gld.*	n. u.	Panama.
	=*A. Atlantica*, Mke.		
204	Margaritiphora Mazatlanica, *Hanl.*	v. r.	
	=*A. fimbriata*, Dkr.		
205	Isognomon Chemnitzianum, *D'Orb.*	n. u.	Panama, W. Indies, Conchagua.
	=*Perna flexuosa*, Sow.		

No.	Name.	Freq.	Other Localities.
206	Isognomon Janus, n. s.	e. r.	
	Pectinidæ.		
207	Pecten circularis, *Sow.*	2	Guaymas.
690	——, sp. ind. (*a*)	e. r.	
691	——, sp. ind. (*b*)	1	
	Spondylidæ.		
208	Spondylus calcifer, n. s.	n. u.	Panama.
	= *S. Lamarckii*, Hanl. MS.		
209	?——, sp. ind.		
210	Plicatula penicillata, n. s.	e. r.	Bay of Fonseca.
	= *P. dubia*, var. Sow. MS.		
	Ostreadæ.		
211	Ostrea iridescens, *Gray*	v. r.	Senegal, Panama, Guacomayo.
	? = *O. spathulata*, Lam.		
	? = *O. margaritacea*, Lam.		
	? = *O. æquatorialis*, D'Orb.		
	? = *O. rufa*, pars, Gld.		
212	—— Virginica, *Gmel*	v. r.	Atlantic, Panama.
	? = *O. rufa*, pars, Gld.		
213	—— Columbiensis, *Hanl.*	v. r.	St. Elena.
214	—— conchaphila, n. s.	n. u.	S.Diego, S.W.Mex., Pan., W.Afr.
214*b*	—— (??——, var.) palmula	e. r.	Upper California, S.W. Mexico.
	Comp. *O. Cumingiana.*		
215	——, sp. ind.	v. r.	San Diego, Panama.
	Anomiadæ.		
216	Placunanomia pernoides, *Gray*	e. r.	Senegal, Panama.
	= *Tedinia pernoides*, Gray.		
217	—— foliata, *Brod.*	2	S.W. Mexico, Island of Muerte, Guayaquil, West Indies.
	+ *P. pectinata*, teste Gray.		
	+ *P. echinata*, teste Gray.		
218	—— claviculata, n. s.	2	
219	Anomia lampe, *Gray*	c.	Monterey, La Paz, Pan., Guayaq.
	Class PTEROPODA.		
	Unknown.		
	Class GASTEROPODA.		
	Subclass OPISTHOBRANCHIATA.		
	Order **Tectibranchiata.**		
	Cylichnidæ.		
221	Cylichna luticola, *C. B. Ad.*	2	Panama.
222	Tornatina infrequens, *C. B. Ad.*	v. r.	Panama.
	? = *Bulla gracilis*, Mke.		
223	—— carinata, n. s.	v. r.	
	Bullidæ.		
224	Bulla Adamsi, *Mke.*	n. c.	
225	—— ? nebulosa, *Gld.*	e. r.	Sta. Barb., San Diego, Guaymas.
226	—— Quoyii, *Gray*	e. r.	Galapagos.
227	—— exarata, n. s.	2	
228	——, sp. ind.	1	
229	Haminea cymbiformis, n. s.	1	
	Philinidæ.		
692	Smaragdinella thecaphora, (*Nutt.*) n. s.	1	

No.	Name.	Freq.	Other Localities.
	Subclass PULMONATA.		
	Order **Geophila.**		
	Testacellidæ.		
230	Glandina Albersi, *Pfr.*	e. r.	
231	—— turris	2	
	Helicidæ.		
232	Orthalicus zebra, *Müll.*	c.	Brazils, Peru, Columbia, West Indies, Conchagua.
	=*Bulimus undatus*, Lam.		
	+*B. melanocheilus*, Val.		
	+*Orthalicus livens*, Beck.		
	+*B. zigzag*, Lam.		
	+*B. princeps*, Brod.		
233	—— Ziegleri, *Pfr.*	e. r.	
234	—— ? Mexicanus, *Lam.*	1	
	Order **Limnophila.**		
	Auriculidæ.		
235	Melampus olivaceus, n. s.	n. u.	San Diego.
	Limnidæ.		
236	Physa aurantia, n. s.	n. c.	
	=*P. Peruviana*, Mke. (non Gray).		
237	—— elata, *Gld.*	v. c.	
238	Planorbis tumens, n. s.	n. u.	
	=*P. tenagophilus*, Mke. non D'Orb.		
	Order **Thalassophila.**		
	Siphonariadæ.		
239	Siphonaria Lecanium, *Phil.*	c.	St. Elena, Guayaquil.
239*b*	—— ——, var. palmata	n. c.	
240	—— æquilirata, n. s.	1	
241	——, sp. ind.	1	
	Subclass PROSOBRANCHIATA.		
	Order **Heteropoda.**		
	Ianthinidæ.		
242	Ianthina striulata, n. s.	v. c.	Sandwich Islands, *Nuttall.*
242*b*	—— ——, var. contorta	e. r.	
243	—— decollata, nom. prov.	e. r.	
	Comp. *I. globosa*, Swains., and *I. prolongata*, D'Orb.		
	Order **Lateribranchiata.**		
	Dentaliadæ.		
244	Dentalium liratum, n. s.	v. r.	
245	—— hyalinum, *Phil.*	1	
246	—— corrugatum, n. s.	1	
247	—— pretiosum, *Nutt.*	e. r.	
	Order **Scutibranchiata.**		
	Chitonidæ.		
248	Lophyrus articulatus, *Sow.*	c.	San Blas.

No.	Name.	Freq.	Other Localities.
249	Lophyrus albolineatus, *Brod. & Sow.*	v. r.	
250	—— striato-squamosus, n. s.	1	
251	Tonicia Forbesii, n. s.	2	
252	Lepidopleurus sanguineus, *Rve.*	v. r.	
	Comp. *Ch. limaciformis*, Sow.		
253	—— clathratus, n. s.	1	
254	—— bullatus, n. s.	2	
254*b*	—— ——, var. calciferus	1	
255	?—— MacAndreæ, n. s.	2	
256	—— Beanii, n. s.	2	
257	Chiton flavescens, n. s.	6	
258	Acanthochites Arragonites, n. s.	e. r.	
	Patellidæ.		
259	Patella Mexicana, *Brod. & Sow.*	c.	Payta.
	=*P. maxima*, D'Orb.		
260	—— pediculus, *Phil.*	n. u.	Acapulco.
	=*P. corrugata*, Rve.		
261	—— discors, *Phil.*	v. c.	S.W. Mexico.
262	Nacella, sp. ind.	1	
	Acmæidæ.		
263	Acmæa mesoleuca, *Mke.*	e. a.	
	=*Patella diaphana*, Rve.	...	Central America.
	=*Lottia ?patina*, C. B. Ad. (non Esch.)	....	Panama.
	?+?*A. personoides*, Midd.	...	Kenai Bay.
	?+?*A. æruginosa*, Midd.	...	Bodegas.
	+*P. striata*, Rve. non Quoy	...	Galapagos.
	+*A. mutabilis*, Mke. pars.		
264	—— fascicularis, *Mke.*	n. u.	San Diego.
	+*A. mutabilis*, Mke. pars.		
265	—— patina, *Esch.* (for syn. v. supra)	2	N. & S. temperate America.
266	—— persona, *Esch.*	1	Sitka—San Diego.
267	—— scabra, *Nutt., Rve., Jay*	1	Monterey &c., S.W. Mexico.
	Non *P. scabra*, Gld.		
268	—— mitella, *Mke.*	n. u.	
	=*P. navicula*, Rve.		
269	Scutellina navicelloides, n. s.	1	
	Gadiniadæ.		
270	Gadinia pentegoniostoma, *Sow.*	n. c.	
	Fissurellidæ.		
271	Fissurella virescens, *Sow.*	v. c.	Panama.
[272	—— Barbadensis, *Gmel.*]	1	West Indies.
273	—— rugosa, *Sow.*	n. u.	Galapagos.
	+*F. chlorotrema*, Mke.		
	+*F. humilis*, Mke.		
	+*F. viminea*, Mke.		
274	—— nigrocincta, n. s.	e. r.	
275	——, sp. ind.	1	
276	—— alba, n. s.	c.	
	?+*F. gemmata*, Mke. (jun.)		
277	—— Peruviana, *Lam.*	1	Peru, Lobos, Iquiqui, Is. Mexillones, Valparaiso.
278	—— spongiosa, n. s.	2	
279	Glyphis inæqualis, *Sow.*	n. c.	Guacomayo, Galap., St. Elena, Monte Christi.
	+*Fissurella pica*, Sow.		
	+*F. mus*, Rve.		
280	—— alta, *C. B. Ad.*	e. r.	Panama.
281	Rimula Mazatlanica, n. s.	e. r.	

No.	Name.	Freq.	Other Localities.
	Trochidæ.		
282	Callopoma fluctuosum, *Mawe*	c.	St. Elena, San Diego, Sitka.[?]
	= *Turbo Fokkesii*, Jonas.		
	= *T. fluctuatus*, Rve.		
283	Phasianella perforata, *Phil.*	e. r.	Payta, Panama.
283*b*	—— ——, var. striulata	2	
284	—— compta, *Gld.*	1	San Diego, Sta. Barbara.
285	Bankivia varians, jun., *Beck*	1	Australia, S. Africa.
286	Uvanilla olivacea, *Mawe*	e. c.	S.W. Mexico.
	= *Trochus brevispinosus*, Val.		
	= *T. erythrophthalmus*, Phil.		
	? = *T. Melchersi*, Mke.		
287	—— inermis, *Gmel.*	2	
	= *Trochus olivaceus*, Phil. (not Wood).		
	= *U. variegatus*, Gray in B.M.		
288	—— unguis, *Mawe*	e. c.	S.W. Mexico.
	= *Turbo digitatus*, Desh.		
	= *Trochus amictus*, Val.		
	= *T. stellaris*, Mke.		
289	Trochus versicolor, Mke.	c.	Payana.
	? = *Ziziphinus Californicus*, A. Ad.		
	= *T. eximius*, Rve.		
290	—— MacAndreæ, n. s.	e. r.	Panama.
	? = *T. minutus*, Mke.		
325	——, sp. ind.	1	
291	Omphalius ? rugosus, var. rufotinctus	v. r.	? China.
292	—— viridulus, *Gmel.*	1	San Diego.
	= *Phorcus variegatus*, A. Ad.		
	= *Trochus Brazilianus*, Mke. teste Ad.		
	+ *T. Byronianus*, Wood.		
	+ *T. reticulatus*, Gld. MS.		
293	—— ligulatus, *Mke.*	c.	
	? = *Phorcus Californicus*, A. Ad.		
294	—— globulus, n. s.	5	
	? = *Trochus glomus*, Mke.		
295	Vitrinella Panamensis, *C. B. Ad.*	1	Panama.
296	—— parva, *C. B. Ad.*	30	Panama.
297	?—— decussata, n. s.	30	
298	—— monile, n. s.	30	
299	—— monilifera, n. s.	7	
300	—— lirulata, n. s.	1	
301	—— subquadrata, n. s.	16	
302	—— bifilata, n. s.	8	
303	—— bifrontia, n. s.	4	
304	—— perparva, var. nodosa	1	Panama.
305	—— exigua, *C. B. Ad.*	6	Panama.
306	—— coronata, n. s.	4	
307	?—— annulata, n. s.	1	
308	—— cincta, n. s.	1	
309	—— carinulata, n. s.	1	
310	?—— naticoides, n. s.	1	
311	?—— planospirata, n. s.	1	
312	?—— orbis, n. s.	4	
313	?Liotia carinata, n. s.	1	
314	?—— striulata, n. s.	1	
315	??—— C-B-Adamsii, n. s.	1	
316	?——, sp. ind.	1	
317	?Globulus tumens, n. s.	3	
318	Ethalia pyricallosa, n. s.	1	
319	—— lirulata, n. s.	2	
320	—— pallidula, n. s.	1	

No.	Name.	Freq.	Other Localities.
321	Ethalia carinata, n. s.	2	
322	—— amplectans, ? n. s.	4	
323	Teinostoma amplectans, n. s.	2	
324	—— substriatum, n. s.	2	
	Neritidæ.		
326	Nerita scabricosta, *Lam.*	n. c.	Is. Timor, Real Llejos, Panama,
	=*N. ornata*, Sow.		S.W. Mexico.
	+*N. Deshayesii*, Récl.		
	+*N. multijugis*, Mke.		
327	—— Bernhardi, *Récl.*	n. u.	Peru, Panama, S.W. Mexico.
	=*N. funiculata*, Mke.		
328	Neritina cassiculum, *Sow.*	c.	San Miguel.
329	—— picta, *Sow.*	a.	Panama.
	Order **Pectinibranchiata.**		
	Suborder ROSTRIFERA.		
	Naricidæ.		
330	Vanicoro cryptophila, n. s. (=Narica cr.)	r.	
	Calyptræidæ.		
331	Trochita ventricosa, n. s.	1	
332	Galerus conicus, *Brod.*	e. r.	Pan., S. W. Mex., Xip. & Salango.
333	—— mammillaris, *Brod.*	n. u.	Is. Muerte, Panama, Acap., Sta.
	+*C. regularis*, C. B. Ad.		Barbara, Payta—Guayaquil.
	=*C. Lamarckii*, Mke.		
	?+*C. Lichen*, Brod.		
334	Crepidula aculeata, *Gmel.*	c.	W. I., E. and W. S. Am., Africa,
	+*C. echinus*, Brod.		E. I., Australia, N. Zealand.
	+*C. hystrix*, Brod.		
	+*C. costata*, Mke.		
	+*C. Californica*, Nutt.		
335	—— dilatata, *Lam.*	2	W. Coast S. America *passim*,
	+*C. Peruviana*, Lam.		? Mauritius.
	+*C. depressa*, Desh.		
	+*C. patula*, Desh.		
	+*C. Adolphei*, Less.		
	+*C. nautiloides*, Less.		
	+*C. strigata*, Brod.		
	+*C. arcuata*, D'Orb. teste Gray.		
	??+*C. pallida*, Brod.		
	?+*C. foliacea*, Brod.		
	?+*C. Patagonica*, D'Orb. (pars).		
336	—— dorsata, *Brod.*, var. bilobata	e. r.	
337	—— excavata, *Brod.*	3	Real Llejos, Panama.
338	—— adunca, *Sow.*	e. r.	Bodegas, Da Fuca Str., Sta. Bar-
	=*C. solida*, Hds.		bara, Panama.
	=*C. rostriformis*, Gld.		
	=*C. rostrata*, C. B. Ad.		
	=*C. uncata*, Mke.		
	=*Garnotia solida*, Gray.		
339	—— incurva, *Brod.*	n. u.	San Blas., Pan., Payta, St. Elena,
	=*C. hepatica*, Mke. non Desh., nec C. B. Ad. nec Krauss.		Xipixapi.
340	—— onyx, *Sow.*	v. r.	Panama, ? S. and W. Africa.
	=*C. ?hepatica*, C. B. Ad. non Mke.		
	=*C. amygdalus*, Val.		
	?=*C. contorta*, Mke.		
	+*C. cerithicola*, C. B. Ad.		
	+*C. Patagonica+protea*, D'Orb. pars.		

No.	Name.	Freq.	Other Localities.
341	Crepidula nivea, *C. B. Ad.*	v. c.	Panama, Is. Muerte, S. America, ? Vancouver's Strait.
	+*C. squama*, Brod.		
	+*C. striolata*, Mke.		
	+*C. Lessonii*, Brod.		
	+*C. unguiculus*, var. Brod.		
	+*C. protea*, D'Orb. pars.		
	Comp. *C. explanata*, Gld. = *C. perforans*, Val. = *C. exuviata*, Nutt.		
342	—— unguiformis, *Lam.*	e. r.	Atlantic, both coasts; Panama, Singapore.
	Patella crepidula, Linn.		
	+*C. Italica*, Defr.		
	+*C. plana*, Say.		
	+*P. goreensis*, Gmel.		
343	Crucibulum imbricatum, *Sow.*	n. u.	W. Coast America, Panama, Peru.
	=*C. scutellatum*, Gray.		
	=*C. rugosa*, Less. non Desh.		
	+*C. extinctorium*, Sow. (non Lam.) = *C. dentata*, Mke.		
344	—— spinosum, *Sow.*	n. u.	W. Coast, Panama, Peru, Sta. Barbara.
	=*C. peziza*, Wood.		
	+*C. hispida*, Brod.		
	+*C. maculata*, Brod.		
	+*C. tenuis*, Brod.		
	=*C. tubifera*, Less.		
	?+*C. rugosa*, Desh. = *C. lignaria*, Brod. + *C. quiriquina*, D'Orb. = *C. Byronensis*, Gray.		
345	Calyptræa cepacea, *Brod.*	1	Is. Muerte, Panama.
	Capulidæ.		
346	Hipponyx serratus, n. s.	r.	
	? = *H. foliaceus*, Mke.		
347	—— antiquatus, *Linn.*	3	West Indies, Senegal, Lobos Is., Panama.
	= *Pileopsis mitrula*, Lam.		
	= *Hipponyx Panamensis*, C. B. Ad.		
348	—— planatus, n. s.	4	Panama.
349	—— barbatus, *Sow.*	v. r.	Society Islands, Panama.
	? = *H. australis*, Mke.		
350	—— Grayanus, *Mke.*	1	Galapagos, Sandwich Islands, Panama, S. W. Mexico, Guinea.
	= *H. radiata*, Gray (non Quoy nec Desh.)		
351	Capulus, sp. ind. (like *C. militaris*)	3	
	Vermetidæ.		
352	Aletes centiquadrus, *Val.*	n. u.	S. W. Mexico, Panama.
	+*Vermetus Peronii*, Val.		
352*b*	—— ——, var. imbricatus	2	
353	—— margaritarum, *Val.*	3	
354	Vermetus eburneus, *Rve.*	v. r.	S. America, W. Columbia.
	? Jun. = *V. pellucidus*, Brod. & Sow.		
355	?Bivonia contorta, n. s.	r.	
	? = *Vermetus glomeratus*, Mke., C. B. Ad., non Phil. nec Linn.		
	Comp. *V. Panamensis*, C. B. Ad.		
355*b*	—— ——, var. indentata	v. r.	
356	—— albida, n. s.	3	
357	——, sp. ind. (*a*)	2	
358	——, —— (*b*)	1	
359	Petaloconchus macrophragma, n. s.	n. u.	Panama.
	Cæcidæ.		
360	Cæcum (Elephantulum) insculptum, n. s.	2	
361	—— —— subspirale, n. s.	12	
362	—— —— abnormale, n. s.	2	
363	—— —— obtusum, n. s.	6	

No.	Name.	Freq.	Other Localities.
364	Cæcum (Elephantulum) liratocinctum, n. s....	50	
	+var. *tenuiliratum.*		
	+var. *subobsoletum.*		
	+var. *subconicum.*		
365	—— —— heptagonum, n. s......................	1	
366	—— (Anellum) elongatum, n. s.	15	
	?+var. *semilæve.*		
367	—— —— subimpressum, n. s.	8	
368	—— —— firmatum, *C. B. Ad.*	14	Panama.
	+*C. diminutum*, C. B. Ad.		
	+*C. pygmæum*, C. B. Ad.		
	+*C. monstrosum*, C. B. Ad.		
	+*C. firmatum*, C. B. Ad.		
369	—— —— clathratum, n. s.	12	
370	—— —— quadratum, n. s.	43	
	+var. *compactum.*		
371	—— —— undatum, n. s.	320	
	?+*C. parvum*, C. B. Ad.	....	Panama.
372	—— (Fartulum) læve, *C. B. Ad.*	170	Panama.
373	—— —— farcimen, n. s.	8	
374	—— —— glabriforme, n. s.	5	
375	—— —— corrugulatum, n. s.	1	
376	—— —— dextroversum, n. s.	20	
377	—— —— reversum, n. s.	1	
378	—— —— teres, n. s.............................	5	
	Turritellidæ.		
379	Turritella goniostoma, *Val.*	n. u.	Acap., S.W. Mex., Pan., Payta, Salango, Guacomayo.
	=*T. Broderipiana*, D'Orb.		
	+*T. lentiginosa*, Rve.		
	?+*T. Hookeri*, Mke. (non Rve.)		
	?+*T. Banksii*, Rve.		
380	—— tigrina, *Kien*................................	e. r.	Conchagua.
	=*T. imbricata*, Mke. (?non Lam.)		
	?+*T. Cumingii*, Rve.		
	?+*T. leucostoma*, Val.		
	Cerithiadæ.		
381	Cerithium maculosum, *Kien*......................	c.	Acap., Gal., S.W. Mex., Taboga.
	=*C. adustum*, C. B. Ad.		
	=*C. nebulosum*, Sow.		
	?var.=*C. adustum*, Sow. (non Kien.)		
382	—— ?famelicum, *C. B. Ad.*, var. mediolæve...	e. r.	Panama, S.W. Mexico.
	=*C. umbonatum*, Sow.—Mus. Cum.		
	Comp. *C. musica*, Val.		
383	—— ?uncinatum, *Gmel.*	e. r.	Panama, S.W. Mexico.
	=*C. famelicum*, C. B. Ad. pars, teste Sow.		
384	——, sp. ind. (*a*)	1	
385	—— alboliratum, n. s.	10	
386	——, sp. ind. (*b*)	1	
387	—— stercus-muscarum, *Val*......................	c.	Acap., S.W. Mex., Pan., Galap.
	=*C. irroratum*, Gld.		
	=*C. ocellatum*, Mke. (?non Brug.)		
388	—— interruptum, Mke............................	r.	Panama, Galapagos.
	?=*C. Gallapaginis*, Sow.		
389	Vertagus gemmatus, *Hds.*	c.	Panama.
390	——, sp. ind.	1	
391	Triforis alternatus, *C. B. Ad*......................	8	Panama.
392	—— inconspicuus, *C. B. Ad*......................	12	Panama.
393	—— ?infrequens, *C. B. Ad.*	6	Panama.
394	Cerithidea Montagnei, *D'Orb.*	c.	Guayaquil, Panama.
	=*Cerithium Reevianum*, C. B. Ad.		
	Comp. *C. pulchrum*, C. B. Ad.		

No.	Name.	Freq.	Other Localities.
395	Cerithidea ? varicosa, var. Mazatlanica.........	n. c.	Guayaquil, Panama.
	=*Cerithium validum*, C. B. Ad.		
	Litorinidæ.		
396	Litorina conspersa, *Phil.*	e. c.	Real Llejos, Panama.
	+*L. puncticulata*, Phil.		
	=*L. modesta*, Mke. non Phil.		
397	—— aspera, *Phil.*	n. u.	Sitka, Mexico, S. Salvador, Pan.
398	—— Philippii, n. s.	c.	
399	——, sp. ind.	3	
400	—— fasciata, *Gray*	v. r.	Tumbez, Panama.
401	Modulus catenulatus, *Phil.*	n. u.	Taboga, S. America.
	=*M. trochiformis*, Eyd. & Soul.		
402	——, sp. ind.	1	
403	—— disculus, *Phil.*	3	Acapulco.
	=*M. duplicatus, var.*, A. Ad.		
	=*M. dorsuosus*, Gld.		
404	Fossarus tuberosus, n. s..........................	3	
405	—— angulatus, n. s.	2	
406	—— (Isapis) maculosa, n. s.....................	e. r.	
407	—— ?——, sp. ind................................	1	
	Rissoidæ.		
408	Rissoina stricta, *Mke*............................	1	
409	——, sp. ind.	2	
410	—— Woodwardii, n. s.	r.	
411	Barleeia lirata, n. s.*	9	
412	Alvania excurvata, n. s.	r.	
413	—— effusa, n. s....................................	1	
414	—— tumida, n. s.	2	
415	——, sp. ind.	1	
416	?Cingula, sp. ind..................................	1	
417	Hydrobia ulvæ, *Penn*............................	4	Europe, Caspian, United States, Ochotsk Sea.
	=*Paludinella stagnalis*, Midd.		
418	?——, sp. ind.......................................	1	
	Jeffreysiadæ.		
419	Jeffreysia bifasciata, n. s.	90	
420	—— Alderi, n. s.	3	
421	—— tumens, n. s.	13	
422	——, sp. ind.	2	
	Truncatellidæ.		
423	Truncatella, sp. ind.	2	
	Planaxidæ.		
424	Planaxis nigritella, *Forbes*	e. a.	San Juan.
	=*P. acutus*, Mke.		
	+*P. obsoletus*, Mke.		
425	Alaba supralirata, n. s.	50	
	Comp. *Cingula tervaricosa*, C. B. Ad.	....	Jamaica.
426	—— violacea, n. s.................................	1	
427	—— terebralis, n. s.	1	
428	—— alabastrites, n. s.............................	1	
429	—— scalata, n. s.	1	
430	?—— conica, n. s.	4	
431	?—— mutans, *nom. prov.*	1	
432	?—— laguncula, *nom. prov.*	1	
433	?——, sp. ind. (*a*)	1	
434	?——, —— (*b*)	1	

* The absence of typical *Rissoæ* among so many species of small shells is deserving of notice.

No.	Name.	Freq.	Other Localities.
	Ovulidæ.		
435	Radius variabilis, *C. B. Ad.*	r.	Pan., San Juan, Sta. Barbara.
	=*O. Californica*, Sow.		
	Cypræidæ.		
436	Cypræa exanthema, *Linn.*	n. u.	West Indies, Pacific Islands.
	?+*C. cervus*, Linn.=*cervina*, Lam.		
	+*C. cervinetta*, Kien.		
437	Luponia ? spurca, *Linn.*	1	Atlantic.
438	Aricia arabicula, *Lam.*	e. c.	S.W. Mex., Pan., St. Elena and
	?+*A. punctulata*, Gray.		Real Llejos. [Lat. 1–10°.
439	Trivia pustulata, *Lam.*	c.	S.W. Mexico, Panama, Is. Plata.
440	—— radians, *Lam.*	r.	St. Elena, Panama, Acapulco.
441	—— Solandri, *Gray*	v. r.	
442	—— sanguinea, *Gray*	c.	St. Elena, Panama.
	+*T. fusca*, Gray.		
	?+*C. lathyrus*, Dufresne.		
443	—— pulla, *Gask.*	1	Galapagos, Bay Guayaquil.
444	—— subrostrata, *Gray*	1	
	Cancellariadæ.		
445	Cancellaria urceolata, *Hinds*	v. r.	Gulf Papagayo, San Blas.
446	—— goniostoma, *Sow.*	n. u.	Conchagua, San Salv., Taboga.
	Strombidæ.		
447	Strombus galeatus, *Swains.*	c.	Gulf Nicoya, Taboga, S.W. Mex.
	=*S. galea*, Wood.		
	=*S. crenatus*, Sow.		
448	—— granulatus, *Swains.*	e. r.	St. Elena, Gal., Pan., S.W. Mex.
449	—— gracilior, *Sow.*	v. r.	St. Elena, Panama, La Paz.
	Suborder TOXIFERA.		
	Terebridæ.		
450	Terebra (Myurella) albocincta, n. s.	n. c.	
	?=*T. armillata*, Mke. (non Hinds).		
451	—— —— Hindsii, ?n. s.	6	
452	—— —— subnodosa, ?n. s.	2	
453	—— —— rufocinerea, ?n. s.	2	
454	Subula luctuosa, *Hds*	c.	Gulf Nicoya, Puerto Portrero.
455	Euryta fulgurata, *Phil.*	c.	East Africa.
	=*Terebra arguta*, Gld.		
456	—— aciculata, (? *Lam.*) *Hinds*	2	Acapulco, Xipixapi.
	Pleurotomidæ.		
457	Pleurotoma funiculata, *Val.*	v. r.	San Blas, S.W. Mex., G. Nicoya.
	=*P. olivacea*, var. Rve. à pr. man.		
458	—— maculosa, *Sow.*	n. u.	W. Columbia.
459	Drillia incrassata, *Sow.*	1	Panama, Monte Xti.
	=*Pleurotoma Bottæ*, Kien.		
460	—— rudis, *Sow.*	e. r.	Monte Xti.
461	—— aterrima, var. Melchersi	n. c.	Monte Xti, Panama.
	?=*Pleurotoma maura*, Val.		
	?+*P. atrior*, C. B. Ad.		
	?+*P. discors*, Sow.		
462	?—— cerithoidea, n. s.	3	
463	—— zonulata, *Rve.*	1	Monte Xti, Xipixapi, Panama.
	=*Pleurotoma cincta*, Sow. non Lam.		
464	—— monilifera, n. s.	1	
465	—— albovallosa, n. s.	1	
466	—— atronodosa, n. s.	3	
467	—— luctuosa, *Hinds* (1843), non *D'Orb.*	n. u.	Bay Guayaq., Gulf Magdalena.

No.	Name.	Freq.	Other Localities.
468	Drillia Hanleyi, n. s.	1	
469	——, sp. ind. (*a*)	2	
470	——, —— (*b*)	2	
471	Clathurella rava, *Hinds* = Defrancia r., *Hds*	2	Gulf Nicoya.
472	—— aurea, n. s.	1	
473	Mangelia ? acuticostata, var. subangulata	1	
474	Cithara, sp. ind.	1	
	Conidæ.		
475	Conus regularis, *Sow.* Comp. *C. arcuatus*, Br. & Sow. in Z. B. Voy., non Rve.	n. c.	Gulf Nicoya, Pan., Guaymas.
476	—— purpurascens, *Brod.* + *C. comptus*, Gld. Comp. *C. interruptus*, Brod. & Sow.	e. r.	Panama, San Blas, Is. Annaa[?], S.W. Mexico.
477	—— regalitatis, *Sow.* ? = *C. purpurascens*, var. ? = *C. achatinus*, Mke.	e. r.	Real Llejos, Pan., S.W. Mexico.
478	—— arenatus, *Brug.*	1	East Indies.
479	—— puncticulatus, *Hwass.*	n. c.	
480	—— gladiator, *Brod.*	r.	Panama, S.W. Mexico.
481	—— nux, *Brod.*	e. r.	Galapagos, Taboga.
482	—— ? scalaris, *Val.*	1	
483	??——, sp. ind. (*a*)	1	
	Suborder PROBOSCIDIFERA.		
	Solariadæ.		
484	Torinia ? variegata, *Lam.* = *Euomphalus radiatus*, Mke.	5	Panama, West Indies.
485	—— ? granosa, *Val.* ? = *Solarium fenestratum*, Hds.	1	Acapulco.
	Pyramidellidæ.		
486	Obeliscus ? conicus, *C. B. Ad.*	1	Panama.
487	Odostomia sublirulata, n. s.	1	
488	——, sp. ind.	1	
489	—— lamellata, n. s.	4	
490	—— subsulcata, n. s.	4	
491	—— vallata, n. s.	10	
492	—— mamillata, n. s.	1	
493	—— tenuis, n. s.	2	
494	—— (Auriculina), sp. ind. (*a*)	3	
495	—— ——, —— (*b*)	2	
496	—— ——, —— (*c*)	1	
497	Parthenia scalariformis, n. s.	2	
498	—— quinquecincta, n. s.	2	
499	—— lacunata, n. s.	7	
500	—— armata, n. s.	12	
501	—— exarata, n. s.	2	
502	—— ziziphina, n. s.	1	
503	Chrysallida ovata, n. s.	12	
504	—— nodosa, n. s.	5	
505	—— rotundata, n. s.	10	
506	—— oblonga, n. s.	5	
507	—— communis, *C. B. Ad.*	500	Panama.
508	—— telescopium, n. s.	13	
509	—— Reigeni, n. s.	1	
510	—— effusa, n. s.	1	
511	—— fasciata, n. s.	20	
512	—— ovulum, n. s.	70	
513	—— clathratula, n. s.	1	Panama.

No.	Name.	Freq.	Other Localities.
514	Chrysallida convexa, n. s.	2	
515	—— Photis, n. s.	2	
516	?—— indentata, n. s.	2	
517	??—— clausiliformis, n. s.	4	
518	Chemnitzia ? Panamensis, *C. B. Ad.*	1	?Panama.
519	—— C-B-Adamsi, n. s.	12	
520	—— ? similis, *C. B. Ad.*	6	?Panama.
521	—— aculeus, *C. B. Ad.*	6	Panama.
522	—— muricata, n. s.	5	
523	—— ? affinis, *C. B. Ad.*	1	?Panama.
524	—— prolongata, n. s.	6	
525	—— gibbosa, n. s.	2	
526	——, sp. ind. (*a*)	2	
527	——, —— (*b*)	1	
528	——, —— (*c*)	1	
529	——, —— (*d*)	1	
530	—— gracillima, n. s.	2	
531	—— undata, n. s.	2	
532	—— flavescens, n. s.	1	
533	—— terebralis, n. s.	1	
534	—— tenuilirata, n. s.	2	
535	—— unifasciata, n. s.	1	
536	—— (Dunkeria) paucilirata, n. s.	1	
537	—— —— subangulata, n. s.	5	
538	—— —— cancellata, n. s.	1	
539	—— —— intermedia, n. s.	2	
540	? Eulimella obsoleta, n. s.	1	
541	——, sp. ind. (*a*)	1	
542	——, —— (*b*)	1	
543	——, —— (*c*)	1	
544	?? ——, ——	1	
545	Aclis fusiformis, n. s.	4	
546	—— tumens, n. s.	1	? Java.
547	Eulima ? hastata, *Sow.*	6	St. Elena.
548	——, sp. ind. (*a*)	2	
549	——, —— (*b*)	3	
550	Leiostraca ? recta, *C. B. Ad.*	2	Panama.
551	—— ? solitaria, *C. B. Ad.*	3	Panama.
552	——, sp. ind. (*a*)	1	
553	——, —— (*b*)	1	
554	—— linearis, n. s.	1	
555	—— ? iota, var. retexta	2	?Panama.
556	—— ? distorta, var. yod	34	West Indies, Atlantic, Britain.
	Cerithiopsidæ.		
557	Cerithiopsis tuberculoides, n. s.	9	
557*b*	—— ?——, var. albonodosa	3	
558	—— cerea, n. s.	1	
559	—— pupiformis, n. s.	4	
560	—— Sorex, n. s.	4	
561	—— convexa, n. s.	1	
562	—— decussata, n. s.	2	
563	—— assimilata, *C. B. Ad.*	20	Panama.
	Scalariadæ.		
564	Scalaria hexagona, *Sow.*	2	Acapulco, Panama.
565	—— suprastriata, n. s.	3	
566	——, sp. ind. (*a*)	3	
567	——, —— (*b*)	1	
568	—— raricostata, n. s.	1	
569	—— (Cirsotrema) funiculata, ?n. s.	2	Panama.

No.	Name.	Freq.	Other Localities.
	Naticidæ.		
570	Natica maroccana, *Chemn.*	n. c.	Guaymas, Panama, S.W. Mexico, Demerara, Philippines, Australia, E. and W. Africa, Red Sea, Pacific Islands.
	=*Nerita marochiensis*, Gmel. (non Lam.)		
	+*Natica lurida*, Phil.		
	+*N. unifasciata*, Lam. pars (non nonnull.)		
	+*N. Chemnitzii*, Pfr. non Récl.=*N. Pritchardi*, Forbes.		
	?+*N. iostoma*, Mke.		
	Comp. *N. tessellata*, Phil.		
571	——, sp. ind.	1	
572	Lunatia tenuilirata, n. s.	2	
573	——, sp. ind. (*a*)	1	
574	——, —— (*b*)	5	
575	——, —— (*c*)	2	
576	Polinices uber, *Val.*	n. u.	Acapulco, ? Panama, Peru.
	+*N. alabaster*, Rve.		
	?=*N. ovum*, Mke.		
	Comp. *N. rapulum*, Rve.		
	Lamellariadæ.		
577	Lamellaria, sp. ind. (*a*)	1	
578	?——, —— (*b*)	1	
	Ficulidæ.		
579	Ficula ventricosa, *Sow.*	e. r.	Acapulco, S.W. Mexico, Panama (Havre Col. only).
	=*Bulla decussata*, Wood.		
	Tritonidæ.		
580	Triton (Argobuccinum) nodosum, *Chemn.*	n. u.	Panama.
	=*Triton Chemnitzii*, Gray.		
	=*Fusus Wiegmanni*, Anton.		
	=*Cassidaria setosa*, Hinds.		
	=*Triton perforatus*, Conr.		
	Turbinellidæ.		
581	Turbinella cæstus, *Brod.*	n. u.	Bay Caraccas, Taboga.
	=*T. ardeola*, Val.		
	Fasciolariadæ.		
582	Lathirus ceratus, *Gray*	e. r.	Galapagos, Panama, S.W. Mex.
583	Leucozonia cingulata, *Lam.*	e. c.	W. Mexico, Panama.
584	Fasciolaria princeps, *Sow.*	n. u.	Peru.
	=*F. aurantiaca*, Sow. (non Lam.)		
585	Mitra lens, *Wood*	n. u.	Pan., St. Elena, Is. Plata, La Paz.
	=*Tiara foraminata*, Swains.		
	=*Mitra Dupontii*, Kien.		
586	Strigatella tristis, *Brod.*	n. u.	St. Elena, Galapagos, Panama.
	Volutidæ.		
587	Marginella minor, *C. B. Ad.*	200	Panama.
588	—— polita, n. s.	6	
589	—— margaritula, ?n. s.	30	
	Comp. *M. ovuliformis*, D'Orb.		West Indies.
	Olividæ.		
590	Oliva angulata, *Lam.*	e. r.	Pan., G. Nicoya, B. Magdalena.
	=*Voluta incrassata*, Dillw.		
591	—— Melchersi, *Mke.*	v. r.	
592	—— intertincta, ? n. s.	20	
593	—— ? venulata, *Lam.*	n. u.	Panama.
	+*O. araneosa*, C. B. Ad.		
	=*O. reticularis*, *var.*, Rve.		
594	—— Duclosi, *Rve.*	2	

No.	Name.	Freq.	Other Localities.
595	Olivella undatella, *Lam.*	c.	Acapulco, Panama.
	= *Voluta tenebrosa*, Wood.		
596	—— tergina, *Ducl.*	e. c.	Conchagua.
597	—— anazora, *Ducl.*	3	Xipixapi.
598	—— ?petiolita, var. aureocincta	v. r.	? West Indies.
599	—— inconspicua, *C. B. Ad.*	20	? West Indies.
600	—— dama, *Mawe*	c.	
	= *O. lineolata*, Gray = *O. gracilis*, Ducl.		
	= *O. purpurata*, Swains.		
601	—— zonalis, *Lam.*	e. r.	Acapulco.
602	Aragonia testacea, *Lam.*	c.	Acapulco, Real Llejos, Panama.
	= *Oliva hiatula*, Ducl. pars (?non Lam.).		
	Purpuridæ.		
603	Purpura patula, *Linn.*	n. u.	Senegal, W. Indies, Philippines.
	= *P. pansa*, Gld.		
604	—— columellaris, *Lam.*	n. u.	Galapagos.
605	—— muricata, *Gray*	e. r.	Acapulco, Monte Xti, Panama.
	= *P. cassidiformis*, D'Orb. = *P. truncata*, Ducl.		
606	—— biserialis, *Blainv.*	v. c.	
	= *P. bicostalis*, Rve. (? non Lam.)		
	= *P. hæmastoma*, Mke. (? non Linn.)		
	= *P. undata*, Val., C. B. Ad. (non Lam.)		
	+ *P. consul*, Mke. (non Lam.)		
	?+ *P. hæmatura*, Val.		
	Comp. *P. Floridana*, Conr.		West Indies.
607	—— triserialis, *Blainv.*	r.	Acapulco.
	= *P. speciosa*, Val.		
	= *P. centiquadra*, Val.		
608	—— triangularis, *Blainv.*	r.	Galapagos, Taboga.
	= *P. Carolensis*, Rve.		
609	Cuma kiosquiformis, *Ducl.*	v. r.	Panama, La Paz.
	+ *Purpura scalariformis.*		
610	—— costata, *Blainv.*	c.	
	Comp. *Purpura diadema*, Rve.		
611	Rapana (Rhizocheilus) nux, *Rve.*	n. c.	
	?+ *Rh. Californicus*, A. Ad.		
612	Vitularia salebrosa, *King*	n. u.	Panama.
	= *Murex vitulinus*, Gray (non Lam.)		
613	Nitidella cribraria, *Lam.*	r.	West Indies, Panama, Ascension Island, Africa, Java.
	= *Columbella mitriformis*, King ? = *Voluta ocelata*, Gmel. = *Buccinum parvulum*, Dkr.		
	+ *C. guttata*, C. B. Ad.		
614	——, sp. ind.	2	
	Buccinidæ.		
615	Columbella major, *Sow.*	e. c.	Panama, S.W. Mex., Is. Muerte.
	= *C. strombiformis*, var. Kien.		
	? = *C. gibbosa*, Val. ? = *C. paytalida*, Kien.		
616	—— strombiformis, *Lam.*	n. u.	Is. Muerte, Panama, Payta.
617	—— fuscata, *Sow.*	c.	Pan., San Blas, Acap., Mte Xti, St. Elena.
	= *C. meleagris*, Kien.		
618	?—— cervinetta, n. s.	1	
618*b*	—— ——, var. obsoleta	2	
619	?Metula, sp. ind. (*a*)	2	
620	——, —— (*b*)	7	
621	——, —— (*c*)	2	
622	——, —— (*d*)	1	
623	Nassa luteostoma, *Brod. & Sow.*	e. c.	Acapulco, Real Llejos, Panama.
	= *N. xanthostoma*, Gray.		
624	—— tegula, *Rve.*	n. c.	
	= *Buccinum tiarula*, (Kien.) B. M.		

No.	Name.	Freq.	Other Localities.
624*b*	Nassa tegula, var. nodulifera, *Phil.*	e. r.	
625	—— acuta, n. s.	4	
626	——, sp. ind. (*a*)	2	
627	——, —— (*b*)	1	
628	——, —— (*c*)	2	
629	——, —— (*d*)	2	
630	——, —— (*e*)	1	
631	—— ?gemmulosa, *C. B. Ad.*	5	?Panama.
632	—— ?versicolor, *C. B. Ad.*	e. r.	?Panama.
633	—— crebristriata, n. s.	1	
634	——, sp. ind. (*f*)	1	
635	——, —— (*g*)	2	
636	——, —— (*h*)	2	
637	——, —— (*i*)	1	
	Pyrulidæ.		
638	Pyrula patula, *Brod. & Sow.*	c.	Acapulco, Bay Caraccas, Pan.
	=*P. melongena, var.*, Sow.		
	Muricidæ.		
639	Fusus pallidus, *Brod. & Sow.*	e. r.	Callao, *Hds.*
	=*Pyrula lignaria*, Rve.		
	var.=*Pyrula turbinelloides*, Rve.		
	Comp. *P. anomala*, Rve.=*Neptunæa anceps*, A. Ad.: also *P. lactea*, Rve.		
640	—— tumens, n. s.	1	
641	—— apertus, n. s.	6	
642	——, sp. ind. (*a*)	1	
643	——, —— (*b*)	1	
644	?Cominella, sp. ind.	1	
645	Anachis scalarina, *Sow.*	3	Panama, Chiriqui.
646	—— costellata, *Brod. & Sow.*	v. r.	Panama.
646*b*	—— ?——, var. pachyderma	v. r.	
646*c*	—— ?——, var.	1	
647	—— coronata, *Sow.*	e. r.	Acap., Quibo, S.W. Mex., Pan.
	?+*Columbella costata*, Val.		
	?=*Columbella terpsichore*, Mke. (non Sow.)		
	Comp. *Buccinum gilvum*, Mke.		
648	—— ?fulva, *Sow.*	1	S.W. Mexico, Panama.
649	—— nigrofusca, n. s.	6	
650	—— serrata, n. s.	12	
651	—— pygmæa, *Sow.*	e. r.	St. Elena, Panama, ?W. Indies.
	?+*Columbella costulata*, C. B. Ad.		West Indies.
652	—— Gaskoignei, n. s.	1	Callao.
653	—— rufotincta, n. s.	15	
654	?—— albonodosa, n. s.	2	
655	?——, sp. ind. (*a*)	2	
656	?——, —— (*b*)	2	
657	—— (Strombina) maculosa, *Sow.*	2	Guacomayo.
658	—— ?——, sp. ind.	2	
659	Pisania insignis, *Rve.*	v. c.	St. Elena, Panama.
	=*Buccinum mutabile*, Val. pars (non Linn.)		
660	—— æquilirata, n. s.	1	
661	—— gemmata, *Rve.*	c.	Monte Xti.
	=*Buccinum gemmulatum*, Mke.		
	=*B. undosum, fem.*, Kien. (non Linn.)		
	=*B. mutabile*, pars, Val.		
662	—— sanguinolenta, *Ducl.*	r.	Panama.
	=*Pollia hæmastoma*, Gray.		
	=*Buccinum Janelii*, Val.		
	=*Tritonium verrucosum*, Mke. MS.		
663	—— ringens, *Rve.*	3	Panama.
664	Murex plicatus, *Sow.*	1	Gulf Nicoya.

No.	Name.	Freq.	Other Localities.
665	Murex ? recurvirostris, var. lividus	n. c.	Gulf Nicoya, Panama.
	=*M. messorius*, Mke. non Sow.		
	Comp. *M. nigrescens*, Sow.		
666	—— (Phyllonotus) nigritus, *Mensch.*	c.	
	+*M. ambiguus*, Rve.		
667	—— —— nitidus, *Brod.*	1	Real Llejos, Guacomayo.
668	—— —— brassica, *Lam.*	n. u.	
	=*M. ducalis*, Brod. & Sow.		
669	—— —— bicolor, *Val.*	e. r.	Acapulco.
	=*M. erythrostomus*, Swains.		
	=*M. regius*, Sch. & Wagn. (non Swains.)		
	Var.=*M. hippocastanum*, Phil.		
670	—— —— regius, *Swains.*	c.	Acapulco, S.W. Mex., Panama.
	=*M. tricolor*, Val.		
671	—— —— princeps, *Brod.*	r.	Puerto Portrero.
672	—— (Muricidea) ? lappa, *Brod.*	1	St. Elena, San Blas.
	Comp. *M. radicatus*, Hds.		
673	—— —— dubia, *Swains.*	3	Panama.
674	—— —— ? erinaceoides, var. indentatus	3	Acapulco.
675	—— ——, sp. ind.	2	
676	—— —— pauxillus, *A. Ad.*	r.	

Analysis of Species.

BRYOZOA 16
PALLIOBRANCHIATA 1
LAMELLIBRANCHIATA { Freshwater 4; Marine ... 214 } 218
GASTEROPODA: *Opisthobranchiata* 10
Pulmonata: { Land .... 5; Freshwater ... 3; Sea .... 4 } 12
Prosobranchiata: Heteropoda 2
Lateribranchiata ... 4
Scutibranchiata...... 82
Pectinibranchiata:—
Rostrifera ... 120
Toxifera 34
Proboscidifera 193
—— 347
—— 435
—— 457
Total .... —— 692

Or thus:—*Bryozoa* 16
Land Shells 5
Freshwater Shells 7
Sea Shells 664
——
Total 692

52. In January 1850, Conrad published in the Journ. Ac. Nat. Sc. Philadelphia, a list of "new and interesting shells from the coasts of Lower California and Peru, presented to the Academy by Dr. B. Wilson." It is not

stated in which of these two widely separated localities each species was found. They are as follow:—

Solecardia [genus described] *eburnea*, Conr.
Petricola sinuosa, Conr.=*P. robusta*, Sow.
Pholadopsis pectinata. [The genus here described is the *Jouannetia* of Desm., the *Triomphalia* of Sow.]
Parapholas bisulcata, Conr.=*Pholadidea melanura*, Sow.
Penitella Wilsonii, Conr.=*Parapholas acuminata*, Sow.
Triton perforatus, Conr.=*Triton Chemnitzii*, Gray.
Oliva propatula, Conr.=*O. testacea*, Lam.

53. The following are extracted from the fourth edition of the Catalogue of the Collection of Dr. Jay, New York, 1850*.

No.
1421. *Pectunculus pectinoides*, Desh. Cuv. Règn. An. pl. 87. f. 8. Panama.
2057. *Anodon Montezuma*, Lea, Trans. Am. Ph. Soc. viii. pl. 23. f. 55. Central America.
2494. *Spondylus pictorium*, Chenu. W. Mexico.
2610. *Terebratula uva*, Brod. Küst. Conch. Cab. pl. 2 *b*. f. 8–10. Gulf Tehuantepec.
3346. *Helix areolata*, Sow. Küst. Conch. Cab. pl. 36. f. 10–12. Pfr. no. 393. Columbia River.
3737. *Helix griseola*, Pfr. Küst. Conch. Cab. pl. 60. f. 17, 18. Pfr. no. 885 = *cicercula*, Fér. = *splendidula*, Anton. Mexico.
4419. *Helix spirulata*, Pfr. Küst. Conch. Cab. pl. 30. f. 11–14. Pfr. no. 56. Real Llejos.
3437. *Helix Buffoniana*, Pfr. Phil. Icon. pl. 9. f. 2. Pfr. no. 507.
3808. *Helix imperator*, Montf. Fér. pl. 52. f. 4: 52 B. 1–3. Pfr. no. 789. Central America.
3852. *Helix labyrinthus*, Chemn. vol. xi. pl. 208. f. 2048. Pfr. no. 1035. Central America.
3919. *Helix lucubrata*, Say, Descr. New Shells, p. 13. Pfr. no. 245. Mexico.

No.
4204. *Helix plicata*, Born. Guér. Mag. Zool. 1838, pl. 10. Pfr. no. 1036. =*Carocolla labyrinthus*, Lam. =*C. Ilaydiana*, Lea. Panama, Porto Cabello.
5056. *Bulimus punctalissimus*, Less. var. Voy. Coq. p. 329. pl. 15. f. 3. Pfr. no. 215. Mexico.
5090. *Bulimus Schiedeanus*, Pfr.=*xanthostomus*, Wiegm. Pfr. no. 505. Phil. Ic. pl. 1. f. 12. Mexico.
5922. *Cyclostoma Mexicanum*, Mke., Thes. Conch. pl. 25. f. 93. Pfr. no. 10. Mexico.
6287. *Lymnæa ferruginea*, Hald. Mon. pl. 13. f. 19, 20. Oregon.
6366. *Physa osculans*, Hald. Mon. pl. 2. f. 11, 12. Mexico.
6454. *Melania Largillierti*, Phil. Ic. pl. 2. f. 10. Central America.
6491. *Melania subnodosa*, Phil. Ic. pl. 4. f. 18. Central America.
7421. *Trochus mœstus*, Jonas, Phil. Ic. pl. 6. f. 5. California.
7859. *Cancellaria bifasciata*, Desh. Lam. A. s. V. p. 413 = *C. oblonga*, Kien. Panama.
8816. *Columbella Boivinii*, Kien. Ic. p. 47. pl. 11. f. 1. Gulf Nicoya.
10,078. *Cypræa eglantina*, Ducl. Guér. Mag. Zool. 1833, pl. 28=*C. Arabica*, teste Jay. California [?].

54. During the winter of 1850–51, Prof. C. B. Adams of Amherst College, Massachusetts, visited Panama for the express purpose of making collections for the College Museum, and obtaining exact information on points connected with habitat and station. Although he only remained thirty-eight days on the spot, he collected—

Gasteropoda	38,920	specimens of	376	species.
Lamellibranchiata ..	2,860	,,	139	,,
Palliobranchiata	50	,,	1	,,
	41,830		516	

* The localities in this Catalogue, unless confirmed from other sources, must be received with great caution. The work is, however, very useful, if only for the list of species, and references to an extensive library.

Prof. Adams had before collected about the same number of marine species at Jamaica; and, holding the theory that no species could be common to the two oceans, he was well qualified to detect any sources of error which might have militated against his own hypothesis. The very minute discrimination also to which he had accustomed himself in his researches among the land shells of Jamaica, would at once prevent him from confounding similar species. And as he visited no other spot than the shores of Panama, and the neighbouring island of Taboga, there is no danger of the admixture of specimens from different localities. The results of the expedition were "read before the Lyceum of Natural History, May 10th, 1852," and published in their Annals, vol. v. They also appear under a separate form as a "Catalogue of Shells collected at Panama, with Notes on their Synonymy, Station, and Geographical Distribution, by C. B. Adams, Professor of Zoology, &c. New York, 1852, pp. 334, 8vo." The author gives all his references from personal research: quotes every assigned habitat, with authorities (discriminating original testimony by the mark !); and, in addition to his own remarks, states the number of specimens from which he writes. He was not able to dredge, nor to make observations on the animals: but for the shore shells, including the minute species, there is scarcely anything left to be desired. The author describes 157 as new species: of the value of many of these there will be two opinions. Prof. Adams in his work on Jamaica shells, "Contributions to Conchology," pp. 84 *et seq.*, gives up the common opinion that species are natural groups, while genera, &c. are artificial: and as he believes that there are different *species* as well as varieties of mankind, it is natural that he should distinguish as species of shells what others might consider varieties, and as varieties what may be accidents of growth. To the discerning reader, however, this does not interfere with the extreme value of the work. In a branch of inquiry so overburdened with carelessly observed or recorded facts, the freedom from the usual sources of error is a matter of the first importance. Where a species has originated in a mere theory, as in the case of common types from the two oceans, the student is at once on his guard. Where it arises from deficiency of materials, as in the *Cæca*, additional knowledge will soon set the error right. And in the present state of our ignorance, to designate forms as species which will hereafter have to be united, is much more pardonable than to overlook differences, all of which should be carefully noted before we can obtain a *Natural* history of any single species*. There appear to be three stages in our progress towards truth. In the first, objects are united, simply because their differences are not appreciated: as when *Dione lupinaria* was considered a variety of *Venus dione*, Linn., simply because they were each spiny. In the second, minute differences are appreciated, while their harmonies are overlooked. Such is the present ordinary condition of conchological science, as represented in the *Achatinellæ*, *Cylindrellæ*, *Anomiadæ*, &c. In the third, species are reunited, with a full perception of the differences among them, from a greater knowledge of the range of variation of which living creatures are susceptible. This third stage, *when faithfully performed on sufficient evidence*, should not be spoken of as "confounding species," and is one of the greatest pieces of

* In the "Researches on the Foraminifera," Trans. Roy. Soc. 1855, p. 228, Dr. W. B. Carpenter states, that "*multitudes of species*" will be shown in the present Report to "have been instituted in various genera of *Californian* shells by the late Mr. C. B. Adams, whose identity is established by a more extended comparison of individuals." This sentence appears simply to embody the impression left by conversation, and not to do justice to the Professor. As I am answerable for the impression I made, I have to request that those who possess the Transactions will make the following corrections:—For "multitudes of species" read "several species," and for "Californian shells" read "shells of Jamaica and Panama."

service that can be rendered to science: when carelessly wrought, as when an author herds together the species of his neighbour, simply because he has not been able to examine them himself, it truly makes "confusion worse confounded." For the first great requirement in a scientific writer, patient and laborious accuracy, this, the last work of Prof. Adams (for he died in 1853) stands in the very foremost rank. The following is an analysis of its contents, for comparison with the fauna of the Gulf of California. It will be observed that the species are arranged in alphabetical order, which may sometimes prevent their affinities from being noted. The new species are described in Latin, with measurements, and with an accuracy which often makes it safer to identify shells from them alone, than from the showy plates and loose diagnoses of some works of the greatest pretensions.

Prof. C. B. Adams's Panama List.

N.B. True and falsely assigned habitats are both quoted: the reader will thus judge of the present state of the science. Original authorities are cited in *italics*. Added synonyms are enclosed in brackets [ ].

No.	Name.	Station.	No. of Specimens.	Other Localities.
1	Ovula avena, *Sow*.	on small Gorgonia, l.s.*	6	Conchagua, *Cum.*; Sta. Barbara, *Jewett.*
2	—— emarginata, *Sow.*	....	7	St. Elena, *Cum.*
3	—— neglecta, n. s.	with *O. avena.*	13	
4	—— variabilis, n. s.	on Gorgoniæ: coloured accordingly, l. s.	56	St. Juan, *Green*; Sta. Barbara, *Jewett.*
5	——, sp. [? = *O. variabilis*, var.]	....	2	
6	Cypræa arabicula, *Lam.*	u. stones, 8–20 in. l. n.	7	Acapulco, *Humb.*; Brazil, Ravenel; St. Elena & Real Llej., *Cum.*
7	—— cervinetta, *Kien.* =*exanthema*, var., Hinds.	u. stones, 15–20 in. l. s.	115	Antilles & Senegal, Kien.; Ind. Oc., Jay.
8	—— punctulata, *Gray* [? = *C. arabicula*, var.]	with *C. arabicula.*	335	Peru and N. Holland, Kien.
9	—— pustulata, *Lam.*	under large stones, l. s.	28	China, Humphrey; Acapulco, *Humb.*; Isl. Plata, *Cum.*
10	—— radians, *Lam.* = *C. oniscus*, Wood, err. typ.	....	2	Adriatic, Wood; Acapulco, *Humb.*; Chili, Ravenel; St. Elena, under stones, *Cum.*
11	—— rubescens, *Gray*	....	1	Galap., under stones, *Cum.*
12	—— sanguinea, *Gray*	....	1	St. Elena, u. s., *Cum.*; Mexico, *Sow.*
13	Erato scabriuscula, *Gray* =*Marg. cypræola*, Sow. =*M. granum*, Kien.	under stones, l. w.	4	Mazatlan, *Jewett*; Acapulco, *Sloat*; St. Elena, *Cum.*
14	Marginella minor, n. s.	....	10	
15	—— sapotilla, *Hinds*	Moving quickly on liquid mud, above l.w.	40+	
16	Mitra funiculata, *Rve.*	....	23	Is. Plata, in coral sand, 14 fm., *Cum.*
17	—— lens, *Wood*	....	24	Red Sea, Kien.; La Paz, *Rich.*
18	—— nucleola, *Lam.*	....	11	Java, Kien.
19	—— solitaria, n. s.	under stones, l. w.	1	Panama, *Bridges.*
20	—— tristis, *Brod.*	under stones, l. w.	28	St. Elena and Gal., *Cum.*
21	Terebra elata, *Hinds*	....	4	Montija, 15 fm. coarse sand, *Hds.*
22	—— larvæformis, *Hds.*	....	2	St. Elena & Mte. Xti, 6–15 fm. sandy mud, *Hds.*
23	—— robusta, *Hds.*	....	5	8° 57′—21° 32′, *Hds.*
24	—— specillata, *Hds.*	....	12	San Blas, *Hds.*

* The following abbreviations are used:—*l. w.* low water; *s.* spring tides; *n.* neap tides; *h.* high water; ½-*t.* half-tide; + above; — below; *u. s.* under stones, &c.

No.	Name.	Station.	No. of Specimens.	Other Localities.
25	Terebra tuberculosa, *Hds*	....	1	Papagayo, San Blas, *Hds.*
26	—— varicosa, *Hds.*	....	1	Papagayo, Hds.
27	——, like specillata	....	2	
28	——, slender brown	....	5	
29	——, small olivaceous, white band	....	1	
30	——, small and delicate	....	1	
31	——, sp.	....	1	
32	Oliva angulata, *Lam.*	....	17	Nicoya, *Cum.*; Peru, Desh.
33	—— araneosa, *Lam.* [? = *O. venulata*, var.]	....	1	Magdalena, Ducl.
34	—— inconspicua, n. s. [? = *O. nivea*, D'Orb.]	....	4	
35	—— pellucida, *Rve.*	....	1	
36	—— porphyria, *Linn.* C. B. A. cites 42 references for this well-known species.	....	3	Brazil, Linn.; Panama, Lam.; La Paz, *Green*; sandy mud at low water, *Cum.*
37	—— semistriata, *Gray*	....	175	Salango, rapidly moving by hundreds in wet sand, *Cum.*
38	—— testacea, *Lam.*	....	20	Real Llejos, sandy mud, 6 fm., *Cum.*
39	—— undatella, *Lam.* = *Voluta tenebrosa*, Wood.	....	15	Sand and mud banks, l. w., *Cum.*
40	—— venulata, *Lam.* = *O. reticularis*, var. Rve.	....	1	La Paz, *Green.*
41	—— volutella, *Lam.* = *V. cærulea*, Wood.	in vast numbers, quickly crawling on wet sand.	4500	Mexico, California, Ducl.
42	Planaxis planicostata, *Sow.* = *Buccinum planaxis*, Wood. = *Plan. canaliculata*, Duv.	under stones, h.w.—½t.	1200	Galapagos, *Cum.*
43	Nassa canescens, n. s.	....	1	
44	—— collaria, *Gould, MS.*	....	5	
45	—— corpulenta, n. s. ? = *festiva*, Powis.	....	17	
46	—— gemmulosa, n. s.	....	1	
47	—— glauca, n. s.	....	32	
48	—— luteostoma, *Brod. & Sow.*	on sand, in run. water, between tide-marks.	330	Senegal, Kien.; Real Llejos & Acapulco, Lesson.
49	—— nodifera, *Pws.*	....	40	Galapagos, coral sand, 6–10 fm., *Cum.*
50	—— pagodus, *Rve.* = *Buccinum decussatum*, Kien. (nec Linn. nec Lam.) = *Triton pagodus*, Rve.	....	22	B. Montija, *Cum.*; W. Africa, Kien.; Peru, Petit.
51	—— Panamensis, n. s.	u. stones, above l. w.	1500	
52	—— proxima, n. s. [? = *N. versicolor*, var.]	....	1	Panama, *Bridges.*
53	—— scabriuscula, *Pws.*	as in *N. luteostoma.*	380	Montija, sandy mud, 12 fm., *Cum.*
54	—— striata, n. s.	....	2	
55	—— versicolor, n. s.	....	500	
56	—— Wilsoni, n. s.	....	5	
57	Buccinum crassum, *Hds.* = *Phos crassus*, Hds.	....	1	G. Fonseca, *Hds.*
58	—— distortum, *Bligh* = *Pollia distorta*, Gray. = *Columbella triumphalis*, Ducl.	crevices of rocks between l.w.s. & l.w.n.	95	N. Holland, Kien.; Chili, Desh.; St Elena, *Cum.*
59	—— insigne, *Rve.* = *mutabile*, Val. [pars.]	under stones in sand	140	St. Elena, *Cum.*
60	—— lugubre, n.s.	under stones, l. w.	175	
61	—— pagodus, *Rve.*	under stones, l. w.	18	
62	—— pristis, *Desh.*	l. w.	6	San Blas, *Burtt*; California, Desh.; St. Elena, *Cum.*
	= *B. serratum*, Kien.	under stones, l. w. n.	275	

No.	Name.	Station.	No. of Specimens.	Other Localities.
63	Buccinum ringens, *Rve.* (not *Phil.*)	under stones, l. w. n.	275	
64	—— sanguinolentum, *Ducl.* ...... =*Pollia hæmastoma*, Gray. =*B. Janellii*, Val.	under stones, l. w.	16	
65	—— Stimpsonianum, n. s.	under stones, l. w.	19	
66	Dolium ringens, *Swains.* .... =*Malea latilabris* + *crassilabris*, Val. v. Syn.	under & between stones extreme low water.	8	9 by 7 in., Barnes. Adult, 2·3 in., C.B.Ad.; Quito Is., Guayaquil, *Don Pedro Abadea*; Peru, *Capt. Skiddy*; Payta, *Cum.*
67	Monoceros brevidentatum, *Wood.* =*Purp. cornigera*, Blainv. +*P. ocellata*, Kien. +*P. maculata*, Gray.	on and between rocks, ½-t. +	300	Peru, Chili, *Kien.*; Payta, *Fontaine*; Xipixapi & Mte Xti, *Cum.*; Monterey, *Rich*; San Francisco, *Jewett.*
68	—— cingulatum, *Wood*	clefts of rocks, l. w.	75	W. Mexico, *Humboldt.*
69	Purpura Carolensis, *Rve.* .... [=*P. triangularis*, Blainv.]	under stones and in crevices of rock, l. w.	20	Charles Island, Galapagos, *Cum.*
70	—— foveolata, n. s. .... [?=*P. biserialis*, jun].	under stones, l. w.	3	
71	—— kiosquiformis, *Ducl.*	on rocks and trees, ½-t. to h. w. n.	170	N. Holland, Ducl.; La Paz, *Green.*
72	——, sp. ind. .... [=*P. kiosquiformis*, var. =*P. scalariformis*, Ducl.]	....	1	
73	—— melo, *Desh.* .... =*P. crassa*, Blainv. =*P. melones*, Ducl.	sides and crevices of rocks, ½—¾ tide.	150	Mte Xti, under stones, low water, *Cum.*
74	—— osculans, n. s. .... [?=*Rhizocheilus nux.*]	....	2	
75	—— tecta, *Wood* .... =*P. callosa*, Sow. =*P. angulifera*, Ducl. =*Cuma sulcata*, Swains. =*Turbinella callosa*, Less.	crevices of rock, l. w. n.—l. w. s.	60	Chili, Kien.; Real Llejos, Less.; Panama, 10 fm. sandy mud, *Cum.*
76	—— undata, [quasi *Lam.*] ...... [=*P. biserialis*, Blainv.]	under stones, l. w. n.	180	Mte Xti, *Cum.*; Acapulco, *Humb.*
77	Columbella atramentaria, *Sow.*...	under stones, l. w.	3	Chatham Island, Galapagos, *Cum.*
78	—— bicanalifera, *Sow.*	....	36	sandy mud, 10 fm., Galapagos, *Cum.*
79	—— Boivinii, *Kien.*	pools in rocks, ½—¾	50+	Nicoya, *Hinds.*
80	—— conspicua, n. s. (?Anachis).	....	1	
81	—— costellata, *Brod. & Sow.* ...	under stones, l. w.	25	Panama and Africa, Gray.
82	—— diminuta, n. s. (Anachis)...	under stones, l. w.	19	
83	—— dorsata, *Sow.*	....	1	Is. Muerte, Guayaquil, *Cum.*
84	—— fluctuata, *Sow.* .... =*C. suturalis*, Griff.	under stones, l. w. n.	400	Nicoya, *Cum.*; Peru, Kien.
85	—— fulva, *Sow.*	under stones, l. w.+	3	
86	—— fuscata, *Sow.* .... =*C. meleagris*, Kien.	under stones, l. w.+	6	Panama, St. Elena, Mte Xti, *Cum.*; San Blas, Kien.; Acapulco, Less.
87	—— gibberula, *Sow.*	....	7	Bay Carac. and P. Portr., sandy mud, 11 fm., *Cum.*; Chili, Kien.
88	—— gracilis, n. s. (? Anachis) ...	....	7	
89	—— guttata, *Sow.* (prim. non postea.) [=*Nitidella cribraria*, Lam. =*Buccinum parvulum*, Dkr.]	under stones, l. w.+	150	East Indies, Ascension, Gorea, Kien.; Java, *Leschenault*; West Indies.
90	—— hæmastoma, *Sow.*	....	1	Pan. & Gal., u. s., *Cum.*; Calif., Kien.
91	—— harpiformis, *Sow.* .... =*C. citharula*, Ducl.	under stones, l. w.	9	Pan., on dead shells, 10 fm., *Cum.*; Mazatlan, Mke.
92	—— labiosa, *Sow.*	under stones, l. w.	10	St. Elena, *Cum.*
93	—— lyrata, *Sow.*	under stones, l. w.	19	Panama & Chiriqui, *Cum.*
94	—— major, *Sow.* .... =*C. gibbosa*, Val. =*C. strombiformis*, var., Kien.	under stones, l. w.	30	Is. Muerte, *Cum.*

No.	Name.	Station.	No. of Speci-mens.	Other Localities.
95	Columbella modesta, *Powis*	....	80	Montija, muddy gravel, 7–17 fm., *Cum.*; Sta. Barbara, *Jewett.*
	=*Buccinum m.*, Pow.			
	=*Truncaria m*, H. & Ad.			
96	—— mœsta, n. s. (? Anachis)	sticks & stones, $\frac{1}{2}$-t. +	58	
97	—— nigricans, *Sow.*	u. s., $\frac{1}{2}$-t. – l. w.	620	Galapagos, *Cum.*
98	—— parva, *Sow.*	....	1	Mte Xti, under stones, *Cum.*
99	—— pulchrior, n. s. (? Nitidella)	under stones, l. w.	5	
100	—— pygmæa, *Sow.*	under stones, l. w.	185	St. Elena, on dead shells, sandy mud, 10 fm., *Cum.*
101	—— rugosa, *Sow.*	u. stones, $\frac{1}{2}$-t.—l.w.n.	1500	Pan. & Xipix., *Cum.*; Real Llej., Mörch.
	=*C. Sowerbyi*, Ducl.			
	=*C. bicolor*, Kien.			
102	—— strombiformis, *Lam.*	....	1	Is. Muerte, *Cum.*; Payta, *Font.*
103	—— tesselata, n. s. (Anachis)	under stones, l. w.	27	
104	—— turrita, *Sow.*	....	1	Montija & St. El., s. m., 10 fm., *Cum.*
105	—— varia, *Sow.* [non *varians*, Sow.]	under stones, l. w.	380	
106	——, sp.	....	1	
107	Ricinula ?carbonaria, *Rve.*	under stones, l. w.	70	Philippines, Jay.
108	—— jugosa, n. s. (Engina)	....	1	
109	—— Reeviana, *C. B. Ad.*	under stones, l. w.	110	Galapagos, *Cum.*
	=*Buccinum pulchrum*, Rve.			
110	Cassis abbreviata, *Blainv.*	....	7	Portugal, Bonanni; Acapulco, Rve.
	=*C. lactea*, Kien.			
111	—— coarctata, *Sow.*	....	1	?N. Zealand, Sow.; Shores of Peru, at Acapulco, Kien.; Gal. in crevices of rocks, *Cum.*; San Juan, *Green.*
112	Oniscia tuberculosa, *Rve.*	....	2	Gal., clefts of rocks, l. w., *Cum.*; Australia, Jay; San Juan, *Green.*
113	Conus brunneus, *Wood*	clefts of rocks, l. w.	4	Gal., P. Portr., Pan., *Cum.*
114	—— gladiator, *Brod.*	u. s. with sand, l. w.	70	
115	—— mahogani, *Rve.*	crawling on very wet s., l. w. — $\frac{1}{2}$-tide.	17	Salango, *Cum.*
116	—— nux, *Brod.*	....	2	Galapagos, *Cum.*
117	—— princeps, *Linn.*	under stones, l. w.	9	Asia, Dillw.; Philippines, Jay; San Juan, *Green*; Mte Xti, & St. El., *Cum.*
	=*C. regius*, Chemn., Lam.			
	=*C. lineolatus*, Val.			
118	—— purpurascens, *Brod.*	under stones, l. w.	12	Annaa, Sow.; San Blas, *Hds.*
119	—— regalitatis, *Sow.*	under stones, l. w.	9, 3 in.	Real Llejos, *Cum.*; Peru, Kien.
120	—— regularis, *Sow.*	....	1	Nicoya & Peru, soft mud, 7 & 23 fm., *Hds.*; Philippines, Kien.; Guaymas, *Gr.*
121	—— vittatus, *Lam.*	l. w.	4	Pan. & Mont., coarse sd., 7–11 fm., *Cum.*
122	Strombus galea, *Wood*	....	fragm.	Nicoya, reefs, l. w., *Cum.*; Peru, Gray.
	=*S. galeatus*, Gray.			
123	—— gracilior, *Sow.*	....	1	Calif. & Tahiti, Jay; La Paz, *Green.*
124	—— granulatus, *Swains.*	....	7	India, Kien.; St. El. & Gal., sandy mud, 6–8 fm., *Cum.*; La Paz, *Green.*
125	—— Peruvianus, *Swains.*	sandy beach, l. w.	24	Caraccas, on reefs, *Cum.*; Peru & ?Red [Sea, Ducl.
126	Triton Chemnitzii, *Gray*	under stones, l. w.	9	
	=*Argob. nodosum*, Chemn.			
127	—— constrictus, *Brod.*	....	4	Mte Xti & Xipix., sandy mud, 7–10 fm., [*Cum.*; Acap., Hds.
	?=*T. decussatum*, Val.			
128	—— fusoides, n. s.	....	1	
129	—— gibbosus, *Brod.*	....	5	Pan. & Mte Xti, coarse sand, 7 fm., *Cum.*
130	—— lignarius, *Brod.*	....	1	P. Portr. & Pan., sandy mud, 7–12 fm., *Cum.*; Mte Xti., *Hds.*
131	—— vestitus, *Hds.*	....	4	Real Llejos, Nicoya & Honda, among [rocks on shore, *Hds.*
	—— ——, var. senior	....	1	
132	Ranella cælata, *Brod.*	u. s., l. w. n. — l. w. s.	190	
	=*R. semigranosa*, Kien. non Lam.			

No.	Name.	Station.	No. of Speci-mens.	Other Localities.
133	Ranella nana, *Brod. & Sow.*		2	Is. Panama, Phil., Sow.
134	—— nitida, *Brod.*	under stones, l. w.	300	Caraccas, *Cum.*
135	—— plicata, *Rve.*		6	
136	Murex dubius, *Sow.*	under stones, l. w.	72	
	=*M. aculeatus*, Wd., non Lam.			
137	—— erosus, *Brod.*	under stones, l. w.	2	
138	—— radix, *Schroet.*	about stones, with	100	Caraccas, *Cum.*; Acapulco, *Humb.*
	=*melanomathos*, Dillw. pars.	sandy mud, l. w.	5½ in.	
	[Non *M. ambiguus*, Rve.]		22 oz.	
139	—— rectirostris, *Sow.*		1	Xipix., sandy mud, 11 fm., *Cum.*
140	—— recurvirostris, *Brod.*		1	Nicoya, sandy mud, 9 fm., *Cum.*
141	—— regius, *Swains.*	crevices of rocks,	18+	Peru, Bligh; Acap., *Humb.*
	=*M. tricolor*, Val.	l. w. n.–l. w. s.		
142	—— salebrosus, *King*	under stones, l. w.	14	Southern coast of S. A., Sow.
143	?—— vibex, *Brod.*	under stones.	13	St. Elena, sandy mud, 6–12 fm., *Cum.*
144	—— vittatus, *Brod.*		1	I. Muerte, sandy mud, 11 fm., *Cum.*
145	Pyrula patula, *Brod. & Sow.*		1+	Caraccas, mud banks, *Cum.*
146	Ficula ventricosa, *Sow.*		8	San Blas, Kien.; India & China, Desh.
	=*Bulla decussata*, Wood.			
147	Fusus bellus, n. s.		1	
148	Fasciolaria granosa, n. s.	stones in mud, l. w.	7	Peru, Kien.
149	Turbinella cæstus, *Brod.*	sand beach, l. w.	2	Caraccas, mud in rocks, *Cum.*
150	—— castanea, *Gray*	crevices of rocks, l. w.	32	
	= *T. acuminata*, Rve.			
151	—— cerata, *Wood*	crev. of rocks & u. s.	....	Maz., Kien.; Galapagos, *Cum.*
152	—— rudis, *Rve.*		30	
153	—— spadicea, *Rve.*		15	
154	Cancellaria affinis, n. s.		3	
155	—— clavatula, *Sow.*		8	Pan. & Payta, sandy mud, 7 fm., *Cum.*
156	—— decussata, *Sow.*		2	Pan., Puert. Por., s.m. 10–13 fm., *Cum.*
157	—— goniostoma, *Sow.*		1	Conchagua, S. Salvador, sd., 8 fm., *Cum.*
158	—— mitriformis, *Sow.*		5	1 sp., sandy mud, *Cum.*
	+*C. uniplicata*, Sow.			2 sp. sand, 10 fm., *Cum.*
159	—— pulchra, *Sow.*		2	Sand, 8–10 fm., St. Elena, *Cum.*
160	—— pygmæa, n. s.		1	
161	—— solida, *Sow.*		1	R. Llej. & St. Elena, 8–10 fm., sd., *Cum.*
162	—— tesselata, *Sow.*		2	Carac., St. El., Xip., s.m. 7–10 fm., *Cum.*
163	Pleurotoma aterrima, *Sow.*	under stones, l. w.	14	Mte Xti, *Cum.*
164	—— atrior, n. s.		1	
	[?=*P. aterrima*, var. *Melchersi.*]			
165	—— bicanalifera, *Sow.*		1	Montija, sandy mud, 10 fm., *Cum.*
166	—— collaris, *Sow.*		4	Caraccas, muddy sand, 8 fm., *Cum.*
167	—— concinna, n. s. (?Mangelia)		1	
168	—— corrugata, *Sow.*		3	Mont. & P. Portr., sdy. md., 10 fm., *Cum.*
	+*P. turricula*, Sow.			
169	—— discors, *Sow.*		5	I. Plata, coral sand, 17 fm., *Cum.*
	[?+*P. aterrima*, Sow.]			
170	—— duplicata, *Sow.*		1	P. Portr. & Mont., sdy. md., 10 fm., *Cum.*
171	—— ?excentrica, *Sow.*		1	Coral sand, 6 fm.; Galap., *Cum.*
172	—— exigua, n. s.		1	
173	—— gemmulosa, n. s.		1	
174	—— grandimaculata, n. s.		2	Philippines, Cum. MS.
	=*P. zonulata*, teste Cum.			
175	—— incrassata, *Sow.*		1	Pan. & Mte Xti, sdy. md., 6–10 fm., *Cum.*
	=*P. Bottæ*, Kien.			
176	—— nigerrima, *Sow.*		3	Carac., sandy mud, 6–10 fm., *Cum.*
	+*P. cornuta*, Sow.			
177	—— obeliscus, *Rve.*		1	
178	—— olivacea, *Sow.*		8	Salango, St. Elena, sdy. md., 5–12 fm.,
	[Comp. *P. funiculata*, Sow.]			*Cum.*; mud, 4–7 fm., Nicoya, *Hds.*
179	—— pallida, *Sow.*		12	P. Portr., sandy mud, 13 fm., *Cum.*

No.	Name.	Station.	No. of Specimens.	Other Localities.
180	Pleurotoma rigida, *Hds.*	....	20	
181	—— rudis, *Sow.*	....	2	Mte Xti, under stones, *Cum.*
182	—— rustica, *Sow.* =*P. thiarella*, Kien.	under stones, l. w.	10	Xipixapi, *Cum.*
183	—— striosa, n. s.	....	13	
184	—— zonulata, *Rve.* =*P. cincta*, Sow., non Lam.	....	2	Mte Xti & Xipix., sand and gravel, 7 fm., *Cum.*
185	——, sp.	....	1	
186	——, sp.	....	1	
187	Mangelia, sp.	....	1	
188	——, sp.	....	1	
189	——, sp.	....	1	
190	——, sp.	....	1	
191	—— neglecta, n. s.	....	4	
192	—— ? sulcosa ?=*Columbella sulcosa*, Sow.	under stones, l. w. n.—	170	Annaa, & Ld. Hood's Is., *Cum.*
193	Cerithium adustum, *Kien.* (plate) =*C. maculosum*, Kien. text.	wet sand, u. s., ½-tide.	206	Indian Ocean, Red Sea, Kiener.
194	—— assimilatum, n. s.	u. s., sponges, l. w., marine plants, &c.	8	
195	—— bimarginatum, n. s.	....	2	
196	—— famelicum, n. s. N.B. The description does not agree with the type sp. in Mus. Cum., and accords better with *C. ? uncinatum*, Gmel., also found at Mazatlan.	....	17	
197	—— gemmatum, *Hds.*	....	19	
198	—— ? interruptum, *Mke.* [=*C. Gallapaginis*, Sow.: non *C. interruptum*, Sow. quasi Gould.]	on & under rks. & st., ½-tide—l. w. n.	1100	
199	——, sp. ind. =*C. interruptum*, var.	....	30	
200	—— irroratum, *Gould* =*C. stercusmuscarum*, Val.	rock-pools, ½-tide+	820	
201	—— neglectum, n. s.	u. s. in dead shells & sponges, l. w.	33	
202	—— Pacificum, *Sow.* =*C. Humboldti*, Val.	....	1	Cumana, *Humb.*
203	—— pauperculum, n. s.	....	2	
204	—— pulchrum, n. s.	½buried in muddy sd. under bushes at h. w.	125	
205	—— Reevianum, n. s. [=*Cerithidea Montagnei*, D'Orb.]	ditto ditto	190	
206	—— validum, n. s. [=*Cerithidea varicosa*, Sow.]	ditto ditto	250	
207	Triphoris alternatus, n. s.	....	5	
208	—— inconspicuus, n. s.	under stones, l. w.	16	
209	—— infrequens, n. s.	....	2	
210	Turritella Banksii, *Rve.* [?=*tigrina*, Kien.]	among & under st., in calc. sd., l. w. n.—l. w. s.	350	Sandy mud, 10 fm., *Cum.*
211	Cæcum diminutum, n. s. [=*firmatum*, jun.]	....	1	
212	—— eburneum, n. s. [=*firmatum*, var.]	....	22	
213	—— firmatum, n. s.	....	85	
214	—— læve, n. s.	....	2	
215	—— laqueatum, n. s.	....	2	
216	—— monstrosum, n. s. [=*firmatum*, adol.]	....	7	

No.	Name.	Station.	No. of Specimens.	Other Localities.
217	Cæcum parvum, n. s. [? = *C. undatum*, jun.]	....	1	
218	—— pygmæum, n. s. [= *C. firmatum*, jun.]	....	2	
219	Chemnitzia aculeus, n. s.	....	4	
220	—— acuminata, n. s. (?Chrysallida)	....	1	
221	—— affinis, n. s.	....	2	
222	—— clathratula, n. s. (Chrysallida)	....	10	
223	—— communis, n. s. (Chrysallida)	under stones, l. w.	90	
224	—— gracilior, n. s.	....	2	
225	—— major, n. s.	....	1	
226	—— marginata, n. s. (Chrysallida)	....	2	
227	—— Panamensis, n. s.	sand, ½-t.—h. w.	11	
228	—— similis, n. s.	....	2	
229	—— striosa, n. s.	....	1	
230	—— turrita, n. s.	....	3	
231	?Littorina angiostoma, n. s. (?Fossarus.)	....	3	
232	—— aspera, *Phil.*	ledges or large pieces of rock, h. w.+	2400	"Sitcha, San Salvador, Mex.," Phil.
232	—— ——, var.	....	33	
233	—— atrata, n. s.	in or near cavities of rocks, ½-tide—h. w.	3300	
234	—— conspersa, *Phil.*	large pieces of rk., h. w.	320	Real Llejos.
235	?—— excavata, n. s. (Fossarus)	....	1	
236	—— fasciata, *Gray*	on trks. & brs. of small trees, ½-t.—h. w.	160	
237	?—— foveata, n. s. (?Fossarus)	....	2	
238	?—— megasoma, n. s. (?Fossarus)	....	1	
239	—— ?parvula, *Phil.*, var. dubiosa. [Comp. *L. Philippii.*]	cav. of rough ledge of rocks, h. w.+	600	
240	—— pulchra, *Sow.*	on mangroves, growing from mud, h. w.—	11	
241	—— puncticulata, *Phil.* [= *conspersa*, var.]	on pieces of rk., h. w.	80	Real Llejos.
242	—— varia	on trunks & branches of trees, ½-t.—h. w.	300	"Pan., Guay., Cusma, Peru," Phil.; Chiloe, Petit.
243	Rissoa clandestina, n. s.	....	2	
244	—— firmata, n. s.	....	1	
245	—— fortis, n. s.	under stones, l. w.	31	
246	?—— inconspicua, n. s. (non *Ald.*)	....	1	
247	—— infrequens, n. s.	....	1	
248	—— Janus, n. s.	....	2	
249	—— notabilis, n. s.	....	1	
250	—— scalariformis, n. s.	....	1	
251	——, sp.	....	1	
252	?Cingula inconspicua, n. s.	....	3	
253	—— paupercula, n. s.	....	4	
254	?—— terebellum, n. s.	....	1	
255	?—— turrita, n. s.	....	1	
256	?Litiopa saxicola, n. s. (Cingula)	under stones, l. w.	7	
257	?Adeorbis abjecta, n. s. (Fossarus)	....	40	
258	Vitrinella concinna, n. s.	....	1	
259	—— exigua, n. s.	....	7	
260	—— Janus, n. s.	....	1	
261	—— minuta, n. s. (Teinostoma)	....	4	
262	—— modesta, n. s.	....	1	
263	—— Panamensis, n. s.	....	24	
264	—— parva, n. s.	....	13	
265	—— perparva, n. s.	....	3	
266	—— regularis, n. s.	....	1	

No.	Name.	Station.	No. of Specimens.	Other Localities.
267	Vitrinella seminuda, n. s.	....	1	
268	—— tricarinata, n. s.	....	1	
269	—— valvatoides, n. s.	....	3	
270	Solarium, sp. (like *granulatum*)	....	3	
271	——, sp. (like *quadriceps*)	....	3	
272	——, sp. (? = *Torinia variegata*)	....	6	
273	Trochus catenulatus, *Phil.* (Modulus.)	....	23	
274	—— coronulatus, n. s. (? Omphalius.)	....	2	
275	—— Leanus, n. s.	under stones, l. w.	7	
276	—— lima, *Phil.*	u. s., l. w. n.—l. w. s.	75	Sta. Barbara, *Jewett.*
277	—— lividus, *Phil.* (Modulus) [= either *disculus*, Phil. or *dorsuosus*, Gld., teste types.]	....	3	Acapulco, *Jewett.*
278	—— Panamensis, *Phil.*	under stones, l. w.	65	
279	—— pellis-serpentis, *Wood* = *T. strigilatus*, Phil.	on or under large st. or rks., $\frac{1}{2}$-tide. Most active at twilight.	505	Acapulco, *Humb.*; California, Phil.
280	—— reticulatus [? = *viridulus*, Gmel.]	under stones, l. w. n.	600	
281	Turbo Buschii, *Phil.* [= *Uvanilla inermis*, Kien.]	on or under stones, l. w. n.—l. w. s.	180	
282	?—— phasianella, ? n. s. ? = *Litorina phasianella*, Phil.	....	112	
283	—— rutilus, n. s.	....	1+	
284	—— saxosus, *Wood*	rocks, l. w. n.	160	
285	Scalaria hexagona, *Sow.*	....	1	Acap., *Moffat.*
286	—— obtusa, *Sow.*	....	1	St. Elena, sandy mud, 6 fm., *Cum.*
287	——, sp.	....	2	
288	——, sp.	....	1	
289	——, sp.	....	1	
290	Eulima iota, n. s.	....	2	
291	—— recta, n. s.	....	5	
292	—— solitaria, n. s.	on Holothuria.	1	
293	Pyramidella, sp.	....	1	
294	—— conica	....	1	
295	Natica Chemnitzii, *Pfr.* (non *Mke.*) [= *maroccana*, Chemn.]	soft mud, l. w.	60	Guaymas, *Green.*
296	—— ? lurida, *Phil.*	sand beach, $\frac{1}{2}$ buried in sand, $\frac{1}{2}$-t.—. The horny opercula were eaten by rats, off Cape Horn.	8	
297	—— otis, *Br. & Sow.* [? = *Gallapagosa*, Récl.]	(same as 296)	11	
298	—— ? Salangonensis, *Récl.*	sdy. mud, $\frac{1}{2}$-t.—l. w.	10	
299	—— Souleyetiana, *Récl.*	....	4	
300	—— ? virginea, *Récl.* (= ? *uber*, Val. teste Mus. Gld.)	....	40	
301	——, sp.	wet sand, $\frac{1}{2}$-t.—l. w.	200	
302	——, sp. (= *uber*, Val.)	wet sand.	2	Callao, Petit.
303	——, sp. like *Haneti*	....	1	
304	Nerita scabricosta, *Lam.* (non *Delessert* = costata). = *ornata*, Sow. + *Deshayesii*, Récl.	rocks, especially crevices, h. w.—$\frac{3}{4}$-t. young, above h. w.	400	Real Llejos, Sow.; California, Phil.: Is. Timor, Récl.
305	——, sp. = *Bernhardi*, Récl.	rks. & st., $\frac{1}{2}$-t.—l. w. n.	2800	
306	Neritina Guayaquilensis, *Sow.* + *intermedia*, Sow. teste *Récl.*	above highest tides, among sticks and leaves, in muddy places overflowed by fresh water.	90	Real Llejos, Guayaquil, *Cum.*

No.	Name.	Station.	No. of Specimens.	Other Localities.
07	Neritina picta, *Sow.* (non *Hœning.*) [N.B. Lieut. Green's specimens, quoted from San Miguel as of extraordinary size, are probably *N. cassiculum*, Sow.]	strictly marine: sticks and stones in grove, ½-t. +: dirty places on rocks, ½-t. −.	290	Pan., on mud-bank partially overflowed with fresh water, *Cum.*
)8	Pedipes angulata, n. s.	under stones, h. w.	90	
)9	Auricula acuta, *D'Orb.* =*Marinula Recluziana*, Cum. MS.	under stones, h. w.	3	Guayaq., near brackish water, *Fontaine.*
.0	—— concinna, n. s.	on short mangrove suckers, h. w.	74	
1	—— infrequens, n. s.	under stones, h. w.	6	
2	—— Panamensis, n. s.	u.s., h. w., or crawling over wet stones.	650	
3	—— stagnalis, *D'Orb.* +*papillifera*, Küst.	under heap of stones, above h. w.	36	Guayaquil, marsh and even fresh water, *Font.*; I. Tumaca, *Cum. MS.*
4	—— Tabogensis, n. s.	on and under stones and rocks, h. w.	800	
.5	—— trilineata, n. s.	....	1	
.6	——, sp.	under stones, h. w.	2	
7	Truncatella Bairdiana, n. s.	under heap of stones, h. w. s.	400	
8	??—— dubiosa, n. s. (?Assiminea)	under heap of stones, h. w. s.	550	
9	Bulla (Tornatina) infrequens, n. s.	....	2	
)	—— (Cylichna) luticola, n. s.	on liquid mud, l. w.	28	
1	—— punctulata, *Ad.* =*punctata*, Ad.	....	25	Acap., *Jewett*; sandy mud, 10 fm., *Cum.*
2	——, sp.	....	1	
3	Vermetus glomeratus, (quasi) *Lam.* pars. [=*Aletes ? centiquadrus*, Val.]	rocks & stones, l. w. n. attached by end of spiral portion.	25+	
	—— Panamensis, *Rouss.*	rocks & stones, l. w. n.	10+	attached by one side of all the whirls.
	Stomatella inflata (? Sigaretus)	....	1	
	Hipponyx, sp. (? subrufa)	....	2	
	—— ? barbata Comp. *Pileopsis pilosus*, Desh. Guér. Mag. 1832, pl. 19.	stones and shells, l. w.	12	Coral reefs, Toubouai, Soc. Is., *Cum.*
	—— Panamensis, *nom. prov.* [=*antiquatus*, Linn.]	stones and shells, l. w.	14	Lobos Is., on stones in coarse sand, 17 fm., *Cum.*
	—— radiata, *Sow.* (non *Quoy*, nec *Lam.*) [=*Grayanus*, Mke.]	stones, l. w.	16	Panama, Galapagos, on rocks, *Cum.*
	Calyptræa aberrans, n. s. [? =*Crep. unguiformis*, var.]	....	1	
	—— (Syphopatella) aspersa, n. s. [=*Galerus.*]	under stones, l. w.	3	
	—— cepacea, *Brod.*	dead shells, l. w.	4	sandy mud, 11 fm., Is. Muerte, *Cum.*
	—— conica, *Brod.*	....	12	Xipix., Sal., on shells, deep water, *Cum.*
	—— dentata, *Mke.* =*rugosa*, Rve. non Desh. [=*Crucibulum imbricatum*, var.]	....	8	
3	—— (Calypeopsis) hispida, *Brod.* [=*Cruc. spinosum*, pars.]	under stones, l. w.	20	Is. Muerte, on dead shells, sandy mud, 12 fm., *Cum.*
3	—— —— imbricata, *Brod.*	....	2	on st., sdy. md., 6–10 fm., *Cum.*; Payta, [*D'Orb.*
3	—— maculata, *Brod.* (non *Quoy*) [=*Cruc. spinosum*, pars.]	....	2	Is. Muerte, on dead shells, in sandy mud, 11 fm., *Cum.*
3	—— planulata, n. s.	on oyster, ½-t. −	1	
3	—— radiata, *Brod.*	....	10	Caraccas, sdy. mud on dead shells, 7–14 fm., *Cum.*

No.	Name.	Station.	No. of Speci-mens.	Other Localities.
340	Calyptræa (Syphopatella) regularis, n. s. [= *Galerus mammillaris*, Brod.]	....	3	
341	—— umbrella, *Desh.* .... = *Crucibulum rude*, Brod.	....	1	Pan. and Real Llej., under stones, *Cum* Guayaq., Jay.
342	—— ??unguis, *Brod*..............	....	1	
343	Crepidula cerithicola, n. s. ...... [= *C. onyx*, jun.]	on *Cerith. stercus-muscarum.*	45	
344	—— echinus, *Brod.* .... [= *C. aculeata*, var.]	under stones, l. w.	18	Lobos Is., *Cum.*
345	—— excavata, *Brod.*.............	....	1	Real Llej., *Cum.*; Chili, Desh.
346	—— ? hepatica, *Desh.* .... [= *C. onyx*, Sow.]	on *Strombus*, *Conus*, & *Cuma*, &c.	28	C. G. Hope, Krauss.
347	—— incurva, *Brod.*	living shells, l. w.+	120	St. Elena and Xipix., on dead shells, 10 fm., *Cum.*
348	—— Lessonii, *Brod*............... [= *C. nivea*, var.]	under stones, l. w.	80	I. Muerte, *Cum.*
349	—— squama, *Brod.*	u. s., & in shells, l. w.	35	
350	—— unguiformis, *Lam.* .... = *C. Italica*, Defr. = *C. plana*, Say. = *C. calceolina*, Desh. [Perhaps = *C. nivea*, var.: but v. B. M. Maz. Cat. p. 284.] Fossil in Italy, Sicily, Bordeaux, Dax, Touraine.	in dead shells, near ½-t. level.	...	Mediterranean, Desh.; Tunis & Algie[rs], *M'Andr.*; Senegal, Potiez; Mai[ne], *Mighels*; Carolina, &c., *Say*; Jamai[ca], *C.B.Ad.*; Is. Chiloe, *Cum.*; Mazatl[an], *Liverpool Col.*
351	—— nivea, n. s...................... [+ *C. squama* + *C. Lessonii* + *C. striolata.*]	under stones, l. w.	45	
352	—— osculans, n. s.	....	1	
353	—— rostrata, n. s.................... = *C. adunca*, Sow. = *C. solida*, Hds. = *C. rostriformis*, Gld. = *C. uncata*, Mke.	....	5	
354	Fissurella æqualis, *Sow*..........	....	5	St. Elena, on dead shells, 6–10 fm., *C*[um.]
355	—— alta, n. s.		26	
356	—— macrotrema, *Sow*.............	....	5	Gal., Real Llej., Lobos Is. Lambeyeq[ue], under stones on shore, *Cum.*
357	—— microtrema, *Sow*............ [? = *F. rugosa*, var.]	....	10	Real Llej., under stones, l. w., *Cum.*
358	—— mus, *Rve.*	....	8	
359	—— nigropunctata, *Sow*.........	on rocks, ½-t.—	95	Gal. and Lobos Is., under stones, *C*[um.]
360	—— ostrina, *Rve*....................	....	3	
361	—— virescens, *Sow*................	ledge of smooth, exposed rocks, ½-t.—l.w.	142	
362	Siphonaria characteristica, *Rve.* [= *S. gigas*, var.]	on rocks, ½-t.+	70	
363	—— costata, *Sow*...................	....	1	Guacomayo, on exposed rocks, l.w., *C*[um.]
364	—— gigas, *Sow.*	on rocks, ½-t. ⊦	220	Gal. Is., Jay; Peru, Voy. Venus.
365	—— maura, *Sow.*	ledges of rocks, ½-t.+	200	
366	—— ? pica, *Sow.*	....	3	Acapulco, Sow., on exposed rocks.
367	Lottia ? patina, *Esch*.............. [? = *Acmæa mesoleuca*, var.]	on & under stones, l.w.n.	34	
368	——, sp..................................	under stones, ½-tide	45	
369	——, sp..................................	under stones, ½-tide	20	
370	——, sp..................................	....	11	
371	? Patella, sp.	rocks, ½-t.	16	
372	Chiton clathratus, *Rve*...........	under stones, l. w.	12	
373	—— dispar, *Sow.*	under stones, l. w. n.	100	Is. Saboga, *Cum.*
374	—— ? luridus, *Sow.*	under stones, l. w.	3	St. Elena, on stones, 5 fm., *Sow.*

No.	Name.	Station.	No. of Specimens.	Other Localities.
375	Chiton pulchellus, *Gray*	under stones, $\frac{1}{2}$ buried in sand, near l. w. n.	80	Arica, *Hennah*; Islay, 30 fm. +, *D'Orb.*
376	—— Stokesii, *Brod.*	under stones, l. w. n.	40+	St. Elena, *Cum.*; Arica & Islay, *D'Orb.*
377	Anomia lampe, *Gray*	l. w.	1	La Paz; and Monterey, 60 fm., *Rich.*
378	—— tenuis, n. s.	l. w.	3	
379	——, sp.	....	1	
380	Ostrea, sp. (*a*)	rocks, $\frac{1}{2}$-t.	6	
81	——, sp. (*b*) .... [? = *O. iridescens*, Gray.]	rocks, $\frac{1}{2}$-t.	3	
82	——, sp. (*c*) .... [? not *O. Columbiensis*, Hanl. = *O. conchaphila.*]	rocks, shells, &c., $\frac{1}{2}$-t.	15	
83	——, sp. (*d*) .... [? = *O. Virginica.*]	in clusters.	35	
84	——, sp. (*e*) .... small, plicated: animal bitter.	rocks & stones, $\frac{3}{4}$ — $\frac{1}{4}$ t.	330	
85	Spondylus ?Lamarckii (non *Sow.*) [= *S. calcifer.*]	....	com.	La Paz, *Green.*
36	——, sp.	....	1	
37	Pecten inca, *D'Orb.* .... [= *P. tumidus*, Sow., non Turt.] [= *P. ventricosus*, Sow.]	....	8 *v.*	St. Elena, Salango, sandy mud, 6–10 fm., *Cum.*; Calapan, Philippines, Sow.
38	—— Tumbezensis, *D'Orb.* ...... = *P. aspersus*, Sow., non Lam.	....	2 *v.*	soft mud, 5 fm., Tumbez, *Cum.*
39	Lima angulata, *Sow.*	....	4	Carac., sandy mud, 12–20 fm., *Cum.*
0	—— Pacifica, *D'Orb.* .... = *L. arcuata*, Sow., not Geinitz.	on reef.	3	Lord Hood's Island, under coral rocks; Panama, sandy mud; Guayaquil;
1	Avicula ? margaritifera.............. [? = *Margaritiphora fimbriata.*]	....	2	Guacomayo, under stones, *Cum.*
2	—— sterna, *Gould*	on Gorgonia, l. w. s.	10	
3	Perna, sp. (*a*) (= Chemnitzianum)	u.s., & in crev. rks., l.w.	130	La Paz, *Green.*
4	——, sp. (*b*)..............	u.s., & in crev. rks., l.w.	30	
5	Pinna maura, *Sow.*	....	1	muddy banks, *Cum.*
6	—— tuberculosa, *Sow.*	crevices of rocks, l. w.	4	muddy banks, *Cum.*
7	Mytilus, sp. (*a*)	....	1	
8	Lithodomus, sp. (*a*)	in thick shells, $\frac{1}{2}$t. — l.w.	20	
9	Modiola ?semifusca, *Sow.* (non *Lam.* teste *Hanl.*). = *M. Braziliensis*, Lam. = *Mytilus Guiaënsis*, Küst.	....	35	
0	Modiola, sp. (*a*)	crev. of rks., $\frac{1}{2}$-t.–l. w.	6	
1	——, — (*b*)	crev. of rks., $\frac{1}{2}$-t.–l. w.	35	
2	——, — (*c*)	....	4	
3	——, — (*d*)	....	2	
4	——, — (*e*)	in soft stones, near $\frac{1}{2}$-t.	2	
5	Chama Buddiana, n. s. .... [The specimen in Dr. Gould's col., supposed to be the above, is *C.* ?*frondosa*, var. *fornicata.*]	ledges of rock, l. w. +	6	Guaymas, *Green.*
	—— ? corrugata, *Brod.*	....	2 *v.*	Real Llej., on stones, l. w., *Cum.*
	—— echinata, *Brod.*	rocks, near l. w.	15	Puert. Port., *Cum.*
	Nucula Elenensis, *Sow.*	....	20 *v.*	St. Elena, sandy mud, 6 fm., *Cum.*
	—— exigua, *Sow.*	....	1 *v.*	Caraccas, sandy mud, 9 fm., *Cum.*
	—— polita, *Sow.*	....	10 *v.*	Sand, 7 fm., *Cum.*
	Pectunculus assimilis, *Sow.*	u. s. in grav., $\frac{1}{4}$-t.–l. w.	20	Puert. Port., sdy. m. & grv., 8–12 fm., *Cum.*
	—— maculatus, *Brod.*	....	1	Puert. Port., fine gravel, 11 fm., *Cum.*
	Arca alternata, *Sow.*	....	4	Ecuador, on st., 12 fm., *Cum.*; Maz., *Jew.*
	—— ? aviculoides, *Rve* .... = *A. auriculata*, Sow.	....	1	St. Elena, 10 fm., mud, *Cum.*
	—— emarginata, *Sow.*	....	3	Real Llejos, Atac., Xipix., sandy mud, 6–8 fm., *Cum.*; Gulf Cal., *Sow.*

No.	Name.	Station.	No. of Speci-mens.	Other Localities.
416	Arca gradata, *Brod. & Sow.*	under stones, l. w.	3	St. Elena, *Cum.*; Sta. Barbara, *Jew.*
417	—— grandis, *Brod. & Sow.* One valve weighed 2¼ lb.	½-buried in m. & small algæ, u. trees, ½-t.+	13	Real Llej., Guayaq., *Cum.*
418	—— mutabilis, *Sow.*	u. s., & crev. rks., l. w.	70	Is. Plata, *Cum.*
419	—(Byssoarca) pholadiformis, n. s.	in soft stones, l. w.	2	
420	—— Reeveana, *D'Orb.* =*A. Helblingii*, Rve. non Brug.	under stones, l. w.	9	St. Elena, Monte Christi, *Cum.* Philippines, Reeve.
421	—— reversa, *Sow.* =*A. hemicardium*, Koch.		4 *v.*	Tumbez, soft mud, 7 fm., *Cum.*
422	—— similis, n. s. [?=*A. tuberculosa*, var.]		10	
423	—— solida, *Sow.*	under stones, l. w.	60	Payta, *Cum.*
424	——(Byssoarca) Tabogensis, n. s. [?=*A. illota*, var.]	under stones, l. w.	60	
425	—— tuberculosa, *Sow.*	thin mud, under mangroves, near h. w.	147	Real Llejos, l. w., *Cum.*
426	——, sp.		2	
427	Cardita affinis, *Sow.* =*modulosa*, Val., ?=*nodulosa*, Lam., not *nodulosa*, Rve.	"boring" in stones and rocks, ½-t.—	70	B. Montija & Nicoya, sdy. m., 6–12 fm. *Cum.* Guaymas, *Green* [?].
428	—— laticostata, *Sow.*	partly buried in calc. sand and gravel, under stones, l. w. s.	150	Guacomayo, St. Elena, Pan., Real Llej. sand, 6–12 fm., *Cum.* t. *Sow.* Ditto, coarse sand & mud, 10–12 fm. *Cum.* teste *Rve.*
429	—— radiata, *Sow.*	l. w.	20	Salango, muddy sand, 6–12 fm., *Cum.*
430	Cardium graniferum, *Brod. & Sow.*		6 *v.*	Gulf Nicoya, Xipix., *Cum.*
431	—— obovale, *Brod. & Sow.*		3 *v.*	Xipix., sandy mud, 11 fm., *Cum.*
432	—— planicostatum, *Sow.* [?=*C. procerum*, var.]		1 *v.*	Guacomayo, fine sand, 13 fm., *Cum.*
433	—— procerum, *Sow.*		6 *v.*	Real Llej., coarse sand, 4–6 fm., *Cum.*
434	—— senticosum, *Sow.* =*C. rastrum*, Rve.		5	St. Elena, sandy mud, 6–12 fm., *Cum.*
435	Venus ? amathusia, *Phil.*		2	Mazatl., *Green.*
436	—— ? discors, *Sow.* [?=*Tapes grata*, Say.]	coarse sand among stones, ¼–½-t.	146	St. Elen. and Guac., sandy mud, 6–9 fm. *Cum.*; Guaymas, *Green.*
437	—— gnidia, *Brod. & Sow.*		4	Payta, *Fontaine.*
438	—— multicostata, *Sow.* =*V. Thouarsi*, Val.		5	Pan., coarse sand, l. w., *Cum.*; La Pa[z] *Green.*
439	—— pectunculoides, *Val.* [=*Tapes histrionica*, Sow.]	coarse sand, under mangroves, ¼–½-t.	172	
440	—— subrugosa, *Sow.* =*V. subsulcata*, Mke.	partly buried in coarse sd. amg. st. or u. tr., ½-t.	33	
441	——, sp. *a*		12 *v.*	
442	——, sp. *b*	coarse sand, ½-t.	14	
443	Cytherea affinis, *Sow.*		10	Xipix., 10 fm., sandy mud, *Cum.*
444	—— aurantiaca, *Sow.* =*C. aurantia*, Hanl.		3	G. Nicoya, Jay.
445	—— consanguinea, n. s.		8	
446	—— radiata, *Sow.*		2	Salang., Xipix., sandy mud, 9 fm., *Cu[m.]*
447	—— squalida, *Sow.*		5	St. Elena, sandy mud, 6 fm., *Cum.*
448	Artemis Dunkeri, *Phil.* =*A. Pacifica*, Trosch. [=*A. simplex*, Hanl.]		36	St. Elena, *Cum.*
449	—— saccata, *Gld.* [=*Cyclina subquadrata*, Hanl.]		2	
450	Gouldia Pacifica, n. s.		64	
451	Cyrena maritima, n. s.	in impalpable mud, under bushes, where a small stream emptied, h. w. *Balani* sometimes attached.	9	

No.	Name.	Station.	No. of Specimens.	Other Localities.
452	Lucina tellinoides, *Rve.*	....	30	Is. Muerte, sandy mud, 11 fm. *Cum.*
453	Capsa altior, *Sow.*	buried in sand, l. w.	3	G. Nicoya, coarse gravel, 12 fm., *Cum.* Var., mud, 5 fm., Tumbez, *Cum.*
454	Donax assimilis, *Hanl.*	a few inches in sd., $\frac{3}{4}$-t.	350	Mazatlan, *Green.*
455	—— gracilis, *Hanl.*	....	20	B. Caraccas, Guay., Chiriqui, *Cum.*
456	—— navicula, *Hanl.*	....	3	Nicoya, *Cum.*
457	—— rostratus, n. s.	....	1	Maz., *Green*; Sta. Barb., *Jewett.*
458	Tellina ? aurora, *Hanl.*	....	3	soft sandy m., 10 fm., *Cum.*; Rio Janeiro, [Jay.
459	—— cognata, n. s. One valve, "closely allied to the Caribbæan *T. similis.*"	....	1 *v.*	
460	—— Columbiensis, *Hanl.*	....	2	Monte Christi, sandy mud, 12 fm., *Cum.*
461	—— concinna, n. s.	....	3	
462	—— crystallina, *Chemn.*	....	1 *v.*	St. Elena, *Hanl.*
463	—— Cumingii, *Hanl.*	....	2	Guacomayo, coral sand, *Cum.*
464	—— Dombei, *Hanl.*	....	12	sandy mud, 12 fm., *Cum.*
465	—— felix, *Hanl.* [?] [Prof. Adams' shell is said by Dr. Gld. to be his *Strigilla fucata.*]	....	36 *v.*	sandy mud, 6–10 fm., *Cum.*
466	—— laceridens, *Hanl.*	....	7	sdy. m., 3–5 fm., Tumbez & Chiriqui, *Cum.*
467	—— prora, *Hanl.*	....	1 *v.*	sdy. m., 6–9 fm., St. Elen. & Salango, *Cum.*
468	—— puella, n. s.	....	12 *v.*	
469	—— rubescens, *Hanl.*	....	2	sandy mud, Tumbez, *Cum.*
470	—— siliqua, n. s.	....	1	
471	—— simulans, n. s. [= *T. punicea*, Hanl. Species constituted from a single valve to include the Pacific specimens of the W. Indian form.]	....	1 *v.*	
72	—— sincera, *Hanl.*	....	15	
73	—— vicina, n. s.	....	10	"Closely allied to *T. bimaculata.*"
74	——, sp. *a*, like elongata	....	1 *v.*	
75	——, sp. *b*	....	1 *v.*	
76	——, sp. *c*	....	5 *v.*	
77	Petricola cognata, n. s.	....	1	
	[? = *P. pholadiformis*, Gld. MS.]	....	...	Guaymas.
78	Saxicava ? tenuis, *Sow.* [? = *S. pholadis*, Linn. var.]	soft stone, $\frac{1}{2}$-t.	1	Pascomayo and Lambeyeque, *Cum.*
79	Cumingia coarctata, *Sow.*	....	4	Caraccas, sandy mud, 7 fm., *Cum.*
80	—— trigonularis, *Sow.*	....	3	St. Elena, stones, deep water, *Cum.*
81	——, sp. *a*	....	4	
82	——, sp. *b*	....	1	
83	——, sp. *c*	....	1 *v.*	
84	——, sp. *d*	....	1	
	Prof. Adams regards the above as "probably new species: but as their characters are *probably* somewhat variable," prudently forebore from describing them without more specimens. They are probably varieties; as *Cumingiæ*, like other nestlers, are *most* variable in form and sculpture.			
35	Amphidesma bicolor, n. s.	....	1 *v.*	
36	—— ? ellipticum, *Sow.*	....	20	Monte Christi, 9 fm., sandy mud, *Cum.*
37	—— proximum, n. s. [= *Semele proxima*, M. Cum. pars: pars = *S. proxima*, B. M. Maz. Cat. p. 28, = *S. flavicans*, Gld.]	....	18	

No.	Name.	Station.	No. of Specimens.	Other Localities.
488	Amphidesma pulchrum, *Sow.* ...	....	4	Carac., *Cum.* teste Sow. in P. Z. S.; St. Elena and Pan., *Cum.* teste Sow. in [Conch. Ill.
489	—— striosum, n. s.	....	1	
490	—— tortuosum, n. s........	....	1	
491	—— ventricosum, n. s. (? Kellia)	....	1 *v.*	
492	Crassatella gibbosa, *Sow.*	....	1 *v.*	St. Elena & Xipix., sdy. m., 11 fm., *Cum.*;
493	Mulinia donaciformis, *Hanl.* [?] . [? = *M. angulata*, Gray.]	....	14	[Payta, *Fontaine.*
494	—— ventricosa, *Gld.* [= *Mactra exoleta*, Gray.]	....	3	
495	Lutraria elegans, *Sow.* (Mactra). Not *L. undulata*, Gld. teste C. B. Ad.	....	6 *v.*	"The Atlantic analogue is *L. canaliculata*, Say."
496	Mactra velata, *Phil.*	....	10	
497	Anatina alta .... (? Thracia or Periploma.)	....	1 *v.*	
498	Pandora cornuta, n. s.	....	1	
499	Potamomya æqualis, n. s........	soft mud, under mangroves, near h. w. & outlet of small stream, with *Arca tuberculosa.*	1 *v.*	
500	—— inflata, n. s.	" " "	3	
501	—— trigonalis, n. s........	" " "	2	[7–17 fm., *Cum.*
502	Corbula bicarinata, *Sow.*	u. s., deep in sd., l. w. +	260	Rl. Llej., Carac., St. Elen., sdy. mud,
503	—— biradiata, *Sow.*........	....	21	Chiriqui & Carac., s. & m., 3–7 fm., *Cum.*
504	—— obesa, *Hds.*	....	6 *v.*	8° 57′–21° 32′, 22–33 fm., *Hds.*
505	—— ovulata, *Sow.*	....	7	Xipix., Mont., Carac., sdy m., 7–17 fm.,
506	—— rubra, n. s.	....	1	[*Cum.*
507	—— tenuis, *Sow.*........	....	1 *v.*	Bay Montijo, sandy m., 12 fm., *Cum.*;
508	——, sp. *a*, like Taheitensis ...	....	1 *v.*	[Maz., *Jew.*
509	——, sp. *b*........	....	2 *v.*	
510	Solecurtus affinis, n. s.	........................[l.w.	10	"Like *S. Caribæus.*"
511	Solen rudis, n. s.	coarse sd. among st.,	55	
512	Pholas crucigera, *Sow.* .... = *crucifera*, Sow. = *cruciger*, Müll.	....	1	Is. Puna, B. Carac., Nicoya, soft sandstone, ½-t.; soft stone, l. w.; hard clay, 13 fm., *Cum.*
513	—— tubifera, *Sow.*	....	1	Carac., in decayed wood, 10 fm., *Cum.*;
514	—— xylophaga, *Val.* (non *Desh.*)	filling the bottom of an old "dug-out," h. w.	20	[Payta, *Fontaine.*
515	—— sp. *a*, like lanceolata	....	2 *v.*	
516	——, sp. *b*........	....	1 *v.*	
517	Orbicula Cumingii, *Brod*........	underside of st., l. w.	50	Payta, St. Elena, l. w.—6 fm., *Cum.*; Chili and Peru, Desh.

If this list of species be estimated according to the standard of judgment followed in the Mazatlan Catalogue, which is necessary for a fair comparison between the two, the following numbers will not be needed:—

Univalves: 5, 33, 52, 70, 72, 164, 174, 199, 211, 212, 216, 218, 241, 330, 334, 337, 343, 348, 349, 362, = 20.

Bivalves: 422, 432, 482, 483, 484, = 5.

The names given to 459 and 471 are also not required.

Others may be discovered on a comparison of specimens or figures (which it is to be hoped the Trustees of Amherst College, who possess the types, will cause shortly to be published), though they are not recognized from the descriptions alone. The discovery of a large number of deep-water species was due to the hermit crabs. Certain observed differences of station between Messrs. Cuming and Adams are very interesting; in a few there may be error; from others we learn what great latitude is allowed to some of the species: *e.g. Corbula bicarinata* is quoted alive from low water to 17 fm.; while *Anomia lampe*, quoted from low-water mark, was found by Major Rich as far north as Monterey in 60 fm. water!

Of the 157 species described as new, 5 had already appeared under other names, and 15 are believed to be only varieties. Fifteen are named from their doubtful characters or similarity to other forms; 8 are designated from their habitat or station; 23 receive names expressive of their small size; 5 are designated according to the number of specimens found; and 6 would probably not have been constituted, had the same shells appeared in the Caribbæan waters.

The following is a comparison of the above collection with that of M. Reigen from Mazatlan, excluding from the latter the land and freshwater shells and the *Bryozoa*; and bringing down the number of species in Prof. Adams's Catalogue to the standard adopted in the latter.

Pan.	Maz.	Common.	
136	215	38=28 per cent.	Bivalves.
356	449	77=21·6 per cent.	Univalves.
492	664	115=23·4 per cent.	Total.
12	104		Old species united: not including synonyms.
139	209		New species described.
61	108	?	Indeterminate species.
73	298	25=34 per cent.	Minute species.

55. The following are extracted from the British Museum Catalogue of the *Veneridæ*, &c. by M. Deshayes. The minute division of species in this and in his recent articles in the Proc. Zool. Soc. contrasts somewhat strangely with the opposite tendency displayed in his extremely valuable edition of Lamarck's Animaux sans Vertèbres, a work which has been employed throughout, but not quoted, simply as not containing original authorities on our present inquiry.

Page.	No.	
13	25	*Dosinia turgida,* Rve. = *Artemis tenuis,* Sow. jun. Central America, *Sale.*
76	70	*Dione brevispinata,* Desh.=*Cytherea brevispina,* Sow. jun. California.
135	48	*Chione callosa,* Desh.=*Ch. Nuttallii,* var. Non *Dosinia callosa,* Conr. California: *not* Sandw. Is.
192	8	*Venerupis foliacea,* Desh. Mazatlan.
207	1	*Petricola mirabilis,* Desh. [Monterey, *Hartweg,* teste *Sow.*] California.
253	37	*Cyrena Fontainii,* Desh.=*olivacea,* Cpr. Non *C. Fontainii,* D'Orb. Mazatlan.
254	39	*Cyrena solida,* Phil. Abbild. Conch. p. 78. pl. 1. f. 9. Nicaragua.
257	49	*Cyrena Floridana,* Conr. Mazatlan and Florida. The Mazatlan specimens are *C. Mexicana, jun.*

56. The collection of which the following is a list, came into my possession exactly as it was received from a sailor, who brought it from a single port on the west coast of North America. The purchaser, judging, from the prevalence of Mazatlan shells in it, that it came from that place, did not make exact inquiries at the time, and the sailor could not be traced afterwards. Though consisting mainly of shore shells, the collection was so remarkably free from imported specimens, that it derives some value as a geographical authority. The general accordance of the species with what we know of

the local-fauna of Acapulco, makes it probable that it came from that place; but it is cited in the B. M. Mazatlan Catalogue as "S.W. Mexico."

1. *Solecurtus violascens*, n. s. B.M. Maz. Cat. p. 27, note. 1 pair.
2. *Tellina princeps*. Fine: 1 val....S.*
3. *Tellina rubescens*. 1 pr............P.
4. *Mactra elegans*. 1 pr...............P.
5. *Mactra angulata*. 1 pr. ......P. M.
6. *Dosinia Dunkeri*. 1 pr. ......P. M.
7. *Dione aurantiaca*. 1 val., fine...P. M.
8. *Dione chionæa*. 1 v. ....P. M.
9. *Venus amathusia*. 1 pr. ......P. M.
10. *Venus Columbiensis*. 1 val. ...P. M.
11. *Tapes grata*. 1 pr. ....P. M.
12. *Anomalocardia subrugosa*. 1 v. P.M.
13. *Anomalocardia subimbricata*. Valves, common......................S. M.
14. *Cardita affinis*. 1 pr...............P.
15. *Chama frondosa*. 1 v. ....P.
16. *Cardium procerum*. Rare. ...P. M.
17. *Cardium consors*. 1 v. (Guatemala). S.
18. *Cardium maculatum*. 1 v.........S.
19. *Lucina tigerrina*. 1 fresh val....M.
20. *Modiola capax*. 1 v. ....M. C.
21. *Mytilus palliopunctatus*. Rare....M.
22. *Arca Pacifica*. 1 pair .........P.M.
23. *Pinna ?rudis*. Extremely thick and large valves ....P. M.
24. *Margaritiphora fimbriata*. Common. P. M.
25. *Pecten ventricosus*. (Colouring extremely variable.) Valves, common ....? S. P.
26. *Pecten ? senatorius*. (China Seas. Perhaps an allied sp.) 2 fresh pairs.
27. *Ostrea conchaphila*. Valves. P.M.C.
28. *Ostrea palmula*. 1 pair ......M. C.
29. *Placunanomia foliata*. 1 fresh valve. M.
30. *Bulla Adamsi*. Rare..............M.
31. *Siphonaria gigas* + *characteristica*. Common ....P.
32. *Patella discors*. Common ......M.
33. *Acmæa scabra*. 1 sp. ....M. C.
34. *Acmæa grandis*, Gray. Common. C.
35. *Fissurella nigropunctata*. Com...P.
36. *Uvanilla olivacea*. Rare ....M.
37. *Uvanilla unguis*. Common.......M.
38. *Pomaulax undosus*. Fresh opercula. C.
39. *Callopoma saxosum*. Rare.........P.
40. *Tegula pellis-serpentis* = *strigilatus*, Anton. Not uncommon ......P.
41. *Nerita scabriuscula*. Large and common......................P. M.
42. *Nerita Bernhardi*. Abundant. P. M.
43. *Crepidula aculeata*. 1 sp. S. P. M.
44. *Crepidula ?unguiformis*. 1 sp. P.M.
45. *Crepidula arenata*. 1 sp. ....S.
46. *Galerus conicus*. 1 sp.......S. P. M.
47. *Galerus mammillaris*. 1 sp....S. P.M.
48. *Crucibulum umbrella*, Desh. = *rudis*, Brod. Common, fine, and very variable ....P.
49. *Crucibulum spinosum*. 1 sp. S.P.M.C.
50. *Hipponyx Grayanus*. On *Pinnæ*. P. M.
51. *Aletes Peronii*. 1 sp. ....P. M.
52. *Turritella goniostoma*. 1 sp....S. M.
53. *Cerithium maculosum*. Common. P. M.
54. *Cerithium stercus-muscarum*. Rare. P. M.
55. *Cerithium famelicum*. 1 sp....P. M.
56. *Cerithium uncinatum*. Rare....P. M.
57. *Cypræa exanthema*, var. *cervinetta*. Common ....P. M.
58. *Cypræa arabicula*. Very common. S. P. M.
59. *Trivia pustulata*. Rare......S. P. M.
60. *Trivia radians*. 1 sp. ......S. P. M.
61. *Strombus galea*. 1 sp..........P. M.
62. *Strombus granulatus*. Common. S. P. M.
63. *Strombus gracilior*. Rare...S. P. M.
64. *Terebra robusta*. 1 sp. ....P.
65. *Pleurotoma funiculata*. 1 sp. ...M.
66. *Drillia rudis*. 1 sp..........S. P. M.
67. *Conus regalitatis*. Very rare. P. M.
68. *Conus Mahogani*. 1 sp............P.
69. *Conus gladiator*. 1 sp..........P. M.
70. *Natica maroccana* and vars. Abundant ....P. M.
71. *Natica excavata*. Very rare ......P.
72. *Polinices uber*. Rare ......S. P. M.
73. *Polinices* (*Galapagosa*?=) *otis*. Very rare ....P.
74. *Ficula decussata*. Rare ......P. M.
75. *Marginella prunum*†. Very rare. P.
76. *Oniscia tuberculata*. Rare.........P.
77. *Cassis coarctata*. Rare.............P.
78. *Malea ringens*. 1 sp............S. P.
79. *Oliva porphyria*. 1 sp., fine ......P.
80. *Oliva cruenta* (Tahiti. ? imported). 1 dead shell.
81. *Olivella volutella*. Very common. P.
82. *Aragonia testacea*. Common. P. M.
83. *Latyrus concentricus*, Rve. Rare. P.
84. *Latyrus castaneus*, Rve. Rare. P.
85. *Latyrus tuberculatus*, Brod. Rare. P.
86. *Cuma tectum*. 1 sp. ....P.
87. *Vitularia salebrosa* (fresh, with operc.). 1 sp. ....P. M.

* *S.* South America. *P.* Panama. *M.* Mazatlan. *C.* California.

† Both this species and *M. sapotilla*, Hds., are quoted from the West Coast.

88. *Purpura patula.* Rare ....M.
89. *Purpura biserialis.* 1 sp....S. P. M.
90. *Purpura triserialis.* 1 sp.........M.
91. *Purpura melones.* Rare.........S. P.
92. *Monoceros brevidentatum*, Gray. 1 sp. S. P.
93. *Columbella fuscata.* Rare...S. P. M.
94. *Columbella labiosa.* Rare......S. P.
95. *Anachis rugosa.* 1 sp. ....S. P.
96. *Anachis fulva.* 1 sp. ....P. M.
97. *Pisania ringens.* Rare ....P. M.
98. *Murex radix.* Rare..................P.
99. *Murex regius.* Common ......P. M.

This collection, containing 99 species, of which only one is certainly and another perhaps imported, shows what a common sailor may do, simply by keeping his shells from being mixed. One species is new; 46 are common to both Mazatlan and Panama; 29 are found at Panama, but not at Mazatlan; 6, though not yet quoted from Panama, are southern types; 14 are found at Mazatlan, and not at Panama; 6 are northern types, being found in Lower California, and of these, two (viz. *Acmæa grandis* and *Pomaulax undosus* [operc.]) were not found at Mazatlan.

57. In the Proceedings of the Boston Soc. Nat. Hist. for Feb. 1855, Dr. A. A. Gould described the following land and freshwater shells from the western part of N. America :—

P. 127. *Helix æruginosa*, Gld. San Francisco, *Dr. Bigelow.*
P. 127. *Helix infirmata*, Gld. San Francisco, *Dr. Bigelow.*
P. 128. *Physa bullata*, Gld. Oregon, *Dr. J. G. Cooper.*
P. 128. *Physa humerosa*, Gld. Colorado Desert, *Dr. Th. H. Webb*; Pecos River, *Mr. W. P. Blake.*
P. 128. *Physa virgata*, Gld. River Gila and near San Diego, *Dr. Th. H. Webb.*
P. 129. *Planorbis ammon*, Gld. Colorado Low Desert, *Dr. T. H. Webb, Mr. W. P. Blake.*
P. 129. *Planorbis gracilentus*, Gld. Great Colorado Desert, low lands, *Dr. T. H. Webb.*
P. 129. *Amnicola protea*, Gld. Colorado Desert, *Dr. T. H. Webb, Mr. W. P. Blake.* = Melania exigua, *Conr.* (read Feb. 13th).
P. 130. *Amnicola longinqua*, Gld. Colorado Desert, *Mr. W. P. Blake.*

The same gentlemen appear to have made collections on the coast; of which the following lists have been obligingly sent by Dr. Gould.

Collected by Dr. Thomas H. Webb.

At Guaymas.

Acmæa æruginosa [=A. mesoleuca, var.].
Neritina picta.
Nerita "? *præcognita*, C. B. Ad."= Bernhardi, *Récl.*
Chlorostoma rugosum, var.

At San Diego.

Tellina nasuta.
Donax.
Venus dispar.
Venus, sp.
Cardium Californiense.
Arca pernoides. 1 valve. "Lieut. Webb."
Pectunculus (dead, rubbed).
Pecten (dead valve).
Ostrea.
Fissurella crenulata (very young).
Haliotis ? Kamtschatkana.
Trochus viridulus (very red var.). "Lieut. Webb."
Phasianella compta.
Calyptræa hispida, =Cruc. spinosum.
Cerithium irroratum, Gld.
Potamis pullatus, Gld.
Cerithidea albonodosa.
Natica ? uber.
Ranella muriciformis.
Oliva splendidula.
Nassa luteostoma.
Nassa tegula, Rve., dead.
Purpura emarginata.

It is probable that some of the above shells, as *Ranella muriciformis, Oliva splendidula, Nassa luteostoma, Natica uber*, had found their way northwards by the accidents of commerce. None of them were seen by Mr. Nuttall, who spent some time at the place.

Collected by Dr. Bigelow at San Francisco.

Venus rigida, Gld. ?=Tapes diversa.
Cardium Nuttallii.
Mytilus Californianus, Conr.
Lottia scabra, Gld. (=spectrum, *Nutt.*)
Natica Lewisii, Gld. (operculum only).
Purpura Conradi, Nutt.

Collected by Mr. William P. Blake.

AT SAN FRANCISCO.

Mytilus edulis, or allied.
Lottia scabra, Gld. (=spectrum, *Nutt.*)

AT SAN PEDRO.

Semele rubrotincta, Conr.
Tellina secta, Conr.
Tapes gracilis, Gld.
Venus discors, Sow. "=grata, *Say*=staminea, *Conr.*"
Venus Nuttallii, Conr.
Venus fluctifraga.
Lucina orbella, Gld.
Lottia patina, Esch.
Lottia scabra, Gld.
Scurria pallida, Gray=mitra, *Brod.*
Trochus mœstus, Brod.
Calyptræa hispida, Brod.
Crepidula incurva, Brod.
Oliva biplicata.

AT SAN DIEGO.

Sphænia Californica, Conr.
Tellina vicina, C. B. Ad.
Tellina secta, Conr.
Solecurtus Californianus, Conr.
Petricola carditoides, Conr.=cylindracea, *Desh.*
Venus fluctifraga, Sow.
Cardium cruentatum, Gld.*
Modiola capax, Conr.
Pecten ? purpuratus.
Pecten monotimeris, Conr.
Bulla nebulosa, Gld.
Bulla virescens, Gld.
Bulla longinqua, Gld.*
Bulla vesicula, Gld.*
Melampus olivaceus.
Phasianella compta, Gld.*
Potamis pullatus, Gld.

* "Not yet from the press." Gould in litt.

58. The latest conchological traveller who has visited the West N. American province is Mr. T. Bridges†; who, in the spring of the present year, has brought a collection from the Bay of Panama. Although he had no dredge, and the district had been well explored, he succeeded in finding 24 new species, besides others new to the fauna of the place. The new species are described in the 'Proc. Zool. Soc.' June 10th, 1856, pp. 159–166; and, with a few others, interesting for their locality, are as follow:—

Corbula ventricosa, Rve.
? *Scrobicularia producta*, Cpr.
?—— *viridotincta*, n. s.
Tellina rhodora, Hanl.
—— *fausta.*
—— *Deshayesii*, n. s.
Strigilla disjuncta, n. s.
Semele obliqua, Wood.
—— *planata*, n. s.
Cumingia trigonularis, var.
Lyonsia diaphana, Cpr.
Mactra (*Mactrella*) *lacinata*, n. s.
—— *elegans*, jun.
Cyclina producta, n. s.
Lima angulata, Sow.
Melampus Bridgesii, n. s.
Umbrella ovalis, n. s. Mouth of the River Chiriqui. Also found exactly in the same place by a French naturalist.
Pyrgula quadricostata, n. s.
Erato ? Maugeriæ, var. *Panamensis.*
Trochus (*Ziziphinus*) *MacAndreæ* [B. M. Maz. Cat. no. 290].
Hipponyx planatus [B.M.Maz.Cat.no.348].
Cithara sinuata, n. s.
Mangelia acuticostata, n. s.
—— ? *striosa*, C. B. Ad.
—— ? *rigida*, var. *fuscoligata.*
Clathurella intercalaris, n. s.
—— *serrata*, n. s.
Drillia punctatostriata, n. s.
? *Pleurotoma gracillima*, n. s.
Scalaria regularis, n. s.
—— *tiara*, n. s.
—— *subnodosa*, n. s.
—— *Cumingii*, n. s.
—— *Hindsii*, n. s.
Cirsotrema funiculata [B. M. Maz. Cat. no. 569].
Natica excavata, n. s.
Polinices Gallapagosa, Rve. ?=ovum.
Mitra solitaria, C. B. Ad.
? *Triton crebristriatus*, n. s.
Phos biplicatus, n. s.
Latyrus tumens, n. s.
Triton eximius, Rve.=parvus, *C. B. Ad.*
Anachis pygmæa, var., exactly resembling the W. Indian *Col. costulata*, C. B. Ad.

† The Mammals and Birds brought by Mr. Bridges are described in Proc. Zool. Soc. 1856, pp. 138–143.

59. Having now presented the results of all known expeditions on the coast, we have further to bring together species collected from stray quarters. The following are described in the 'Proc. Zool. Soc.' 1832–56. Most of the Gulf shells were collected by Lieut. Shipley, and of those from California by Mr. Hartweg.

Page.	Proc. Zool. Soc.	Locality.	Station.
1832.			
57	Marginella cypræola, *Sow.* [? Erato]...	Acapulco, St. Elena.	under stones & sand.
59	Chiton lævigatus, *Sow.*	Guaymas, *Mr. Ealing* of H.M.S. 'Sapphire.'	under stones at low water.
1833.			
22	Arca cardiiformis, *Sow.*	San Blas.	on the sands.
36	Corbula radiata, *Sow.*......................	Acapulco.	1 sp. on sands.
53	Conus concinnus, *Brod.*	Gulf of California.	on sands.—Mus.Cum.
84	Cardium elatum, *Sow.*	Guaymas.	in sandy mud, l. w.
85	—— maculosum, *Sow.* .... = *C. maculatum*, Sow. in Conch. Ill.	Is. 3 Marias (Gulf Calif.).	on the sands.
1834.			
19	Conus ferrugatus, *Sow.*	"Gulf Calif. & *Is.* Guaym."	
61	Terebra variegata, *Gray.* .... = *T. Africana*, Gray, Griff. Cuv. pl. 23. f. 5.	(No loc.) but *v.* P.Z.S. 1843, p. 164, no. 67, where Hinds gives it, on the authority of Mr. Cuming, as "Guaymas, 10–12 fms., sandy mud."	
1835.			
6	Siphonaria pica, *Sow.*......................	Acapulco.	on rocks in exp. situat.
22	Venus subimbricata, var.	Acapulco.	
22	—— undatella, *Sow.*	Is. 3 Marias.	
43	—— leucodon, *Sow.* .... = *V. Californiensis*, var. teste Sow. jun.	Guaymas.	coarse sand, l. water.
43	—— Californiensis, *Brod.* (non *V. Californica*, Conr.)	Guaymas.	sandy mud, low water.
46	Cytherea Dione, var. γ, *Brod.* (= *C. lupinaria.*)	San Blas.	sandy mud, 7 fms.
50	Monoceros cymatum, *Sow.*............... = *M. lugubre*, Sow.	California.	
50	—— unicarinatum, *Sow.*.................. = *M. brevidens*, Conr.	(no locality)	
109	Pecten subnodosus, *Sow.* var. *a*.........	Gulf of California.	
110	—— circularis, *Sow.*	Guaymas.	sandy mud, 7 fms.
200	Cypræa candidula, *Gask.* .... = *C. approximans*, Beck. = *C. olorina*, Ducl.	"Mexico."	
1842.			
199	Buccinum elegans, *Rve.*..................	California.	
1843.			
5	Donax punctatostriata, *Hanl.*............	(no locality)	
5	—— carinata, *Hanl.*	(no locality)	
33	Pectunculus giganteus, *Rve.*	Guaymas, *Babb, R. N.*	
79	—— bicolor, *Rve.* .... = *P. inæqualis*, Gray, non Sow.	Gulf of California.	
166	Terebra aciculata, *Hds.* (?*Lam.*)	Acapulco.	
1844.			
27	Scalaria indistincta, *Sow. jun*...........	"S. Blas, *Hon. Mr. Harris.*"	
29	—— hexagona, *Sow. jun.*	Acapulco, *Col. Moffat.*	
76	Marginella imbricata, *Hds.*...............	Acapulco, *Col. Moffat.*	
139	Ranella triquetra, *Rve.*	San Diego, *Nutt.*	
1845.			
14	Donax culter, *Hanl.*	{ var. *a.* "Matzellan." var. *b.* Acapulco.	
75	Achatina (? Glandina) fusiformis, *Pfr.*	Mountain of Coban, Vera Cruz.—Mus. Cum.	

Page.	Proc. Zool. Soc.	Locality.	Station.
1845.			
75	Glandina nigricans, *Pfr*.	Vera Cruz.—Mus. Cum.	
75	—— monilifera, *Pfr*.	Mountain of Coban, Vera Cruz.—Mus. Cum.	
131	Helix ventrosula, *Pfr*.	Mexico(*Hds.*) Texas(*Sow.*)	
132	—— Hindsi, *Pfr*.	Mexico(*Hds.*) Texas(*Sow.*)	
139	Littorina aspera, *Phil*.	Sitka, *Barc.*; Mex. *Hegew.*	rocks at low water.
140	—— Sitkana, *Phil*.	Sitka, *Barclay.*	rocks, ½-t.
141	—— modesta, *Phil*.	Sitka, *Barclay*; Mauritius, *Capt. Caldwell.*	rocks, ½-t.
1846.			
24	Cypræa pulla, *Gask*.	?	
29	Bulimus fenestratus, *Pfr*.	Mexico.	
29	—— Darwini, *Pfr*.	Galap., *Darwin.*	on bushes.
29	—— sculpturatus, *Pfr*.	Galap., *Darwin.*	on bushes.
30	—— Gruneri, *Pfr*.	Mexico.	
31	Achatina cylindracea, *Pfr*.	Tortilla, Centr. Am.	damp places.
32	—— (Glandina) Sowerbyana, *Pfr*.	Totontepec[?Tehuantepec]	decayed veget. matter.
32	—— (——) Isabellina, *Pfr*.	Mexico.	dec. trunks of trees.
32	—— (——) Tortillana, *Pfr*.	Tortilla.	damp places.
54	Haliotis splendens, *Rve*.	California.	
58	—— aquatilis, *Rve*.	Kurile Is.	
113	Bulimus Moricandi, *Pfr*.	Mt. Coban, C. A., *Lattre.*	
1849.			
117	Anomia lampe, *Gray*	California, *Lady Wigram.*	
121	Placunanomia macrochisma, *Desh*. =*P. Broderipii*, Gray, MS.	Kamtschatka, *Deshayes.* Onolaski, Mus. Cum.	
121	—— cepio, *Gray*	California, *Lady Wigram.*	
122	—— alope, *Gray*	California, *Lady Wigram.*	
130	Helix Baskervillei, *Pfr*.	Vancouver's I., *Baskerville.*	
170	Sanguinolaria tellinoides, *A. Ad.* pl. 6. f. 6	Gulf of California.	
1850.			
187	Melania maxima, *Lea*	Copan, C. A.	
195	—— polygonata, *Lea*	Copan, C. A.	
203	" Modulus Carchedonicus, *Lam*." " =*Monodonta Sayii*, Nutt." Atooi is in the Sandwich Is., not in California. Mr. N. found no *Modulus* in California. *M. carchedonica*, Lam. is the W. Indian species, teste D'Orb. Coll.	" Atooi, California, *Nutt.*," teste *A. Ad.*	
1851.			
12	Columbella Californiana, *Gask*.	Sandeago.	
153	Infundibulum Californicum, *A. Ad.*	California.	
157	Phorcus Californicus, *A. Ad*.	California.	
164	Ziziphinus annulatus, *Martyn* =*Trochus virgineus*, Gmel.	Monterey, *Hartweg.*	
165	—— filosus, *Wood*, Ind. Suppl. pl. 5. f. 23. ?=*Trochus castaneus*, Nutt. =*T. ligatus*, Gld.	Str. San Juan de Fuco.	
168	—— Californicus, *A. Ad.* ?=*Trochus versicolor*, Mke.	California.	
190	Margarita calostoma, *A. Ad.*	Juan de Fuco.	
197	Tedinia pernoides, *Gray* =*Placunanomia pernoides*, B. M. Maz. Cat.	? California.	
225	Velutina Sitkensis, *A. Ad.*	Sitka.	
233	Natica intemerata, *Phil*.	Gulf Calif., *Rev. — Steel.*	
260	Helix annulifera, *Pfr*. =*H. labyrinthus*, var. *sipunculata*, Forbes, P. Z. S. 1850, p. 53. pl. 9. f. 4.	Panama, *Kellett & Wood.*	
272	Lagena Californica, *A. Ad*.	California.—Mus. Cum.	

Page.	Proc. Zool. Soc.	Locality.	Station.
1852.			
60	Bulimus nucula, *Pfr.*	Galapagos.	
82	Orbicula Evansii, *Dav.*, pl. 14. f. 32–34.	Bodegas.	
100	Cardita Californica, *Desh.*	Gulf of California.	
157	—— incrassatus, *Pfr.*	Galapagos.	
1853.			
70	Typhis fimbriatus, *A. Ad.*	Gulf of California.	
71	Murex pauxillus, *A. Ad.*	Gulf of California.	
71	—— fimbriatus, *A. Ad.*	Gulf of California.	
71	—— armatus, *A. Ad.*	Gulf of California.	
96	Semele Californica, *A. Ad.*	Gulf of California.	
174	Morum xanthostoma, *A. Ad.* = *Oniscia tuberculata*, var. *α*, Rve.	Galapagos.	
185	Pseudoliva Kellettii, *A. Ad.*	?—Kellett & Wood. [Probably Lower California.]	
1854.			
20	Cyrena (Anomala) insignis, *Desh.*	Bay of California.	
21	—— subquadrata, *Desh.*	California.	
22	—— (Anomala) Cumingii, *Desh.*	Central America.	
23	—— —— inflata, *Desh.*	Panama.	
42	Typhis grandis, *A. Ad.*	California.	
67	Mactra angusta, *Desh.*	Panama.	
68	—— Californica, *Desh.*	Gulf of California.	
70	—— goniata, *Gray, MS.*	California.	
137	Rhizochilus asper, *A. Ad.*	Gulf of California.	
295	Achatina Albersi (Glandina), *Pfr.*	Gulf of California.	
314	Latyrus armatus, *A. Ad.*	California.	
316	Chlorostoma funebrale, *A. Ad.*	California.	
342	Corbicula convexa, *Desh.*	Central America.	
351	Donax bella, *Desh.*	Acapulco.	
351	—— Conradi, *Desh.* Jun. = *D. culter*, Hanl. + *D. contusus*, Rve. + *D. Californica*, Desh. MS. non Conr. ? + *D. radiatus*, Val.	California.	
352	—— obesula, *Desh.* ? = *D. Californica*, Conr. non Desh.	Central America.	
352	—— ovalina, *Desh.*	Central America.	
359	Tellina Mazatlanica, *Desh.*	Mazatlan.	
362	—— brevirostris, *Desh.*	C. America & California.	
363	—— delicatula, *Desh.*	Mazatlan.	
363	—— straminea, *Desh.*	Bay of California.	
1855.			
100	Achatina (Glandina) conularis, *Pfr.*	Mexico, *Sallé.*	
116	Bulimus verrucosus, *Pfr.*	Galapagos.	
121	Rhizochilus (Coralliophila) Californica, *A. Ad.* [= *Murex nux*, Rve.]	Gulf of California.	
183	Erycina papyracea, *Desh.*	West Columbia.	
224	Dosinia simplex, *A. Ad.* [not *Artemis simplex*, Hanl. = *D. Dunkeri*, Phil.]	Singapore.	
228	Pandora claviculata, *Cpr.*	Mazatlan, *Lieut. Shipley.*	
228	Lyonsia (Osteodesma) diaphana, *Cpr.*	Mazatlan, *Lieut. Shipley.*	
229	Periploma excurvata, *Cpr.*	Mazatlan (*Gruner*).	
229	—— papyracea, *Cpr.*	Mazatlan (Mus. Cum.).	
229	Thracia squamosa, *Cpr.*	Mazatlan, *Lieut. Shipley.*	
230	? Scrobicularia producta, *Cpr.*	Gulf Calif., *Lieut. Shipley.*	
230	Donax semistriatus, *Cpr.* [non *Poli*] = (*Donax*) *Serrula Carpenteri*, H. & A. Ad. Gen. ii. 405.	Gulf Calif. (Mus. Cum.)	
230	Diplodonta subquadrata, *Cpr.*	Mazatlan (Mus. Cum.).	
231	Chiton Montereyensis, *Cpr.*	Monterey, *Hartweg.*	on exposed rocks.
231	—— Hartwegii, *Cpr.*	Monterey, *Hartweg.*	on exposed rocks.
232	—— regularis, *Cpr.*	Monterey, *Hartweg.*	under stones.

Page.	Proc. Zool. Soc.	Locality.	Station.
1855.			
233	Patella ?toreuma, *Rve.*, var. tenuilirata	Monterey, *Hartweg.*	
233	Galerus ?Sinensis, var. fuscus........... (Probably from another source, by error of ticket.)	"G. Calif." (Mus. Cum.)	
233	—— subreflexus, *Cpr.*	"G. Calif." (Mus. Cum.)	
234	Fissurella nigrocincta, *Cpr*.............. (The locality is omitted by accident in the Proceedings.)	Mazatlan (Mus. Cum.).	
234	Callopoma ?fluctuatum, var. depressum (=*Turbo funiculosus*, Kien. pl. 30. f. 1. Diagn. postea visâ.)	California (Mus. Cum.).	
234	Litiopa divisa, *Cpr*......................	CapeS.Francisco*,*Hds.*Str. Sunda, among small drifted canes, Mus. Archer.	
235	Scalaria reflexa, *Cpr.*	San Blas, *Capt. Donnell.*	1 sp.
1856.			
41	Fusus pallidus (animal descr. by Gray)	Guaymas.	
41	Pisania elegans ,, ,,	Panama.	
41	Triumphis distorta ,, ,,	Panama.	
43	Malea ringens ,, ,,		
44	Imperator, ? n. s. ,, ,,	Panama.	
44	Callopoma saxosum ,, ,,	Panama.	
44	Tegula pellis-serpentis ,, ,,	Panama.	
167	Crucibulum spinosum, var. compresso-conicum.	California (Mus. Cum.).	
167	—— ?? i mbricatum var. Cumingii ...	Callao, Valparaiso.	
168	—— ? imbricatum, var. Broderipii ...	? Peru (Mus. Cum.).	
	Trichotropis† Gouldii, *A. Ad.*	Chiriqui, *Bridges.*	

60. The following species and localities are extracted from the "Conchological Illustrations, by G. B. Sowerby," a small but exceedingly valuable work, remarkable for the excellence of the figures, but the disappointing brevity of its information.

No.	Fig.	
2	46.	*Cardium Indicum,* Lam. N.W. Coast of America.
76	11, 35.	*Chiton fastigiatus,* Gray. California.
	152.	—— *tunicatus,* Sow. = *Katherina Douglasiæ,* Gray. California.
54		*Bulinus unifasciatus* = *Bulinulus undulatus,* Guild. St. Vincent's.
115	32.	*Cypræa sanguinea,* Gray. Panama and Mexico.

61. The following are taken from the "Thesaurus Conchyliorum," by G. B. Sowerby, continued by G. B. Sowerby, Jun. The illustrations are excellent; but some of the later numbers do not equal the earlier portions. Several of the Monographs are very carefully drawn out by Messrs. Hanley, Hinds, and A. Adams. There are the same geographical errors as in other similar works.

No.	Page.	Pl.	Fig.	
	46	15	101.	*Pecten laqueatus.* N.W. America, *Capt. Dixon* (California, *Rve.*).
48	96	25	141.	*Scalaria indistincta,* Sow. jun. San Blas, *Hon. — Harris.*
13	115	36	20, 27.	*Columbella festiva.* "Brought from Acapulco by H. Cuming," [who never was there].
64	173	43	63.	*Terebra variegata,* Gray = *T. africana,* Gray, Griff. Cuv. "Guaymas, 10–12 fm., sandy mud, Cuming."

* Probably in Ecuador; not in Upper California, as supposed when described.

† This shell, described as "differing from the typical genus in the canal of the aperture being almost obsolete," is regarded by several eminent conchologists as a dead *Melania.* It was found near the mouth of a river.

No.	Page.	Pl.	Fig.	
18	352	70	50–2.	*Terebratula Californica*, Küst. "Abounds on the coast of California."
91	534	116	249–51.	*Neritina Listeri*, Pfr. Cuba and St. John's Riv., Nicaragua.
55	578	123	79, 80.	*Bulla nebulosa*, Gould. Sand, 12 inch. Guaymas.
12	615	128	35.	*Cytherea intermedia*, Sow. jun. "California, Cuming."
59	628	132	98.	—— *chione*, Linn. "Mr. Cuming's specimens are from Mazatlan."
65	631	132	104–6.	—— *circinata*, Born. =*Venus rubra*, Gmel. ?+*C. alternata*, Brod. Mazatlan, *Capt. Donnel, R.N.*
71	632	132	109.	—— *brevispinosa*, Sow. jun. 1 sp. California.
3	656	140	2.	*Artemis ponderosa*, Gray, Anal. 1838, p. 309. =*Cytherea gigantea*, (Sow. MS.) Phil. Abbild. pl. 7. f. 1. Sandy mud, low water. Gulf of California.
65	697	146	41.	*Tapes diversa*, Sow. jun. Monterey, *Hartweg*.
16	708	153	17, 18.	*Venus simillima*, Sow. jun. California.
18	709	144	26, 27.	—— *amathusia*, Phil. Abbild. pl. 11. f. 4. =*V. encausta*, ? cujus. California.
24	769	165	30.	*Venerupis paupercula*, Desh. P.Z.S. 1853, p. 5. [N. Zealand, Mus. Cum. et Brit. teste *Desh.*] "Mazatlan, *Cuming*," teste *Sow.*
25	811	171	33.	*Obeliscus clavulus*, A. Ad. On the sands. Acapulco, *Col. Moffat.*
143	881	184	246.	*Cerithium assimilatum*, C. B. Ad. "Shells of Jamaica. A darkly coloured Jamaican shell, like *C. trilineatum*," Phil. Medit. [=*C. assimilatum*, C.B.Ad., Pan. Shells, no. 194. *C. terebellum*, C. B. Ad. Contr. Conch. is the Jamaican species.]

62. The following species* are extracted from Mr. Reeve's 'Conchologia Iconica'; a work, the principal advantage of which is, that it figures the specimens in the Cumingian collection. The species are often very minutely subdivided: for this indeed the author may not always be answerable. It is to be regretted that there is sometimes a want of precision in the statement of localities†.

Pl.	Sp.	Fig.	Name.	Station.	Depth in fms.	Locality.
3	19	...	Amphidesma Californica, *A. Ad.* .... =*Semele C.*, A. Ad. P. Z. S. July 1853.	....	......	Gulf of California.
3	20	...	—— proxima, [*Rve.* quasi] *C. B. Ad.* ... [=*Semele flavicans*, Gld.: v. antea, p. 279. no. 487.]	....	......	Panama [?]
4	24	...	Donax contusa, *Rve.* .... [=*D. Conradi*, adol.: v. B. M. Maz. Cat. p. 47.]	....	......	Mazatlan.
9	34	...	Mactra angulata, *Gray, MS.*	....	......	Gulf of California.
17	89	...	—— elegans, *Sow.* Tank. Cat.	....	......	Florida, Mus. Cum. [?]
18	93	...	—— angusta, *Desh.* P. Z. S. 1854.........	....	......	Panama, *Cum.*
20	114	...	—— Californica, *Desh.* ,, ,, ...	....	......	California, Mus. Cum.
4	17	...	Lucina annulata, *Rve.*......................	....	......	? California.
3	17	...	Arca Brasiliana, *Lam.* .... =*A. cardiiformis*, Sow.	on the sands	......	"San Blas, Bay of California, *Cum.*"[!] Rio Janeiro, Lam.
1	3	...	Pectunculus giganteus, *Rve.*	sandy mud	7	Guaymas, *Babb.*
4	16	...	—— inæqualis, *Sow.* P. Z. S. 1832 ...... =*Arca pectiniformis*, Wd., S. pl. 2. f. 11.	sandy mud	10	Bay Panama, Real Llejos, *Cum.*

* See also pp. 187, 208, where many of the species now quoted would have been arranged, had I been able to refer to the Conch. Ic. whenever occasion required.

† When Mr. Cuming is given as the authority for depths and stations in places which he never visited, the more correct phrase (now generally adopted) would perhaps have been "Museum Cuming." The following instance will show the need of caution. Under *Mactra carinulata*, Desh. pl. 10. sp. 38, we read "Gulf of California: from the same locality as *M. donaciformis*." On turning to the latter, we find its locality given as New Zealand.

Pl.	Sp.	Fig.	Name.	Station.	Depth in fms.	Locality.
5	20	...	Pectunculus bicolor, *Rve.* P. Z. S. 1843 .. =*P. inæqualis*, Gray, Z. B.V., non Sow. [nec Krauss.]	....	......	Gulf of California.
7	31	*a, b*	Pecten ventricosus, *Sow.* in Thes. Conch. =*P. tumidus*, Sow. P.Z.S. 1835, p. 109, non Turt.	sandy mud	6–10	St. Elena, *Cum.*; also Philippines, *Cum.*
31	137	...	—— circularis, *Sow.* „ „ p. 110 ?=*P. nucleus*, var.	sandy mud	7	California, *Cum.* [!]
1	2	2, 3	Hinnites giganteus, *Gray*, Ann. Phil. 1826, vol. xii. p. 103. [=*Hinnita Poulsoni*, Conr. 1834, Journ. Ac. Nat. Sc. Phil. vol. vii. pt. i. p. 182. pl. 14.]	....	......	California and Straits of Juan Fernandez [!].
9	34	...	Spondylus limbatus, *Sow.* Thes. Conch. p. 427. pl. 88. f. 51. [For the Mazatlan specimens, v. B. M. Cat. no. 208.]	....	......	Panama and Mazatlan.
14	52	...	—— radula, *Rve.*	....	......	Tehuantepec, *Capt. Dare.*
			Pfr. Jay.			
36	214	...	Bulimus fenestratus, *Pfr.* no. 258 4802	....	......	Mexico [? ubi].
51	332	...	—— Gruneri, *Pfr.* „ 585 4845	....	......	Mexico.
45	286	...	—— rudis, *Anton,* „ 535 5082	....	......	Mexico [sp. 216, err. typ.]
100	552	...	Helix uncigera, *Pet.* .... *Caracolla u.*, Petit, Guér. Mag. Zool. 1838, pl. 113.	....	......	Panama.
117	684	...	—— Baskervillei, *Pfr.* P.Z.S. 1849, p. 130	....	......	Vancouver's Is., *Lieut. Bask*
1	3	...	Siphonaria gigas, *Sow.*	....	......	Galapagos and Panama.
2	8	*a, b*	—— characteristica, *Rve.*	....	......	Galapagos and Panama.
4	15	*a, b*	—— æquilorata, [*Rve.* quasi] *Gray, MS.* March 1856. [*S. æquilirata*, Cpr. B. M. Cat. no. 240. Apr. 1856.]	....	......	Mazatlan.
7	33	*a, b*	—— amara, [*Rve.* quasi] *Nutt. MS.* ... [?=*S. Lecanium**, Phil. var.]	....	......	California.
2	11	...	Chiton albilineatus, *Sow*	....	......	Guaymas.
2	7	...	—— articulatus, *Sow*	" u. stones,	l. w.	San Blas, *Cum.*" !
10	55	...	—— Sitkensis, *Rve.* (non *Midd.*)	....	......	Sitka, *Lady Douglas.*
17	106	...	—— scaber, *Rve.*	....	......	Central America.
24	161	...	—— proprius, *Rve*	....	......	W.C. Cent. Amer., *Sinclai*
16	37	*a, b*	Patella Cumingii, *Rve.* .... [=*Acmæa patina*, Esch.]	....	......	"Valparaiso, Cum.," Rve "Never took it," Cur ipse. "Monterey, Har weg," teste Mus. Cum
16	38	*a, b*	—— clypeaster, *Less.* Voy. Coq. .... [?=*A. patina*, var.]	....	......	Monterey, *Hartweg.*
10	18	*a, b, c*	—— venosa, *Rve.*	....	......	Is. Chiloe, W. Col. [!!], *Cu*
19	47	*a, b*	—— exarata, *Nutt.* .... The *P. exarata*, Nutt., of Jay's Cat. 2814, and of Nuttall's coll. is from the Sandw. Is. The Oregon shell may be a variety of the shell called *Mazatlanica*, probably=*A. cassis*, Esch.	....	......	Oregon, *Lieut. Baskervil*
24	...	62*ab*				
24	60	*a, b, c*	—— cinis, *Rve.* [=*A. patina*, var.]	....	......	Monterey, *Hartweg.*
26	67	*a, b*	—— vespertina, *Rve*	....	......	Panama and Gulf Calif.
27	69	*a, b, c*	—— toreuma, *Rve.*	....	......	Monterey, *Hartweg.*

* Specimens of this species (along with the proof-sheet of Siphonariadæ) were sent, at Mr. Cuming's request, for the use of the author of the Conch. Ic., but no notice of it has been found in the Monograph. As Mr. Nuttall found no *Siphonaria* in California, it is presumed that Mr. Reeve's species, if of Nuttall, is from the Sandwich Islands; if "Californian," that it is the Mazatlan *S. Lecanium*, Phil.

Pl.	Sp.	Fig.	Name.	Station.	Depth in fms.	Locality.
29	75	*a, b*	Patella livescens, *Rve.* [allied to *P. toreuma*]	....	......	Mazatlan.
29	76	*a, b*	—— spectrum, *Nutt.* [= *P. scabra*, Gld. non Nutt.]	....	......	California.
29	78	*a, b*	—— discors, *Phil.* Abbild. pl. 2. f. 6 ...	....	......	Mazatlan, *Shipley*.
30	81	*a, b*	—— Nuttalliana, *Rve.* [? = *A. patina*, var.]	....	......	Oregon.
31	87	*a, b*	—— verriculata, *Rve.* [= *A. patina*, var.]	....	......	California.
34	101	*a, b*	—— leucophæa, *Nutt.* [= *A. pelta*, Esch.]	....	......	Upper California.
35	107	*a, b*	—— umbonata, *Nutt.* [= *A. persona*, var.]	....	......	Upper California.
36	112	*a, b*	—— Oregona, *Nutt.* [= *A. persona*, Esch.]	....	......	Oregon.
37	119	*a, b*	—— scabra, *Nutt.* [non Gld. = *spectrum*, Nutt.]	....	......	Upper California.
38	121	*a, b*	—— fenestrata, *Nutt.* [= *A. patina*, var.]	....	......	Upper California.
40	130	*a, b*	—— navicula, *Rve.* [= *A. mitella**, Mke.]	....	......	Mazatlan, *Shipley*.
40	132	*a, b*	—— corrugata, *Rve.* [= *P. pediculus*, Phil.]	....	......	Acapulco.
42	140	*a, b*	—— mamillata, *Nutt.* [= *A. patina*, var.]	....	......	California.
8	56	...	Fissurella rugosa, *Sow.*	under stones	l. w.	Galapagos, *Cum.*
9	64	...	—— densiclathrata, *Rve.* .... [? = *Glyphis aspera*, Esch.]	....	......	?
3	9	...	Turritella lentiginosa, *Rve.* .... [= *T. goniostoma*, var.]	coarse sand	5	Payta, *Cum.*
4	13	...	—— Cumingii, *Rve.*	mud	11–16	Panama, *Cum.*
			[? = *T. tigrina*, var.]	....	......	Conchagua, *Belcher*.
4	15	...	—— Banksii, *Gray, MS.* .... [? = *T. goniostoma*, jun.]	sandy mud	10	Panama, *Cum.*
6	27	...	—— sanguinea, *Rve.*	....	......	California, *Mus. Belcher*.
5	25	...	Ampullaria Columbiensis, *Sow. MS.*	....	......	Chiriqui, Veragua.
17	81	...	—— Cumingii, *King*, Zool. Journ. vol. v. p. 344.	....	......	Is. Taboga, Panama.
21	99	*a, b*	—— cerasum, *Hanl.* Conch. Misc.	....	......	Mexico †.
4	12	...	Haliotis corrugata, *Gray*, in Wd., pl. 8. f. 5	....	......	California.
7	23	...	—— Cracherodii, *Leach*, Zool. Misc. 1814, vol. i. p. 131. = *H. glaber*, Schub. & Wagn.	....	......	California.
8	26	...	—— Californiensis, *Swains.* Zool. Illustr. vol. ii. p. 80.	....	......	California.
5	18	...	Turbo tessellatus, [*Rve.* quasi] *Kien.*	....	......	California.
12	57	...	—— marginatus, *Nutt. MS.*	....	......	Upper California [?].
4	20	*a, b*	Neritina Californica, *Rve.*	....	......	Gulf of California.
15	71	*a, b*	—— Listeri, [*Rve.* quasi] *Pfr.*	....	......	Cuba, Nicaragua.
25	109	...	—— Michaudi, *Récl.* P. Z. S. 1841, p. 315	....	......	Panama.
28	126	*a, b*	—— Listeri, [*Rve.* quasi] *Pfr.* [non eadem]	....	......	St. John's Riv., Nicaragua.
10	39	*a–c*	Cypræa onyx, *Linn.* = *C. adusta*, Lam.... [= *C. nymphæ*, Ducl. = *C. pulla*, Gmel. (non Gask.) teste Jay.]	....	......	San Diego [? auct.].
3	61	...	—— punctulata, *Gray*, Z. Journ. i. 387..	under st.	......	Panama, *Cum.*
8	94	...	—— albuginosa, *Mawe*, Z. Journ. i. 510..	....	......	California.
1	113	...	—— Solandri, *Gray*, Sow. Conch. Ill. no. 128. f. 43.	....	......	California.
1	119	...	—— Maugeriæ, *Gray*, Sow. Conch. Ill. no. 111. f. 30.	....	......	Galapagos, *Cum.*
3	128	*a, b*	—— Californica, *Gray*, Z. Journ. iii. 365.	....	......	California.
5	141	...	—— rubescens, *Gray*, P. Z. S. 1832, p. 185.	under st.	......	Galapagos, *Cum.*

* It is to be regretted that the author of the Conch. Ic., when describing so many new species of Limpets from the West coast of America, did not avail himself of the previous labours of Eschscholtz and Menke in the same field.

† Supposed to be from the Reigen (Havre) Col., as well as other species described from Mexico: but no dependence can be placed on the localities of the shells sold at the auctions: *v. antea*, p. 242.

Pl.	Sp.	Fig.	Name.	Station.	Depth in fms.	Locality.
25	142	*a, b*	Cypræa suffusa, *Sow.* Conch. Ill. n. 126. f. 41. = *C. armandina*, Ducl.*	....	......	Galapagos, *Cum.*
13	70	...	Conus pyriformis, *Rve.*	sandy mud	7–10	Caraccas & Montija, *Cum.*
14	72	*a, b*	—— brunneus, *Sow.* P. Z. S. 1834	clefts of rks.	......	Puert. Pt., Pan., Gal., *Cum.*
14	75	...	—— vittatus, *Lam.*	coarse sand	7–11	Bay Pan. & Montija, *Cum.*
22	126	...	—— Mahogani, *Rve.* P. Z. S. 1843 [? *C. interruptus*, var.]	sandy mud	......	Salango, *Cum.*
26	143	...	—— minimus, *Linn.*	....	......	Ceylon.—Is. Annaa, *Cum.*
			var. β. = *C. tiaratus*, Brod.	pools on sds.	......	Galapagos, *Cum.*
26	146	...	—— regularis, *Sow.* Conch. Ill. f. 45	soft mud {	23	Gulf Nicoya.
					7	Bay Panama, *Hinds.*
27	153	...	—— concinnus, *Brod.* P. Z. S. 1833	on the sands	......	"B. of Calif.," *Babb, R.N.*
9	33	*a, b*	Natica alabaster, *Rve.* [? = *N. uber*, var.]	....	......	Mazatlan.
2	7	*a, b*	—— Chemnitzii, *Récl. MS.* 1855, non *Mke.*	....	......	Panama.
4	12	...	—— perspicua, *Récl.* in Pet. Jour. Conch. vol. i. p. 379. pl. 14. f. 1, 2.	....	......	Mouth of Oregon, *Lieut. Baskerville.*
10	40	*a, b*	—— bifasciata, *Gray*	sand	l. w.	Guaymas, *Mr. Babb, R.N.*
13	54	...	—— uber, *Val.*	muddy sand	4	Casma, Peru, *Cum.*
19	85	*a, b*	—— unimaculata, *Rve.*	....	......	Mazatlan, *Lieut. Shipley.*
4	8	*a–d*	Harpa rosea	sand	dp. w.	Senegal.
4	9	*a–c*	—— crenata, *Rve.* = *H. rosea*, var. Kien. = *H. Rivoliana*, Less. [= *H. testudinalis* + *H. Mexicana*, teste Jay.]	sandy mud	d. w.	Acapulco, *Cum.* [!]
4	5	...	Dolium ringens, *Sow.* Tank. Cat. App. p. xxi. = *Malea latilabris*, Val.	....	......	Payta, *Cum.*
8	18	*a, b*	Cassis abbreviata, *Lam.* + *C. lactea*, Kien. + *C. centiquadra* + *C. doliata*, Val.	....	......	Acapulco.
1	5	*a, b*	Oniscia tuberculosa, *Sow.* Gen. p. 2 var.	....	......	Gulf California, Mus. Cum
1	1	*a, b*	Voluta Cumingii, *Brod. P. Z. S.* 1832	....	9	Gulf Fonseca, San Salvador
5	26	...	Turbinella castanea, *Rve.* = *T. acuminata*, Rve. Conch. Syst.: non Gray in Wood Suppl.	crev. of rks.	......	Panama, *Cum.* [*Cum*
7	37	...	—— cerata, *Gray*	under st.	l. w.	Galapagos, *Cum.*
8	40	...	—— tectum, *Gray* [Cuma]	sandy mud	10	Bay Panama, *Cum.*
1	3	...	Fasciolaria princeps, *Sow.*	....	......	Peru, *Cum.*
1	1	*a, b*	Oliva angulata, *Lam.* = *Voluta incrassata*, Dillw. = *O. azemula*, Ducl.	sandy mud	9	Gulf Nicoya, *Cum.*
10	16	*a–i*	—— reticularis, *Lam.*	....	......	Is. Granada, West Indies
			"vars. = *O. araneosa*, Lam. + *O. Timoria* + *O. venulata* + *O. obesina* + *O. pindarina*, Ducl."	....	......	Gulf of California, *Donne*
11	19	*a, b*	—— Cumingii, *Rve.*	....	......	Gulf Calif., *Donnet.*
18	36	...	—— testacea, *Lam.*	sandy mud	6	Real Llejos, *Cum.*
20	48	...	—— biplicata, *Sow. Tank. Cat. App.* p. 33	sands	l. w.	Monterey, *Hinds.*
23	63	*a, b*	—— lineolata, "*Gray*, Wood Suppl. = *O. dama*, Ducl." [*O. lineolata*, Gray, Z. B. V. = *O. dama*, Mawe, in Wood Suppl.]	....	......	California.
25	73	*a–e*	—— undatella, *Lam.* + *O. nedulina* + *O. ozodina*, Ducl.	sand & mud banks	l. w.	Bay Panama, *Cum.*
25	74	*a, b*	—— anazora, *Ducl.*	sandy mud	10	Xipixapi, *Cum.*
26	80	*a–c*	—— tergina, *Ducl.*	sand banks	......	Conchagua, *Cum.*
4	13	...	Triton clandestinus, *Chemn.* {	sandy mud	6	Philippines, *Cum.*
				under st.	......	Galapagos, *Cum.*
20	97	...	—— pagodus, *Rve.* [Nassa]	....	......	Bay Montija, *Cum.*
20	99	...	—— pictus, *Rve.*	under st.	l. w.	Galapagos, *Cum.*
1	3	...	Purpura patula, *Linn.*	....	......	Philippine Is., *Cum.*
6	28	*a, b*	—— bicostalis, [*Rve.* ? non] *Lam.*	on rocks	l. w.	St. Elena, *Cum.*

* Whether this and *C. subrostrata* (Rve. pl. 26. f. 147) be the Pacific or the Caribbæan species, or whether they are identical, has not yet been decided.—Vide B. M. Maz. Cat. p. 379.

Pl.	Sp.	Fig.	Name.	Station.	Depth in fms.	Locality.
4	23	...	Ricinula alveolata=*Purpura a.*, *Kien.* Icon. Conch. p. 42. pl. 9. f. 23. [Non Rve.]	....	......	Panama, *Cum.*
1	1	...	Monoceros unicarinatum, *Sow.* C. I. f. 5. "=*P. spicata*, Blainv., Kien.=*P. engonata*, Conr." [*v.* antea, p. 201.]	....	......	California.
1	2	...	—— punctatum, *Gray*, Z. B. V. p. 124... "=*P. lapilloides*, Conr." [v. p. 201.]	....	......	Is. Cocos, N.W. Mexico, *Capt. Colnett.*
6	39	...	Buccinum pristis, *Desh*..................... =*B. serratum*, Dufresne. =*B. Northiæ*, Gray, MS.	....	......	St. Elena.
6	43	...	—— pusio, *Linn.*	....	......	Honduras, California. [?]
7	50	...	—— pagodus, *Rve.*	clefts of rks.	l. w.	Island Taboga, *Cum.* v. r.
3	10	...	Pyrula subrostrata, *Gray*, Z. B. V. pl. 36. f. 15. =*Buccinum subrostratum*, Wood. =*Fusus lapillus*, Brod. & Sow.	sandy mud	12	Bay Montija, *Cum.*
2	9	...	Fusus* Dupetit-Thouarsii, *Kien.*	....	......	Galapagos, *Cum.*
16	61	...	—— Oregonensis, *Say*=*Triton O.*, Say.	....	......	N. America [?ubi].
	77	...	—— Mexicanus, *Rve*......................	....	......	Mexico [?ubi].
19 2	7	...	Murex monoceros, *Sow.* P. Z. S. 1840 ... ?=*M. Nuttalli*, Conr.	....	......	California.
3	12	...	—— foliatus, *Gmel.*	rky. places	......	Sitcha, *Eschscholtz.*
24	98	*a, b*	—— salebrosus, *King*	under st.	......	Panama, *Cum.*
28	128	...	—— horridus, *Brod.* P. Z. S. 1832 ...... =*Fusus h.*, Sow. Conch. Ill. f. 29. =*M. Boivinii*, Kien.	sandy mud	8–12	St. Elena and Panama.

63. The Monographs of Kiener, in his "Coquilles Vivantes," are generally executed with great care, and are extremely valuable for the identification of species. The writer does not fall into the common error of minute division of species: on the other hand, he sometimes unites what will be almost universally considered as distinct. His judgment is not always correct on small shells, as when he thinks that *Cerithium trilineatum* of Phil. ought without doubt to be considered as a dextral variety of *C. perversum.* For the identification of the Lamarckian species, his work is extremely valuable. But on points connected with geographical distribution, the following list will show that, unconfirmed, it cannot be regarded as an authority. The "California" of French authors, as of English, generally applies to the W. Mexican fauna. Unfortunately, there are no dates, by which questions of the priority of nomenclature may be decided.

No.	Page.	Plate.	Fig.	
?	?	30	1.	*Turbo funiculosus*, Kien. [=*T.* ?*fluctuatus*, var. P.Z.S. 1855, p. 234.]
?	?	14	2, 2*a*.	*Trochus inermis* [quasi] Gmel.
22	29	4	2.	*Turritella tigrina*, Kien.
25	36	13	3.	*Cerithium maculosum*, Kien. [Named *adustum* on the plate.] S. Sea, Acapulco, Galapagos.
26	37	13	2.	—— *adustum*, Kien., non Sow. [Named *maculosum* on the plate.] Indian Ocean, Red Sea. [Probably correct.]
31	38	7	3.	*Cypræa Sowerbyi*, Kien. =*C. zonata*, Sow. non Chemn. Calif.
51	59	8	2.	—— *Lamarckii*, Ducl., Val., Rve., p. 334. Acapulco. [Not so given in Val., Rve.]
133	146	22	4.	—— *lathyrus*, Dufresne. =*C. sanguinea*, var. Pacific.

* *Fusus corrugatus*, Rve. pl. 20. sp. 84, *a b*, is said to be=*Trophon muriciforme*, King, Zool. Journ.

No.	Page.	Plate.	Fig	
138	152	45	3,3a.	*Cypræa subrostrata*, Gray. Isle of France.
136	150	52	1.	—— *candidula*, Gask. W. Mexico.
9	14	7	2.	*Cancellaria goniostoma*, Sow. =*C. brevis*, Sow., teste Kien.
12	18	8	2.	—— *chrysostoma*, Sow. Panama, Peru, Galap.
24	18	16	1.	*Pleurotoma funiculata*, Val. San Blas.
37	59	23	1.	—— *maura*, Val. [=*P. Melchersi*, Mke.] Mazatlan, *Botta*.
26	33	15	2.	—— *Bottæ*, Val. [=*P. incrassata*, Sow.] Mazatlan, *Botta*. 1 sp.
115	139	55	1.	*Conus Lorenzianus*, Chemn. Acapulco.
7	10	4	7, 7 a.	*Solarium variegatum*, Lam. N. Holland, Manilla, N. Ireland. "=*S. cyclostomum*+*S. Æthiops*, Mke.+*S. tessellatum*, Desh."
18	27	12	2.	*Pyrula ventricosa*, Val. San Blas.
10	19	8	15.	"*Cassis coarctatum*, Sow., Les côtes du Perou à Acapulco."
7	11	7	1.	*Ranella bufonia*, Lam. Red Sea, Seychelles, N. Ireland, Calif.
13	19	11	2.	—— *semigranosa*, Lam. "= *R. cœlata*, Brod." Panama.
23	31	8	1.	—— *argus*, Lam. "=*Triton Ranelliformis*, King, Z.J. p. 347. Var. = *Ranella vexillum*, Sow. Conch. Ill. pl. 1. f. 3." Chili.
27	36	4	2.	—— *anceps*, Lam. =*R. pyramidalis*, Brod. P.Z.S. 1832, p. 194.
22	30	15	1, 2.	—— *scabra*, Grateloup. Peru.
16	25	16	1.	*Turbinella cerata*, Griff. Mazatlan, common. *Du Petit Thouars.*
17	26	16	2.	—— *tubercularis*, Griff. (A few sp. from the voyage of Du Petit Thouars.) Mazatlan.
25	36	20	1	—— *cingulata*. [Operculum described. Yet Reeve, after this, places the shell under *Monoceros*.]
61	98	26	70.	*Purpura chocolatum*, Ducl. Coasts of California.
71	114	37	87.	—— *biserialis*, Blainv. Shores of Mazatlan.
40	64	17	49.	—— *bezoar*, Bl. China and California.
49	78	20	58.	—— *columellaris*, Lam. Red Sea and Pacific, Chili, California.
...	81	21	60*b*.	—— *callosa*, var. [= *P. triserialis*.]
68	109	28	74.	—— *Grayi*, Kien. "= *Mon. grandis*, Gray." Pacific.
92	141	44	102.	*Monoceros lugubris*, Sow. Gen. no. 5. f. 3. "= *M. cymatum*, Tank. Cat. 1888. = *Buccinum denticulatum* + *armatum*, Wood Suppl." Peru and California.
24	23	9	28.	*Buccinum serratum*. [=*Northia pristis*.] "Habite la Mer du Sud, sur les côtes de la Californie," Eydoux.
4	2	10	2.	*Columbella hæmastoma*, Sow. California.
5	3	1	2.	—— *paytalida*, Ducl. "=*C. rustica*, Sow. Gen. f. 3. non Lam." = *C. fuscata*, Sow. California.
7	10	3	3.	—— *meleagris*, Ducl. San Blas.
9	14	2	1, 2.	*Pyrula patula*. [N.B. The operculum of *P. melongena*, as figured by Kiener, is broader in proportion than that of *P. patula*.] [He thinks, however, that the species should be reunited.]
11	15	11	...	*Fusus Dupetithouarsi*, Kien. California. [Galap., *Cuming*, Rve.]
5	9	10	2.	*Murex messorius*, Sow. "=*motacilla*, B., Lam. + *rectirostrum*, Sow.+*nigrescens*, Sow." Senegal.
31	43	19	2.	—— *corrugatus*, Sow. Red Sea, California.
39	55	21	2.	—— *oxyacanthus*, Sow. S. Sea, California.

64. In a paper by Dr. L. Pfeiffer, "Ueber die geographische Verbreitung der Heliceen," in the Zeit. f. Mal. 1846, pp. 74–79, 87–96, occur the following lists of land shells from the western districts of North America:—

Page		
94.	*From Oregon*	Helix Vancouverensis, Columbiana, fidelis.
94.	*From California*	—— areolata, levis, tudiculata, Sagraiana, Townsendiana, Californiensis, Columbiana, Dupetithouarsii.
94.	*From Mexico*	—— lucubrata, Oajacensis, Buffoniana, Humboldtiana, Mexicana, bicincta, tenuicostata, *Dkr.*, griseola, Hindsi, ventrosula.
94.	„ „	Dædalochila implicata.
94.	„ „	Polygyra contortuplicata.

Page.		
94.	*From Central America* ..	Helix Ghiesbreghti, griseola, labyrinthus, plicata, quadridentata, Euryomphala, quinquestrigata.
94.	*From Real Llejos*	—— spirulata, Nystiana.
94.	*From Panama*	—— Antoni, uncigera.

Many of the species quoted from Mexico and Central America probably belong to the east side of the mountain range. In the same work, pp. 158–160, are described the following land shells, brought from the Mexican Republic by Liebmann. They are probably from the eastern side:—

Page		Page	
158.	*Helix caduca*, Pfr.	159.	*Achatina Liebmanni*, Pfr.
158.	*Bulimus Liebmanni*, Pfr.	159.	—— *streptostyla*, Pfr.
158.	*Achatina coronata*, Pfr.	159.	*Cylindrella Liebmanni*, Pfr.

In the Zeit. f. Mal. for 1844, 1845, occur the following:—

	Page.	No.	
1844.	35	...	*Ampullaria malleata*, Jonas. Tabasco, Mexico.
1845.	152	1	*Helix Buffoniana*, Pfr. Rio Frio, Mexico.
,,	152	2	—— *lævis*, Pfr. California, *Hinds*.
,,	154	7	—— *areolata*, Sow. MS. California, *Hinds*.
,,	168	7	*Haliotis Kamtschatkana*, Jonas. Near Island of Oonalaszka.

In the Zeit. f. Mal. 1847, pp. 1, 2, Dr. Menke describes the two following species, brought by Liebmann from Mexico:—

Cylindrella teres, Mke. Prov. of Puebla. | *Cylindrella Pfeifferi*, Mke. Tehuacan.

In the Zeit. f. Mal. 1847, pp. 93–96, Dr. Philippi describes the following freshwater shells, brought from Mexico and Central America by Largilliert and Liebmann:—

No. 32.	*Unio cyrenoides*, Phil.	Lake Nicaragua (*Larg.*).
,, 34.	—— *Aztecorum*, Phil.	Mexico (*Lieb.*).
,, 35.	—— *Mexicanus*, Phil.	Mexico (*Lieb.*).
,, 36.	—— *Liebmanni*, Phil.	Mexico (*Lieb.*).

In the mixed collections of shells described by Philippi in the Zeit. f. Mal. 1848, 1849, occur the following species:—

1848.

Page.	No.	
19	81	*Cerithium* (*Potamides*) *Hegewischii*, Ph. Mexico, *Hegewisch*. Resembles *Cerithidea varicosa*, Sow. [but it is not stated in which ocean it was found.]
127	53	*Trochus* (*Phorcus*) *Panamensis*, Phil. Panama, *E. B. Philippi*.
129	55	*Adeorbis scaber*, Phil. Panama. Found in *Avicula margaritifera* by *E. B. Philippi*.
130	57	*Anodonta cornea*, Phil. Nicaragua, *Largilliert*.
,,	58	—— *atrovirens*, Phil. ,, ,,
,,	59	—— *Nicaraguæ*, Phil. ,, ,,
141	79	*Bulla Panamensis*, Phil. Panama, *E. B. Philippi*.
143	84	*Cerithium filosum*, Phil. California.—Mus. Largilliert.
145	87	*Donax Panamensis*, Phil. Panama, *E. B. Philippi*.
149	96	*Kellia pulchra*, Phil. West coast of America.
,,	97	*Litorina parvula*, Phil. Panama, *E. B. Philippi*.
,,	98	—— *phasianella*, Phil. ,, ,,
153	7	*Mactra velata*, Phil. ,, ,, ?"An *Mulinia exalbida*, Gray."
163	33	*Petricola robusta*, Phil. ,, ,, In *Avicula margaritifera*. [This fortunately appears to be one of the many forms of *Petricola robusta*, Sow.]
164	34	*Phasianella perforata*, Phil. Panama and Payta, *E. B. Philippi*.
175	59	*Tellina Panamensis*, Phil. Panama, *E. B. Philippi*.
176	62	*Unio nuculinus*, Phil. Nicaragua, *Largilliert*.

Page.	No.	
188	67	*Trochus* (*Calcar*) *erythrophthalmus*, Phil. = *T. olivaceus*, Wood. California. [Described under the erroneous impression that the *T. olivaceus* of Wood's Cat. was the white mouthed shell. = *T. inermis*, Gmel. teste Kien.]
1849.		
148	...	*Trochus Belcheri*, Phil. Mus. Hanley. Voyage Belcher.
149	...	—— *callichrous*, Phil. „ „ „ „
150	...	—— *callicoccus*, Phil. „ „ „ Venus.
168	...	—— *metaformis*, Phil. „ „ „ Belcher.
170	...	—— *neritoides*, Phil. „ „ „ „
171	...	—— *nucleus*, Phil. „ „ „ „
191	...	—— *suavis*, Phil. „ „ „ „
1850.		
84	48	*Succinea brevis*, Dunker. Mexico.
1851.		
61	73	*Buccinum Panamense*, Phil. Panama, Payta, *E. B. Philippi*.
71	94	*Cyrena inflata*, Phil. Costa Rica.—Mus. Busch.
74	100	*Cytherea solidissima*, Phil. California. [= *Trigonella crassatelloides*, Conr.]
75	2	*Donax obesa*, Phil. California. [= *D. Californicus*, Conr.]
123	47	*Terebra Belcheri*, Phil. "... ex itin. *Belcheri*."
126	52	*Venus distans*, Phil. Panama, *E. B. Philippi*.
1852.		
79	13	*Avicula* (*Meleagrina*) *fimbriata*, Dkr. Central America. [? = *Margaritiphora Mazatlanica*, Hanl.]
1853.		
112	40	*Lutraria inflata*, Dkr. California, teste Bernhard.

In the "Malacozoologische Blätter für 1854," which is a continuation of the Zeit. f. Mal. by the same editors, occurs the following:—

1854. Page 28. *Pyramidella bicolor*, Mke. [*Obeliscus*.] Calif., teste *J. W. E. Müller*.

65. The following are from Philippi's Monographs in Kuster's edition of Martini's Continuation of Chemnitz's 'Conchilien Cabinet':—

Kust. Mart., p. 57. no. 60. pl. 9. f. 4. *Natica otis*, Brod. & Sow. Mazatlan and Marquesas.

Kust. Mart., p. 78. pl. 12. f. 1–5. *Natica maroccana*, Chemn. Morocco, *Chemn.*, W. Indies, *Chemn.* Guinea, *Largilliert*. E. Africa, *Rodatz*. W. Mexico, *Pfr.* Panama, *C.B. Adams*. (Var. lurida), Havanna, Sandw. Is., Lieukieu Is., *Largilliert*. (Var. unifasciata), Peru, *Petit*.

66. Besides the authorities given in published works, the following have been noted from the British Museum Collection:—

Saxicava arctica. N. Zealand. *Capt. Stokes*. B. M.
Tellina nasuta. Icy Cape.
Donax punctatostriatus. S. America. *Capt. Ld. Byron*.
Donax scortum. San Blas. [? ubi.]
Tellina rufescens. St. Domingo. *Sir R. Schomburgk*.
Pinna ? rudis. Panama. Miss Saul.
Chiton, sp. ind. California.
Chiton vestitus, Sow. *Capt. Beechey*.
Bulla ? nebulosa. Pedro Blanco, Mexico. *Mr. J. Robertson*.
Physa elata. California. *Dr. Sinclair*.
Fissurella mutabilis, Swains. Galapagos.
Dentalium pretiosum. Central America. *Dr. Sinclair*.
Dentalium, like *entalis*. Vancouver's Isl. *C. Ede, Esq.* (used by the natives for money).
Litorina fasciata. Sandwich Is. *Lieut. Strickland*.
Cerithium ocellatum, Brug. Madagascar. (Compare with *C. stercus-muscarum*.)
Odostomia. Monterey. *Capt. Beechey*. (Probably *O. gravida*, Gould.)
Eulima distorta. St. Vincent's, W. I.
Natica bifasciata, Gray. W. Columbia.
Marginella curta, Sow. jun. Mazatlan.
Fusus ? Dupetithouarsii, var.
Trophon labiosa, Gray. Callao.
Nitidella cribraria. S. America. *Capt. King*.
Pisania ? ringens. Pernambuco. *J. P. G. Smith*.

67. The following species and localities have also been noticed in Mr. Cuming's collection:—

Petricola denticulata. Mazatlan.
Thracia plicata, Desh. W. N. America.
Periploma Leana. Mazatlan. *Capt. Keppell* and *Mr. Ede, R.N.*
Lyonsia nitida. "China Seas, Belcher:" probably an error.
Tellidora Burneti. Salango and St. Elena, *Cuming.*
Donax assimilis. Conchagua.
Mactra angulata: plentiful from the Gulf, rare further south, teste Cuming.
Crassatella gibbosa and *undulata.* West Columbia.
Cardium Belcheri. Panama, *Cuming.*
Diplodonta semiaspera. St. Thomas, W.I. *Merk.*
Lucina fenestrata. Monte Xti, San Blas.
Kellia suborbicularis. Is. Muerte (Guayaquil), sandy mud, 11 fms. Conception, Chili.
Modiola capax. Galapagos, *Cuming.*
Helix vincta, Val.; *Baskervillei,* Pfr. From California and the neighbourhood.
Acmæa gigantea=grandis, Gray. Montery, exposed situations.
Omphalius Californicus, A. Ad. Moreton Bay.
Chlorostoma funebrale. California.
Ovulum gibbosum. Panama, *Cuming.*
Torinia variegata. Is. Annaa, coral reefs.
Lathyrus armatus. California.
Leucozonia Californica. Gulf of California, *Lieut. Shipley*: appears a *Lathyrus.*
Ranella, like *vexillum.* Mazatlan.
—— ? *tuberculata,* var. Mazatlan (Havre Col. teste Powis).
Nassa nodocincta, A. Ad. Galapagos.
Rhizocheilus asper. Gulf of California.
Typhis grandis. California.

68. Lastly, the following have been collected from various sources:—

Gray, Syst. Ar. Moll.* p. 52 (*Ianthinidæ*). *Recluzia Rollandiana.* Mazatlan.
Gray, Syst. Ar. Moll. p. 117. *Garnotia solida,* genus described. Mazatlan.
Gray, Syst. Ar. Moll. *Scurria mitra,* genus described. Mazatlan.
Phil. Arch. 1847, p. 63. pl. 3. f. 7. *Amphichæna Kindermanni.* Mazatlan. (Appears to be a *Psammobia.*)
Tellidora Burneti. W. Columbia, *Lieut. Freer.*—Bristol Mus.
Dione lupinaria. Valparaiso, *H. Babb, R.N.*—Bristol Mus.
Cardita affinis. Cubaco, *Lieut. Wood.*—Bristol Mus.
Lithophagus aristatus. Panama.—Bristol Mus.
Lithophagus aristatus. Algiers, *M'Andrew.*
Isognomon Chemnitzianum. Panama, *L. Wood.*—Bristol Mus.
Chiton consimilis. Upper California.
Paludina nuclea, Lea. Sacramento River.
Anodon angulatus, Lea. ,, ,,
"*Oliva splendidula.* Mazatlan, — *Babb, Esq., R.N.*"—Bristol Mus.=*O. Melchersi.*
Conus concinnus. Bay of California, *Capt. Babb.*
Purpura coronata. California.
Turritella sanguinea. California.
Cassis abbreviata. Acapulco.
Marginella imbricata. Acapulco.
Litorina coronata. San Blas.—Mus. Nutt.

69. Having now presented an abstract of all the original sources of information (so far as known to the writer), we proceed to embody them in a table, arranged at the same time geographically† and zoologically, so as to exhibit in one view as much of the foregoing materials as may be looked upon as tolerably satisfactorily made-out. Doubtful species, or those whose locality rests on insufficient evidence, are not included. Where the evidence is good, but suspected, the name, if inserted, is in [ ]; where it is poor, but *à priori* correct, it is enclosed in ( ). Species entirely omitted can be written in by the student, from the foregoing lists, if he is satisfied with the evidence. All names printed in the same horizontal line are regarded as probably conspecific; synonyms being distinguished by a single (.

* Of this work, "Systematic Arrangement of Mollusca" (with figures of the teeth of Gasteropoda), now passing through the press, Dr. Gray obligingly allowed me the use of the proof-sheets. The main grouping of the Gasteropoda has been followed to a considerable extent.

† In the second column, A. signifies *Asia* (chiefly Kamtschatka and the Sea of Okhotsk; B. *Behring Sea.* In the last column, E. signifies the coasts of *Ecuador* and *Peru*; C. those of *Chili.*

MOLLUSCA OF THE WEST COAST OF NORTH AMERICA.

Class BRYOZOA.

Zoological Divisions. FAMILIES, *Genera* and *Sub-genera.*	*Asia & Behring Sea.*	NORTHERN FAUNA. *Arctic.*	*Oregon.*	*Upper California.*	*Lower California.*	TROPICAL FAUNA. *Gulf of California.*	*Central America.*	*Panama.*	*Galapagos.*	*South America.*
MEMBRANIPORIDÆ: *Membranipora*						denticulata.				
						gothica.				
Lepralia				sp.		atrofusca.				
						trispinosa.				
						Mazatlanica.				
						rostrata.				
						marginipora.				
						hippocrepis.				
						humilis.				
						adpressa				E.
						sp.				
CELLEPORIDÆ: *Cellepora*						papillæformis.				
						cyclostoma.				
						sp.				
DISCOPORIDÆ: *Defrancia*						intricata.				
TUBULIPORIDÆ: *Tubulipora*						sp.				

Class TUNICATA.

Unknown.

Class PALLIOBRANCHIATA.

Zoological Divisions. FAMILIES, *Genera* and *Sub-genera.*	*Asia & Behring Sea.*	*Arctic.*	*Oregon.*	*Upper California.*	*Lower California.*	*Gulf of California.*	*Central America.*	*Panama.*	*Galapagos.*	*South America.*
DISCINIDÆ: *Discina*				Evansii.		Cumingii		Cumingii		E.
LINGULIDÆ: *Lingula*					albida.					
TEREBRATULIDÆ: *Waldheimia*				(Californica).						
Terebratula			pulvinata.							
[*chonella.*			canrena.							
RHYNCHONELLIDÆ: *Rhynchonella*	A.	psittacea.								

Class LAMELLIBRANCHIATA.

PHOLADIDÆ: *Pholas*	......	......	......	......	......	......	cornea.			
							cruciger	cruciger	......	E.
								xylophaga.		
								2 sp.		
Pholadidea ...	......	......	......	penita	penita.					
					ovoidea.					
						melanura	......	......	......	E.
						curta	curta.			
								tubifera	......	E.
Parapholas ...	......	......	......	Californica ...	Californica.					
						calva......	......	calva.		
						acuminata ...	......	acuminata.		
Martesia	......	......	......	......	......	intercalata.				
GASTROCHÆNIDÆ: *Gastro-*	......	......	......	......	......	truncata	......	truncata	......	E.
[*chæna*.						ovata	......	ovata	......	E.
									rugulosa.	
									brevis.	
									hyalina.	
SAXICAVIDÆ: *Saxicava* ...	A. B.	Pholadis	......	Pholadis	Pholadis	? arctica	......	tenuis	......	E.
PETRICOLIDÆ: *Petricola* ...	......	gibba.								
		cylindracea ...	cylindracea ...	cylindracea.						
				Californica ...	Californica.					
						dactylus.				
						denticulata.				
						ventricosa ...	......	......	......	? E.
						sp.				
						robusta......		robusta......	......	E.
						pholadiformis	......	cognata	......	E.
									amygdalina.	
Rupellaria ...	......	......	......	lamellifera ...	lamellifera.					
						foliacea.				
						paupercula.				
						lingua-felis.				
						exarata.				
						sp.				
Saxidomus.	A.	gigantea.								
	A. B.	Petitii	......	Petitii.						
			Nuttalli	Nuttalli	Nuttalli.					

Zoological Divisions.	*Asia.*	*Arctic.*	*Oregon.*	*U. California.*	*L. California.*	*G. California.*	*C. America.*	*Panama.*	*Galapagos.*	*S. A.*
(Petricolidæ : ? *Naranio*)	......	......	......	......	......	scobina.				
						sp.				
Myadæ : *Mya*	A.	arenaria.								
	?A.	......	præcisa.			? sp.				
Panopæa	......	......	generosa.							
Lutraria	......	maxima	......	maxima.						
Platyodon	......	......	......	cancellata......	cancellata.					
Cryptodon	......	......	......	Nuttalli.						
Sphænia	......	......	......	Californica ...	Californica.					
						fragilis.				
						2 sp.				
Corbulidæ : *Potamomya*...	......	......	......	......	......	......	......	æqualis.		
								inflata.		
								trigonalis.		
Corbula	......	......	......	polychroma...	......	polychroma.				
						2 sp.				
				[bicarinata]...	......	bicarinata......	bicarinata......	bicarinata......	......	E.
						tenuis	tenuis	tenuis.		
						obesa	obesa	obesa.		
						biradiata	biradiata	biradiata	......	E.
						?ovulata	ovulata......	ovulata......	......	E.
						pustulosa	......	pustulosa.		
						ventricosa ...	......	ventricosa.		
							Boivinea.			
				[nasuta]	......	......	nasuta	......	......	E.
							marmorata.			
							fragilis.			
							radiata.			
							nuciformis ...	......	......	E.
							speciosa	speciosa.		
								rubra.		
								2 sp.		
Anatinidæ : *Thracia*	......	......	......	curta.						
						squamosa.				
Tyleria	......	......	......	......	......	fragilis.				
Lyonsia	......	......	bracteata.							
				Californica ...	(nitida.					
						sp.				

						diaphana	....	diaphana.		
			[picta]	....	....	picta..........	....	....	....	E.
Mytilimeria..	......	....	....	Nuttalli.						
Periploma ...	......	....	....	....	argentaria.					
						Leana. planiuscula. excurvata. papyracea.				
								alta.		
Neæra........	......	....	....	....	....	....	didyma.			
							costata	....	....	E.
Pandora	......	....	....	punctata.						
						claviculata.				
								cornuta. brevifrons.		
SOLENIDÆ: *Solen*...........	......	....	sicarius. maximus.							
								rudis.		
SOLECURTIDÆ: *Machæra*...	A. B.	costata.								
			Nuttalli	Nuttalli. lucida.						
Solecurtus..	......	....	....	subteres	subteres.					
				Californianus..	Californianus.					
						politus. sp.				
						affinis	....	affinis.		
							violascens.			
TELLINIDÆ: *Sanguinolaria*	......	....	Californiana.							
				grandis. rubroradiata.						
					Nuttalli.					
					miniata	miniata	(purpurea.			
						tellinoides.				
Psammobia...	......	....	....	....	Pacifica.					
						Kindermanni. sp.				
Tellina	A. B.	solidula.								
	B.	(lata).								
	A. B.	(lutea).								
	A. B.	edentula	edentula.							

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(Tellinidæ: *Tellina*)......	A.B.	nasuta	nasuta	....	nasuta.					
			(inquinata).							
			Californica.							
			Bodegensis ...	Bodegensis.						
			secta............	secta............	secta.					
				alta.						
					vicina.					
					pura	pura	....	pura.		
						gemma.				
						Mazatlanica.				
						Broderipii.				
						straminea.				
						donacilla.				
						regularis.				
						lamellata.				
						delicatula.				
						denticulata.				
						3 sp.				
						rufescens	....	....	....	E.
						eburnea	....	....	....	E.
						Dombei	....	Dombei	....	E.
						punicea	....	punicea	....	E.
						felix	....	felix.		
						Cumingii	Cumingii	Cumingii.		
						puella	....	puella.		
						brevirostris ...	brevirostris.			
							regia.			
							virgo.			
							gubernaculum			
							elongata.			
							plebeia.			
							brevirostris.			
							petalum.			
							insculpta.			
							princeps	....	....	E.
							vicina	vicina.		
							laceridens......	laceridens......	....	E.
							rubescens......	rubescens......	....	E.

								aurora.		
								cognata.		
								concinna.		
								siliqua.		
								Deshayesii.		
								Panamensis.		
								rhodora.		
								tersa.		
								fausta.		
								3 sp.		
								Columbiensis		E.
								crystallina		E.
								prora		E.
								hiberna		E.
Strigilla					carnaria	carnaria.				
						lenticula.				
						pisiformis.				
						dichotoma.				
						ervilia.				
								sincera.		
								disjuncta.		
Tellidora						Burneti				E.
?*Scrobicularia.*				biangularis.						
						producta		producta.		
								viriditincta.		
Semele					rubrolineata.					
					decisa.					
					flavescens	flavescens.				
						Californica.				
						? venusta				E.
								ventricosa.		
								bicolor.		
								elliptica.		
								proxima.		
								striosa.		
								tortuosa.		
								obliqua.		
								planata.		
								pulchra		E.

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(Tellinidæ: *Semele*)									rupium.	
									punctatum.	
Cumingia				Californica	Californica	Californica.				
						lamellosa	lamellosa	lamellosa		E.
						trigonularis		trigonularis		E.
						sp.		sp.		
Donacidæ: *Iphigenia*						lævigata.				
						altior	altior	altior		E.
Donax				flexuosus.						
				Californicus	(obesus.					
				rostratus		rostratus		rostratus.		
				gracilis			gracilis	gracilis		E.
						Carpenteri				
						transversus.				
						punctatostriatus.				
						Conradi	Conradi.			
						carinatus	carinatus.			
						assimilis	assimilis	assimilis.		
						navicula	navicula	navicula.		
							bella.			
							ovalina.			
								Panamensis.		
Mactridæ: *Mactra*	A.B.	(ovalis).								
			falcata.							
				Californica.						
				planulata.						
					nasuta.					
						pallida.				
						goniata.				
						fragilis.				
						Californica.				
						exoleta		exoleta		E.
						angulata	angulata	angulata.		
						elegans	elegans	elegans.		
								velata.		
								laciniata.		
								angusta.		
Gnathodon						mendicus.				

Trigona				tantilla.		gracillima.				
				crassatelloides	crassatelloides	[crassatelloides].				
						humilis.				
						argentina	argentina.			
						radiata	radiata	radiata		E.
Dosinia				callosa.		planulata		planulata		E.
						Annæ.				
						ponderosa				E.
Cyclina						Dunkeri	(simplex	Dunkeri		E.
						subquadrata		(saccata		E.
								producta.		
Dione						brevispinosa.				
						lupinaria				E.
						circinata				E.
						concinna		concinna }		
								affinis }		E.
								tortuosa }		
						rosea		rosea.		
						chionæa	(biradiata	(squalida		E.
						aurantia	aurantia	aurantia.		
						vulnerata	vulnerata.			
							unicolor			E.
Cytherea								consanguinea.		
Venus	B.	(Astartoides).				petechialis.				
			calcarea.							
			ampliata.							
			sp.							
			rigida	rigida.						
				Nuttalli	Nuttalli.					
					excavata.					
					simillima.					
					fluctifraga.					
					dispar.					
					Californiensis	Californiensis				? E.
						reticulata.				
						undatella.				
						2 sp.				

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(VENERIDÆ: *Venus*)						?crenifera	?crenifera			E.
						Columbiensis	Columbiensis			E.
						amathusia	amathusia	amathusia.		
						gnidia		gnidia		E.
						distans		distans.		
						multicostata		multicostata.		
							Kellettii.			
							fuscolineata.			
							pulicaria			E.
							neglecta			E.
								ornatissima.		
								2 sp.		
Anomalocardia						subimbricata	subimbricata			E.
						subrugosa	subrugosa	subrugosa		E.
?*Tapes*				diversa.						
				tumida.						
				straminea	straminea.					
					gracilis.					
						squamosa.				
						histrionica	histrionica	(pectunculoides		E.
						grata	(discors	grata		E.
								tenerrima.		
ASTARTIDÆ: *Astarte*	B.	(corrugata).								
Gouldia						varians.				
Circe						Pacifica		Pacifica.		
						margarita.				
						subtrigona.				
Crassatella								gibbosa		E.
Trapezium				Californicum	Californicum.					
						sp.				
Cardita			ventricosa.							
						Californica.				
							Cuvieri.			
							crassa.			
							affinis	affinis.		
							laticostata	laticostata		E.
								radiata		E.
									incrassata.	
									varia.	

CHAMIDÆ: *Chama*	......	......	......	exogyra	exogyra	sp.			
				pellucida	pellucida.	exogyra.			
							frondosa	frondosa.	
				fr. Mexicana...	......	fr. Mexicana...	fr. Mexicana...	Buddiana.	
						spinosa......	spinosa......	......	Ld. Hood's Is.
							producta.		
							corrugata......	corrugata.	
								Panamensis.	
								echinata	...... E.
									Janus.
									imbricata.
CARDIADÆ: *Cardium*	A.B.	Californiense..	......	Californiense..	Californiense.				
	A.B.	Nuttalli	Nuttalli	Nuttalli	Nuttalli.				
			blandum.						
				quadragenarium.					
				(Laperoussii).					
					substriatum.				
					luteolabrum.				
					cruentatum.				
					elatum	elatum.			
						alabastrum.			
						rotundatum.			
						7 sp. ind.			
						graniferum ...	graniferum ...	graniferum ...	...... E.
						maculosum ...	maculosum ...	......	...... E.
						?senticosum ...	......	senticosum ...	...... E.
						Belcheri	......	Belcheri.	
						procerum......	procerum......	procerum......	...... E.
							(planicostatum	Panamensis.	
							Cumingii.		
							consors......	......	...... E.
								biangulatum.	
								obovale	...... E.
LUCINIDÆ: *Lucina*	......	......	......	......	bella.				
					Californica.				
					Nuttalli.				
					punctata	punctata	......	punctata.	
						annulata.			
						? muricata.			

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(LUCINIDÆ: *Lucina*)						excavata.				
						pectinata.				
						cancellaris.				
						Mazatlanica.				
						prolongata.				
						3 sp.				
						fenestrata				E.
						eburnea		eburnea		E.
						tigerrina	tigerrina.			
							Artemidis.			
?*Fimbria*						sp.				
DIPLODONTIDÆ: *Diplodonta*				orbella	orbella.					
						semiaspera.				
						subquadrata.				
						obliqua.				
							calculus.			
Felania						serricata.				
							cornea.			
								tellinoides.		
KELLIADÆ: *Kellia*				Laperousii.						
						suborbicularis		suborbicularis		E.
Lasea						? rubra.				
						trigonalis.				
						oblonga.				
						sp.				
Lepton						Clementinum.				
						Dionæum.				
						umbonatum.				
Pythina						sublævis.				
Montacuta						elliptica.				
						subquadrata.				
						sp.				
Scintilla								Cumingii.		
CYCLADIDÆ: *Cyclas*			patella.							
			egregia.							
Cyrena						olivacea.				
						Mexicana.				
						insignis.				

						subquadrata.				
							solida.			
								maritima.		
UNIONIDÆ: *Unio* ...	...	...	famelicus.					inflata.		
							cyrenoides.			
							nuculinus.			
Alasmodon ...	...	...	falcata ...	falcata.						
Anodon ...	...	...	feminalis.							
			Oregonensis.							
			Wahlamatensis							
			cognata ...	cognata.						
			Nuttalliana ...	Nuttalliana.						
				angulata.						
						(ciconia ...	glauca.			
							cornea.			
							Nicaraguæ.			
							atrovirens.			
MYTILIDÆ: *Mytilus* ...	A.	edulis ...	edulis ...	edulis.						
			(Californianus)	Californianus .	Californianus.					
				bifurcatus.						
				glomeratus.						
						multiformis.				
						palliopuncta-	palliopunctatus.			
						[tus		sp.		
Septifer ...	...	...	...	...	...	Cumingianus.	...	Cumingianus.		
Modiola ...	A.	cultellus.								
	A.B.	modiolus ...	modiolus.							
			elongata.							
				recta.						
				nitens.						
				capax ...	capax ...	capax ...	capax ...	...	capax.	
			flabellata ...	...	...	Braziliensis ...	...	Braziliensis ...	...	E.
								5 sp.		
Crenella ...	...	...	discrepans.							
						coarctata ...	...	...	coarctata.	
Lithophagus ...	...	...	...	Gruneri.						
					attenuatus ...	attenuatus ...	...	...	...	E.
						calyculatus.				
						cinnamomeus .	cinnamomeus .	sp.		

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(MYTILIDÆ: *Lithophagus*)	......	....	....	....	....	aristatus	....	aristatus.		
						plumula	....	plumula.		
Leiosolenus ...	......	....	....	....	....	spatiosus.				
						sp.				
ARCADÆ: *Arca*	......	....	....	....	....	bifrons.				
						cardiiformis.				
						2 sp.				
						brevifrons ...	....	....	....	E.
						multicostata...	multicostata.			
						labiata	labiata	....	....	E.
						tuberculosa ...	tuberculosa ...	tuberculosa.		
						grandis........	grandis........	grandis........	....	E.
						reversa........	....	reversa........	....	E.
						emarginata ...	....	emarginata ...	....	E.
							concinna.			
							formosa.			
								nux.		
								Reeviana	....	E.
Byssoarca	......	....	....	....	pernoides.					
						vespertilio.				
						fusca.				
				[gradata]......	....	gradata........	....	gradata	....	E.
						Pacifica	Pacifica	Pacifica	....	E.
						mutabilis	....	mutabilis	....	E.
						solida	....	solida	....	E.
						illota...........	illota	(Tabogensis.		
								pholadiformis.		
								alternata	....	E.
								aviculoides ...	....	E.
									truncata.	
Pectunculus......	......	septentrionalis	septentrionalis							
						giganteus.				
						bicolor.				
						parcipictus.				
						?multicostatus.	....	....	....	E.
				[inæqualis] ...	....	inæqualis	inæqualis	inæqualis	....	E.
								maculatus.		
								pectenoides.		
Nucula		castrensis.								

				cælata.		exigua	exigua	exigua	....	E.
							crispa.			
								excavata.		
								lyrata.		
Leda	......	....	....	....	....	?Elenensis ...	....	Elenensis	....	E.
							gibbosa........	....	....	E.
				[polita]	....	....	....	polita.		
								costellata.		
Aviculidæ: *Pinna*	......	....	....	....	....	lanceolata ...	....	....	....	E.
						maura	....	maura.		
						rugosa	....	rugosa.		
							sp.			
								tuberculosa.		
Avicula	......	....	....	....	....	sterna	....	sterna.		
Margaritiphora	......	....	....	....	....	(Mazatlanica..	fimbriata	fimbriata.		
Isognomon	......	....	....	costellatum.						
						Chemnitzia-	(flexuosum ...	Chemnitzia-		
						Janus. [num		[num.		
								sp.		
Pectinidæ: *Pecten*	......	rubidus.								
			Fabricii.							
			caurinus.							
			hericeus.							
			Townsendi.							
				latiauritus ...	latiauritus.					
					floridus.					
					purpuratus.					
						circularis.				
						dentatus.				
						nodosus.				
						2 sp.				
						subnodosus ...	subnodosus ...	....	....	E.
							fasciculatus.			
							(ventricosus...	inca	....	E.
								Tumbezensis. .	....	E.
								sericeus.		
									magnificus ...	E.
Lima	......	....	....	....	....	tetrica.				
							angulata	angulata.		
							Pacifica	Pacifica	Ld. Hood's Is.	E.
								arcuata........	arcuata.	

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SPONDYLIDÆ: *Hinnites* ...	......	....	....	....	giganteus.					
Spondylus ...	......	....	....	....	....	sp.				
						calcifer........	....	calcifer.		
							princeps.			
							dubius.			
							radula.			
								limbatus.		
								sp.		
Plicatula ...	......	....	....	....	....	penicillata ...	penicillata.			
OSTREADÆ: *Ostrea*	......	....	....	sp.						
			? conchaphila..	conchaphila ...	conchaphila ...	conchaphila ...	conchaphila ...	conchaphila.		
					palmula	palmula	palmula.			
						Cumingiana.				
						sp.				
						Columbiensis..	....	....	....	E.
						Virginica	....	Virginica.		
						iridescens......	iridescens......	iridescens.		
								2 sp.		
ANOMIADÆ: *Placunanomia*	A.	patelliformis.								
	A.	(macroschisma	)	macroschisma.						
			cepio.							
			alope.							
						claviculata.				
						pernoides......	....	pernoides.		
						foliata	foliata	....	....	E.
							Cumingii.			
Anomia	......	....	lampe	lampe	....	lampe	....	lampe	....	E.
								tenuis.		
								fidenas.		
								sp.		
									adamas.	

Class PTEROPODA.

Unknown.

Class GASTEROPODA.

OPISTHOBRANCHIATA.

Nudibranchiata.

DORIDÆ: *Doris*	......	......	sp.							
Goniodoris	......	......	sp.							
TRITONIADÆ: *Dendronotus*	A.	arborescens.	sp.							
ÆOLIDÆ: *Æolis*	......	pinnata.	sp.							
Chioræra	......	......	leonina.							
Flabellina	......	crassicornis. subrosacea.								
Tectibranchiata.										
PLEUROBRANCHIDÆ: *Umbrella*	......	......	......	......	......	......	......	ovalis.		
PHILINIDÆ: *Smaragdinella*	......	......	......	......	......	thecaphora.				
BULLIDÆ: *Bulla*	......	......	......	nebulosa	nebulosa ...... virescens. longinqua.	nebulosa. exarata. sp. Quoyii ...... Adamsi	 ...... Adamsi. punctulata ...	 ...... punctulata. Panamensis. sp.	 Quoyii.	
Haminea	......	......	sp.		vesicula.				rufolabris.	
CYLICHNIDÆ: *Cylichna*	......	......	......	......	......	cymbiformis. luticola	......	luticola.		
Tornatina	......	......	......	culcitella. cerealis.	inculta.	carinata. infrequens ...	......	infrequens.		
PULMONATA.										
LIMACIDÆ: *Limax*	......	......	Columbianus.							
ARIONIDÆ: *Arion*	......	......	foliolatus.							
TESTACELLIDÆ: *Glandina*	......	......	......	......	......	Albersi. turris.				

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(TESTACELLIDÆ : *Glandina*)	......	....	....	....	....	....	obtusa.			
							Sowerbyana.			
HELICIDÆ : *Helix, &c.*	......	....	Oregonensis.							
			labiosa.							
			loricata.							
			Baskervillei.							
			fidelis.							
			strigosa.							
			sportella.							
			Vancouverensis.							
			germana.							
			Pandoræ.							
			Kellettii	....	Kellettii.					
			tudiculata......	tudiculata ...	tudiculata.					
			Columbiana ...	Columbiana.						
			Townsendiana	Townsendiana.						
			Californiensis .	Californiensis.						
			areolata	areolata.						
				vincta.						
				loricata.						
				Nickliniana.						
				Dupetithouarsii.						
				infumata.						
				levis.						
				vecillata.						
				Sagraiana.						
				æruginosa.						
							spirulata.			
							Nystiana.	Antoni.		
							quadridentata.	uncigera.		
								plicata.		
								annulifera.		
Bulimus, &c.	......	....	....	....	pallidior.					
						Ziegleri.				
						zebra	(princeps	....	....	E.
						Mexicanus ...	Mexicanus.			

							corneus. discrepans.	fimbriatus. alternatus. Panamensis. translucens. vexillum. unicolor.	nux. verrucosus. unifasciatus. rugulosus. Eschariferus. Darwinii. Achatinellinus incrassatus. ustulatus. calvus. Jacobi. Chemnitzoides corneus. sculpturatus. rugiferus. nucula. Gallapaganus. Manini.	
Tornatellina	......	....	....	....	....	....	Cumingiana.			
Succinea ...	......	....	rusticans. Oregonensis...	sp.						
AURICULIDÆ : *Melampus*...	......	....	....	....	olivaceus	cingulata. olivaceus.		acutus. concinnus. infrequens. Panamensis. stagnalis. Tabogensis. trilineatus. Bridgesii. sp.		

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(Auriculidæ): *Pedipes* …	…	…	…	…	…	…	…	angulata.		
Limnæidæ: *Limnæa* …	…	…	lepida.							
			apicina.							
			Nuttalliana.							
			ferruginea.							
			umbrosa …	umbrosa.						
Physa …	…	…	bullata.							
			sp.							
				humerosa.						
				virginea.						
				virgata …	virgata.					
						aurantia.				
						elata.				
Planorbis …	…	…	vermicularis.							
			corpulentus.							
			subcrenatus.							
			opercularis …	opercularis.						
				ammon.						
				gracilentus.						
						tumens.				
								Panamensis.		
Siphonariadæ: *Siphonaria*	…	…	…	…	…	æquilirata.				
						lecanium …	…	…	…	E.
						sp. …	gigas …	gigas …	gigas …	E.
							costata …	costata.		
							pica …	pica.		
								maura.		
									scutellum.	

Prosobranchiata.

Heteropoda.

Zoological Divisions.	*Asia.*	*Arctic.*	*Oregon.*	*U. California.*	*L. California.*	*G. California.*	*C. America.*	*Panama.*	*Galapagos.*	*S. A.*
Ianthinidæ: *Ianthina* …	…	…	…	…	…	striulata.				
						decollata.				
Recluzia …	…	…	…	…	…	Rollandiana.				

Lateribranchiata.

Dentalium ...	......	politum	sp.			liratum. hyalinum. corrugatum. pretiosum......	pretiosum. tessaragonum.	....	....	E.
Scutibranchiata.										
CHITONIDÆ: *Lophyrus* ...	......	....	....	[Stokesii] ...	....	....	....	Stokesii	....	E.
						articulatus. albolineatus. striatosquamosus. lævigatus.				
								dispar.		
									Goodallii. sulcatus.	
Callochiton...	......	....	interstinctus.							
								pulchellus ...	....	E.
Lepidopleurus	......	....	....	....	Magdalensis...	Magdalensis. clathratus. bullatus. M'Andreæ. Beanii. sanguineus ...	limaciformis...	....	....	E.
Lepidochiton.	......	lividus.								
				Mertensii. scrobiculatus.						
							proprius.			
Tonicia	A.	Brandtii. Sitchensis. Eschscholtzii. Merckii. insignis.								
	A.	lineata	....	lineata.						
						Forbesii.		crenulata.		
Chiton	......	....	muscosus.							
				scaber.						
						flavescens.				

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(CHITONIDÆ: *Chiton*)							scabricula			E.
								luridus		E.
								Columbiensis.		
Mopalia			vespertina.							
				Simpsonii.						
					Blainvillei.					
								Hindsii.		
Acanthochites						Arragonites.				
Katherina	A.	submarmorea.								
		tunicata.								
			Douglasiæ.							
Cryptochiton.	A.	Stelleri	Stelleri	Stelleri.						
Plaxiphora							retusa			E.
Genera indet.		Wosnessenskii		Wosnessenskii						
			lignosus.							
			dentiens.							
				Nuttalli.						
				Californicus.						
				acutus.						
				consimilis.						
				Montereyensis						
				Hartwegii.						
				regularis.						
					ornatus.					
							setosus.			
								clathratus.		
								lineatus.		
								Elenensis	[mis.	E.
									hirundinifor-	E.
PATELLIDÆ: *Patella*						Mexicana				E.
						pediculus	pediculus.			
						discors	discors	sp.		
								stipulata.		
Nacella		Asmi.								
			instabilis.							
					depicta.					
					incessa.					
						sp.				

Acmæa	...	personoides.								
		pileolus.								
		digitalis.								
		cassis ...	...	...	...	[Mazatlandica]				
	A.	pelta...	pelta...	pelta.						
	A.	patina ...	...	patina ...	patina ...	patina ...	...	...	...	C.
		persona...	persona...	...	persona ...	persona.				
			textilina.							
			fimbriata.							
			cribraria ...	cribraria.						
			spectrum ...	spectrum ...	spectrum.					
				toreuma.						
				grandis...	grandis...	...	grandis.			
				scabra ...	scabra ...	scabra ...	scabra.			
				æruginosa ...	mesoleuca ...	mesoleuca ...	(diaphana ...	? mesoleuca ...	striata.	
					fascicularis ...	fascicularis.				
						vespertina ...	...	vespertina.		
						livescens.				
						mitella.				
								3 sp.		
Scurria ...	...	mitra ...	mitra ...	mitra ...	mitra ...	...	...	...	...	C.
Scutellina ...	...	...	...	...	...	navicelloides.				
GADINIADÆ : *Gadinia* ...	...	...	...	...	...	pentegoniosto-	stellata.			
FISSURELLIDÆ : *Fissurella* ...	...	[violacea] ...	...	[violacea] ...	...	...[ma	...	...	...	C.
				ornata.						
				volcano ...	volcano.					
						nigrocincta.				
						alba.				
						spongiosa.				
						sp.				
						rugosa ...	...	...	rugosa.	
						virescens ...	...	virescens.		
						[Peruviana]...	...	...	...	E.
							Mexicana.			
							microtrema ...	microtrema.		
							macrotrema ...	macrotrema...	macrotrema.	
							nigropunctata	nigropunctata	nigropunctata	E.
								gibberula.		
								mus.		
								ostrina.		

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(Fissurellidæ: *Fissurella*)	......	......	......	......	......	......	......	Panamensis.	mutabilis.	
									obscura.	
Glyphis	......	aspera	(cratitia	(densiclathrata.						
				Lincolni.						
						alta	......	alta.		
						inæqualis	(pica	......	inæqualis	E.
							crenifera.			
Lucapina	......	......	......	crenulata.						
Fissurellidæa	......	......	......	......	......	......	......	æqualis	......	E.
Puncturella	......	......	cucullata.							
			galeata.							
Rimula	......	......	......	......	......	Mazatlanica.				
Haliotidæ: *Haliotis*	A.	aquatilis.								
	A.	Kamtschatkiana	......	......	(Kamtschatkiana).					
			sp.							
				rufescens.						
				corrugata.						
				splendens......	splendens.					
				Californiensis .	Californiensis.					
				Cracherodii ...	Cracherodii.					
Trochidæ: ? *Stomatella*	......	......	......	......	......	......	......	inflata.		
Phasianella	......	......	......	compta......	compta......	compta.				
						perforata	......	perforata	......	E.
Callopoma	......	[Fokkesii]	......	(Fokkesii	(Fokkesii	fluctuosum	......	......	......	E.
							saxosum	saxosum.		
								phasianella.		
Turbo	......	......	......	......	......	......	......	rutilus.		
								squamigera ...	squamigera.	
Pomaulax	......	......	......	undosus	......	......	(undosus).			
Uvanilla	......	......	......	......	......	olivacea	olivacea.			
						unguis	unguis.			
						inermis......	......	Buschii.		
Bankivia	......	......	......	......	......	[varians].				
Trochus	......	......	annulatus......	annulatus.						
(*Ziziphinus.*)			filosus	filosus	filosus.					
				Antonii.						
						versicolor.				

						M'Andreæ ...	......	M'Andreæ.		
						sp.				
								Leanus.		
			[lima]	......	......	......	......	lima.		
Trochiscus...	......	......	Norrisii.					Panamensis.		
Livona	......	......	[pica].							
Osilinus......	......	ater	......	ater	(gallinus.					
Tegula	......	......	......	......	......	......	pellis-serpentis	pellis-serpentis		
Gibbula......	......	......	......	......	......	......	......	coronulata.		
Omphalius...	......	modestus.								
		mœstus	......	mœstus	mœstus.					
		euryomphalus	......	euryomphalus.						
				Pfeifferi.						
				fuscescens.						
				marginatus.						
				maculosus.						
				aureotinctus...	aureotinctus.					
					brunneus.					
						rugosus.				
						viridulus	......	(reticulatus.		
						ligulatus.				
						globulus.				
Polydonta...	......	......	......	......	......	......	dentata.			
Margarita...	A.	arctica.								
	A.	striata.								
		sulcata.								
		callostoma.								
Vitrinella ...	......	......	......	......	......	decussata.				
						monilis.				
						monilifera.				
						lirulata.				
						subquadrata.				
						bifilata.				
						bifrontia.				
						coronata.				
						annulata.				
						cincta.				
						carinulata.				
						naticoides.				

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(Trochidæ: *Vitrinella*)						planospirata.				
						orbis.				
						Panamensis		Panamensis.		
						parva		parva.		
						perparva		perparva.		
						exigua		exigua.		
								concinna.		
								Janus.		
								modesta.		
								regularis.		
								seminuda.		
								tricarinata.		
								valvatoides.		
?*Liotia*						carinata.				
						striulata.				
						C-B-Adamsi.				
						sp.				
?*Globulus*						tumens.				
Ethalia						pyricallosa.				
						lirulata.				
						pallidula.				
						carinata.				
						amplectans.				
Teinostoma						amplectans.				
						substriatum.				
								minutum.		
Adeorbis								scaber.		
Neritidæ: *Nerita*						scabricosta	(ornata	(Deshayesii.		
						Bernhardi	(funiculata	Bernhardi		E.
Neritina						Californica.				
						cassiculum.				
						picta		picta.		
							latissima.			
							globosa.			
							Listeri.			
							intermedia	intermedia.		
							Guayaquilensis	Guayaquilensis		E.
								Michaudi.		
								pulchra.		

Pectinibranchiata.

Rostrifera.

Naricidæ: *Narica* ...	...	...	...	...	...	cryptophila.				
Calyptræidæ: *Crucibulum*	...	...	...	spinosum ...	spinosum ...	spinosum ...	spinosum ...	spinosum ...	...	E. C.
							(lignarium ...	...	...	C.
						Jewettii.				
						imbricatum ...	imbricatum ...	imbricatum ...	...	E.
							serratum.			
							umbrella ...	umbrella ...	...	E.
								radiatum ...	...	E.
Calyptræa ...	...	...	...	...	...	cepacea ...	...	cepacea ...	...	E.
							corrugata.			
								planulata.		
Galerus ...	...	...	fastigiatus.						varia ...	E.
				[mammillaris]	...	mammillaris ...	mammillaris ...	(regularis ...	...	E.
						conicus ...	conicus ...	conicus ...	...	E.
						subreflexus.				
								aspersus.		
Trochita ...	...	...	...	...	...	spirata.		unguis.		
Crepidula ...	A.	(grandis).				ventricosa.				
		Sitchana.								
		minuta ...	? nummaria ...	sp.						
				explanata.						
			(rostriformis ...	(solida ...	...	adunca ...	...	(rostrata.		
			?(lingulata ...	aculeata ...	...	aculeata ...	aculeata ...	aculeata ...	...	E.
				incurva ...	incurva ...	incurva ...	...	incurva ...	...	E.
				rugosa.						
						excavata ...	excavata ...	excavata.		
						onyx ...	...	onyx ...	...	E. C.
						nivea ...	...	nivea ...	...	E. C.
						unguiformis ...	...	unguiformis ...	...	E. C.
						dorsata ...	...	...	...	E.
						[dilatata] ...	...	...	...	E. C.
							arenata ...	...	...	E.
								osculans.		

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(Calyptræidæ: *Crepidula*)								marginalis		E.
								sordida.		
Capulidæ: *Hipponyx*					Grayanus	Grayanus	Grayanus	(radiatus	Grayanus.	
						serratus.				
						antiquatus		(Panamensis		E.
						planatus		planatus.		
						barbatus		barbatus	[Polynesia.]	
								mitrula.		
Capulus						sp.				
Vermetidæ: *Aletes*				squamigerus	squamigerus.					
						margaritarum.				
						centiquadrus	centiquadrus	(Peronii.		
Vermetus						eburneus.				
							Hindsii.			
Bivonia						contorta		contorta.		
						albida.				
						2 sp.				
								Panamensis.		
Spiroglyphus				sp.						
Petaloconchus					macrophragma	macrophragma		macrophragma		
Cæcidæ: *Cæcum.*										
Elephantulum						insculptum.				
						subspirale.				
						abnormale.				
						obtusum.				
						liratocinctum.				
						heptagonum.		laqueatum.		
Anellum						elongatum.				
						subimpressum.				
						clathratum.				
						quadratum.				
						undatum		?(parvum.		
						firmatum		firmatum.		
Fartulum						farcimen.				
						glabriforme.				
						corrugulatum.				
						dextroversum.				

						reversum.				
						teres.				
TURRITELLIDÆ: *Turritella*	...	Eschrichtii.				læve ...	...	læve.		
						goniostoma ...	(lentiginosa ...	goniostoma ...	...	E.
						tigrina ...	tigrina ...	? (Banksii.		
							nodulosa.			
							fascialis.			
					[rum	[rum	rubescens.			
CERITHIADÆ: *Cerithium* ...	...	...	...	...	stercusmusca-	stercusmusca-	stercusmusca-	(irroratum ...	(ocellatum.	
						alboliratum.	[rum			
						2 sp.				
						maculosum ...	maculosum ...	(adustum ...	(nebulosum.	
						famelicum ...	famelicum ...	famelicum.		
						uncinatum ...	uncinatum ...	uncinatum.		
						interruptum ...	...	interruptum ...	(Galapaginis.	
							musicum.			
Vertagus ...	...	...	...	...	...	gemmatus ...	...	Pacificum ...	...	E.
								gemmatus.		
						sp.				
							fragraria.			
Bittium ...	...	...	...	sp.						
Triphoris ...	...	...	...	...	...	alternatus ...	...	alternatus.		
						inconspicuus ..	...	inconspicuus.		
						? infrequens ...	...	infrequens.		
Cerithidea ...	...	...	...	sacrata ...	sacrata.					
					pullata.					
					albonodosa.					
						varicosa ...	varicosa ...	(valida ...	...	E.
						Montagnei ...	...	(Reeviana ...	...	E.
								pulchra.		
MELANIADÆ: *Melania* ...	...	...	silicula.							
			plicifera.							
			bulbosa.							
			plicata.							
				Wahlamatensis.						
				occata.						
?Melania ...	...	...	...	...	...	...	...	Gouldii.		
Amnicola ...	...	...	...	protea.						
				longinqua.						

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(MELANIADÆ:) *Pyrgula* ...	......	......	......	......	......	......	......	quadricostata.		
PALUDINIDÆ: *Bithinia* ...	......	......	......	seminalis. nuclea.						
AMPULLARIADÆ: *Ampullaria*	......		......	......	......	malleata.		Cumingii. giganteus.		
CYCLOSTOMIDÆ: *Cyclotus*...	......	......	......	......	......	......	......	Bairdiana.		
TRUNCATELLIDÆ: *Truncatella*	......	......	......	......	......	sp.	......	??dubiosa.		
LITORINIDÆ: *Litorina*......	A.	Kurila. Sitchana. modesta ...... [aspera]	...... lepida. scutellata.	modesta. planaxis. plena. [aspera]	?fasciata	fasciata ...... coronata. sp. aspera ...... conspersa ...... Philippii	...... aspera ...... conspersa	fasciata. aspera. conspersa. ?(parvula. aberrans. atrata. pulchra. varia.		
Modulus......	......	......	......	......	......	catenulatus ... disculus ...... sp.	...... (dorsuosus ...	catenulatus ... disculus.	porcata.	E.
Fossarus ...	......	......	......	......	......	tuberosus. angulatus.		abjectus. angiostoma. excavatus. foveatus. megasoma.		
Isapis......	......	......	......	......	......	ovoidea.				

RISSOIDÆ : *Rissoina*	....	....	....	....	....	maculosa.				
						sp.				
						stricta.				
						Woodwardii.				
						sp.				
								clandestina.		
								firmata.		
								fortis.		
Barleeia	....	....	....	....	....	lirata.				
?*Rissoa*	....	....	....	....	....	....	....	infrequens.		
								Janus.		
								notabilis.		
								scalariformis.		
								sp.		
?*Alvania*	....	....	....	....	....	excurvata.				
						effusa.				
						tumida.				
						sp.				
								inconspicua.		
								inconspicua *bis*		
								terebellum.		
								turrita.		
Cingula	....	....	....	....	....	sp.				
								paupercula.		
								saxicola.		
Hydrobia	A.	....	....	....	....	ulvæ.				
						sp.				
LACUNIDÆ : *Lacuna*	A.	glacialis.								
			carinata.							
				unifasciata.						
JEFFREYSIADÆ : *Jeffreysia*	....	....	....	....	....	bifasciata.				
						Alderi.				
						tumens.				
						sp.				
PLANAXIDÆ : *Alaba*	....	....	....	....	....	supralirata.				
						violacea.				
						terebralis.				
						alabastrites.				
						scalata.				
						conica.				

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(PLANAXIDÆ: *Alaba*) ...	...	...	...	...	...	mutans.				
						laguncula.				
						2 sp.				
Planaxis ...	...	...	...	...	...	nigritella.				
								planicostata...	planicostata.	
OVULIDÆ: *Radius* ...	...	...	...	variabilis ...	(Californica ...	variabilis ...	...	variabilis.		
							inflexa.			
							avena ...	avena.		
								emarginata ...	...	E.
								æquale.		
Ovula ...	...	...	...	...	...	...	...	gibbosa.		
CYPRÆIDÆ: *Cypræa* ...	...	...	...	...	...	exanthema ...	(cervinetta ...	(cervinetta.		
Luponia ...	...	...	...	spadicea.						
						[? spurca].				
									nigropunctata	E.
Aricia ...	...	...	...	...	...	arabicula ...	arabicula ...	arabicula ...	...	E.
								? (punctulata ..	...	E.
Trivia ...	...	...	...	Californica.						
						subrostrata.				
						pulla...	...	...	pulla...	E.
						sanguinea ...	...	sanguinea...	...	E.
									(fusca ...	E.
						Solandri ...	...	Solandri.		
						radians...	radians ...	radians ...	radians...	E.
						pustulata ...	pustulata ...	pustulata.		
							Pacifica ...	...	Pacifica.	
							suffusa ...	...	suffusa.	
								rubescens...	rubescens.	
									Maugeriæ.	
Erato ...	...	...	...	leucophæa.						
				columbella ...	...	columbella.				
					vitellina.					
						scabriuscula...	scabriuscula...	scabriuscula...	...	E.
								Maugeriæ.		
CANCELLARIADÆ: *Tricho-*	B.	(bicarinata).								
[*tropis*		(cancellata ...	borealis.							
		insignis.								
		inermis.								

	B.	arctica.								
Cancellaria …	…	…	…	…	funiculata.					
					ventricosa.					
						candida.				
						obesa …	obesa …	…	…	E.
						urceolata …	urceolata.			
						ventricosa …	ventricosa.			
						cassidiformis ..	…	cassidiformis.		
						solida …	solida …	solida …	…	E.
						goniostoma …	goniostoma …	goniostoma …	…	E.
							brevis.			
							bullata …	…	…	E.
							acuminata.			
							buccinoides …	…	…	E.
							gemmulata.			
							bulbulus.			
							albida …	albida …	…	E.
								elata.		
								crenata.		
								affinis.		
								bifasciata.		
								indentata.		
								uniplicata(+mitriformis).		
								pygmæa.		
								tessellata …	…	E.
								pulchra …	…	E.
								decussata …	…	E.
								clavatula …	…	E.
								chrysostoma…	?chrysostoma..	E.
									hæmastoma.	
Strombidæ: *Strombus* …	…	…	…	…	…	galeatus …	galeatus …	galeatus.		
						granulatus …	granulatus …	granulatus …	granulatus …	E.
						gracilior …	…	gracilior …	…	E.
								Peruvianus …	…	E.
Toxifera.										
Terebridæ: *Subula* …	…	…	…	…	…	luctuosa …	luctuosa …	…	…	E.
							varicosa …	varicosa.		
								strigata.		

Zoological Divisions.	*Asia.*	*Arctic.*	*Oregon.*	*U. California.*	*L. California.*	*G. California.*	*C. America.*	*Panama.*	*Galapagos.*	*S. A.*
(TEREBRIDÆ): (*Euryta*) ...	...	...	...	...	...	fulgurata.				
						aciculata ...	aciculata ...	...	...	E.
Terebra ...	...	...	...	...	...	specillata ...	...	specillata.		
						robusta ...	robusta ...	robusta.		
							lingualis.			
							uva.			
								ornata ...	ornata.	
(*Myurella*)..	...	...	...	...	armillata ...	armillata ...	armillata ...	armillata.		
						tuberculosa ...	tuberculosa ...	tuberculosa.		
						variegata.				
						albocincta.				
						Hindsii.				
						subnodosa.				
						rufocinerea.				
							elata...	elata.		
								larvæformis ...	...	E.
								aspera.		
								5 sp.		
									frigata.	
PLEUROTOMIDÆ: *Pleuroto-* [*ma.*	...	...	...	...	gemmata.					
						tuberculifera.				
						bituberculifera				
						nobilis.				
						funiculata ...	funiculata.			
						maculosa ...	...	...	...	E.
						picta...	picta...	picta.		
							unimaculata...	...	...	E.
							clavulus.			
							arcuata.			
							pudica.			
							olivacea ...	olivacea ...	...	E.
								gracillima.		
								cedo-nulli.		
								oxytropis ...	...	E.
Drillia ...	...	...	...	...	inermis.					
					plumbea.					
					luctuosa ...	luctuosa ...	...	...	...	E.
						cerithoidea.				

						monilifera.				
						albovallosa.				
						albonodosa.				
						Hanleyi.				
						2 sp.				
						rudis …	rudis…	rudis …	…	E.
						aterrima …	…	ater.?+discors	…	E.
						zonulata …	…	zonulata …	…	E.
						incrassata…	…	incrassata…	…	E.
							nitida.			
							militaris.			
							impressa.			
							pardalis.			
							cœlebs.			
							duplicata …	duplicata …	…	E.
							granulosa…	granulosa.		
							collaris…	collaris…	…	E.
							corrugata…	corrugata…	…	E.
								(atrior).		
								punctatostriata.		
								grandimaculata.		
								obeliscus.		
								striosa.		
								unicolor.		
								2 sp.		
								nigerrima…	…	E.
								pallida …	…	E.
								rustica …	…	E.
								excentrica …	excentrica.	
								bicolor …	bicolor.	
									rugifera.	
									albicostata.	
									splendidula.	
							arcuata.			
							hexagona.			
							cincta [=modesta].			
							cœlata.			
Bela …	…	…	fidicula.							
Clathurella	…	…	…	…	…	aurea.				
[*Defrancia*]						rava …	rava.			

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(Pleurotomidæ: *Clathu-[rella.)*	......	......	......	[bella]	......	......	bella.			
							cornuta.			
							variculosa.			
							ericea.			
							quisqualis.			
							occata.			
							neglecta.			
							candida.			
							merita.			
							micans.			
							corrugata	......	......	E.
							bicanalifera ...	bicanalifera.		
								intercalaris.		
								serrata.		
								sculpta.		
								rigida.		
								exigua.		
								gemmulosa.		
Daphnella	......	......	......	......	......	......	casta.			
Cithara	......	......	......	......	......	sp.	......	sinuata.		
								stromboides.		
Mangelia	......	......	......	......	plumbea.					
						acuticostata ...	......	acuticostata.		
								concinna.		
								neglecta.		
								sulcosa.		
								4 sp.		
Conidæ: *Conus*	......	......	......	ravus.						
					Californicus.					
						ferrugatus.				
						concinnus.				
						pusillus.				
						puncticulatus.				
						sp.				
						scalaris......	scalaris.			
						nux	......	nux	nux.	
						gladiator	gladiator	gladiator.		
				[(comptus] ...	......	purpurascens..	purpurascens..	purpurascens.		

						regalitatis ...	regalitatis ...	regalitatis.		
						regularis	regularis	regularis.		
						?(arcuatus.				
						princeps	princeps	princeps	....	E.
							Lorenzianus.			
							Archon.			
							Orion.			
							patricius.			
							lineolatus.			
							cinctus.			
							ravus.			
							vittatus	vittatus.		
							pyriformis ...	....	....	E.
							mahogani......	mahogani......	....	E.
								(Ximenes).		
								tornatus	....	E.
								brunneus	brunneus	E.
									minimus, var.	
									varius, var.	
									Luzonicus, var.	
									diadema.	
Proboscidifera.										
Solariadæ: *Solarium*......	......	....	....	....	placentale.					
						(granulatum)..	granulatum ...	?granulatum.		
								quadriceps.		
								sp.		
Torinia	......	....	....	....	....	variegata	....	?variegata.		
						?granosa	granosa.			
							bicanaliculata.			
								sp.		
Pyramidellidæ: *Obeliscus*	......	....	....	....	....	(achates	clavulus.			
						?conicus	....	conicus.		
								sp.		
Odostomia	......	....	....	gravida.						
						sublirulata.				
						lamellata.				
						subsulcata.				

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(PYRAMIDELLIDÆ: *Odostomia*)						vallata.				
						mammillata.				
						tenuis.				
						sp.				
(*Auriculina*)						3 sp.				
Parthenia						scalariformis.				
						quinquecincta.				
						lacunata.				
						armata.				
						exarata.				
						ziziphina.				
Chrysallida						ovata.				
						nodosa.				
						rotundata.				
						oblonga.				
						telescopium.				
						Reigeni.				
						effusa.				
						fasciata.				
						ovulum.				
						convexa.				
						Photis.				
						indentata.				
						clausiliformis.				
						communis		communis.		
								clathratula.		
								?acuminata.		
								marginata.		
Chemnitzia				tenuicula.						
				torquata.						
						prolongata.				
						muricata.				
						gibbosa.				
						gracillima.				
						undata.				
						flavescens.				
						terebralis.				
						tenuilirata.				

						unifasciata.				
						4 sp.				
						C-B-Adamsi.				
						Panamensis ...	....	Panamensis.		
						similis	....	similis.		
						aculeus....	....	aculeus.		
						affinis	....	affinis.		
								gracilior.		
								major.		
								striosa.		
								turrita.		
(*Dunkeria*)	....	....	....	....	....	paucilirata.				
						subangulata.				
						cancellata.				
						intermedia.				
Eulimella	....	....	....	....	....	obsoleta.				
						3 sp.				
						?sp.				
Aclis	....	....	....	....	....	fusiformis.				
						tumens.				
EULIMIDÆ: *Eulima*	....	....	....	....	....	hastata....	....	....	....	E.
						2 sp.				
							interrupta.			
							acuta.			
Leiostraca	....	....	....	....	....	linearis.				
						?distorta.				
						2 sp.				
						?recta	....	recta.		
						?solitaria	....	solitaria.		
						?iota....	....	iota.		
Stylifer	....	....	....	....	....	....	....	....	astericola.	
CERITHIOPSIDÆ: *Cerithiop-* [*sis.*	....	....	filosa.							
						tuberculoides.				
						cerea.				
						pupiformis.				
						Sorex.				
						convexa.				
						decussata.				
						assimilata....	....	assimilata.		
								bimarginata.		

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(Cerithiopsidæ : *Cerithi-* [*opsis.*])	......	......	......	......	......	......	......	neglecta.		
								paupercula.		
Scalariadæ : *Scalaria*	A.	Grœnlandica.								
			australis	......	......	......	......	......	......	E.
			sp.							
						indistincta.				
						reflexa.				
						suprastriata.				
						raricostata.				
						2 sp.	......	(3 sp.)		
						hexagona	hexagona	hexagona.		
							mitræformis.			
							Dianæ.			
							aciculina.			
							vulpina.			
								statuminata.		
								regularis.		
								tiara.		
								subnodosa.		
								Cumingii.		
								Hindsii.		
								obtusa	......	E.
Cirsotrema..	......	......	......	......	......	funiculata ...	......	funiculata.		
									diadema.	
Naticidæ : *Natica*	A.	clausa.		? maroccana var. Californica }	......	maroceana ...	(Pritchardi ...	(Chemnitzii ...	maroccana ...	E.
						bifasciata.				
						sp.				
							excavata	excavata.		
								Haneti.		
								zonaria.		
								2 sp.		
								Souleyetiana..	......	?E.
Lunatia	A.	flava.								
			caurina.							
			impervia	......	......	......	......	......	......	E.
			(Lewesii	herculæa.						
			algida.							

						tenuilirata.				
						3 sp.				
						otis	(Gallapagosa..	otis	(Gallapagosa.	
							Bonplandi.			
Neverita	......	......	......	Recluziana.				lurida.		
Polinices	......	......	perspicua.			glauca	(patula........	....	....	E.
					?uber	uber	uber	....	....	E.
						intemerata.				
						unimaculata.				
								virginea.		
								Salangonensis	....	E.
								Panamaensis.		
Sigaretus	......	......	......	......	......	debilis.		sp.		
VELUTINIDÆ: *Velutina* ...	A.	coriacea.								
	A.	spongiosa.								
		Sitchensis.								
LAMELLARIADÆ: *Lamellaria* ...		......	......	......	......	2 sp.				
FICULIDÆ: *Ficula*	......	......	......	......	......	ventricosa ...	(decussata ...	ventricosa.		
DOLIADÆ: *Malea*	......	......	......	......	......	....	(latilabris......	ringens	....	E.
CASSIDÆ: *Oniscia*	......	......	......	......	......	tuberculosa ...	tuberculosa ...	tuberculosa...	tuberculosa.	
									xanthostoma.	
Cassis	......	......	......	......	......	coarctata	coarctata	coarctata	coarctata.	
							abbreviata ...	abbreviata.		
TRITONIIDÆ: *Triton*	......	......	[tigrinus] ...	......	......	......	tigrinus.		tenuis.	
							scalariformis.			
							anomalus.			
							vestitus	vestitus.		
								fusoides.		
								crebristriatus.		
								eximius.		
								constrictus ...	....	E.
								gibbosus	....	E.
								lignarius	....	E.
									reticulatus.	
									Sowerbyi.	
									pictus.	

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(TRITONIDÆ: *Triton*) ...	...	...	...	...	...	...	...	...	clandestinus.	
(*Argobuccinum*)	A.	cancellatum...	(Oregonense.							
		scabrum ...	...	scabrum ...	(?scabrum) ...	...	...	...	...	E.
						nodosum ...	...	(Chemnitzii.		
						...	ridens.			
Persona ...	...	...	...	...	triquetra.					
Ranella ...	...	...	...	...	Californica.					
					muriciformis...	...	muriciformis.			
						pectinata.				
						sp.				
						? tuberculata.				
						nana...	...	nana.		
								cælata.		
								albifasciata.		
								plicata.		
								convoluta.		
								anceps.		
								pyramidalis.		
								nitida ...	...	E.
TURBINELLIDÆ: *Turbinella*	...	...	...	...	...	cæstus ...	(ardeola ...	cæstus ...	...	E.
FASCIOLARIADÆ: *Lathirus*	...	...	...	...	...	armatus.				
						Californicus.				
						ceratus...	ceratus...	ceratus...	ceratus.	
							concentricus.			
							tuberculatus ..	...	tuberculatus.	
							castaneus ...	castaneus.		
								rudis.		
								spadiceus.		
								nodatus.		
								tumens.	varicosus.	
Leucozonia ...	...	...	...	...	...	cingulata ...	cingulata ...	cingulata.	...	E.
Fasciolaria ...	...	...	...	...	...	princeps ...	...			
							salmo.			
								granosa.		
								bistriata.		
MITRINÆ: *Mitra* ...	...	...	...	maura.		lens ...	...	lens ...	...	E.
							effusa.			

							attenuata.			
							Belcheri.			
							Hindsii.			
							sulcata.			
							babea.			
								nucleola.		
								solitaria.		
								funiculata......	....	E.
									guasapata.	
									gratiosa.	
									muricata[Pol.]	
Strigatella	......	....	....	....	....	tristis	....	tristis	tristis	E.
							effusa	....	effusa.	
VOLUTIDÆ : *Voluta*	......	....	....	....	....	harpa	....	....	....	E.
Marginella ...	......	....	....	Jewettii.			Cumingii	....	....	E.
						curta.				
						polita.				
						margaritula.				
						minor	....	minor.		
				[imbricata] ...	....	....	imbricata.			
							cypræola.			
							sapotilla	sapotilla.		
							cærulescens ...	(prunum.		
OLIVIDÆ : *Oliva*	......	....	....	....	....	intertincta.				
						Duclosi	....	....	[Polynesia].	
						?eburnea.				
						porphyria......	porphyria......	porphyria.		
						angulata	angulata	angulata.		
						Melchersi......	....	Melchersi.		
						splendidula ...	....	splendidula.		
						venulata	....	venulata.		
						Cumingii	?(polpaster ...	?(polpaster.		
							Julieta.			
Olivella	......	....	sp.							
				rufofasciata.						
				biplicata	(glandinaria.					
						dama.				
						intorta.				
						p. aureocincta.				
						anazora	....	....	....	E.
						zonalis	zonalis.			

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(Olividæ: *Olivella*)……	……	……	……	……	……	tergina ……	tergina.			
						undatella ……	undatella ……	undatella.		
						inconspicua …	……	inconspicua.		
							volutella ……	volutella.		
								pellucida.		
								semistriata …	……	E.
									Kaleontina …	E.
Aragonia ……	……	……	……	……	……	testacea ……	testacea ……	testacea.		
Harpa……	……	……	……	……	……	……	scriba.			
							crenata.			
Purpuridæ: *Purpura* …	A. B.	Freycinettii.								
	B.	(decemcostata)								
	A.	lapillus……	lapillus.							
		septentrionalis	septentrionalis							
			ostrina.							
			lagena.							
				macrostoma.						
				harpa.						
				emarginata …	emarginata …	emarginata.				
						triangularis …	……	triangularis …	(Carolensis.	
						triserialis……	(speciosa.			
						patula ……	(pansa ……	……	patula.	
						columellaris…	columellaris…	……	columellaris.	
						muricata ……	muricata ……	muricata ……	……	E.
						biserialis ……	(bicostalis …	(undata ……	……	E.
							(melones ……	melo……	……	E.
								alveolata.		
									planospira.	
Cuma……	……	……	……	……	……	costata.				
						kiosquiformis..	……	kiosquiformis..	……	E.
							tecta……	tecta.		
Rhizocheilus……	……	……	……	……	foveolata.					
						asper.				
						nux ……	……	nux.		
Vitularia …	……	……	……	……	Belcheri.					
						salebrosa ……	salebrosa ……	salebrosa ……	salebrosa.	
Pseudoliva…	……	……	……	……	Kellettii.					
Monoceros…	……	……	……	engonatum.						
				brevidens.						

					(lugubris).	tuberculatum.				
				[brevidentatum]	....	[(cornigerum]	brevidentatum	{ (maculatum brevidentatum }	....	E.
									grande.	
Engina	......	....	....	....	....	....	....	jugosa.		
								alveolata.		
								heptagonalis.		
								contracta	....	E.
								carbonaria ...	carbonaria.	
								Reeviana	(pulchra.	
								pyrostoma ...	pyrostoma.	
								maura	maura.	
								crocostoma ...	crocostoma.	
									zonata.	
Nitidella	......	....	....	Gouldii.						
					Californica.					
						sp.				
						cribraria	....	cribraria.		
								pulchrior.		
BUCCINIDÆ: *Columbella* ...	......	....	gausapata.							
				Santa Barbarensis.						
				carinata	carinata.					
					Californiana.					
						cervinetta.				
						nasuta.				
						major	major	major	....	E.
						strombiformis	strombiformis	strombiformis	....	E.
						fuscata	fuscata	fuscata	....	E.
							pulcherrima.			
							ligata.			
							castanea.			
							pardalis.			
							festiva.			
							labiosa	labiosa	....	E.
							Boivinei	Boivinei.		
								harpiformis.		
								procera.		
								livida.		
								hæmastoma ...	hæmastoma.	
									varians.	

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(Buccinidæ: *Columbella*)									unicolor.	
Metula						4 sp.				
							Hindsii.			
Truncaria				[modesta]			modesta	modesta.		
Buccinum	A.	tenebrosum.								
	B.	(ovum).								
			corrugatum.							
				Poulsoni.						
[*Pseudo-Buccinum.*]							leiocheilus.			
								Panamense		E.
									biliratum.	
									pulchrum.	
Bullia	A.	ampullacea.								
Nassa			mendica.							
			fossata	fossata	fossata.					
				perpinguis	perpinguis.					
					tegula	tegula.				
						crebristriata.				
						9 sp.				
						versicolor	versicolor	versicolor.		
						luteostoma	luteostoma	luteostoma.		
						?(acuta	pagodus	pagodus.		
						gemmulosa		gemmulosa.		
							mœsta.			
							scabriuscula	scabriuscula.		
								pallida.		
								canescens.		
								collaria.		
								corpulenta.		
								glauca.		
								Panamensis.		
								striata.		
								Wilsoni.		
								festiva		E.
								nodifera	nodifera.	
									angulifera.	
Phos							Veraguensis.		nodocincta.	
							gaudens.			

								crassus	crassus.		
									articulatus.		
									turritus.		
									biplicatus.		
PYRULIDÆ: *Pyrula*	......	....	....	....	....	patula	patula	patula	....	E.
MURICIDÆ: *Chrysodomus* ..	A.	Sabinii.								
	A. B.	(antiquus).								
	B.	(deformis).								
	B.	(Islandicus).								
	B.	(Behringii).								
	B.	(Baeri).								
		Sitchensis.								
		luridus.								
Fusus	......	....	....	....	....	lignarius.				
						ambustus.				
						tumens.				
						apertus.				
						2 sp.				
						pallidus	....	....	....	E.
							Dupetithouarsii	....	Dupetithouarsii.	
Trophon	A.	clathratum.						bellus.		
			Orpheus.							
			corrugatum.							
			cancellinum.							
								Hindsii.		
Cominella	......	....	....	....	....	sp.				
Anachis	......	....	....	....	....	tæniata.				
						nucleolus.				
						pallida.				
						nigrofusca.				
						serrata.				
						rufotincta.				
						albonodosa.				
						2 sp.				
						Gaskoinei	....	....	....	E.
						costellata	....	costellata.		
						scalarina	scalarina	scalarina.		
						coronata	coronata	coronata.		
						fulva	fulva	fulva.		
						pygmæa	....	pygmæa	....	E.

Zoological Divisions.	Asia.	Arctic.	Oregon.	U. California.	L. California.	G. California.	C. America.	Panama.	Galapagos.	S. A.
(Muricidæ: *Anachis*)							lentiginosa.			
							fluctuata	fluctuata.		
							rugosa	rugosa		E.
								conspicua.		
								diminuta.		
								gracilis.		
								lyrata.		
								mœsta.		
								tessellata.		
								varia.		
								sp.		
								parva		E.
								nigricans	nigricans.	
								atramentaria	atramentaria.	
									rugulosa.	
Strombina						sp.				
						maculosa	maculosa.			
							elegans.			
							fusiformis.			
							turrita	turrita		E.
								angularis.		
								dorsata		E.
								gibberula		E.
								bicanalifera	bicanalifera.	
									lanceolata	E.
Pisania						gemmata				E.
						sanguinolenta.		sanguinolenta.		
						insignis		insignis		E.
						? (æquilirata)		pagodus.		
						ringens	ringens	ringens.		
							pastinaca.			
								lugubris.		
								nigrocostata.		
								Panamensis.		
								Stimpsoniana.		
									cinis.	
Northia						pristis		(serrata		E.
Clavella								distorta		E.
Murex						armatus.				

						plicatus	plicatus.			
						recurv. lividus	recurvirostris..	recurvirostris.		
								rectirostris ...	....	E.
								erosus.		
								horridus	....	E.
									pumilus.	
									nucleus.	
(*Pteronotus*)...	......	....	....	....	festivus.					
							centrifuga.			
(*Cerastoma*)...	......	monodon	foliatum.							
				Nuttallii.						
(*Phyllonotus*)..	......	....	....	....	....	imperialis.				
						nigritus.				
						brassica.				
						princeps.				
						nitidus	nitidus.			
						bicolor	bicolor.			
						regius	regius	regius.		
							oxyacanthus.			
							radix	radix	....	E.
(*Muricidea*) ...	......	lactuca.			perita.					
						radicata.				
						fimbriata.				
						pauxillus.				
						sp.				
						lappa	....	....	....	E.
						?(er. indentata	(erinaceoides..	alveata.		
						dubia	....	dubia.		
							incisa.			
								vittata	....	E.
								vibex	....	E.
Typhis	......	....	....	....	....	fimbriatus.				
						grandis.				
							quadratus......	....	....	E.

Class CEPHALOPODA.

OCTOPODIDÆ : *Octopus* ...	B.	(sp.)								
ONYCHOTEUTHIDÆ : *Ony-* [*choteuthis*	B.	(Bergii).								

70. Now let the student of geographical distribution of Mollusca begin by observing the fauna of our own seas, and learn, from the invaluable work of Forbes and Hanley, to discriminate species and eliminate those that are spurious. Let him then, taking Philippi and M'Andrew as his guides, compare them with the shells of the Atlantic and Mediterranean shores. Let him, with Gould and DeKay, note both the similar and dissimilar forms on the shores of the United States. Let him, after studying the very characteristic fauna of the Caribbean Sea, again cross the Atlantic, and observe the reappearance of well-known forms, in spite of the vast extent of ocean. Let him trace the fauna of Senegal with Adanson, of the Guinea coast with Dunker, and of the Cape and Port Natal with Krauss. Here let him enter on the vast Indo-Pacific province; and, having taken-in the general conception of the fauna from any collection of East Indian shells, let him examine its special districts, from Akaba, to Easter Island in the latitude of the Gulf of California. Let him learn from Cuming the vast variety of generic and specific forms which culminate in the Philippines. Let him trace some of these westward even to the northern extremity of the Red Sea, where they associate with types from the Mediterranean and even the West Indies; and eastward from group to group of the coral or volcanic islands in the vast expanse of the Pacific. Let him note the reappearance of forms at the Cape and Australia, in spite of the broad waters of the Indian Ocean. Let him learn from Nuttall the species which are common to the Red Sea and the Sandwich Islands; and from Stutchbury those which abound both in New Holland and Tahiti. And, having at every step in his inquiry found somewhat in common with the last; having, when examining the shells of the Marquesas in the center of the Pacific, found several conspicuous and well-known forms of the Asiatic Seas, in spite of (in parts) the profound depth of ocean that lies between; he will naturally expect, as he reaches the American shores, to find also not a little in common with the opposite shores. He crosses the vast unbroken expanse of the West Pacific; one flank of the hemisphere of waters, which of itself almost rivals the Atlantic in extent. He pauses at the solitary Archipelago of the Galapagos, in the very longitude of the Gulf of Mexico, guarding (as it were) the great bay of Central America, and within 600 miles of its shores. Even here his eye rests with pleasure on a few well-known Cones and other forms, which have crossed the fathomless depths and come to claim kindred with their molluscan brotherhood of the New World. But here they stop. They could traverse half a world of waters. The human spirit that gives them understanding and a voice, beholds them on the very threshold of the promised continent, in whose bays and harbours, protected by the chain of everlasting mountains, they shall find the goal of their long pilgrimage. But the Word of the unknown Power has gone forth; and the last narrow channel they attempt to cross in vain.

We speak now of the first general impression, without regard to exceptional cases: and the ascertained facts fully bear us out in saying that there does not exist on the surface of the earth a more separate, independent assemblage of mollusks than is to be found, under three great typical divisions, from Oregon to Chili. Mr. Nuttall, in passing from California to the Sandwich Islands, found only a *Hipponyx* in common. Messrs. Cuming and Hinds, both of whom had well explored the seas of the E. and W. Pacific, and of whom the former made his great collections in the two equatorial boundaries, with no inconsiderable research among the intermediate groups, having compared about 2000 species from the two districts, came to the conclusion that only one shell is common to east and west, and not even that to the intermediate islands*.

71. And if we are thus struck with the isolation of the W. American fauna in general, so are we with the separation of its component parts. Let us compare (as being the most unmixed sources of information) the central collection of Prof. Adams at Panama, on the one side with the equatorial collections of Messrs. Cuming and Fontaine, and with the Chilian researches of the former and D'Orbigny; and on the other with the Gulf collection of M. Reigen, and those in California by Mr. Nuttall and the U.S. Exploring Expedition. We find that, while so large a number of species are common to Mazatlan, Panama, Guayaquil and the Galapagos, that they may fairly be reckoned as one great province, scarcely any are common to the equatorial districts and Chili, and still fewer to the Gulf and San Francisco; insomuch that on a comparison of known forms between Mr. Nuttall's collection, M. Reigen's, and the W. Indian fauna, it may be safely asserted that there is more in common between the two latter than the two former.

We proceed now to the details and the exceptions; merely premising that the student must bear in mind the very unsatisfactory nature of most of our materials, and must therefore receive what follows simply as the approximation partially attainable in the present state of the science, and not as absolute truth.

72. In the *Boreal Fauna*, we naturally look for different conditions from those which prevail in the continent generally. The near connexion of Asia and America at Behring's Straits and the Aleutian Islands leads us to expect similar forms on the two continents; and as the boreal species are known to be both widely distributed and extremely variable, we shall not be surprised to meet again with a few familiar European types.

The following Polar species are quoted from the extreme north at Icy Cape:—

Corbula gibbosa.
Tellina alternidentata.
—— inconspicua.
—— nasuta.
Astarte crassidens } { =corrugata.
—— lactea } { =semisulcata.
Trichotropis borealis.
Natica pallida.
Buccinum angulosum.
—— polare.
—— tenue.
Chrysodomus fornicatus.
Trophon lamellosus.

Of these none as yet appear in the Sitcha lists but *Tellina nasuta*, and the European *Trich. borealis*. The latter probably reaches Oregon, while the former travels as far south as San Diego.

73. From the Sitcha district are quoted 102 species (25 bivalves, and 77 univalves); of which 16 are northern forms, not known south of Behring Sea; 18 biv.+26 un.=44 are found in Asia, principally in the Ochotsk Sea; 7 biv.+12 un.=19 are common to Oregon; about the same number, but not the same shells, are found in Upper California, and a few have a wide range. *Triton scaber* is the only Sitcha Proboscidean which reaches California. The Kamtschatkian *Cryptochiton Stelleri* and *Placunanomia macroschisma* reappear in Upper California, but have not yet been found in intermediate stations. *Mytilus edulis* reaches from Kamtschatka to Upper, and *Tellina nasuta* with *Cardia Nuttalli* and *Californiense* to Lower California; while *Acmæa patina* travels

* *Vide* Woodward's "Manual of Mollusca," pp. 373 *et seq.*, London, Weale, 1851–56: a work which combines in a small compass, and at a price within the reach of all, a larger amount both of accurate detail and philosophical research than is anywhere else accessible. The chapters on geographical and geological distribution are invaluable.

under a host of names to the peninsula, and even straggles into the Gulf. *Scurria mitra, Osilinus ater* and *Omphalius mœstus* reach from Sitcha to Lower California, and *Acmæa persona* sparingly enters the Gulf; while the ubiquitous *Saxicava*, one species probably under a variety of names and forms, appears, like man and dog, to adapt itself to every variety of climate, and to reappear in every well-searched fauna, boasting also of being one of the most ancient types now living on the surface of our globe. The *Litorina aspera* and *Callopoma fluctuatum*, quoted on the authority of Barclay, are so essentially tropical, that we may be allowed to suspend our judgment before we receive them into the fauna.

74. The Oregon shells belong, in the main, to the Californian type, but present, thus far, peculiarities which demand a separate study. The total

		Bivalves.	Ordinary Univalves.	Toxifera.	Probosci-difera.
number known are	144=	49	72	1	22
Of these have, in addition, been found only in Upper California	16=	6	9	0	1
„ also in Lower California	12=	5	6	0	1

The following—*Crenella discrepans, Trichotropis borealis* and *Bela ?turricula*, are European forms. The following are the principal sea shells as yet peculiar:—

Terebratula pulvinata and canrena.
Panopæa generosa.
Solen sicarius.
Venus calcarea and ampliata.
Cardium blandum.
Pecten caurinus, hericeus and Townsendi.
Placunanomia alope and cepio.
Chitonidæ dentiens and lignosus.
Callochiton interstinctus.
Mopalia vespertina.
Chiton muscosus.
Katherina Douglasiæ.
Puncturella cucullata and galeata.
Litorina lepida and scutellata.
Lacuna carinata.
Cerithiopsis filosa.
Lunatia caurina, herculæa, algida.
Purpura ostrina and lagena.
Columbella gausapata (the most northerly species of the genus.)
Nassa mendica.
Trophon Orpheus and corrugatus.

75. A comparison of the shells of the N. W. and S. W. shores of America offers certain remarkable points of identity. The standard limpet of the northern seas is *Acmæa patina*. On reaching the Gulf, it is replaced by *A. mesoleuca*, which probably extends through the Panamic province. But when we approach Chili, we again find the *A. patina* in D'Orbigny's collections, and it is figured by Mr. Reeve as though brought by Cuming. Indeed if the Chilian and Californian specimens were mixed, it would be impossible to separate them by the shells alone. It is true that Philippi, recognizing some of Eschscholtz's Sitchian species as southern forms, accuses the latter of mixing the labels; but probably they occur in each fauna. The *Scurria mitra* also, though somewhat more local, is a very abundant shell on both coasts. The *Acmæa cassis* of Eschscholtz appears only a northern reproduction of the Patagonian *Patella deaurata*, Gmel. The *Fissurrella violascens*, Esch., is assigned by him to the south, to which in type it belongs; but it has some claims on the northern fauna for admission. The *Bullia ampullacea*, Midd., is essentially a southern type, especially abounding in peninsulas; of its specific relations we are not yet able to judge. The *Natica caurina* of Gould, appears a geographical creation for the southern *N. impervia* of Philippi; while of the Oregonian *Scalaria*, Dr. Gould confesses that he has

seen no marks by which it can be separated from *S. australis*, though he expects that some will be eliminated hereafter.

76. The UPPER CALIFORNIAN district presents a very peculiar assemblage of shells; essentially of a temperate cast, but including a few forms of tropical type. The leading species are as follow, including several which also make their way into Oregon and Lower California :—

Discina Evansii.
Pholadidea penita.
Parapholas Californica.
Petricola Californica.
Rupellaria lamellifera.
Saxidomus Petitii and Nuttalli.
Platyodon cancellatus.
Cryptodon Nuttalli.
Sphænia Californica.
Thracia curta.
Mytilimeria Nuttalli.
Pandora punctata.
Machæra Nuttalli.
Solecurtus subteres and Californicus.
Sanguinolaria grandis.
Tellina Bodegensis, secta and alta.
Donax flexuosus and Californicus.
Mactra Californica and planulata.
Trigona crassatelloides.
Dosinia callosa.
Venus Nuttalli.
Tapes straminea.
Trapezium Californicum.
Chama exogyra.
Diplodonta orbella.
Kellia Laperousii.
Mytilus Californianus and bifurcatus.
Modiola recta and nitens.
Nucula cœlata.
Leda polita.
Isognomon costellatus.
Pecten latiauratus.
Bulla nebulosa.
Tornatina culcitella and cerealis.
Lepidochiton Mertensii and scrobiculata.
Mopalia Simpsonii.
Chitonidæ Nuttalli, ornatus, Montereyensis, Hartwegii.
Nacella depicta and incessa.
Acmæa scabra and toreuma.
Fissurella ornata and volcano.
Lucapina crenulata.
Haliotis, 5 sp.
Trochus filosus.
Omphalius aureotinctus.
Trochiscus Norrisii.
Crepidula rugosa.
Aletes squamigerus.
Litorina planaxis.
Trivia Californica.
Defrancia bella.
Conus ravus.
Odostomia gravida.
Chemnitzia tenuicula and torquata.
Neverita Recluziana.
Mitra maura.
Marginella Jewetii.
Purpura macrostoma and harpa.
Monoceros engonata and lapilloides.
Nitidella Gouldii.
Columbella carinata and StaBarbarensis.
Nassa perpingius.
Cerastoma Nuttalli.

The total number of mollusks known to inhabit this district, excluding most of those of which the habitat is only loosely stated as "California," &c., is as follows :—Bryozoa, 1; Palliobranchs, 2; Lamellibranchs, 73; Ordinary Gasteropoda, 100; Toxifera, 2; Proboscidifera, 24: Total, 202. Of these there have only as yet been found common also to Lower California (San Diego to Cape St. Lucas), Bryozoa, 0; Palliobranchs, 0; Lamellibranchs, 27; Ordinary Gasteropoda, 23; Toxifera, 0; Proboscidifera, 6: Total, 56; but as scarcely 140 species are as yet known from that region, it is next to certain that the common species will be hereafter found much more numerous. Of the comparatively small assemblage known from Upper California, containing next to no pelagic forms and only about half-a-dozen minute species, it will be observed how large a proportion are bivalves, and how few proboscideans; also how much larger the proportion of the widely extended species is in the former than in the latter group. A very few, as *Cultellus lucidus* and *Lyonsia Californica*, are perhaps identical with North Atlantic shells; but in general there is a wide disagreement. Here are found the largest species of *Parapholas* and *Trigona*; and the types of *Platyodon*, *Cryptodon*, *Mytilimeria* and

Saxidomus. The tendency of the *Muricidæ* and *Purpuridæ* to assume the acanthoid type, is well known, both in these and the West Southern shores. The *Lithophagus Gruneri* rests on tolerably satisfactory evidence from New Zealand as well as from Monterey. The wide-spread *Strigilla carnaria*, even more like the usual Caribbean type than are the Mazatlan specimens, here appears in tolerable abundance; while even the *Livona pica* is stated to have been found alive. Of course it may retain a lingering existence in the upper seas, as *Lucina tigerrina* in the lower, while on the coast bordering on the Caribbean it has died out; but it is more natural at present to suppose it an error. For the *Litiopa divisa*, an East Indian pelagic shell, said to have been found on "Cape San Francisco," a locality of the same name occurs near the Bay of Guayaquil. The sudden appearance of *Haliotidæ*, of great size and beauty, in the temperate shores of West N. America, is very remarkable. Not a single specimen occurred in the vast Reigen collection, nor have any been taken in Central America, or in South America, the head-quarters of Chitonidæ. On crossing the Pacific Ocean, however, we find that Japan, which represents the same zone on the Asiatic coast, is equally rich in beautiful forms. The following species are quoted from

Japan.	California.
Haliotis Japonica, Rve.	*Haliotis splendens*, Rve.
—— *gigantea*, Chemn.	—— *corrugata*, Gray.
—— *discus*, Rve.	—— *Cracherodii*, Leach.
—— *Siebaldii*, Rve.	—— *Californiensis*, Swains.
—— *aquatilis*, Rve.	—— *rufescens*, Swains.

Two of the Asiatic species, *H. aquatilis*, Rve., and *H. Kamtschatkana*, Jonas, stretch upwards within the bounds of the Polar fauna in Behring's Sea; while the latter appears to have crossed the waters, and to have found its way sparingly down the American coast.

77. Of the fauna of Lower California, meaning the peninsula from San Diego to Cape St. Lucas, one of the most interesting portions in the American coast, but the least thoroughly investigated, very little is known, and that little but inaccurately. The shells of San Diego, as collected by Nuttall, are almost entirely distinct from those of the Gulf. Most of them belong to the Upper Californian type, but several fresh species make their appearance, which are still distinct from the Mazatlan fauna. This ground was well searched by Messrs. Kellett and Wood; and it is probable, though the evidence is very slight, that many of the peculiar shells of their expedition, such as *Hinnites giganteus*, *Pseudoliva Kellettii*, &c., were obtained in this district. The little that is known accurately of the peninsula, shows that the stations on both shores of the Gulf belong essentially to the Panamic type; those within the Gulf being even more tropical than those at the mouth; as evidenced by *Oliva porphyria*, *Cassis coarctata*, *Oniscia tuberculosa*, *Terebra robusta*, and other Panama species not found in the Reigen collection: while the Bay of Magdalena and other stations in the Pacific are peopled, principally by the Californian colony moving southwards, and stopped at the Cape by the upward equatorial current; partly by Gulf shells making their way round the corner; and partly, it seems, by a special little fauna of its own. It will be an abundant recompense for the labour of this Report, if it should lead any careful naturalist to make a diligent search of the district, both as to its shore shells and its pelagic species; making accurate notes *at the time* what species are taken alive and what dead; in what circumstances and quantities; and with such precautions as shall effectually guard against all

chances of error. We shall then know, and not satisfactorily till then, where and how the two great faunas of West N. America, both of which go loosely by the name of "Californian," find their separation.

The imperfect data of the Pacific coast of Lower California only furnish us with Palliobranchs, 1; Lamellibranchs, 60; ordinary Gasteropods, 49; Toxifera, 7; Proboscidifera, 20: total 137 species. As the localities are so far from being satisfactorily established, an exact analysis of them will not here be attempted: but the fauna of each spot will be given entire so far as known, both on the Pacific shores and in the Gulf. The species marked * belong to the Californian type; those marked † to the Panamic.

The following list contains the known shells of San Diego:—

Pholadidea ovoidea.
*—— penita.
*Parapholas Californica.
Saxicava Pholadis.
*Petricola Californica.
*Saxidomus Nuttalli.
*Platyodon cancellatus.
*Sphænia Californica.
*Lyonsia Californica.
Periploma argentaria.
*Solecurtus subteres.
*—— Californianus.
Sanguinolaria Nuttalli.
Psammobia Pacifica.
*Tellina nasuta.
*—— secta.
—— pura.
—— vicina.
Cumingia Californica.
*Semele decisa.
—— flavescens.
*—— rubrolineata.
*Donax Californicus.
*Venus Nuttalli.
*—— Californiana.
—— excavata.
—— dispar.
—— fluctifraga.
*Tapes straminea.
*Trigona crassatelloides.
*Cardium Nuttalli.
*—— Californiense.
*—— substriatum.
†—— elatum.
—— luteolabrum.
Cypricardia Californica.
*Chama exogyra.
—— pellucida.
*Diplodonta orbella.
†Lucina punctata.
—— bella.
—— Californica.
—— Nuttalli.
†Lithophagus attenuatus.
*Mytilus Californianus.
Modiola capax.
Arca pernoides.
*Pecten latiauritus.
Pecten floridus.
—— purpuratus.
†Ostrea conchaphila.
†—— plumula.
Hinnites giganteus.
*Helix tudiculata.
*—— Kellettii.
Bulimus pallidior.
†Melampus olivaceus.
Haminea vesicula.
*Bulla nebulosa.
—— virescens.
—— longinqua.
Tornatina inculta.
Mopalia Blainvillei.
*Acmæa patina.
*—— persona.
*—— grandis.
*—— spectrum.
*—— scabra.
—— fascicularis.
*Fissurella volcano.
*Haliotis Californiensis.
*—— Cracherodii.
*—— splendens.
*Osilinus ater.
*Trochus filosus.
*Omphalius aureotinctus.
*—— brunneus.
*Phasianella compta.
†Turbo Fokkesii.
†Petaloconchus macrophragma.
*Cerithidea sacrata.
—— albonodosa.
—— pullata.
†Natica uber.
Ranella triquetra.
—— muriciformis.
—— Californica.
†[Oliva splendidula].
Purpura emarginata.
Columbella carinata.
—— Californica.
†Nassa luteostoma.
—— fossata.
†—— tegula.
Murex Belcheri.

The following shells are quoted from San Pedro:—

Sanguinolaria Nuttalli.
*Semele rubrotincta.
*Tellina secta.
Mactra nasuta.
*Venus Nuttalli.
—— fructifraga.
—— Californiensis.
*Tapes straminea.
—— gracilis.
*Diplodonta orbella.
Cardium cruentatum.
*Chama exogyra.
*Bulla nebulosa.
†Acmæa mesoleuca.
*Acmæa scabra.
*Scurria mitra.
*Trochus mœstus.
†Crepidula incurva.
†Calyptræa spinosa.
†Litorina ? fasciata.
Oliva biplicata.

The following shells are quoted from Guaymas. They all belong to the Southern fauna, except *Bulla nebulosa* and *Venus straminea*, which last belongs to that of Upper California. It may be a wrong determination for the not dissimilar *Tapes histrionica*.

Periploma planiuscula.
†Petricola robusta.
†Venus Columbiensis.
—— Californiensis.
*—— straminea.
†Tapes grata.
Cardita Californica.
Chama f. Mexicana.
Cardium elatum.
Pectunculus giganteus.
Pecten circularis.
*Bulla nebulosa.
Lophyrus lævigatus.
—— albolineatus.
†Acmæa mesoleuca.
†Neritina picta.
†Nerita Bernhardi.
Omphalius rugosus.
Terebra variegata.
Conus ferrugatus.
†—— regularis.
†Natica maroccana.
—— bifasciata.
Fusus pallidus.
—— lignarius.

The following shells are quoted from San Juan; many others are probably from the same place, but are assigned by error to the Straits of the same name in Oregon.

†Sanguinolaria purpurea.
Tellina gemma.
*Donax Californicus.
Bulimus pallidior.
†Radius variabilis.
†Terebra fulgurata.
†Conus princeps.
†Oniscia tuberculosa.
†Cassis coarctata.
Olivella intorta.
†Olivella tergina.
—— ? eburnea.
Monoceros tuberculatum.
†Purpura muricata.
†Murex plicatus.

The following are quoted from La Paz:—

Thracia plicata.
†Mactra elegans.
Venus reticulata.
†Dione Chionæa.
†Artemis gigantea.
Petricola dactylus.
†Lucina punctata.
Modiola capax.
†Isognomon Chemnitzianum.
Lima tetrica.
Pecten nodosus.
—— dentatus.
Spondylus, sp.
†Ostrea Cumingiana.
†Cancellaria obesa.
†—— solida.
†—— cassidiformis.
Sigaretus debilis.
†Strombus gracilior.
†Oliva porphyria.
†—— splendidula.
†Purpura patula.
*—— emarginata.
†—— biserialis.
†—— kiosquiformis.
†Murex bicolor.

78. A mere glance at the general Table, contrasting the species on each side of the double central dividing line, especially leaving out of view the uncertain column of Lower California, will satisfy the inquirer of the marked and rapid separation between the two faunas of California-proper and the Gulf. The actual difference is, however, much greater than the apparent, since the name of a species occurs in a column if only one specimen has been obtained, whether or not it were living there; or if living, whether it were an habitual resident or a straggler. For it will be observed that our present lists are much in the condition of those of British shells, before the labours of the dredging naturalists of our own day; when a W. Indian shell was duly

entered on the fauna, if it could be shown to have been picked up on British sands. There are two main sources of information for the comparison of the faunas:—(1.) The collections of Mr. Nuttall and M. Reigen; and (2.) those of the Mexican War naturalists. Now with every respect for the labours of the latter gentlemen, who doubtless did the very best that it was possible for them to do under their peculiar circumstances, we hesitate before we receive from that source alone results at variance with the former. And for this simple reason; that Mr. Nuttall did not travel further south than San Diego, nor did M. Reigen pass beyond the district of Mazatlan: while the officers were moving from place to place, and liable to the errors that even peaceable naturalists may make under such circumstances. As the results of their collections have been carefully tabulated above, those who place implicit reliance upon them can easily add to the lists accordingly: but we think it a sufficient ground for hesitation, that no less an authority than Dr. Gould had formed the opinion, judging from these collections alone, that Mazatlan belonged to the Californian rather than the Panamic type; the contrary of which is abundantly proved by the Reigen collection. It appears also that Prof. Adams entertained the same doubts, though he does not express them; for while he quotes the war-naturalists for seven of his Panama species as inhabiting Upper California, he says in his introduction that none of the species of the province inhabit San Diego, which is at the borders of Lower California. The following are the species common to Mr. Nuttall's and M. Reigen's collections, the specimens quoted from the latter being all that were found out of several myriads of shells.

Californian Fauna.	Species.	Gulf Fauna.
Not uncommon.........	1. Strigilla carnaria	Not common.
Typical	2. Cumingia Californica	Very rare.
Typical and abundant.	3. Trigonella crassatelloides ...	Two minute dead valves, possibly the fry of this species.
Typical	4. Chama exogyra	One pair and a valve, probably of this species.
One young sp.	5. —— (frondosa) Mexicana ...	Typical.
? Rare.....................	6. Modiola capax	Very rare.
Not uncommon.........	7. Ostrea conchaphila & plumula	Very common.
Typical	8. Bulla nebulosa	A very few, resembling *B. nebulosa*, but possibly = *B. Adamsi*, var.
Typical, very abundant	9. Acmæa patina	2 sp. (? ballast).
Typical, very abundant	10. —— persona	1 sp. (? ballast).
Typical, local............	11. —— scabra	1 sp. (? ballast).
Very rare	12. Crucibulum spinosum	Typical, widely diffused.
Dwarf var., common...	13. Crepidula aculeata	Typical, widely diffused.
Extremely rare	14. Hipponyx Grayanus	Extremely rare.
1 sp.	15. Petaloconchus macrophragma	Typical, common.
? Var. *Californica*	16. Natica maroccana	Var. *Pritchardi*.

In this list nos. 3, 4, 8 & 16 are doubtful. Nos. 9, 10 & 11 appear to be stragglers. Nos. 1, 2, 6, 7 & 13 honestly belong to both faunas, and are forms of wide geographical extent; the few remaining being creatures of sedentary habits, that are easily transported from place to place. Out of the 694 species therefore, sent from Mazatlan, to say nothing of the additional species brought by Lieut. Shipley and others, only 16 are in common with Mr. Nuttall's Californians; and even these, to a very limited extent.

79. The following table will give an abstract of what is now known of the Mexico-Peruvian fauna, grouped in families and in columns according to their

distribution. A. *Species as yet only known from the Gulf,* including Mazatlan and St. Blas.—B. *Species found in the Gulf and Central America,* from Acapulco to Gulf Dulce.—C. *Gulf and Panama.*—D. *Gulf and S. America.*—E. *Gulf and Galapagos.*—F. Total Gulf.—G. *Central America,* peculiar.—H. *Central America and Panama.*—I. *Central America and S. America.*—K. *Panama,* peculiar.—L. *Panama and S. America.*—M. Total Panama.—N. TOTAL of N. American tropical fauna.

Families, &c.	A.	B.	C.	D.	E.	F.	G.	H.	I.	K.	L.	M.	N.
BRYOZOA	16	...	...	...	...	16	...	...	...	...	...	...	16
TUNICATA	...	...	...	...	...	...	...	...	...	...	...	...	...
PALLIOBRANCHIATA	...	...	1	1	...	1	...	...	...	...	1	1	1
Total	16	...	1	1	...	17	...	...	...	...	1	1	17
LAMELLIBRANCHIATA.													
Pholadidæ	1	1	2	1	...	5	1	1	1	3	2	7	11
Gastrochænidæ	...	...	2	2	...	2	...	...	...	...	2	2	2
Saxicavidæ	...	...	1	1	...	1	...	...	...	...	1	1	1
Petricolidæ	10	...	2	...	...	12	...	...	...	...	2	2	13
Myadæ	4	...	...	...	...	4	...	...	...	...	...	...	4
Corbulidæ	3	5	7	3	...	10	4	6	5	6	3	14	23
Anatinidæ	8	...	1	1	...	10	1	...	1	3	...	4	15
Solenidæ	...	...	...	...	...	...	...	...	...	1	...	1	1
Solecurtidæ	2	...	1	...	...	3	1	...	...	...	...	1	4
Tellinidæ	23	4	9	6	...	39	8	5	4	23	11	41	81
Donacidæ	4	5	4	1	...	10	2	4	2	1	2	6	14
Mactridæ	5	2	3	1	...	8	...	2	...	3	1	6	11
Veneridæ	9	13	14	17	...	34	2	8	12	6	10	21	45
Astartidæ	6	...	1	...	...	7	2	2	1	...	3	5	13
Chamidæ	1	2	1	...	...	3	1	2	...	1	1	4	7
Cardiadæ	10	3	4	4	...	15	1	3	4	1	4	7	20
Lucinidæ & Diplodontidæ	15	1	2	2	...	19	3	...	...	1	1	3	23
Kelliadæ	*12	...	1	1	...	13	...	...	...	1	1	2	14
Cycladidæ	4	...	...	...	...	4	1	...	...	2	...	2	7
Unionidæ	...	1	...	...	...	1	5	...	...	...	...	...	6
Mytilidæ	4	3	5	2	2	13	...	1	...	6	1	11	19
Arcadæ	9	7	10	11	...	23	2	5	4	4	11	17	32
Nuculidæ	...	1	2	2	...	2	1	1	2	4	2	6	8
Aviculidæ	1	2	5	1	...	7	1	2	...	2	...	7	10
Pectinidæ	6	1	...	1	...	7	1	3	3	1	3	6	14
Spondylidæ	1	1	1	...	...	3	3	...	...	2	...	3	8
Ostreadæ	2	3	3	1	...	7	...	2	...	2	...	5	9
Anomiadæ	1	1	2	2	...	4	1	...	1	3	1	5	8
Total	141	56	83	60	2	266	41	47	40	76	62	189	423
PTEROPODA	...	...	...	...	...	...	...	...	...	...	...	...	...
GASTEROPODA.													
Opisthobranchiata	6	1	2	...	1	10	...	1	...	2	...	6	15
Pulmonata.													
Geophila	4	2	...	...	...	6	6	2	...	8	...	10	22
Limnophila	4	...	...	...	...	4	...	...	...	11	...	11	15
Thalassophila	1	1	1	2	1	3	...	3	1	1	1	4	6
Total	15	4	3	2	2	23	6	6	1	22	1	31	58

* This figure includes *Montacuta chalcedonica,* found in the fronds of *Murex nigritus* (Reigen Col.), since the Table was printed.

Families, &c.	A.	B.	C.	D.	E.	F.	G.	H.	I.	K.	L.	M.	N.
Prosobranchiata.													
HETEROPODA.													
Ianthinidæ	3	...	...	...	...	3	...	...	...	...	...	...	3
LATERIBRANCHIATA.													
Dentaliadæ	3	1	...	...	...	4	...	...	1	...	...	...	5
SCUTIBRANCHIATA.													
Chitonidæ	12	1	...	1	...	13	2	...	3	6	4	10	27
Patellidæ	1	2	1	1	...	4	...	1	...	1	...	2	5
Acmæidæ	5	2	2	...	1	9	1	1	...	3	...	5	13
Gadiniadæ	...	1	...	...	...	1	...	...	...	...	...	...	1
Fissurellidæ	5	1	2	1	2	9	2	3	2	4	2	10	18
Haliotidæ	...	...	...	...	...	...	...	...	...	...	...	...	...
Trochidæ	32	2	7	...	2	43	2	2	...	14	1	27	64
Neritidæ	2	2	3	1	...	5	3	4	2	2	2	7	12
Total	63	12	15	4	5	91	10	11	8	30	9	61	148
PECTINIBRANCHIATA.													
Rostrifera.													
Naricidæ	1	...	...	...	...	1	...	...	...	...	...	...	1
Calyptræidæ	4	6	12	11	...	17	2	7	6	5	13	20	28
Capulidæ	2	1	4	1	1	6	...	1	...	1	1	5	7
Vermetidæ	5	1	3	...	...	8	1	1	...	1	...	4	10
Cæcidæ	16	...	3	...	...	19	...	...	...	1	...	4	20
Turritellidæ	...	2	2	1	...	2	3	2	1	...	...	2	5
Cerithiadæ	4	5	11	2	3	15	2	5	1	1	3	13	19
Melaniadæ	...	...	...	...	...	...	...	...	...	2	...	2	2
Paludinidæ	...	...	...	...	...	...	...	...	...	...	...	...	...
Ampullariadæ	1	...	...	...	...	1	...	...	...	1	...	1	2
Cyclostomidæ	...	...	...	...	...	...	...	...	...	1	...	1	1
Truncatellidæ	...	...	1	...	...	1	...	...	...	1	...	2	2
Litorinidæ	8	3	6	1	...	14	...	3	...	9	1	15	23
Rissoidæ	11	...	...	...	...	11	...	...	...	14	...	14	25
Lacunidæ	...	...	...	...	...	...	...	...	...	...	...	...	...
Jeffreysiadæ	4	...	...	...	...	4	...	...	...	...	...	...	4
Planaxidæ	11	...	...	...	...	11	...	...	...	...	1	...	12
Ovulidæ	...	...	1	...	...	1	1	1	...	2	1	5	6
Cypræidæ	2	5	7	...	3	10	...	5	3	1	5	10	16
Cancellariadæ	1	5	3	3	...	7	4	2	6	7	8	16	26
Strombidæ	...	2	3	2	1	3	...	2	1	...	1	4	4
Total	70	30	56	21	8	131	13	29	18	47	34	118	213
Toxifera.													
Terebridæ	6	5	4	2	...	12	2	5	2	7	1	15	25
Pleurotomidæ	11	4	7	5	...	22	22	8	6	24	12	43	86
Conidæ	5	6	6	1	1	13	7	7	3	...	4	10	29
Total	22	15	17	8	1	47	31	20	11	31	17	68	140
Proboscidifera.													
Solariadæ	...	2	2	...	...	3	1	1	...	3	...	5	7
Pyramidellidæ	54	1	6	...	...	61	...	...	...	8	...	14	69
Eulimidæ	6	...	3	1	...	10	2	...	...	...	...	3	12
Cerithiopsidæ	6	...	1	...	...	7	...	...	...	3	...	4	10
Scalariadæ	4	1	4	...	...	8	4	1	...	7	1	12	20
Naticidæ	9	4	2	3	2	13	1	3	3	9	3	13	25
Velutinidæ	...	...	...	...	...	...	...	...	...	...	...	...	...
Lamellariadæ	2	...	...	...	...	2	...	...	...	...	...	...	2
Ficulidæ	...	1	1	...	...	1	...	1	...	...	...	1	1
Carried forward	81	9	19	4	2	105	8	6	3	30	4	52	146

Families, &c.	A.	B.	C.	D.	E.	F.	G.	H.	I.	K.	L.	M.	N.
(*Proboscidifera*, continued)......	81	9	19	4	2	105	8	6	3	30	4	52	146
Doliadæ....................	...	...	...	...	...	...	...	1	1	...	1	1	1
Cassidæ....................	...	2	2	...	2	2	...	3	...	...	...	3	3
Tritonidæ..................	3	...	2	...	...	5	5	1	...	9	4	16	27
Turbinellidæ...............	...	1	1	1	...	1	...	1	1	...	1	1	1
Fasciolariadæ..............	2	2	2	1	1	5	2	3	...	6	...	9	15
Mitrinæ....................	...	...	2	2	1	2	5	...	...	2	3	5	11
Volutidæ...................	3	...	1	1	...	5	2	2	1	...	...	3	10
Olividæ....................	5	7	9	1	...	18	3	6	...	1	1	12	24
Purpuridæ..................	4	6	7	3	4	15	...	6	3	4	6	21	29
Buccinidæ..................	17	6	7	3	...	24	9	11	4	14	6	30	59
Pyrulidæ...................	...	1	1	1	...	1	...	1	1	...	1	1	1
Muricidæ...................	28	11	14	7	...	50	7	11	4	16	14	45	90
Total Proboscidifera	143	45	67	24	10	233	41	52	18	82	41	199	417
Total Rostrifera	70	30	56	21	8	131	13	29	18	47	34	118	213
Total Toxifera..................	22	15	17	8	1	47	31	20	11	31	17	68	140
Total Pectinibranchiata	235	90	140	53	19	411	85	101	47	160	92	385	770
Total Scutibranchiata, &c.......	63	12	15	4	5	91	10	11	8	30	9	61	148
Total Opisthobranchiata and Pulmonata.	15	4	3	2	2	23	6	6	1	22	1	31	58
Total Gasteropoda	313	106	158	59	26	525	101	118	56	212	102	477	976
CEPHALOPODA....................	...	...	...	...	...	...	...	...	...	...	...	...	...
Total Lamellibranchiata.........	141	56	83	60	2	266	41	47	40	76	62	189	423
Total Palliobranchiata & Bryozoa.	16	...	1	1	...	17	...	...	...	...	1	1	17
TOTAL FAUNA, Gulf to Panama	470	162	242	120	28	808	142	165	96	288	165	667	1416

80. Now let it be carefully borne in mind that every column of this *résumé* is, without doubt, very far from the actual truth. Whatever may be learnt from it must be estimated positively, and by no means negatively. *E.g.* notwithstanding the scrutinizing researches of Cuming, C. B. Adams, Hinds, Bridges and others in the Bay of Panama, and our almost complete ignorance of all parts of the Gulf except its entrance, 808 species are quoted from the latter and only 697 species from the former, giving a balance of 111 species in favour of the northern station. Now when it is borne in mind that Panama is in the central tropical region, that it receives both the North American species as they travel southwards, and the South American as they move upwards, besides (in all probability) a little nest of bay shells peculiar to its own quiet haunts; while the Gulf fauna receives scarcely any importations from the north, and only those southern forms of life which are capable of subsisting at the very borders or beyond the tropics; it must be evident that much more has to be done before even the central portion has been brought up to its proper standing. Then let it be remembered how many species must be yet unknown in the Gulf district. Large as is our acquaintance with the minute species, as the whole of it has been obtained by ransacking the worm-eaten passages of a few *Chamæ* and *Spondyli*, and examining the dirt on the backs of other shells, what may be expected when the shores and sea-bed have been subjected to the minute examination of a Barlee, an Alder, or a Bean! In the British fauna, 170 out of 511 species are minute. It might have been thought that degeneration of size was a condition of high latitudes; but wherever attention has been paid, the tropical seas are found

as rich in the minuter forms of life as are those that wash colder shores, or even more so. Till the time of D'Orbigny, no one in the tropics seemed to deign to bend his attention to what the amateur collector did not value; but Prof. Adams has already described many small species from Jamaica, and 80 from Panama, the latter simply by the examination of dead drift. In these days of microscopic observation, most interesting results may be anticipated if only dredgers will bring back labelled parcels of fine siftings from deep waters; and ordinary collectors, sieved sand or mud from the shores. If shells were packed in the sieved sand of the place; if they were always sent home in the rough; if those who decorticate their backs with acid, thus destroying the minute microscopic sculpture which is often the best guide for the discrimination of species, would only first brush them without acid, and send the bottoms of the wash bowl to some microscopical malacologist, taking care to wash only the shells from one spot at a time, and not to mix the dirt; we should soon acquire a knowledge of molluscan distribution which would advance the science by rapid strides. Here do not apply many of the sources of error common to larger shells. Ballast can scarcely mix its anomalous transportations with the *Cæca*, *Vitrinellæ* and *Chemnitziæ* in the interior of an oyster; and the facts of distribution are as accurately seen in these minuter forms as in the history of Cones and Olives. The remark made by one of our very foremost naturalists, when it was first proposed to investigate the Mazatlan shells, was that it was not likely that there should be anything new among them; as the large shells would be all the same as Mr. Cuming's, and the small ones as those of Prof. Adams. And yet, comparing the 314 small species from Mazatlan with the 80 described from Panama, only 28 appear identical. The *Cæcum firmatum*, which is the abundant Panama form, is extremely rare at Mazatlan, where it is replaced by the beautiful and still more abundant *C. undatum*, of which only one minute specimen was perhaps found at Panama. Of the principal Panamic *Vitrinella*, only one individual was found at Mazatlan; where it is replaced by the shell first termed *V. clathrata*, which turns out to be the same of which an aberrant variety was imperfectly named and described from Panama as *V. parva*. And so in other instances, as in the larger shells; *Chemnitziæ* being always rare in individuals, fruitful in species, with many of a wide range; *Odostomiæ* not yet found at Panama; *Chrysallida communis*, a coast shell, and very abundant in both districts, while the other species from deeper water are rare and local; *Bullidæ* and small *Marginellæ*, diffused; *Rissoidæ*, local; and so on in ways on which it would be pleasant but not safe yet to generalize. As the same large *Spondylus* which furnished the Mazatlan minutiæ is also found in Panama Bay, where it is dived-for by the natives to burn for lime, with all its *Parapholades*, *Gastrochænæ*, *Lithophagi* and other rich treasures, travellers in that region would do service to science by bringing home a few valves, that it may be found how far the small nestlers correspond, as the boring bivalves are known to do.

But even with regard to the large shells, the distribution of many species is anything but satisfactorily made-out. The fauna of the Central American seas has never been properly published. A variety of new species are described from Messrs. Cuming's and Hinds' collections, but of the old shells found in the same stations we are left in ignorance. The practice of describing only new species from voyages, instead of giving complete lists of those found, very unnecessarily retards our geographical knowledge. The quotations from Acapulco are like those from Dorsetshire or Guernsey in the old British writers. What we yet know makes it far from improbable that while one great type of shells extends at least from Guaymas to the Bay of Guayaquil, each portion (the upper Gulf, the Gulf mouth, S. W. Mexico, Central America proper, the Bay of Panama, the N. W. shores of South America, and the Galapagos,) has its peculiar species, or at least those which culminate in that locality. A large number, especially those which are also common to the Galapagos, are found on the whole length of coast, wherever there is a suitable station; while others, perhaps nearly related species, are very local. Thus the beautiful *Venus gnidia* is found wherever there is a muddy bottom to protect its delicate frills, (*Hinds*); while the *V. amathusia*, so near that by Gray and even Deshayes it is regarded as identical, has only yet been found in a typical state at Mazatlan, straggling and of modified form below. The *Dione lupinaria* is in extreme profusion at Mazatlan, and also found far down the coast of South America; but the *D. brevispinosa*, which resembles it with blunted spines, has not yet come to light except from the Gulf. But we must check these comparisons, so interesting to those who have made them a matter of study; and which, if developed, even according to our present knowledge, would fill a volume. Nor would a history of even the Atlantic waters, furnish materials for one more interesting and instructive.

81. One fact however is deserving of special notice. On comparing the shells of the Gulf and South America, we obtain the following results:—Out of 143 Gulf Bivalves, 50 are found in South America, or 1 out of 2·86. Out of 490 Gulf Univalves, only 89 have been found in South America, or 1 out of 5·5; while of the 151 Gulf Proboscideans, only 14 are yet known from South America, or 1 out of 10·8. This may be accounted for partly by the fact that the bivalves cast their spawn loose into the sea, while the univalves, which have larger locomotive powers, generally affix their eggs to shells and stones. (*Gray.*) Accordingly, the Lamellibranchiate fry are borne on in the direction of the current, and are found far beyond what may fairly be considered the limits of the species. This further accounts for the absence of some South American bivalves from Panama which are however found at Mazatlan; the fry, with the current, not sweeping into the bay, but landing on the Mexican coast. It is confirmed by finding the young of many South American species in the sand of Mazatlan, which are not known there in the adult state. Only two bivalves are quoted from Mazatlan and the Galapagos (one of these, *Modiola capax*, a Gulf and Californian species, having probably been added in error from Kellett's voyage); that group being out of the current which we may suppose to convey species from Guayaquil to the northern shores.

How far the Gulf species, or those of Panama, extend on the South American coast, we are not yet able to state with any confidence. Most of Mr. Cuming's recorded South American species are from Ecuador and Columbia; and D'Orbigny's collections are too scanty, especially in pelagic species, for much comparison. It seems probable that but few reach Callao, and extremely few the coasts of Chili. A few indeed are quoted as far south as the Island of Chiloe, but (except in the widely distributed forms, such as Calyptræidæ) they need confirmation; as do also the appearance of *Crepidula nivea* (*Lessonii*) and *Lyonsia picta*, both southern forms, at Vancouver's Island.

82. A comparison with the shells of the Galapagos Islands offers points of peculiar interest. They are known to us by the researches of Messrs. Cuming and Darwin, the latter of whom has given a most graphic picture of their peculiarities in his 'Journal of Researches,' pp. 145, 162. Collections have also been made there by Messrs. Kellett and Wood; but for reasons before stated, less dependence should be placed on them. Unfortunately, though

previous *results* have been tabulated, the materials have not been made public. Mr. Cuming prepared a list of 90 sea shells for Mr. Darwin's use, but it has been mislaid; nor can Mr. Darwin furnish any additional information, having unfortunately distributed his valuable collections before they were geographically tabulated. The following list has been constructed from one most kindly drawn out for this Report by Mr. Cuming, with as much completeness as his extremely limited time allowed; with the addition of species tabulated in the Monographs, and a few from the Pandora Voyage. It is probable that some species have been overlooked from "Hood's Island," which appears both in the Galapagos group and in the central Pacific: both of them are quoted in the Monographs as "Lord Hood's Island," and they are very rarely distinguished from each other.

List of Galapagos Shells.

In this table, stations in America are marked in columns to the left; *M.* Mazatlan and *G.* the Gulf; *C. A.* Central America; *P.* Panama; and *S. A.* South America; while Pacific stations are recorded to the right.

American Localities.				No.	Species.	Station.	Pacific Localities.
				1	Gastrochæna rugulosa, *Sow.*		
				2	—— brevis, *Sow.*	....	Society Islands.
				3	—— hyalina, *Sow.*	In *Aviculæ*, 3–7 fm.	
				4	Petricola amygdalina, *Sow.*...		
				5	Semele rupium, *Sow.*	reefs & rocks.	
				6	—— punctata, *Sow.*		
				7	Cardita varia, *Brod.*	fine sand, 6 fm.	
				8	—— incrassata.		
				9	Chama imbricata, *Brod.*.........	*Aviculæ*, l. w.–7.	Pearl Island.
				10	—— Janus, *Rve.**	on *Aviculæ*.	
(M.)	......	...	......	10*b*	Modiola capax, *Conr.* [?].		
M.	......	...	......	11	Crenella coarctata, *Dkr.*		
				12	Byssoarca truncata, *Sow.*	stones & *Aviculæ*.	Society Islands.
			S. A.	13	Pecten magnificus, *Sow.*.........	coral sand, 6–17 fm.	
		P.	......	14	Lima arcuata*.		
				15	Anomia adamas, *Gray*	on *Aviculæ*.	
M.	......	...	......	16	Bulla Quoyi, *Gray.*		
				17	—— rufolabris, *A. Ad.*		
				a	Bulimus nux, *Brod.*	on bushes.	
				b	—— verrucosus, *Pfr.*		
				c	—— unifasciatus, *Sow.*	under lava.	
				d	—— rugulosus, *Sow.*		
				e	—— Eschariferus, *Sow.*		
				f	—— Darwinii, *Pfr.*		
				g	—— Achatinellinus, *Forbes.*		
				h	—— incrassatus, *Pfr.*		
				i	—— ustulatus, *Sow.*	on lava.	
				k	—— calvus, *Sow.*	dry grass.	
				l	—— Jacobi, *Sow.*	under scoriæ.	
				m	—— Chemnitzioides, *Forbes.*		
				n	—— corneus, *Sow.*		
				o	—— sculpturatus, *Pfr.*		
				p	—— rugiferus, *Sow.*	under scoriæ.	
				q	—— nucula, *Pfr.*		
				r	—— Galapaganus, *Pfr.*		
				s	—— Manini, *Pfr.*		
				t	Helix, sp..........................	....	Sandw.I.(*Darwin*).
?M.	C. A.	P.	S. A.	18	Siphonaria gigas, *Sow.*		
				19	—— scutellum.		

* *Chama spinosa* (M., C. A.) and *Lima Pacifica* (C. A., P., S. A.), are also quoted from "Lord Hood's Island," and are probably Galapagian species.

American Localities.				No.	Species.	Station.	Pacific Localities.
				20	Lophyrus Goodallii, *Brod.*	under stones, l. w.	
				21	—— sulcatus, *Wood*	under stones, l. w.	
			S. A.	22	?Chiton hirundiniformis, *Sow.*	under stones, l. w.	
M.	C. A.	P.	......	23	Acmæa striata, *Rve.*		
				24	Fissurella mutabilis, *Sow.*		
				25	—— obscura, *Sow.*	under stones, shore.	
M.	......	...	......	26	—— rugosa, *Sow.*	under stones, l. w.	
	C. A.	P.	S. A.	27	—— macrotrema, *Sow.*	under stones, shore.	
	C. A.	P.	S. A.	28	—— nigropunctata, *Sow.*	stones & rks. ½-t.—	
M.	C. A.	...	......	29	Glyphis inæqualis (+pica), *Sow.*	u. s., shore—8 fm.	
		P.	......	30	Turbo squamigera, *Rve.*	7 fm.	
				31	Nerita sp., *Kellett & Wood.*		
			S. A.	32	Calyptræa varia, *Brod.*	......	Society Islands.
M.	C. A.	P.	......	33	Hipponyx Grayanus, *Mke.*	on stones, l. w.	
M.	C. A.	P.	......	34	Cerithium stercus-muscarum	sand pools, ½-t.	
M.	C. A.	P.	......	35	—— maculosum, *Kien.*	under stones, ½-t.	
M.	......	P.	......	36	—— interruptum, *Mke.*	under stones, ½-t.	
				37	Litorina porcata, *Phil.*	exposed rocks.	
				v	Paludina, sp.	......	Tahiti & V. Diemen's Land (*Darwin*).
		P.	......	38	Planaxis planicostata, *Sow.*	u. s., ½-t.—h. w.	
			S. A.	39	Luponia nigropunctata, *Gray*	under stones.	
M.	......	...	......	40	Trivia pulla, *Gask.*		
	C. A.	...	......	41	—— Pacifica, *Gray*	under stones.	
M.	......	P.	......	42	—— (sanguinolenta, var.) fusca, *Gray.*		
	C. A.	...	......	43	—— suffusa, *Gray.*		
		P.	......	44	—— rubescens, *Gray*	under stones.	
				45	—— Maugeriæ, *Gray*	under stones.	
		P.	......	46	Cancellaria chrysostoma, *Sow.*	sand, 8–10 fm.	
				47	—— hæmastoma, *Sow.*	sand, 10–16 fm.	
M.	C. A.	P.	S. A.	48	Strombus granulatus, *Swains.*	sandy mud, 6–8 fm.	
		P.	......	49	Terebra ornata, *Gray*	coral sand, 5–7 fm.	
				50	Myurella frigata, *Hinds.*		
		P.	......	51	Drillia excentrica, *Sow.*	coral sand, 6 fm.	
		P.	......	52	—— bicolor, *Sow.*	sand, 8 fm.	
				53	—— rugifera, *Sow.*	coral sand, 6 fm.	
				54	—— albicostata, *Sow.*	coral sand, 6 fm.	
				55	—— splendidula, *Sow.*	coral sand, 6 fm.	
G.	......	P.	......	56	Conus nux, *Brod.*	? shore, l. w.	
		P.	S. A.	57	—— brunneus, *Wood*	clefts of rocks, l. w.	
				58	—— tiaratus = minimus, *Linn.*	sand pools, l. w.	East Indies.
				59	—— varius = interruptus, *Wood*	clefts of rocks, l. w.	Philippines.
				60	—— diadema, *Sow.*	clefts of rocks, l. w.	
				61	—— Luzonicus, var. *Sow.*	clefts of rocks, l. w.	Philippines.
				62	Stylifer astericola, *Brod.*	in *Asterias solaris.*	
				63	Cirsotrema diadema*, *Sow.*		
M.	C. A.	P.	......	64	Natica maroccana, *Chemn.*	......	"All over the warm climate," *Cuming.*
M.	C. A.	P.	......	65	Lunatia Galapagosa (= otis, *Zool. Beech. Voy.*).	coral sand.	
M.	C. A.	P.	......	66	Oniscia tuberculosa, *Sow.*	clefts of rocks, l. w.	
				67	—— xanthostoma, *A. Ad.*		
				68	Cassis tenuis, *Wood*	sandy mud, 6 fm.	
G.	C. A.	P.	......	69	—— coarctata, *Sow.*	crevices of rocks.	
				70	Triton reticulatus, *Dillw.* = turriculatus, *Desh.*	6 fm.	Quoted from Mediterranean.
				71	—— Sowerbyi = lineatus, *Brod.*	sandy mud, 6 fm.	
				72	—— pictus, *Rve*	under stones, l. w.	
				73	—— clandestinus, *Chemn.*		

* Closely resembles *C. funiculata* from Mazatlan and Panama; at first thought identical by Mr. Cuming; differing simply in the size and obtuseness of the apical portion.

American Localities.				No.	Species.	Station.	Pacific Localities.
G.	C. A.	P.	......	74	Lathyrus ceratus, *Wood*	u. s. & rocks, l. w.	
	C. A.	...	......	75	—— tuberculatus, *Brod.*	under stones.	
				76	—— varicosus, *Rve.*	crevices of rocks.	
				77	Mitra muricata, *Swains.*	sandy mud, 6 fm.	Marquesas.
				78	—— gratiosa, *Rve.*	coral sand, 7 fm.	
				79	—— gausapata, *Rve.*	10 fm.	
M.	......	P.	S. A.	80	Strigatella tristis, *Swains.*	6–10 fms., sandy mud: also u. s. l. w.	
	C. A.	...	......	81	—— effusa, *Swains*	sandy mud, 12 fm.	
			S. A.	82	Olivella Kaleontina, *Ducl.*		
M.	C. A.	...	......	83	Purpura patula, *Lam.*	shore.	
M.	C. A.	...	......	84	—— columellaris, *Lam.*	exposed rocks, l. w.	
M.	......	P.	......	85	—— triangularis (= Carolensis, *Rve.*), *Blainv.*	under stones, l. w.	
				86	—— planospira, *Lam.*	exposed rocks.	
M.	C. A.	P.	......	87	Vitularia salebrosa, *King.*		
				88	Monoceros grandis, *Gray*	crev. rocks, l. w.	
		P.	......	89	Engina carbonaria, *Rve.*		
		P.	......	90	—— Reeviana = pulchrum, *Rve.*	under stones, l. w.	
		P.	......	91	—— pyrostoma, *Sow.*	under stones.	
		P.	......	92	—— maura, *Sow.*	under stones.	
		P.	......	93	—— crocostoma, *Rve.*		
				94	—— zonata, *Rve.*	under stones, l. w.	
		P.	......	95	Columbella hæmastoma, *Sow.* ...	under stones.	
				96	—— varians, *Sow.*		
				97	—— unicolor, *Sow.*		
				98	?Buccinum biliratum, *Rve.*		
				99	—— pulchrum, *Rve.* [? = Engina Reeviana.]		
		P.	......	100	Nassa nodifera, *Pow.*	coral sand, 6–10 fm.	
				101	—— angulifera, *A. Ad.*		
				102	—— nodocincta, *A. Ad.*		
?G.	C. A.	...	......	103	Fusus Dupetithouarsi, *Kien.*		
		P.	......	104	Anachis atramentaria, *Sow.*	under stones, l. w.	
		P.	......	105	—— nigricans, *Sow.*	u. s., ½-t.—l. w.	
				106	—— rugulosa, *Sow.*		
		P.	......	107	Strombina bicanalifera, *Sow.* ...	sandy mud, 10 fms.	
				108	—— lanceolata, *Sow.*	coral sand, 6–8 fm.	
				109	Pisania cinis, *Rve.*	under stones.	
				110	Murex pumilus, *Brod.*	under stones.	
				111	—— nucleus, *Brod.*	coral sand, 8 fms.	
25	22	38	11				11 species.

This list (which is believed to be very accurate in all respects except *Modiola capax*, which is not included in the analysis) contains 20 land and freshwater shells, all of which are believed to be peculiar to the islands, except a *Helix* found at Tahiti, and a small *Paludina*, common to Tahiti, and Van Diemen's Land (*Darwin*). Of the 90 marine shells analysed by Darwin, 47 were not known elsewhere; 25 inhabited the West coast of America, 8 being distinguishable as varieties; the remaining 18 having been found by Mr. Cuming in the Low Archipelago, and some of them also at the Philippines. Prof. Forbes, speaking of the Galapagos in the 'Mem. Geol. Soc. Gr. Br.' vol. i. p. 402, note, says, "We have distinct systems of creatures related to those of the nearest land by representation or affinity, and not by identity." The latter word does not hold good of the sea shells; for there are already known 111 species at the Galapagos, of which 55, or nearly one half, are American shells; of these 25 inhabit the Gulf; 22 have already been taken in Central America; 38 are found at Panama; but only 11 from the parallel latitudes in South America. Only 4 bivalves are quoted from the continent; two [?] from the Gulf; one from Panama; the other (a distinct variety), from deep water, from Isle Plata. On glancing over the genera with their stations, it will be found that the coast shells common to the two are more numerous than those from deep water; and that the general aspect of the collection is essentially American *. The only genus not yet found on the coast is *Stylifer*, which may indeed afterwards receive species now placed in kindred genera, or be discovered on due search of Echinoderms.

83. Scarcely any generic forms are peculiar to the West Coast Fauna; except indeed *Platyodon*, *Cryptodon* and *Mytilimeria*, from California; *Leiosolenus*, from the Gulf; *Callopoma* and *Teinostoma*, from the Central Province, and *Concholepas* from Peru. But many attain here their greatest development; especially *Calyptræidæ*, *Fissurellidæ*, *Acmæa*, *Uvanilla*, *Pomaulax*, *Cæcum*, *Chrysallida*, *Monoceros*, *Leucozonia*, *Cancellaria*, *Columbellidæ*, *Periploma*, *Parapholas*, *Saxidomus*, *Trigona*, &c. The familiar genera of the East are often entirely absent; especially the shell-bearing Cephalopods, *Stomatellidæ*, *Dolium*, *Melo*, *Eburna*, *Ancillaria*, *Rostellaria*, *Pterosceras*, *Phorus*, *Placuna*, *Malleus*, *Tridacnidæ*, *Glauconome*, *Meroë*, *Anatina*, *Aspergillum*, &c. Others, abundant in the Indo-Pacific province, are here barely represented by a few species, or by minute or aberrant forms. Such are *Marginella*, *Cithara*, *Liotia*, *Rimula*, *Cypricardia*, *Clementia*, *Circe*, *Mesodesma*, *Crassatella*, *Pythina* and *Scintilla*; and the tribes of *Cassidæ*, *Harpidæ* and *Volutidæ*. The genera *Conus*, *Oliva*, *Cypræa*, *Terebra*, &c., the staple commodities of the East, are here but poorly represented; no large Cowry living on the coast except *Cypræa exanthema*, and not a single species having been yet found in South America below the Bay of Guayaquil. (*Hinds.*) The almost entire absence of coral, so common in the West Indies and Polynesia, is to be remembered in connexion with the paucity of those tribes that usually feed on its banks.

84. The point, however, which may prove most interesting to the geologist and the geographical student, is whether there be any species common to the Pacific and the Atlantic shores of tropical America; and if so, what are they? It is easy for man to cross the narrow isthmus; have any Mollusks done the same? The determination of this question is a matter of great difficulty; for while ordinary naturalists treat shells as of the same species, if there be no greater variation between them than is known to be allowable between individuals under the same name, it is the present custom with geographical conchologists to treat all similar shells as "analogues" or "representative species," if they occur in unexpected places. In arranging the materials of this Report, those species have been treated as absolutely identical, where no difference obtained between the shells of different seas greater than was observed between individuals in one sea. Thus when the supposed peculiarities of the Pacific *Purpura pansa*, Gld., and *Trochus picoides*, Gld. are found in West Indian specimens, it is regarded as a mere deference to theory to keep them distinct. In other cases, where the shells of the two coasts have a marked difference of aspect, though not greater than may obtain in the same species, if a separation has been made, it is temporarily allowed, though it is more than probable that they will hereafter prove identical. In other cases, the differences, though slight, appear permanent and specific; and in a fourth group they are simply "interesting analogues," but would at once be pronounced distinct, although from the same shore.

* Dr. Gray states [Dr. Richardson's Rep. Ichth. Chin. and Jap. 1846, p. 191, note] that the reptiles which inhabit the Galapagos also belong to American groups.

Now even Prof. Adams allowed that one shell was common, viz. *Crepidula unguiformis**; and Dr. Gould himself inserts *Venus circinata* and *Crepidula aculeata* in his Mexican War Lists. We therefore naturally argue, if one may be common, why not others also? Because *we* cannot see how they should find their way to other seas, is only an argument drawn from our ignorance. Prof. Forbes, on glancing over the list of the Reigen Collection, allowed that there might be species in common; and in the 'Quarterly Journal' of the Geological Society will be found a paper by Mr. Henniker, in which the author gives geological reasons for the probability of the intercommunication. As the level of the Atlantic is higher than the Pacific, any such communication must have poured the treasures of the Atlantic into the Pacific, and scarcely allowed of an exchange in the other direction. Such is found to be the case; no species fairly belonging to the exclusive Pacific fauna being found in the West Indies. Is it possible that some such intercommunication may have been correlative with the glacial conditions of the European seas? Some of the supposed Caribbean shells in the Pacific appear to have migrated northwards; the *Cypræa exanthema* being poor and small at Panama, where it is called *C. cervinetta*, but large, fine and tolerably abundant at Mazatlan; the *Strigilla carnaria* also, not even noticed as an analogue by Prof. Adams, appears blanched but not uncommon at Mazatlan, and having crossed the "Cape Cod†" of the western shores, assumes its normal condition on the Californian coast. The ubiquitous *Purpura patula*, unknown at Panama, is extremely fine at the Gulf. Other species, however, seem to be dying out; as *Lucina tigerrina* and *Mactra fragilis*.

A. *Species regarded as identical between the Pacific and Atlantic.*

Pacific.	*West Indies.*
1. Gastrochæna truncata ...	sp.—BristolMus.
2. —— ovata	sp.—BristolMus.
3. Petricola cognata	pholadiformis.
4. Tellina simulans	punicea.
5. —— rufescens	operculata.
6. —— vicina.................	bimaculata.
7. Strigilla fucata	carnaria.
8. ——pisiformis, teste *Phil.*	pisiformis.
9. Mactra fragilis	fragilis.
10. Dione circinata (? + alternata.	circinata.
11. Lucina tigerrina...........	tigerrina.
12. Diplodonta semiaspera...	semiaspera, teste *Phil.*
13. Modiola Braziliensis	Braziliensis.
14. Lithophagus aristatus ...	caudigerus.
15. —— cinnamomeus	cinnamomeus.
16. Arca labiata	labiata.
17. Isognomon flexuosum ...	Chemnitzianum.
18. Ostrea Virginica	Virginica.
19. Placunanomia foliacea ...	foliacea.
20. Orthalicus zebra	undata.
21. Hipponyx antiquatus......	mitrula.
22. —— Panamensis	subrufa.
23. Crepidula hystrix ...... —— echinus	aculeata.
24. —— unguiformis	Goreensis.
25. Crucibulum Cumingii ...	sp.
26. Ovulum gibbosum, teste *Cuming.*	gibbosum.
27. Cypræa cervinetta.........	exanthema.
28. Torinia variegata	variegata.
29. Leiostraca ?distorta	? distorta.
30. Olivella zonalis	sp.
31. Marginella cærulea [not sapotilla].	prunum.
32. Nitidella guttata	cribraria.
33. Purpura pansa	patula.
34. Anachis pygmæa	costulata.
35. Pisania ringens	sp. [Pernambuco, Br. Mus. Perhaps error.].

It will be seen that more than half the marine shells are bivalves.

* It is generally said that this shell is only a variety of local types. Each local white shell may take the form *unguiformis*; but there remains a distinct type, known by the form of the vertical whirls, which appears to be ubiquitous. It is not always recurved, and in its natural state appears to be the *Patella Goreensis* of Gmel.—*Vide* Plate.

† This Cape separates the two faunas in Massachusetts: *Cochlodesma, Montacuta, Cumingia, Corbula, Tornatella, Vermetus, Columbella, Cerithium, Pyrula, Ranella*, do not pass northwards; nor *Panopæa, Glycimeris, Terebratula, Puncturella, Trichotropis, Aporrhais*, nor *Admete* southwards. Of 197 marine species, 83 do not pass to the south, and 50 are not found on the north: 70 are found in Europe. (*Gould, Rep. Inv. Mass.*)

B. *Species which may prove to be identical.*

Pacific.	*West Indies.*
1. Petricola robusta......	Choristodon typicum.
2. Solecurtus affinis	Caribbæus.
3. Corbula bicarinata.........	Cubaniana.
4. Tellina cognata	similis.
5. Donax rostratus............	rugosa, *Cutting* in Bristol Mus.
6. Venus ? crenifera	crenifera.
7. —— neglecta...............	cancellata.
8. Trigona radiata	mactroides.
9. Gouldia Pacifica............	Crassatella Guadaloupensis.
10. Chama frondosa (var. Mexicana).	sp.
11. Felania serricata...........	Lucina Candeana.
12. Byssoarca mutabilis	Americana.
13. —— gradata	? Domingensis.
14. —— fusca	? fusca.
15. Ianthina decollata	prolongata.
16. Crucibulum umbrella ...	extinctorium.
17. Crepidula onyx	sp.
18. Hipponyx Grayanus	? Grayanus.
19. Turritella tigrina	imbricata.
20. Cerithium ? uncinatum ...	uncinatum.
21. Modulus catenulatus......	Carchedonicus.
22. —— disculus................	— (pars) *D'Orb.*
23. Trivia suffusa	? suffusa.
24. —— ? pediculus .... [? imported].	pediculus.
25. Erato ? Maugeræ	Maugeræ.
26. Lamellaria, sp.	sp.
27. Marginella minor	minima.
28. —— margaritula	ovuliformis.
29. Oliva inconspicua	? oryza.
30. —— Melchersi	sp.
31. —— araneosa	reticulata.
32. Olivella p. aureotincta ...	petiolita.
33. Purpura biserialis .... [= *P. undata*, C. B. Ad.]	Floridana. [not *P. undata*, Lam.].
34. Pisania gemmata	tincta, *Conr.*

The Gasteropods have now gained a large majority.

C. *Species really separated, but by slight differences.*

Pacific.	*West Indies.*
1. Lyonsia picta...............	plicata.
2. Capsa lævigata	Braziliensis.
3. Mactra elegans	canaliculata.
4. Tapes histrionica	granulata.
5. Dione Chionæa, var.	maculata.
6. —— lupinaria	dione.
7. Cyclina subquadrata	sp.
8. Gouldia varians	Crassatella, sp. *D'Orb.*
9. Cardium consors	muricatum.
10. Lucina pectinata	pecten.
11. Byssoarca solida	sp.
12. Avicula sterna	Atlantica.
13. Planorbis tumens	affinis.
14. Physa aurantia	Maugeræ.
15. —— elata	sp.
16. Bulla Adamsi...............	striata.
17. Ianthina striulata	fragilis.
18. Acmæa fascicularis	Antillarum.
19. —— mitella	sp.
20. Fissurella virescens, var. .	Barbadensis.
21. Phasianella compta	sp.
22. Neritina picta...............	virginea.
23. Crepidula excavata	porcellana.
24. Hipponyx serratus.........	sp.
25. Turritella goniostoma ...	meta.
26. Cerithidea varicosa	Lavalleana.
27. Rissoina Woodwardi	Catesbyana (St. Thomas).
28. Alaba supralirata	tervaricosa.
29. Trivia subrostrata	sp.
30. Ovulum variabile	subrostrata.
31. Strombus gracilior.........	pugilis.
32. Terebra luctuosa	cinerea.
33. Drillia incrassata	sp. (?alabastra, or
34. —— aterrima	sp. [?gibbosa).
35. Crysallida communis......	cancellatus.
36. Cerithiopsis assimilata ...	terebella.
37. Lathyrus tuberculatus ...	Knorrii.
38. Olivella tergina	conoidalis.
39. Purpura biserialis	deltoidea.
40. Pyrula patula...............	melongena.
41. Murex recurvirostris	messorius.

The Gasteropods maintain their majority.

D. *Analogous but quite distinct species.*

Pacific.	*West Indies.*
1. Tellidora Burneti	sp.
2. Mactra exoleta	carinata.
3. Venus amathusia	dysera.
4. Anomalocardia subrugosa	flexuosa.
5. Cardium elatum...........	serratum.
6. —— aspersum	bullatum.
7. Chiton sanguineus, *Rve*...	sanguineus, *Cutt.*
8. Glyphis microtrema	sp.
9. Nerita Bernhardi	tessellata.
10. Petaloconchus macrophragma	varians.
11. Litorina Philippii	ziczac.
12. Strombus Peruvianus ...	gigas.
13. Conus purpurascens	achatinus.
14. Odostomia vallata.........	sp.
15. Parthenia armata	gemmulosa.
16. Chemnitziæ, sp............	sp.
17. Polynices uber	lactea.
18. Ficula decussata...........	gracilis.
19. Mitra nucleola	granulosa.
20. Cassis abbreviata	inflata.
21. —— coarctata	testiculus.
22. Oniscia tuberculosa	oniscus.
23. Triton vestitus	pilearis.
24. Nassa versicolor............	ambigua.
25. Anachis costellata	terpsichore.
26. Murex erosus...............	intermedius.
&c.	&c.

It is probable that these lists will hereafter be greatly extended. The shells will be moved from one head to another, according to opinion and opportunities of judgment. Unfortunately, although the West Indian shells were among the first examined, they are to this day very little better known than by the Lamarckian conchologists. Most of the shells in collections are dead and worn, and the dredge has been but little used, especially in the great and doubtless prolific Gulf of Mexico*. At present our best sources of information are—(1.) The Sagra collection from Cuba (mostly poor shells), kept distinct in the British Museum. (2.) The St. Vincent collections of the late Rev. L. Guilding, scattered in the general collections of the British Museum. (3.) The very fine Barbadoes collections of Dr. Cutting in the Bristol Museum. (4.) Prof. Adams' sea-shells from Jamaica, which have not yet been fully tabulated, though several are described in the 'Contributions to Conchology.' Others also appear scattered in the 'Zeitschrift für Malacozoologie,' and other works. The Pacific shells having been so little known to the earlier writters, when there are analogous species, it is fair to suppose that the West Indian forms are intended. This is another reason for their careful study.

85. But the analogies of the Mazatlan shells extend further than the Caribbæan waters. Not merely some West Indian species, as *Nitidella cribraria*, found also in the Pacific, have made their way to the east shores of the Atlantic; but several Mazatlan forms, not yet quoted from the West Indian islands, unexpectedly reappear on the Senegambian and Guinea coast, as though they loved western shores.

Species ? common to the West (Pacific) American shores and Africa.

W. A.=West Africa. *S. A.*=South Africa. *E. A.*=East Africa (*Capt. Owen*, B.M.).

	West America.	*Africa.*
1.	Saxicava arctica	arctica, S. A.
2.	Kellia suborbicularis	suborbicularis, W. A.
3.	Isognomon Chemnitzianum	Chemnitzianum, W. A.
4.	Lithophagus aristatus	caudigerus, W. A.
5.	Ostrea iridescens	spathulata, W. A.†
6.	—— conchaphila	conchaphila, W. A.
7.	Placunanomia pernoides	pernoides, W. A.
8.	Crepidula unguiformis	Goreensis, W. A.
9.	—— aculeata	aculeata, S. A.
10.	Hipponyx antiquatus	antiquatus, W. A.
11.	Bankivia varians‡	varians, S. A.
12.	Natica maroccana (Pritchardi)	maroccana, W. A.§
13.	Marginella cærulescens	prunum, W. A.
14.	Nitidella guttata	cribraria, W. A.
15.	Purpura pansa	patula, W. A.

* If the "Central American difficulty" should ever draw our Transatlantic brethren, Messrs. Rich, Jewett and Green, to the Caribbæan seas, it is hoped that they will explore them well; an occupation surely more worthy of a philosopher than killing his brothers; and a "difficulty" requiring solution quite as much as the ownership of the Mosquito territory.

† It is believed that *Petricola robusta* was found in the African oysters; but this only rests on circumstantial evidence: *v.* B.M. Mazatlan Cat. p. 19.

‡ The solitary young specimen of this characteristic species in the Reigen collection, was taken from the debris of a *Spondylus*, which is a sea (not shore) shell.

§ Having very carefully compared large numbers of the West American shells (*Pritchardi*, Forbes) with a fine series from Gambia, sent by Chief Justice Rankin to the Bristol Museum, I cannot but regard them as identical, both as to shell, operculum, and similarity of variations. The shells called *unifasciata* may or may not belong to this species: several unquestionably do.

The following species might be divided into groups answering to B, C, and D of the West Indian parallels.

1.	Discina Cumingii	striata, W. A.
2.	Pholadidea melanura	clausa, W. A.
3.	Parapholas acuminata	branchiata, W. A.
4.	Tellina rufescens	perna, *Spl.* (Madagascar.)
5.	Iphigenia lævigata	sp., W. A. (Bristol Mus.)
6.	Trigona, var. Hindsii	tripla, W. A.
7.	—— planulata	? bicolor, W. A.
8.	Diplodonta semiaspera	circularis, W. A.
9.	Pectunculus multicostatus	inæqualis (*Krauss* not *Reeve*), S. A.
10.	Arca grandis	senilis, W. A.
11.	Gadinia pentigoniostoma	afra, W. and S. A.
12.	Crepidula onyx*	hepatica, *Krauss.*
13.	Cerithium maculosum	adustum (? Red Sea).
14.	—— stercus-muscarum	ocellatum, E. A.
15.	Terebra armillata	interstincta, W. A.
16.	Euryta fulgurans	sp., E. A.
17.	—— aciculata	? Cosentini. (Mediterranean, &c.)
18.	Aragonia testacea	hiatula + Steeriæ, W. A.
19.	Harpa crenata	rosea, W. A.
20.	Vitularia salebrosa	vitulina, W. A.
21.	Purpura biserialis	hæmastoma, W. A.

The comparative preponderance of bivalves in these lists is still apparent.

86. The *Kellia suborbicularis*, *Lasea rubra*, *Saxicava arctica*, and *Hydrobia ulvæ*, of the Gulf, even belong to the British fauna. The *Dione Chionæa* is so like the *D. Chione* of our southern shores, that Mr. Sowerby at first united them, quoting under *Cytherea Chione*, "Mr. Cuming's specimens are from Mazatlan," while the dull S. Pacific specimens were described as *C. squalida*, and the banded ones of the same species (by Dr. Gray) as *C. biradiata*. The *Cæcum glabrum* of the British, and *C. glabriforme* of the Mazatlan seas are almost indistinguishable. The same may be said of the form *Leiostraca distorta*. The *Cerithiopsis tubercularis* and *C. tuberculoides* are most closely allied; as are also *Byssoarca mutabilis* and *tetragona*, *B. solida* and *lactea*, *Tellina donacina* and *donacilla*, *Modiola modiolus* and *capax*, *Thracia squamosa* and *villosiuscula*, *Acmæa mesoleuca* and *testudinalis*, *Galerus mammillaris* and *Sinensis*, *Ianthina striulata* and *communis*, *I. prolongata* and *pallida*, *Jeffreysia bifasciata* and *opalina*, and *Nassa crebristriata* and *reticulata*. The *Gouldia varians* may compare with *Astarte triangularis* and *Tornatina infrequens* with *Cylichna mammillata*. The reappearance of the rare genera *Montacuta*, *Lepton*, and *Barleia*, is also worthy of notice.

87. Besides these analogies with the Atlantic shells, there are a few singular exceptions to the general dissimilarity with the Asiatic and Indo-Pacific faunas. Thus we have the Japanese *Cytherea petichialis* reappearing at Mazatlan; and *Nassa acuta* most closely resembling an Australian species in Mr. Cuming's collection. The *Oliva Duclosi* is quoted from the Pacific islands; as are also the ubiquitous *Natica maroccana* and *Nitidella cribraria*, the pelagic *Ianthina striulata*, the sedentary *Hipponices barbatus* and *Grayanus*; and a few other species, concerning which there is a fair chance of inaccuracy, especially in shells from "Lord Hood's Island."

88. Of the land and freshwater shells little is yet known except those brought from Oregon. These are of a different type from those of the

* Dr. Dunker also quotes *Cr. Peruviana*=*dilatata* from the Guinea coast. His solitary specimen may be from ballast; but it has been plentifully received as from Mauritius.

Atlantic states, and have more the general appearance of old world forms. The few known from Mazatlan are essentially tropical in type, and differ from those found on the east of the Rocky Mountains.

89. The Bryozoa are included in this Report, because it appears universally acknowledged that they have more in common with the lower Tunicata and the Molluscan type in general, than with the Radiata. What few are known have been described by Mr. G. Busk, who regards one species as identical with a British form, another with a specimen dredged by Mr. Darwin, from 96 fms. in Chiloë, a third with a tertiary fossil from Vienna, and the rest as new.

90. Of the Pteropods nothing is known; of the naked Gasteropods only a few forms from Sitcha and Oregon; of the Palliobranchiata scarcely any; and of the Cephalopods only two, not characterized, from the Behring Sea.

91. It would be extremely interesting, after comparing the West American shells with other existing faunas, to carry our researches back in time, and compare them with the fossils known to occur on the same coasts. For such inquiries, however, there exist scarcely any materials. All that we know is a little concerning the fossils of Oregon in the tenth volume of the 'U. S. Exploring Expedition,' Geology, by Jas. D. Dana. In Appendix I. p. 723, the following fossil shells from the sandstone of *Astoria* are described.

Astorian fossils.

Teredo substriata, Conr. [=*Dentalium**.]	*Arca devincta*, Conr.
Mya abrupta, Conr. [?*Panopæa.*]	——, sp.
Thracia trapezoides, Conr.	*Pecten propatulus*, Conr. [B.M.]
Solemya ventricosa, Conr.	*Terebratula nitens*, Conr.
Tellina arctata, Conr.	*Bulla petrosa*, Conr.
—— *emacerata*, Conr.	*Crepidula prorupta*, Conr.
—— *albaria*, Conr.	——, sp.
—— *nasuta*, Conr.	*Turritella*, sp.
—— *bitruncata*, Conr.	*Cerithium mediale*, Conr.
?*Donax pretexta*, Conr. [?cast of *Solemya.*]	? *Rostellaria indurata*, Conr. [resembles *Strombus vittatus.*]
Venus bisecta, Conr.	*Sigaretus scopulosus*, Conr. [?*Naticina.*]
—— *angustifrons*, Conr.	*Natica saxea*, Conr.
—— *lamellifera*, Conr.	? *Dolium petrosum*, Conr.
—— *brevilineata*, Conr.	? *Buccinum devinctum*, Conr.
Lucina acutilineata, Conr.	*Fusus geniculus*, Conr.
Cardita subtenta, Conr.	—— *corpulentus*, Conr.
Nucula divaricata, Conr.	*Nautilus angustatus*, Conr. [?=*N. zigzag.*]
—— *impressa*, Conr. [*Leda.*]	
Pectunculus patulus, Conr.	
—— *nitens*, Conr. [resembles *Limopsis.*]	

The "Dolium" is interesting from its close resemblance to the anomalous *Argobuccinum nodosum*=*Cassidaria setosa*, Hinds.

Of the tertiary fossils of the United States, while many Atlantic species occur, none have been noticed exclusively Pacific. There are some few which are found in both oceans; and a *Vermetus*, among Mr. Nuttall's Claiborne fossils, closely approaches *V. eburneus*, while it differs from the West Indian forms. These fragments of information are all that are yet accessible.

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92. The object of this Report has been so to condense and arrange the existing materials that those who consult it may know what has been done, and may have the means of deciding on the value to be attached to different sources of information. Thus they may be enabled to begin where the writer

* The notes in [ ] are added by Mr. S. P. Woodward, who kindly furnished the above list.

leaves off, and not spend precious time in working out afresh what has already been ascertained*. He has stated his opinions with some freedom; because it was thought that an expression of the difficulties encountered in the prosecution of the subject and of their causes, might (1) put other students on their guard, and (2) contribute somewhat towards their removal. They will be received simply as the judgments of a learner who came fresh to the subject, without previous acquaintance with books and naturalists. His object has been, not himself to build, but to clear away some of the encumbrances, lay part of the foundations, and collect a few of the materials, ready for the great architects of science to erect the beautiful edifice of harmonious knowledge. The first scientific explorer of these regions, the venerable Baron Humboldt, still lives to enjoy the earthly rest after his labours: but the early death of so many whose names have been quoted, of Eschscholtz, of Hinds, of Souleyet, of Reigen, of Adams, and of Forbes, urges us to "work while it is day"; that we may prepare for that state where ignorance shall have passed away, and where "we shall know even as also we are known."

Warrington, Aug. 8th, 1856.

Abstract of First Report on the Oyster Beds and Oysters of the British Shores. By T. C. Eyton, *F.L.S., F.G.S.*

For convenience sake I shall divide this Report into three sections:—1st, A history of oysters and the laws relating to them. 2ndly, An account of the different beds. 3rdly, The history of the oyster from its embryo state in the parent shell until it is seven years old; and, lastly, a summary of deductions from the reports I have received. The oyster fisheries of England are of great antiquity,—the luxurious Romans held the British oyster in high estimation. There have at different times been many Acts of Parliament passed for the protection of oyster-beds; the fisheries are at present, however, regulated by a Convention entered into between Her Majesty the Queen and the King of the French; and an Act passed to carry the same into effect (6 & 7 Vict. c. 79), which enacts that the fisheries shall open on the 1st of September and close on the 30th of April.

The oyster-beds which I have visited or received reports from are the following:—Loch Ryan, the whole of the Welsh beds, Loch Fyne (a bed of no commercial value), Isle of Man beds, Jersey, Guernsey and Sark beds, Kentish and Essex beds. The oysters, from which the spawn I am about to mention was taken, were obtained from Loch Ryan, at the entrance to the Clyde, on the 10th of July, and were forwarded to me in a box packed in wet grass; they were thirty-two in number, of which only three proved to be in spawn: in these, from a rough calculation, which I believe to be much under the mark, the number of young was about 3,000,000. The first oyster I opened had the spawn exuded, so that it lay on one side between the folds of the mantle. The mass was of a purplish colour; and on examining it with a hand-glass, I could perceive some motion; but on placing some on a glass plate under a $\frac{1}{4}$-inch power in the microscope, I could clearly perceive that what I had taken with the naked eye for ova were living animals varying slightly in shape. The animal was semi-transparent, with two reddish elongated dots placed on each side behind the cilia, which were in constant

* The Plates appended to this Report, at the recommendation of the Committee, are intended to illustrate some of the principal variations observed in individuals of the same species, especially when the forms have been described as different species, or represent the characters of different (so called) subgenera. They are to be regarded as portraits, not photographs of the Mazatlan shells in the British Museum Collection.

and rapid motion. They were exceedingly tenacious of life, the cilia moving until the water was dryed upon the glass. Some that I placed in a little salt and water were alive the next day. The oysters on the table have been, through the kindness of Mr. Sweeting, fishmonger, Cheapside, sent to me, and are from one to four years old.

It now, therefore, only remains to trace the life of the oyster and the changes it undergoes from the state I in which found it in the parent until it has formed its shell and attached itself to some substance, which I hope to be able to do next year in a continuation of this Report. From the reports I have received and my own observations, I think that the fence months might be advantageously altered on many beds, and that if such alteration was made, the markets might be supplied the greater portion of the year. The depth of water appears to be the chief cause of a difference in the time of spawning; and it is exceedingly doubtful if on some deep beds they spawn at all; and they are probably supplied by the fry drifting from some neighbouring bed in shallower water. The commonly received opinion among the fishermen, that the oyster deposits its spawn in masses, is entirely erroneous. Oysters are best for the table out of shallow water, and at the entrance of a river if suitable ground is found, and feed quicker in such situations.

The author then read a series of questions, which it was requested any person connected with oyster-beds would be kind enough to answer and forward to him:—1. Name of fishery? 2. Depth of water? 3. Computed size of beds? 4. At what age do oysters spawn? and do all oysters above that age spawn? 5. Does the time of spawning differ on different beds within your knowledge? 6. If such difference exist, is it caused by a variation in the depth of water, or any other reason? 7. What is the ground? 8. Do the oysters differ on different sorts of ground? 9. Add any other information.

Report on Cleavage and Foliation in Rocks, and on the Theoretical Explanations of these Phænomena.—Part I. *By* John Phillips, *M.A., F.R.S., Reader in Geology in the University of Oxford.*

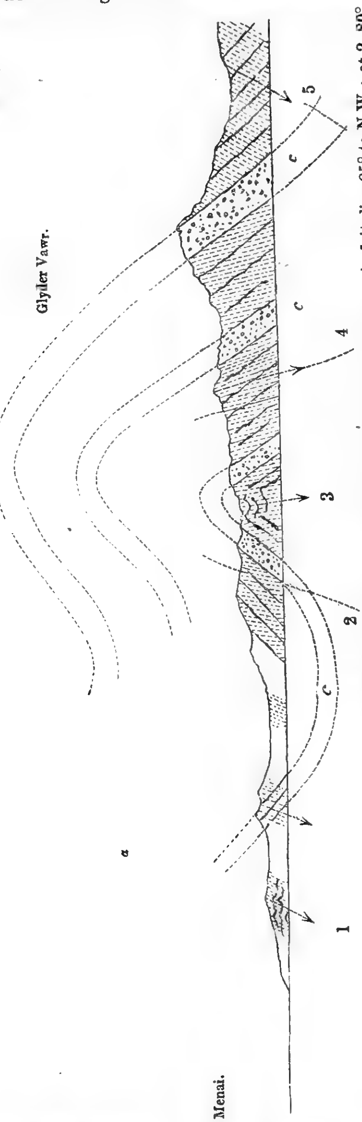
Of the numerous structures existing in rocks, two more predominant than the rest have long been referred to their appropriate causes—sedimentary deposition—crystalline aggregation. The 'strata,' formed by the first process, have all the varieties of mineral substance and magnitude of grain, and all the inequality of extent and bulk which we observe to occur in modern deposits from water; the granite and other quartzo-felspathic rocks offer a large range of crystalline aggregates, always analogous to, and sometimes undistinguishable from, the products of actual volcanoes.

But in many, and especially in mountainous countries, examples occur of rocks which seem both crystalline in texture and stratified in structure, and others which are apparently formed by sediments, but are thoroughly fissured to a degree of tenuity, and with a regularity and continuity not observed in ordinary cases of stratification. The former case is exemplified in gneiss, the latter in clay-slate. Giving to the divisions of gneiss the name of 'foliation,' and to the fissures of slate the title of 'cleavage,' we may proceed to trace the observations and inferences by which some light has been thrown on these phænomena. We begin with cleavage.

§ 1. *Cleavage distinct from Stratification.*

The drawing No. 1 is a transverse section of the strata in the Snowdonian chain from the Menai through the great slate quarries of Mr. Pennant. It shows the argillaceous and arenaceous strata dipping to the right (S.E.) or left (N.W.), according to the anticlinal and synclinal axes of the district. The fine lines mark the cleavage which crosses the strata, the dotted lines above show the continued arcs of the strata, the deficiencies being attributed to enormous waste of the surface; dotted lines also mark the supposed extension of the cleavage surfaces. The section is *an extension* of that given by Professor Sedgwick*, the spectator being supposed to look northward.

Fig. 1.



In this section *c c c* are conglomeritic beds. Cleavage is marked by fine dots, and indicated by arrows. At 1 it dips 85° to N.W.; at 2, 80° to 85° N.W.; at 3, 80° to 85° S.E.; at 4, 80° S.E.; at 5, 80° W. The anticlinal strata at 3 are subject to some undulations on the summit.

Professor Sedgwick has also given another section in the same line†, which shows a complete anticlinal at *a*. I did not observe this with certainty.

It is remarkable that the investigation of 'cleavage' is one almost entirely British,—till within a very few years almost entirely English; for neither Saussure, nor Werner, nor any of their followers, appear to have clearly distinguished between stratification and cleavage. Saussure‡ indeed was too good an observer to pass without record the remarkable lamination of the argillaceous and calcareous rocks on the flanks of the great mountains which he so laboriously ascended. He recognized two sets of fissures, but he attributed to stratification the often vertical traces of cleavage, and was surprised to

* Geol. Trans. 1835. † Geol. Proc. 1846. ‡ Voyage dans les Alpes, §§ 1049, 1050 (1786).

find these laminæ crossed by repeated fissures, nearly at right angles. The 'repeated fissures' are, however, often the traces of strata, and the nearly vertical laminæ, so common in these parts of the mountains, are sometimes genuine cleavage*. In the gneissic axis of Mont Blanc the nearly vertical divisions are 'foliation.' Even in our own day the true reading of the structure of the Alps is a difficult problem, and laminæ of cleavage are there frequently described as layers of stratification.

The following extracts from 'Travels in the Tarentaise in 1820, 1821, 1822,' by Robert Bakewell, published in 1823, show that this ingenious author had conceived views nearly approaching those of subsequent writers:—

"On the eastern side of the valley (Thônes), about two miles from the town of Thônes, there is a rock which presents an appearance of double stratification, not uncommon in the calcareous mountains of the Alps, and which has frequently induced Saussure to suppose that the vertical strata were placed in junction with other strata nearly horizontal; an error into which he has been led by mistaking very distinct vertical cleavages for stratification. On approaching that rock I had little doubt that the strata were vertical, but when I came in front of it I perceived the true strata-seams forming curves, which were intersected at one end by a vertical cleavage. It sometimes happens that the strata-seams are entirely concealed in the perpendicular escarpment of rock by a calcareous incrustation deposited over the face of the rock, and in such instances the cleavages often project and resemble strata so much that it requires great care to avoid error in tracing the true line of dip in the stratification. This probable cause of error is of frequent occurrence in the Alps."—Vol. i. p. 67.

In the valley of the Arve—"The cleavages on a large scale are often as regular as the strata themselves, and can be scarcely distinguished from them; and as these cleavages intersect the strata nearly at right angles, this has also led to many erroneous conclusions respecting the stratification of the calcareous mountains of this part of Savoy."—Vol. i. p. 337.

From the Appendix, vol. ii. p. 423:—"There are other situations where the calcareous mountains of the Alps present to the hasty observer an appearance of the most irregular and contorted stratification imaginable, which is merely an optical illusion produced by a variety of cleavages in the mountain limestone; some being at right angles to the line of dip, and others to the line of bearing. There is likewise another cleavage in some of these mountains which is curved, and is produced by a tendency to a globular structure in the mass of the mountain. [A mountain in the valley of Lauterbrun, referred to as an illustration.] Near the end of the mountain the true strata-seams are seen, and are nearly horizontal, while farther up the valley several curved perpendicular cleavages present the appearance of thick beds of strata very much bent. In this instance the overlapping of the edges of the strata and the direction of the natural cleavages have nearly concealed the true form of the stratification. Such instances as this are of frequent occurrence in the Alps, and have been the source of many erroneous conclusions, for they have hitherto been but imperfectly understood. This tendency to a globular structure *en masse* I observed very frequently in the Bernese Oberland. It is altogether independent of stratification, though it has often been mistaken for it; but it has not hitherto been noticed, that I know of, by any geologist that has visited the Alps. The limestone in which I observed the curved cleavage most distinctly is dark coloured, hard and

* See Renevier, Bull. de la Soc. Vaudoise, 4 July, 1855; Forbes, Travels in the Alps; Sharpe, Geol. Proceedings, 1854.

brittle; and it is intermixed with schist. This limestone seems to pass by gradation into flinty slate."

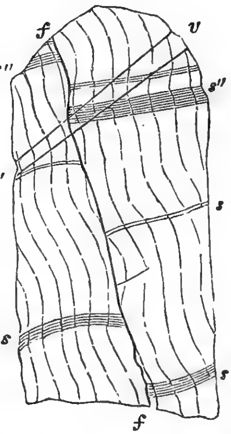
In his 'Introduction to Geology' (published 1813) the same author expresses a positive opinion. Speaking of slate, he observes,—"This rock is always represented as stratified; but in this respect it resembles gneiss and mica-slate, and the slaty and tabular structure are, I conceive, *the effect of crystallization*, depending on the nature of its constituent parts."—P. 86.

The earliest notice of a real and firm distinction between cleavage and stratification, derived from English examples, which I have met with, is in Otley's 'Concise Description of the English Lakes*.' The modest and intelligent author, speaking of the middle division of the slaty rocks, notices their prevalent though obscure stratification dipping to the south-east, speaks of the beds of slate with frequently vertical cleavage, and adds, "*but it is found in various degrees of inclination, both with respect to the horizon and planes of stratification.*"

In 1821 I made the acquaintance of this able author, verified his remarks on slaty cleavage, and in the same year sketched some of the more curious and special phænomena in the Lake district, which caught the attention of W. Smith, then engaged on his geological map of that country†. In the mind of that great observer cleavage was separated from stratification, and regarded as a kind of crystallization, running in particular beds.

Dr. MacCulloch was too practised in observations among primary rocks not to have observed the peculiarites of slate, and we find him distinguishing cleavage from stratification, and referring it to *concretionary action*‡.

Fig. 2.



$s\ s'\ s''$ are bands of stratification, displaced by a small fault f, across which, and across the stratification, two small spar veins run quite straight. "The curved lines are edges, more than usually flexuous and symmetrical, of a scaly structure, lying obliquely to the plane of cleavage." (Is this a case of secondary cleavage?)

§ 2. *Cleavage continuous through large ranges of country.*

Notwithstanding these and probably many other partial views which recognized some difference between cleavage and stratification, it was reserved for Professor Sedgwick, in the year 1835§, to define in a satisfactory manner the essential character of slaty cleavage, and to show its exact place in the series of changes by which soft argillaceous deposits have been stratified and solidified, cleft and jointed. Instructed by the repeated examinations of the schistose rocks of Westmoreland and Wales (begun in 1822), how to discover the almost evanescent traces of bedding, which in some cases are all that metamorphic action has left, and recognizing in these

* Keswick, 1823. There was an earlier publication in the Kirkby Lonsdale Magazine, 1820.

† See Memoir of W. Smith, p. 99.

‡ Journal of the Roy. Inst. 1825. System of Geology, 1831, i. 139; ii. 186.

§ Geol. Trans. 2nd series, vol. ii.

tracts the enormous and repeated undulations of the strata,—he found these seemingly irregular structures crossed and cut through by a series of planes characterized by almost unvarying symmetry—parallel and continuons through the heart of Snowdonia and the steeps of the Westmoreland Alps,—and so regular as to appear like the results of enormous crystallization.

These results—confirmed by universal research among the mountainous tracts of the old and new world—by Studer and Forbes in the Alps, by Murchison in Siluria, Darwin in the Andes, and Rogers in the Appalachians*, —leave no doubt that cleavage is a peculiar structure impressed on certain rocks and in certain regions, by the operation of some very extensive cause operating after the stratified rocks had undergone great displacement. For this fundamental generalization we are, I believe, entirely indebted to Sedgwick.

§ 3. *Cleavage in continuous parallel planes across bent and contorted Strata.*

Of this remarkable fact, and of its extensive bearing on the theory of cleavage, Professor Sedgwick's memoir gives the earliest notice, confirmed by abundant examples in Wales:—"A rugged country, more than thirty miles in length and eight or ten in breadth, stretching from the gorge of the Wye above Rhaiadr to the upper gorges of the Elan and the Towy, exhibits on a magnificent scale, thousands of examples of much contorted strata, crossed by parallel cleavage planes. Of the true bedding in these cases there is not a shadow of a doubt. Many parts are of a coarse mechanical texture; but subordinate to these are fine chloritic slate. But the coarser beds and the finer, the twisted and the straight, have all been subjected to one change. *Whatever be the contortions of the rocks, the planes of cleavage pass on, generally without deviation, running in parallel lines from one end to the other, and inclining at a great angle to a point only a few degrees west of magnetic north*†." The Diagram No. 3 shows the directions here assigned. Those which follow (4, 5) are vertical sections copied from Sedgwick, to show the parallelism of cleavage planes across strata bent anticlinally (4) and contorted (5).

Fig. 3.

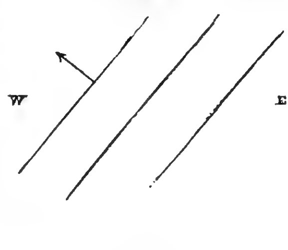


Fig. 4.

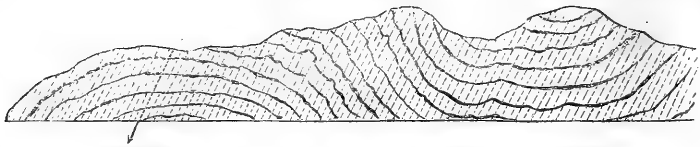
River Wye above Rhaiadr.

Cleavage dips to N.W., across anticlinal.

* Proceedings of American Naturalists and Geologists, 1845.
† Geol. Trans. 2nd series, vol. ii. p. 477.

Fig. 5.

On the River Towey.

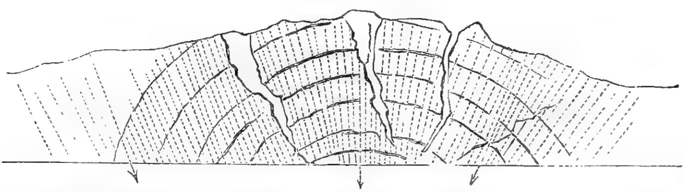


Cleavage dips N.W. by north, and is parallel across many flexures.

In Diagram 6, a case of local exception to the rule is given by Sedgwick. There the cleavage planes preserve their strike, but change the direction and amount of their inclination, in such a way as to pass vertically through the anticlinal axis, and to be inclined toward this axis on each side of it. There is *no cleavage* observable in the lower or more central parts of the bent mass of rocks.

Fig. 6.

Craig Gibbon.



On road from Llangollen to Ruthin. Cleavage convergent to an anticlinal dipping N.N.E. on one side, and S.S.W. on the other, but vertical in the axis of the strata.

§ 4. *Cleavage symmetrically related to axes of movement of the Strata.*

In a great number of examples in Wales, Westmoreland and Yorkshire, where the cleavage is perfect and the strata are distinct, it is found that the edges of the laminæ of cleavage show themselves very plainly in the surfaces of stratification, and these edges are often nearly horizontal. To use the expression of Sedgwick, who first declared the fact, "where the cleavage is well developed in a thick mass of slate rock, *the strike of the cleavage is nearly coincident with the strike of the beds**." This is most frequently observed where the strike of the strata is most persistent; or in other words, where the anticlinal and synclinal axes of movement are most simple, continuous, and uniform in direction.

But where the axes of movement are complicated by small folds and twists, the local coincidence of the strike of cleavage and the strike of stratification frequently fails; the cleavage maintains, or tends to maintain, one uniform direction, and thus crosses the folds of the strata under various circumstances, more or less suggestive of an influence more general than that which determined the folds.

If the expression above quoted from Prof. Sedgwick be well considered, and taken in connexion with the exceptions which he mentions, it will appear that in his mind the direction of cleavage in a large district was coincident,

* Geol. Trans. 2nd series, vol. vi. p. 473. The word "strike" was, I believe, first employed in this sense by Sedgwick.

or nearly so, with *the main or mean direction of the strike of the beds,* though it is not actually so stated in the paper. In 1843 I presented as the result of a special study of the geographical relation in question, among the slaty rocks of Wales, the following explicit expression,—"The cleavage planes of the slate rocks of Wales are always parallel to the *main direction of the great anticlinal axes, but are not affected by the small undulations and contortions of those lines* *," which may be regarded as confirming the views of Sedgwick. Prof. Jukes finds the same result in Newfoundland†. Mr. Darwin has an analogous expression for South America:—"The cleavage laminæ range over wide areas with remarkable uniformity, being parallel in strike to the *main axes* of elevation, and generally to the outlines of the coast‡." And since 1837, Professors H. D. Rogers and W. B. Rogers have observed and recorded, in Virginia, Pennsylvania, and New Jersey, "the close parallelism of the cleavage planes of a given district with each other, and with the *main axis* of elevation of the district§." And lastly, in 1849, Mr. D. Sharpe, in reviewing these statements, adds, as from his own conviction, that "the direction of the strike of the cleavage is parallel to the main direction of the axes of elevation, and has no necessary connexion with the strike of the beds‖." This is somewhat enigmatical, for it is by the "strike of the beds" that we determined the axes of elevation and depression: Mr. Sharpe had perhaps misunderstood Professor Sedgwick's use of the word strike, and probably meant to say that the cleavage observed at any one place was not necessarily dependent on the strike of the beds *at that place.* Professor Harkness has found remarkable agreements between the strike of cleavage and the axes of movements in the S.W. of Ireland ¶. According to these authors, then, though cleavage is really or nearly independent at every point of the previously fixed position of the strata there, crosses them with little variation, whether they be curved or plane, and preserves or nearly preserves its own dip or its own verticality, in whatever direction and in whatever degree they are inclined; cleavage and stratification have, nevertheless, one real geographical relation, an approximate parallelism of strike, dependent on the axes of movement of the rocks. To this conclusion, however, there are many exceptions; one of the most remarkable exceptions known to me is found in North Devon, where the general strike of the beds is nearly east and west; but the cleavage strike is nearly E.N.E. and W.S.W., by the observations of Sedgwick, Sharpe and myself.

In Charnwood Forest I find the average strike of the strata, exactly measured, to form an angle of 19° 12′ with the average strike of the cleavage.

§ 5. *Relation of Cleavage Planes to the Inclination of the Strata.*

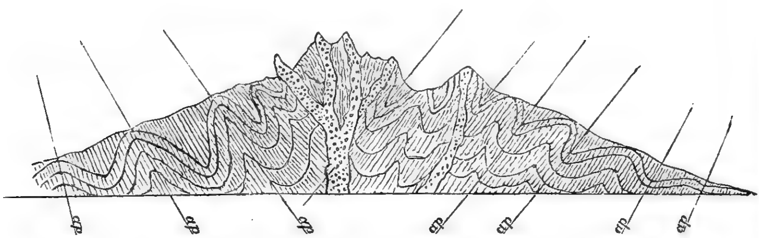
Almost every observer in mountainous regions who has once perceived the symmetrical relation of the strike of cleavage to the great axes of movement of the masses, seeks for some corresponding symmetry between the *dip of the strata* and the *inclination of the cleavage.* But unless the investigation be carried *across a whole district,* so as to furnish comparisons on both sides of all the anticlinals and synclinals, the result cannot be much relied on. Mr. Darwin, who has in this respect the advantage of great range of observation, having observed the persistence of the *strike* of cleavage, and

* Reports of the British Association, 1843, p. 61.
† Geological Survey of Newfoundland, p. 130.
‡ Geological Observations in South America, p. 162.
§ Ann. Reports on the Surveys of these States, 1837-40.
‖ Proceedings of Geol. Soc. 1846.
¶ Reports of British Association, 1855, p. 82.

the frequent change of their dip both in angular value and direction, sought for some order in these changes. He observed that frequently, in Tierra del Fuego and in other countries in South America, cleavage planes were inclined in opposite directions on opposite sides of an anticlinal, so as to dip inwards*. The Alps, given as an example of this fan-like arrangement of strata by Studer†, and the corresponding appearance previously recorded by von Buch in Norway, are mentioned by Darwin as possibly related to this phænomenon of cleavage. Professor H. Rogers submitted to the American Association for the Advancement of Science, a further statement, that "*the cleavage dip is parallel to the average dip of the anticlinal and synclinal axis planes*, or those bisecting the flexures‡." The Alps in this view are supposed to have on their flanks many folds of strata, whose "axis planes" dip inwards; and parallel to these "axis planes" the cleavage structure is developed. The axis planes are more highly inclined at greater distances from the central summit ridge.

Fig. 7.

Hypothetical Sketch Section of Alps.



For the most detailed view yet presented on this subject we are indebted to Mr. D. Sharpe, now unhappily lost to science. According to Mr. Sharpe, if we trace geographically any particular plane of cleavage by following its strike 5, 10, 20 or more miles, we shall find it preserve, within narrow limits, the same angle of dip, and in the same direction. On proceeding a few miles to the right or left, and selecting a second plane of cleavage, it is probable that this will not dip at the same angle, possibly not in the same direction; but this angle and this direction of dip are equally persistent along the line of strike to which they belong. When by repeated trials of this kind the structure of a large tract of country is ascertained, it is found that along certain lines of strike some miles apart, the cleavage is vertical, or nearly so; that near these lines the cleavage surfaces are steeply inclined toward them, but far from them greatly inclined. Thus something like anticlinal and synclinal axes appear, and "systems of cleavage" are traced through countries which also manifest "systems of movement."

Thus Mr. Sharpe states, that in North Wales a line of vertical cleavage runs N.E. and S.W. along the slate beds which lie on the western flank of the Snowdon chain; another such line runs through the great slate quarries between Dinas Mowddy and Mallwyd. These lines are about 35 miles apart. Between them the cleavage is inclined,—near the north-western line the dips are north-westward,—near the south-eastern line they are south-eastward,—the angle of inclination being least towards the middle part of the area included

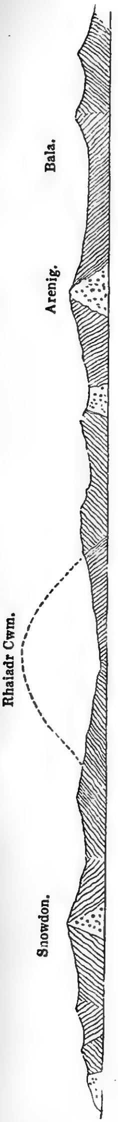
* Geological Observations in South America, p. 164.

† Edinb. New Phil. Journal, vol. xxxiii. p. 144.

‡ Trans. Roy. Soc. Edinb. 1856, p. 447.

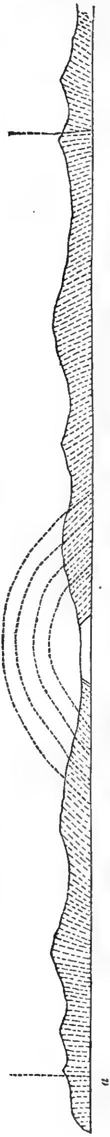
between the lines*. The general result of that inquiry, as regards this tract of country, may be understood by reference to the drawings marked 8, 9.

Fig. 8.



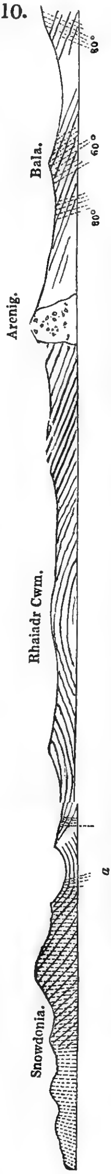
Section of strata in North Wales, on a line from N.N.W. to S.S.E., according to Sharpe.

Fig. 9.



Section of cleavage on the same line of country, according to Sharpe: at *a* and *b* cleavage vertical.

Fig. 10.



Section of strata and cleavage on line from Snowdon to Bala. At *a* (Beddgelert) the usual cleavage dip to N.W. is, for a short space only, exchanged for vertical inclinations. The cleavage dips near Bala, as far as I observed seldom exceeded 80°.

In his description of these sections, Mr. Sharpe calls attention to the fact, that "in this wide area we have only one axis of the cleavage, but there are several anticlinal and synclinal axes of the stratification; these (with the exception of the central one at Rhaiadr Cwm) have no effect on the cleavage, which follows its own direction indifferently through beds dipping in opposite directions. Still there is so much relation between the direction of the cleavage planes and the position of the beds, that we might infer from this section alone that *the cause which produced the cleavage of the rocks* had helped to *determine the elevation of the beds*." This inference is not only obscure, but seems opposed to those already established, which assign priority of date to the movements of the strata, and more extensive symmetry to cleavage than to inclination of beds.

The region thus sketched by Mr. Sharpe was previously traversed by myself in 1836 and 1843 with a view to measured re-

* Sharpe, 1846; "On Slaty Cleavage," Proc. of Geol. Soc. p. 90, &c.

sults, but I did not feel authorized by my observations to draw the same conclusions. The section, as it appeared to me, is given in Diagram No. 10.

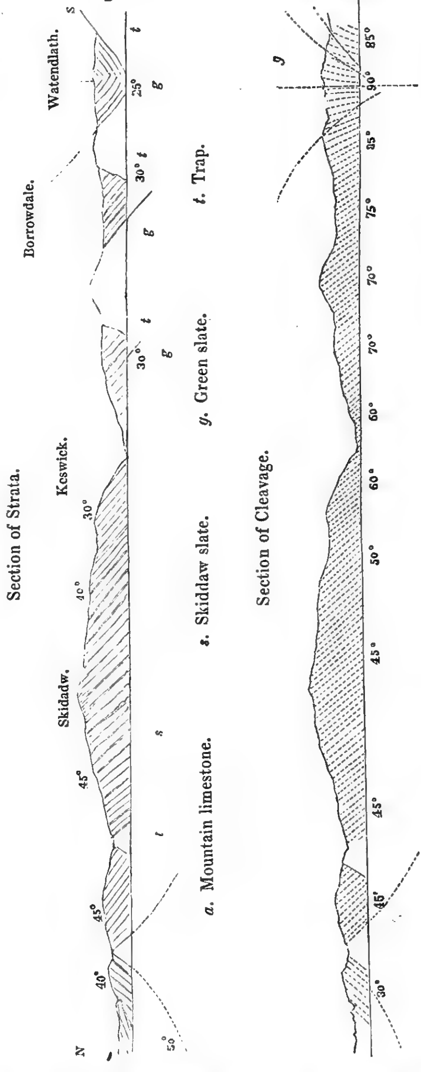
We are indebted to the same observer for observations of the same general character in the Lake district of England.

The Diagrams 11 and 12 represent sections from north to south, through Skiddaw and the region of the Borrowdale Fells, as far as Watendlath, drawn on the same plan as Diagrams 8 and 9.

In these sections the axes of cleavage and stratification are identical in place and in strike; the strata and cleavage agree in the *direction* of their dip; they agree even in the *angle* of dip on the south side of the axis of elevation (45°), but from this point southward the dip of the beds grows less and less till we reach the synclinal, where it is 25°, while the dip of the cleavage grows greater and greater till at the synclinal it is vertical. The strike of the beds varies from N. 15° E. to N. 30° E. That of the cleavage is generally N. 60° E., but varies from N. 45° E. to N. 75° E.

I have lately followed this section with attention in Borrowdale, Watendlath and Skiddaw. It appears to correspond in the southern part with the cleavage dips of the region, but the dips of the strata are more various in direction and angle than the section shows. The cleavage dips are vertical about Watendlath, and in the parallel valley about Rosthwaite on lines N. 67° E. (E.N.E.) In descending Borrowdal as far as Bowderstone, this direction of cleavage strike is frequently observable, with a dip to the southward growing less and less (82°–72°), while the dip of the strata is also southward (45°–24°). Still

Fig. 11. Fig. 12.



further northward, at a great quarry the cleavage dip is southward 52°, the dip of the beds irregular, but northerly about 60°; and still farther the cleavage dip is southerly 50°, 40°, 38°,—which last observation was made at Grange.

Fig. 13.

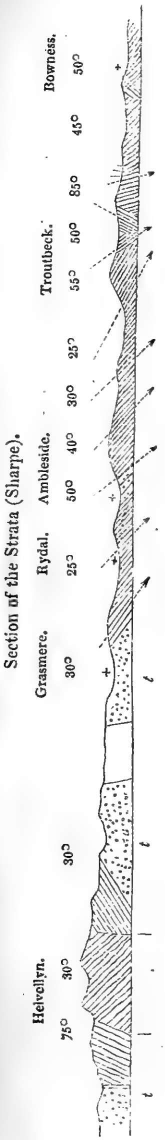
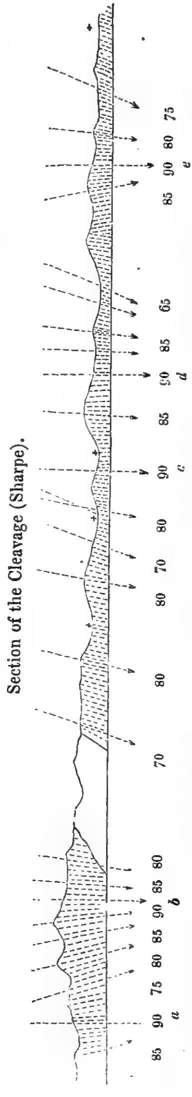


Fig. 14.



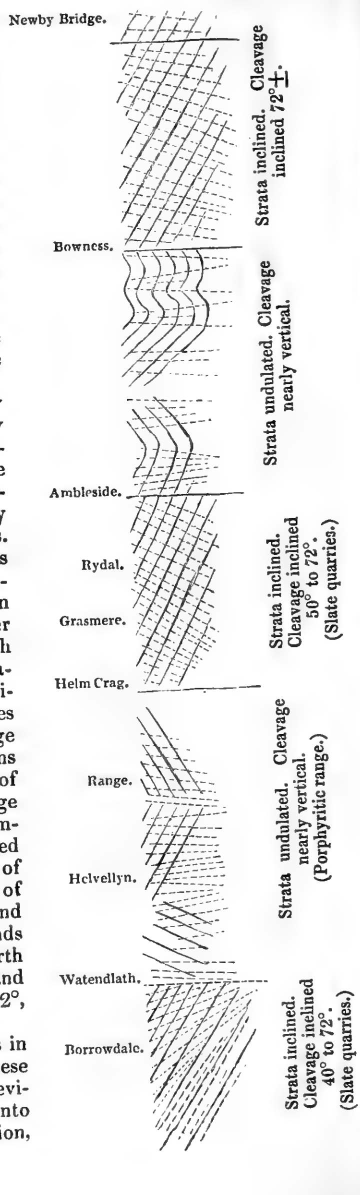
These results are all on the north side of the line of vertical cleavage at Watendlath, and in the middle slate series. In the Watendlath Valley and in the fells between it and Borrowdale, the phænomena are much less regular. In the Skiddaw slate which appear near Grange, the cleavage surfaces are sometimes twisted so as to be partly vertical, and partly dipping south, with an irregular strike N. 25° E., which differs from the strike of Watendlath, Bowderstone, and Grange above 40°. When the beds and the cleavage dip in *opposite* directions, the angle included between the planes is in several cases about 68°; when the dip is in the *same* direction, the cleavage at the highest angle, the included angle is often about 32°. When the beds are nearly vertical, the cleavage is nearly coincident with the strata. I have seen no horizontal cleavage in the Lake district*.

In the still more interesting sections on this page (Diagrams 13 and 14), Mr. Sharpe represents the bedding and the cleavage in a line of country crossing the strikes of both, from Helvellyn to Bowness. In Diagram 13 the strata are seen to be bent anticlinally and synclinally in Helvellyn,—raised in a broad arch north of Grasmere, and from thence subject only to smaller folds, dipping generally south-south-eastward. In Diagram 14, the cleavage dips are shown for the same region, these being per-

* Prof. Sedgwick has obliged me by a note confirming this statement in regard to the Lake district, but he has observed horizontal cleavage in Cornwall and Wales, and Mr. Sharpe records it in Devonshire.

pendicular on five lines, *a*, *b*, *c*, *d*, *e*; on each side of these lines highly inclined, at points farther removed less so; the least (recorded) inclination being 65° to the N.N.W. (south of Troutbeck), and 75° to the S.S.E. (north part of Helvellyn). Thus the extreme difference of dip in the cleavage of the slates of this tract is 40°; the most prevalent dip of cleavage is to the N.N.W., about 80°. The lines whose cleavage is vertical are mostly coincident with faults, or remarkable folds of the strata. The dip of the strata is most regular and continuous between Grasmere and Troutbeck,—on an average about 33° to the S.S.E.: in the same tract the dip of the cleavage on an average is 80° to the N.N.W. The angles included between the planes of cleavage and those of stratification = on an average 67°.

Fig. 15.



I have examined this tract of country many times, and have recorded carefully the strikes and dips of bedding and cleavage in a great number of cases. The facts of my survey agree in several features with Mr. Sharpe's data, but they conduct to somewhat different inferences.

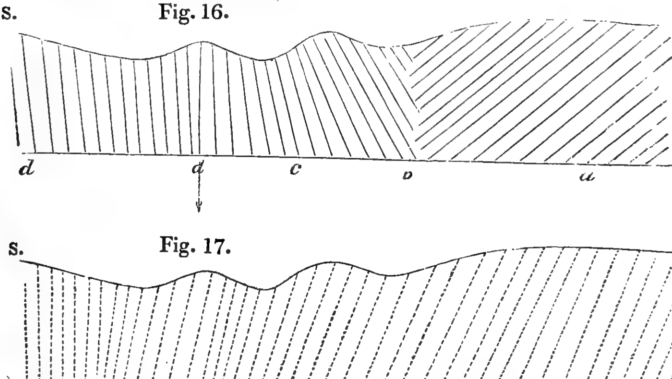
There are not so much *lines* or axes as several parallel *bands* in which the cleavage is vertical or deviates 5° to 10° on either side, and these bands are rather suddenly succeeded by others in which the cleavage dips with considerable steadiness about 70°. Thus a band of vertical and highly inclined cleavage passes through Helvellyn; a band of cleavage inclined 50° to 70° northwardly runs through Grasmere and Rydal; a band of vertical and highly inclined cleavage passes through the tract between Ambleside and Low Wood Inn, and indeed extends as far south as a little north of Bowness; then succeeds another band of cleavage inclined 72° to N.N.W.; and this is followed by nearly vertical bands in the lower part of Windermere. North of the Helvellyn band comes in the band of Borrowdale, *inclined southwardly* 72°, 52°, 40°.

By combining these observations as in Diagram No. 15, the succession of these bands appears distinctly; and it is evident that the cleavage dips run into systems of greater and less inclination, which induced Mr. Sharpe to employ the terms "anticlinal and synclinal," and to represent the lines of cleavage as parts of elliptical curves*, to which however, they really bear but slight resemblance.

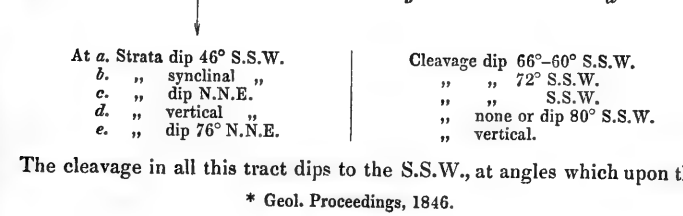
It is further evident, that when the dips of the strata are most uniform in direction, the cleavage also mostly dips in one direction ; and that where the strata are subject to much contortion and frequent changes of dip, the cleavage is either vertical, or deviates only a few degrees (5° to 10°) on either side of the vertical. For the most part the cleavage planes are steeper than the surfaces of the strata.

The most prevalent direction of the cleavage strike in Westmoreland is E.N.E., varying however to E. and N.E. This corresponds nearly with the strike of the beds. In the country east of Kendal, about Hougill Fells, it is nearly E. and W. (N. 80° E., N. 85° E.). In the same vicinity the beds strike E.N.E. and N. 85° E., or on the whole a little more to the northward. Proceeding to the S.E., we find cleavage well-developed in the clearly bedded rocks of Ribblesdale, subjacent to the mountain limestone, *which shows no sign of cleavage.* The *beds* of slate are marked by graptolites and shells; the cleavage is always traceable. The beds are undulated on axes directed between 15° north of west, and 3° north of west. (In a certain limited roll, the strikes vary 37° (from 22° north of west to 15° south of west). The cleavage strike is nearly parallel, in a general sense, to the strike of the beds ; it varies only 10° (from 16° north of west to 6° north of west).) There is one principal synclinal roll of the strata (*b*), with dips on the north side (*a*) of 46° to S.S.W.; on the south side (*c*) 60°, 73°, 80° to N.N.E.; then for a narrow space the beds are vertical (*d*); after which is a broad band of dips (*e*) 76°, 80°, 76°, &c. to N.N.E.

S. Fig. 16. N.



S. Fig. 17. N.



At *a*.	Strata dip 46° S.S.W.	Cleavage dip	66°–60° S.S.W.
b.	,, synclinal ,,	,, ,,	72° S.S.W.
c.	,, dip N.N.E.	,, ,,	S.S.W.
d.	,, vertical ,,	,,	none or dip 80° S.S.W.
e.	,, dip 76° N.N.E.	,,	vertical.

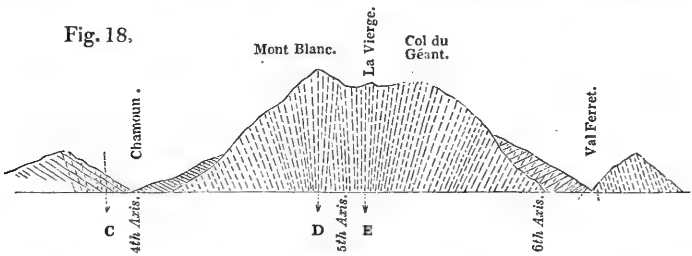
The cleavage in all this tract dips to the S.S.W., at angles which upon the

* Geol. Proceedings, 1846.

whole grow greater and greater toward the southern end; so that beginning in the northern part at 60° and 66°, they augment in the synclinal roll to 72°, south of it to 80°, and at length appear vertical, *near the line of the North Craven Fault*, which ranges E.S.E., nearly parallel to the strike of the beds and the cleavage. In Diagrams 16 and 17 these remarkable facts are expressed in a section from N. to S. in Ribblesdale, which may be compared with Diagrams No. 4, 5, 6.

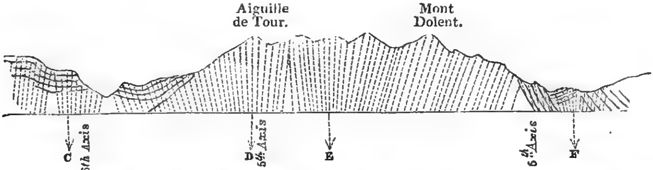
As already observed, the rocks which form the needles and sharp crests on the flanks of Mont Blanc, appeared to Studer and other geologists to be composed of laminæ which, viewed on a great scale, dip inward on each side of the great chain, so as to produce in the section a *fan-shaped structure*; and this has the more caught attention because the lowest in the scale of lamination contain organic remains and appear to be covered by crystalline schists,—the gneissic and granitic series of Mont Blanc. It appears to Mr. Sharpe that these fan-shaped laminæ are due to cleavage; that an anticlinal axis of foliation shows itself between two lines of vertical foliation in Mont Blanc, and runs through the whole chain; and that there is really no superposition of gneiss above fossiliferous strata. He traces across the region of the Swiss Alps, nine of these parallel axes and ten vertical bands of cleavage and foliation. The following is Mr. Sharpe's section* of the granitic or gneissic mass (protogine) of Mont Blanc, and the strata adjoining which *appear* to dip into or under the gneissic rocks.

Fig. 18.



The Section No. 19 exhibits the same systems of cleavage and foliation, the same axes, and the same verticals; the strata on the flanks of the Mont Blanc are seen reposing against the gneiss, not dipping into or under it. The gneiss is not supposed to be *stratified*, but *foliated*; the foliation being in planes parallel to, and even continuous with, those of cleavage.

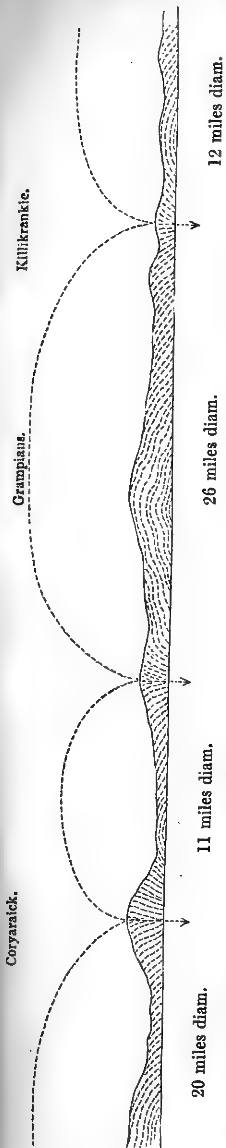
Fig. 19. From the Col de Balme to the Col Ferret.



Prof. Forbes and Prof. Rogers do not admit the statements and conclusions of Mr. Sharpe in regard to the Mont Blanc range. They are indeed much different from the usual ideas of geologists, and well deserve a careful revision and verification before being implicitly adopted in the theory of

* Geol. Proceedings, Nov. 1854.

Fig. 20.



cleavage and foliation. It can, however, scarcely be doubted that in this district bands of nearly vertical cleavage alternate with bands of cleavage inclined 40°, 50°, 60°, 70°. The reference of these dips to certain anticlinal and synclinal* axes is the part of Mr. Sharpe's view which specially requires the attention of observers both in Scotland and in Switzerland.

Mr. Sharpe obtained results of the same general character in the Highlands, but with the vertical bands (synclinal axes) much further apart than in the Alps, and the anticlinal arches very much flattened, so as to be represented by two ellipses† (Diagram 20).

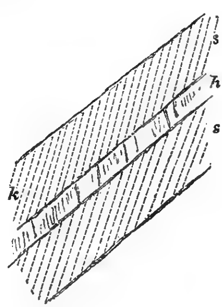
By Lyell and most writers the foliation here referred to axes, is regarded as the stratification, or traces of the stratification, of the metamorphic rocks of gneiss and mica-schist. The strike of the vertical planes over Scotland seems to radiate from Donegal, and is in general included between N. 25° E., and N. 50° E.; but in the northern part of the Isle of Lewis and the western parts of Ross and Sutherland it is about N.W., or nearly perpendicular to the usual course.

§ 6. *Cleavage varies in Strata of unlike quality.*

In a series of strata subjected to cleavage forces, the result varies according to the nature of the strata; perfect slaty structure being confined to argillaceous, and mostly to thick-bedded argillaceous deposits.

(*a.*) In a given section some of the strata are completely traversed by cleavage, others not at all.

Fig. 21.



In this Diagram, representing a section at Aberystwyth, 1836, the beds *s*, *s'* are softer and more argillaceous; *h* is harder and more arenaceous. The cleavage crosses *s* and *s'*, but is interrupted in *h*. Across *h*, however, there are generally found a considerable number of "joints," which are always more nearly perpendicular to the plane of the beds than the cleavage planes are. These joints have in some cases the same strike as the cleavage.

* Mr. Sharpe does not mark these in his section; they in fact coincide with his vertical dips.

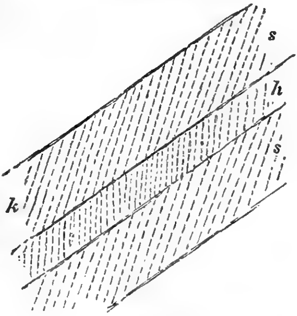
† Phil. Trans. Roy. Soc., 1852, p. 445.

Sedgwick seems to refer to such a case as one of imperfect cleavage, marked by parallel planes at definite distances, which it might be difficult to class with joints or cleavages.

(*b.*) In other examples all the strata are traversed by cleavage, but not all at the same angles of inclination.

In this Diagram, taken by the author from Leck Beck near Kirkby Lonsdale, 1823*, the letters indicate, as before, soft and hard beds: the inclination of the cleavage planes varies in these beds in such a way, that in the harder bed they deviate more from planes of stratification than in the softer beds.

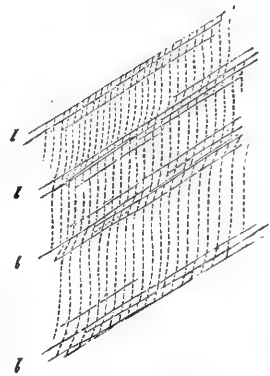
Fig. 22.



Such cases were observed by the author in Wales, 1836; North Devon, 1839; Cove of Cork, 1843; by Sharpe in Langdale, 1849; by Townsend at Cork, 1854; by Harkness in the S.W. of Ireland, 1855.

(*c.*) Not unfrequently, when beds alternate whose mineral aggregation is not uniform, the cleavage surfaces are curved in the remarkable manner shown in Diagram 23.

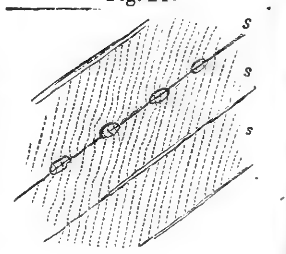
Fig. 23.



In this Diagram (23) the cleavage edges seen in the principal section are bent, so that at the surfaces of each bed they tend to coincide with the stratification, but in the middle of each bed they form a considerable angle with the stratification. The first example I ever saw of this was at Sallenche, in the Liassic slate, at the base of Mont Blanc, in 1830. I afterward observed it at Dolbadarn, in North Wales, in Westmoreland, and Devonshire. Mr. Sharpe has since confirmed this statement. It is sometimes possible to trace near the bounding surfaces of the beds laminæ (*l*) of deposition, and sometimes the original distinction of beds is only marked by such laminæ.

(*d.*) Cleavage surfaces are usually disturbed when traversing or passing near to masses of unequal hardness.

Fig. 24.

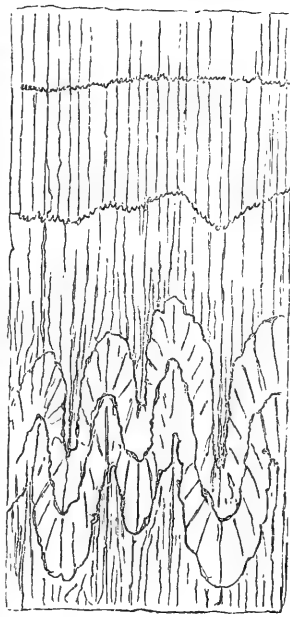


When, as in Diagram 24, beds of slate enclose nodules of greater hardness,—as limestone or 'calliard,' or ironstone,—the cleavage, which is perfect and continuous in the mass of slate, becomes irregular and interrupted so as to resemble a series of cracks in the nodules; these cracks follow the law indicated in Diagram 21, and traverse the nodules in directions more nearly

* Geol. Trans. 1828.

perpendicular to the planes of the stratification than the cleavage planes are. Carbonate of lime, or quartz, may often be found filling these cracks; sulphuret of iron also occurs in them. The slaty laminæ are somewhat twisted about the nodules.

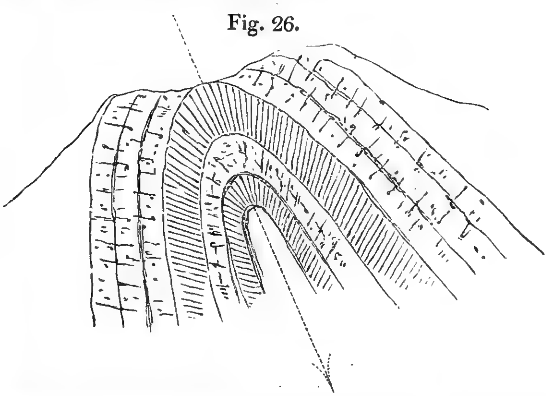
Fig. 25.



Mr. Sorby has given us an example (Diagram 25) of the deviation of cleavage planes in passing through a thin bed of indurated gritstone, lying in fine-grained slate near Ilfracombe. The strata being subject to much pressure, the thin gritstone layer is bent in parallel folds, and is of greatest thickness in the vertices of the folds. In this remarkable case, which is on a small scale, the cleavage laminæ in the slate are more or less parallel to the axial planes of the folds; but in the gritstone, they deviate into fan-shaped arrangements, which on a small scale resemble the laminar structure of Mont Blanc. Here also, as in Diagram 21, the cleavage fissures, on passing through the harder substance, deviate toward a direction perpendicular to its surface. When the axes of the contortions of such a bed as *g* (the hard gritstone) pass in different directions, the cleavage invariably passes through the centre of them *in planes coincident with the axes.*

This is on a small scale the same law as that already quoted from Professor Rogers, the cleavage plane in each case bisecting the flexures. The author just named pre-

Fig. 26.



sents us with a drawing (Diagram 26) very well suited to explain his idea of fan-like cleavage planes, in materials of unlike nature, and bent anticlinally*.

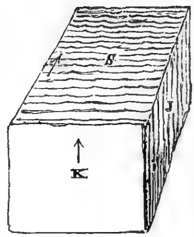
* Trans. of Roy. Soc. of Edinburgh, 1856.

§ 7. *Cleavage accompanied by change of dimensions in Rocks.*

In rocks subject to cleavage, the parts of the mass have undergone some change of place; and the whole mass has suffered compression in one direction. This will be evident from the following facts:—

(*a*.) Surfaces of stratification are frequently undulated and wrinkled by edges of cleavage.

Fig. 27.



Thus in Diagram 27, let S be a surface of stratification, K a plane of cleavage, and J a vertical joint. The cleavage edges are often traced on the bed S by undulated, interrupted ridges and hollows, which appear in no other surfaces, and suggested to me the idea of a "creeping movement among the particles of the rock, along the plane of cleavage, the effect of which was to roll them forward, in a direction always uniform, over the same tract of country." In this expression the term 'creep' is borrowed from experience in collieries, where argillaceous strata are frequently thrown into undulations which slowly propagate themselves under continued pressure. These undulations are often formed on a plane highly inclined to the axis of pressure, as in the case of slaty cleavage. The interrupted character of the ridges and furrows on the plane of the strata arises sometimes from the unequal yielding power of the materials.

(*b*.) These undulations are really due to pressure of some kind, and affect the figure of shells and other flexible and compressible objects on the surfaces of the strata, so that *in the direction of the dip of the strata these objects are often much shortened in dimension.*

Thus a thin object originally circular, fig. 28 (as *Orbicula*), becomes shortened to an elliptical figure, fig. 29, on the plane, and arched, as fig. 30, in the section. Thus it is certain that the effect of cleavage is to cause relative "motion among the parts of stratified rocks," such as would be produced by a compression in the direction perpendicular to cleavage.

Fig. 28.

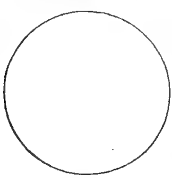


Fig. 29.

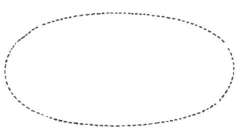


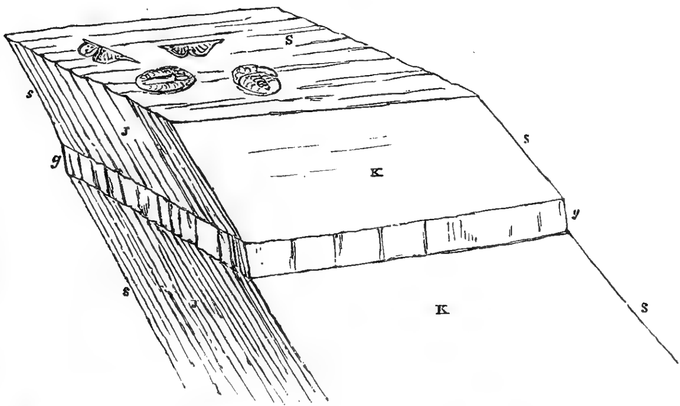
Fig. 30.

I am not aware of any observations on record regarding these curious phænomena of change of place in the parts of a slaty mass prior to 1843, when I communicated them with other facts to the British Association at Cork*. One of the points then much insisted on was the fact of the move-

* "On certain movements in the parts of Stratified Rocks," Reports of Brit. Assoc. 1843, p. 61.

ment uniformly in the line of the dip of the strata of the parts of symmetrical fossils like trilobites, *Lingulæ*, *Spiriferæ*; so that, when presented in one direction, these objects were shortened,—in a direction at right angles to the former they were relatively lengthened (really narrowed), and in an intermediate direction distorted, fig. 31. And the change of figure was employed as a measure of the movement on the plane of stratification, viz. $\frac{1}{4}$ or $\frac{1}{2}$ an inch in the common trilobite of Llandeilo (*Ogygia Buchii*), equals $\frac{1}{10}$th or $\frac{1}{5}$th of the whole space. The movement does not seem, in the case of Irish or North Devon rocks, to have affected the thicker and harder shells, but only those which were thin, as also the Algæ and Trilobites; the latter in Llandeilo flags are often covered with little folds, or even thread-like striations parallel to the wave of motion, fig. 32, which, when lying right across the axis of figure, may deceive an inexperienced person into the supposition of a real transverse striation. The same thing occurs in North Devon, and in the south of Ireland.

Fig. 31.



(*c*.) By attending carefully to the surfaces of stratification and marking the phænomena on these surfaces where they are modified by cleavage, another curious and important structure is indicated, which appears to have escaped publication, though I learn with pleasure that it has not been unobserved by Sedgwick.

Let S be the strike of a bed, σ the strike of cleavage on the surface of the bed, and parallel to it (not in this instance coincident with S), ridges and furrows indicating the internal movements of the mass.

Fig. 32.

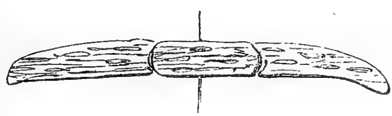
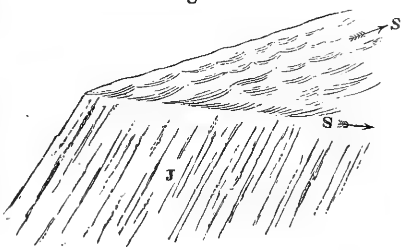


Fig. 33.



In the remarkable case sketched, the ridges and hollows assume a regularity of wavy interruptions which appear the effect of concretionary forces whose axes cross the bed, the concretions being subsequently pressed by cleavage, so that the rock can sometimes be practically divided by art, and in other cases is found actually divided by nature into irregular oblong solids whose axis is parallel to the line of dip of the cleavage. Phænomena of this order are observable among the slaty rocks of Westmoreland (Windermere Head, Bowness), and in some tracts of South Wales (Llandowror), but they do not yield good slate.

In some cases the irregular surface of the beds is apparently due to original *ripple structure*, which by the general movement of the mass of the rock across the cleavage planes, have acquired superposed wrinkles parallel to the cleavage edges. Thus in several cases may the planes of stratification be clearly distinguished from joints.

The steps thus placed for a mechanical theory of the series of changes by which the structural characters and accidents of position in slate rocks might be determined, were relaid with care, and strengthened by new observations, by Mr. D. Sharpe*.

In the quarries of South Petherwin, where argillaceous, ochraceous, and calcareous beds occur, the former are wholly cleft, the latter partially so, or rather cracked, the soft ochreous beds not marked by cleavage. In the argillaceous slate the thinner and more tender fossils are much changed in figure, the encrinite columns not so. The distortion is greatest where the angle between the planes of cleavage and stratification is least. The *contraction* of dimensions in the plane of the strata on the line perpendicular to the strike of cleavage, is estimated at one-fourth, and there is an *expansion* in the plane of cleavage on the line of the dip. Mr. Sharpe's general result is expressed in these distinct terms:—"From these and similar cases, we learn that the shells have been compressed by a force acting in a direction perpendicular to the planes of cleavage, and that the compression of the mass between the cleavage planes has been counterbalanced by its expansion in a direction corresponding to the dip of the cleavage." And again, "As the expansion of the rock in one direction may have been caused by its compression in the contrary direction, it follows that all the effects yet described may have originated in the compression of the mass of the rock in a direction perpendicular to the cleavage planes." The oblique pressures which appear to have affected many shells in the planes of stratification and produced such extraordinary distortions as that of *Spirifera disjuncta* (Diagram 34 *a*, compared with 34 *b*), "may always be resolved into the same two direct forces; one forwards along the plane of cleavage towards the intersection of the cleavage and the bedding, the other downwards in a direction perpendicular to the cleavage. When the bedding and cleavage exactly coincide at Tintagel, the shells are flattened and drawn out considerably, even 50 per cent., in one direction,"—the direction being, doubtless, that of the line of dip of the cleavage planes.

Fig. 34 *a*.

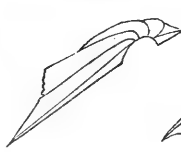
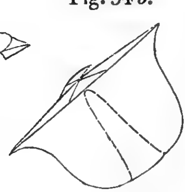


Fig. 34 *b*.



Mr. Sharpe thus concludes this part of his investigation:—

"It may be asserted as probable, that all rocks affected by that peculiar fissile character which we call slaty cleavage have undergone,—

* See Geol. Proc. 1846 and 1848.

"1. A *compression* of their mass in a direction everywhere perpendicular to the planes of cleavage.

"2. An *expansion* of their mass along the planes of cleavage in the direction of a line at right angles to the line of incidence of the planes of bedding and cleavage; or in other words, in the direction of the dip of the cleavage.

"3. No proof has been found that the rock has suffered *any change* in the direction of the strike of the cleavage planes. We must therefore presume that the masses of rock have not been altered in that direction."

These conclusions, presented in 1846, on the sure evidence of the changed forms of shells, trilobites, &c., were extended in 1848 to slates in which no traces of any organic forms had been observed. The evidence in this case was found by examination of the mechanical structure of the slates, especially by certain apparently brecciated slates including masses of discernible magnitude, and distinct colour and quality. Such are frequent in Westmoreland and Cumberland about Rydal, in Langdale, Patterdale and Borrowdale. "In all these slaty breccias, the included masses are flatter between the planes of cleavage than in any other direction. Their flattest sides are always parallel to the cleavage planes,—they are usually rather longer on the line of dip of the cleavage than along the strike,—thus confirming the opinion that the rocks have expanded in the direction of the dip of the cleavage."

Fig. 35.

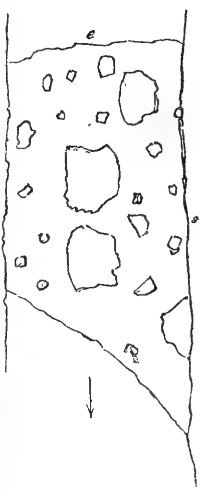


Fig. 36.

The Diagram No. 35 represents the appearance of the included masses on the plane of cleavage, they being somewhat elongated in the line of dip; while Diagram 36 gives the appearance of similar masses on the *edge* of the same sheet of slate, the fragments being all more or less flattened between the planes of cleavage. It is curious to observe in some of these brecciated slates which have undergone much metamorphosis, crystals which have suffered no change by compression. These crystals (*e. g.* garnets) have probably been generated in the mass by the metamorphic actions consequent on communicated heat.

It is obvious, that with such a structure the easy cleavage of slate in parallel planes is completely provided for. Moreover, in each sheet of slate, where the parts are sensibly extended in the direction of dip, there is a somewhat greater facility of fracture in that direction than in any other. This comparative facility of fracture is called by Mr. Sharpe "secondary cleavage*;" it is of some importance in the working of slate, and gives rise to the terms "end" (*e* in fig. 35), and "side" (*s* in fig. 36). Slates are best split by inserting the tool at the end.

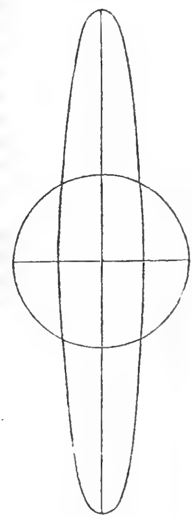
The labours of Mr. Sorby † now claim attention. Accustomed to investigate

* This term is not used in the same sense by other writers.

† Edinb. New Phil. Journal, 1853.

the structure of rocks by the microscope, and especially by the use of thin sections, he has applied this method of research to ascertain the origin of slaty cleavage. In the course of a careful examination of contortions in North Wales and Devonshire, he was convinced that they indicate a very considerable amount of lateral pressure, the thickness of the contorted beds being very different in one part to what it is in another (see Diagram 25). In the case referred to, the amount of compression inferred is so great, that points which appear to have been 38 inches apart, are now at the distance of only 9 inches. Unyielding parts have been contorted, yielding parts simply pressed together in one direction and extended in another. The green spots so often seen in purple slate, also indicate great change of dimensions in the mass. In rocks without cleavage they appear spherical; in cleaved slates they are found to be compressed in the perpendicular to cleavage, elongated in the line of its dip; so that, if originally spherical, they have become ellipsoids of three dimensions, the shortest axis lying across the cleavage, the longest in the line of cleavage dip, while the third axis of intermediate length coincides with the strike of the cleavage. These three axes, in a case not supposed to be extreme, though doubtless above the average, in the slates of Llanberis and Penrhyn, are found as 1 : 3·75 : 6; from which it follows that the sphere has been compressed to less than half the original bulk (as $3{\cdot}75^3$ to $1 \times 3{\cdot}75 \times 6{\cdot}0$), or as 100 to 43.

Fig. 37.

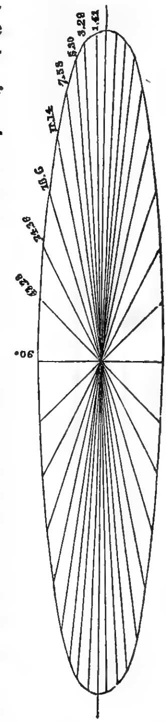


In a mass so compressed, the relative angular positions of all the particles not exactly perpendicular to the line of pressure or exactly parallel to it would be changed. Supposing the particles, or some of them, to be unsymmetrical (as they mostly are in the brecciated slates, and indeed in most kinds of slate), and that their lengths were equally presented in all directions, or inclined at all angles to the plane perpendicular to the line of pressure,—we shall find after compression their inclination θ' by the formula $\tan\theta' = \frac{\tan\theta}{c}$, where c is the ratio of the longer to the shorter axis of the ellipse representing the compression, θ the original angle, and θ' the angle to which it has been changed by compression. In the case assumed above $c=6$, where θ and θ' appear in the following Table:—

Originally.	After compression.	
$\theta = 0°$	$\theta' = 0°$	0′
10	1	41
20	3	28
30	5	30
40	7	58
50	11	14
60	16	6
70	24	36
80	43	23
90	90	0

Or suppose in a small part of the original mass the particles to be so distributed as to occasion ten planes of equal fissility, having the same strike, and surrounding the same axis, and inclined to one another 10°,—this part of the mass, after undergoing compression c (6 : 1), would still possess ten cleavage planes, but they would be inclined to one another as in Diagram 38, which corresponds to the calculation just given.

Fig. 38.



By inspection of this figure, the great tendency of a mass so penetrated by secret fissures to split in planes approximately parallel is evident. This tendency may be exhibited numerically for any particular angle of inclination to the plane of principal cleavage.

"If we suppose (says Mr. Sorby) that in a mass of rock there were 600 particles having their longer axes lying in the space included within 5° on each side of positions inclined at 0°, 10°, 20°, &c. to the line of pressure, so that they were uniformly distributed, as is nearly the case in thick-bedded uncleaved rocks, then, after compression in the ratio 1 : 6, their distribution would be changed, as shown in the following Table* :—

Inclination to the direction of the pressure.	Original distribution.	Subsequent distribution.
0°	600 in each case.	100
10		103
20		113
30		134
40		168
50		236
60		376
70		733
80		1825
90		3324."

These numbers exhibit the relative tendency to cleavage in each arc of 10° in the compressed mass. If instead of 5° on each side of a given position we had assumed a very small angle only, the tendency to fissility along the principal cleavage plane, as compared to that perpendicular to it in the line of strike, would have been as 36 : 1.

The structure here assigned by calculation does actually occur in slaty rocks, but not in others. "The water of Ayr stone, which has no cleavage, consists of mica and a very few grains of quartz sand, imbedded in a large proportion of decomposed felspar; the peroxide of iron being collected to certain centres, and having the character of peroxidized pyrites. The flakes of mica do not lie in the plane of the bedding, but are inclined at all angles; so that there is no definite plane of structural weakness independent of that due to bedding." But in a rock of similar composition having cleavage, a section cut perpendicular to cleavage in the line of its dip, shows by far the greater part of the flakes of mica inclined at low angles, so that the majority lie within 20° on each side of it, being most numerous in and nearly in the plane of cleavage,—twenty times as many nearly in it as nearly in the plane of 45° to it, and very few at 90°. In a section perpendicular to cleavage, and in the line of strike, there is still a preponderance of flakes of mica in and near the plane of cleavage, but in a less marked degree. On the plane of cleavage itself, a slight tendency to arrangement of the flakes parallel to the line of dip is observable.

One of the latest and most instructive of Mr. Sorby's observations relates to the cleavage of Devonian limestones. In a specimen from Kings Kerswell near Torquay, the cleavage pressure has affected the whole mass of the rock,

* Phil. Mag., January 1856.

including the encrinites, which are found with their substance *compressed and crushed* so as to occupy, in the direction of the perpendicular to cleavage, only a quarter of the space they fill in the direction of cleavage dip. Thus the originally nearly equiaxed cells of the encrinital stem are altered by cleavage to elongated fusiform shapes, whose longer axes are parallel, and four times as great as the shorter axes. Even *crystals* of calcareous spar and dolomite are found crushed, bent and broken up, so as to be with difficulty recognizable.

The instances thus collected of the movements of the parts of the rocks subject to slaty cleavage, in directions normal to the planes of cleavage, have been, if possible, made more convincing by imitative experiments, which show that some of the phænomena of cleavage are attainable by means of pressure in materials composed of particles capable of change of figure, or change of position. Mr. Sorby, observing by the microscope that in certain uncleaved stones (*e. g.* water of Ayr stone) mica occurred in plates inclined evenly in all directions,—while in slates in which cleavage was manifest the mica was found more collected on the cleavage planes and inclined at low angles to it,—a circumstance directly deducible from the phænomena of compression already proved,—made a cleavable mass in the following manner *:—He mixed scales of oxide of iron with soft pipe-clay, so that the scales lay evenly in all direction as in water of Ayr stone, and then pressed it so as as to alter the dimensions of the mass in the same proportion as the slate of Llanberis already referred to. Having then dried and baked it, he examined the interior state of the substance by rubbing smooth faces, one face perpendicular to pressure and in the line of elongation or dip; another in what represented the line of strike, and a third face in the plane of the pressure corresponding to the cleavage plane. The particles of oxide of iron were found distributed just as mica is in well-cleaved slate; the mass was capable of easily splitting parallel to the pressure planes, but not across them.

Professor Tyndall has more recently taken up this part of the subject, and has produced a variety of results, confirming and extending the ingenious reasonings and experiments of Mr. Sorby †. Perhaps his most remarkable experiment is that made with pure white wax, which in the ordinary state admits of fracture in all directions equally, and contains no unequiaxed particles like mica and scales of oxide of iron. This substance, being subject to pressure ‡, is found to have acquired true slaty structure, even in a higher degree than any known slate, for it splits to much finer and more equal laminæ. "The finer the slate the more perfect will be the resemblance of its cleavage to that of the wax," is the conclusion of the author of this instructive experiment.

The experiments and reasonings of Professor Tyndall, Mr. Sorby, and Mr. Sharpe, will again come under review in a future Report, when the theory of slaty cleavage may be examined, and the 'mechanical pressure' which these authors advocate may be placed in comparison with the crystalline polarity, formerly advanced by Prof. Sedgwick. The veined structure of glaciers, which reminded Professor J. Forbes of the analogous lamination in slates,—an idea since expressed by Rogers and Tyndall,—and Mr. Fox's ingenious imitation of slaty cleavage by electrical currents passing through clay, will then receive the attention which they merit.

* Edinb. New Phil. Journal, July 1853.

† Lecture to the Royal Institution, June 6, 1856.

‡ The wax is kneaded with the fingers, and pressed between thick plates of glass previously wetted. In cold weather, or when cooled by a freezing mixture, it splits beautifully.

§ 8. *Secondary Cleavage of Slate.*

It is difficult to break slates of the usual thickness (about $\frac{1}{4}$th of an inch) so as to produce surfaces even rudely rectangled to the plane of cleavage; a circumstance which need occasion no surprise. But in this respect two lines may be chosen in the slate, along one of which the rudely perpendicular fracture may occasionally be looked for; this is the line of dip,—on the other it can hardly be produced even with the utmost care; this is parallel to the strike. In experiments for this purpose, it should be observed whether the surfaces produced by fracture on lines parallel to the strike tend to parallelism. If a sheet of slate be laid on two supports parallel to and equidistant from the strike edges, it may be found that at one of these edges fracture will be more easy than at the other. Then turn over the slate to see if the facts will be reversed, and the other edge give the easiest fracture. [An observation in the affirmative is in my note book, for 1836, at Llanberis. I shall be glad to know if it has been noticed by others in this or other localities.]

Hence it appears probable, that besides the principal cleavage, some slates contain a secret lamination, or 'secondary cleavage,' which occasions a partial fissility; but in general this kind of structure produces no such distinct appearances in the blocks and masses as to be often recognized on a great scale. Some cases in which I had supposed such a structure to be real and important, turned out on further research to be merely examples of symmetrical jointing. Prof. Sedgwick, however, refers me for satisfactory instances to the old black slates of Buttermere, and to the vicinity of Yspytty Evan, in North Wales.

One of the cases in which a second set of cleavage planes was supposed to cross the principal cleavage frequently and regularly, is the "pencil bed" of Skiddaw slate dug in Westmoreland, near Shap. Mr. Sharpe has examined this curious rock, and finds in one case (Thornthwaite Gill) the principal cleavage parallel to the original beds and dipping N.W. 60°; the secondary cleavage crosses it nearly at right angles and dips S.E. between 20° and 30°. In another case (Rosgill Moor) the beds dip N.E. 30°; the principal cleavage N. by W. 60°; the secondary cleavage S. by E. 15°. By natural decomposition, small square prisms are produced, whose sides measure one-quarter to half an inch across, and these may be sometimes split again parallel to the faces. Mr. Sorby has found proof that this so-called 'secondary cleavage' is due to many small parallel joints.

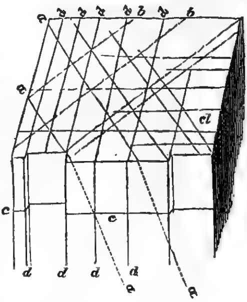
The following case occurred to me in North Wales, in 1836:—A sheet of slate was excavated into a notch on one dip-edge, and the other struck by a heavy tool on the opposite point (the plane of cleavage being held vertical); it yielded along a zigzag line so as to show two sets of planes on the fracture meeting each other at 90° $\pm$ on the plane of cleavage, but with a common edge oblique to the plane (70° and 110°). This I regard as a case of secret jointing, and wish to know if any thing of the kind has been observed by others.

§ 9. *Relation of Cleavage to Joints.*

The joints which traverse cleavage, in well-cleaved and massive slate rocks, show much regularity for short spaces, and often present the same or nearly equal angles of intersection. After examining and measuring innumerable instances, I believe that this apparent symmetry is not delusive, and that by a careful classification of joints with reference to the plane of stratification and the plane of cleavage, some data of importance in the theory of their origin may be obtained. An example of joints seen on a plane of stratification (sketched in 1836) in the quarries of Dolbadarn, will illustrate this remark.

In this case, *a* and *b*, which meet each other at a right angle *on the plane of the strata*, are also perpendicular to that plane, and may be regarded as depending on it,—while *c* and *d*, on the contrary, seem to depend on the *plane of cleavage*, for they are perpendicular to it and to each other. *a* and *b* predominate in coarse beds where cleavage is least developed; *c* and *d* in fine slate; *b* is not a joint, but a 'band,' or as it is called in Ribblesdale, a 'row' or small regular fold.

Fig. 39.

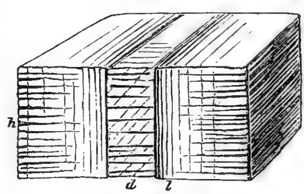


The joint here marked *c* constitutes what in the Dolbadarn quarries is sometimes called 'Level bottom;' and where the 'split' or cleavage dips from the vertical 4 inches in a yard to the S.E., the 'level bottom' deviates as much from the horizontal to the N.W. The joint marked *d* makes the 'square ends' of the same quarries, from which 'bevel ends' differ by the want of strict perpendicularity with the 'split.' The joint marked *a* seems to be what is called 'Crub,'—said to 'steal away the level bottom;' *cl* marks undulated lines on the bed formed by the edges of the cleavage. Green veins in this place follow the split-level, and dip here west 42°; parallel to these are the variations of colour—the changes of texture—the boundaries of the workable slate: 'wrinkles' are also parallel to them, being, in fact, discontinuous small strata, often useful in marking and measuring the effect of a fault.

§ 10. *Occurrence of structures analogous to Cleavage near Greenstone Dykes.*

"A case of this kind fell under the author's notice in 1834, at Coley Hill near Newcastle*. In the annexed cut *d* is a Greenstone dyke, nearly vertical, and between 20 and 30 feet across, ranging east and west, and appearing at the surface.

Fig. 40.



"*s* is the ordinary coal shale, which is, as usual, very much laminated at a moderate distance (a few yards) from the dyke, and contains fern leaves and other plants between the laminæ.

"At the sides of the dyke the horizontal lamination is obscured, the slaty mass is indurated, and traversed by numerous vertical divisional planes parallel to the faces of the dyke, most numerous near the dyke, so as to occur in every half-inch of breadth, but becoming less and less abundant in the parts removed from the dyke till they entirely vanish. On the horizontal section, the lines of these vertical planes would, on a minute scale, represent the cleavage edges of slate."

Another remarkable case occurred to me while examining the great greenstone dyke, of Brockhill, in the Abberley district, first described by Murchison. This dyke measures 30 feet across; its structure is rather tabular than prismatic; it divides the sandstones and marls of the old red series. "For

* Treatise on Geology, vol. ii. p. 86, first edition (1839).

a space of 30 feet on the north and 17 feet on the south of the dyke, the sandstones and marls are changed in hardness, texture and structure, so that for these breadths they are excavated with the trap; and from their density, hardness, and resemblance to basalt, amygdaloid or porphyry, may be easily mistaken for primeval rocks of fusion. They have been literally *baked* under pressure, not *roasted* with freedom of access and escape for volatile matter." —"In regarding the *structures* of the stratified rocks, we observe that on approaching toward the dyke the stratification grows less distinct and suddenly becomes untraceable; that instead of it, especially on the south side, a great abundance of angularly intersecting divisional planes occur, so as to produce prismatic structures perpendicular to the plane of the dyke. Further, we observe, parallel to the dyke, to a distance of 30 or more feet from it, several very long, very straight, nearly vertical joints, continuous through all the beds, without any sign of vertical displacement, or any mark of lateral disturbance, unless the appearance of broad striation or narrow fluting, which horizontally marks the vertical sandstone surface, 30 feet from the dyke on the north side, be of the nature of slickenside, and referrible to lateral movement*."

If these examples be attentively considered, it will appear that under the circumstances described—heat being probably the principal agent, and pressure very little if at all evident—the following changes occur, near to and parallel to the heating surfaces:—

1. Extinction of the stratified structure.
2. Production of a new structure.
3. Accompanied in one case by great molecular and mineral changes.

But it must be remarked, that the change indicated in the second of these sentences is really distinct from that which slate has undergone. Slate is cleavable in all its parts, more or less perfectly; because its ultimate molecular texture is altered to such a condition; near these dykes the rocks are cleft indeed, but not further cleavable; split, but not traversed by numerous planes of easy fissility.

I have seen phænomena of a somewhat similar character, but less marked, near great faults, as, for example, in the line of the Craven fault in Yorkshire.

§ 11. *The Cleat in Coal.*

In the northern coal districts of England, and in other tracts, there exists, besides the lamination parallel to the bounding surfaces of the beds, a series of approximate often nearly vertical divisional surfaces, along which the coal admits of easy fissility. This structure is called cleat, and it is of the greatest importance in coal working, since parallel to it the 'headways' are driven in the 'post and stall' workings of Northumberland and Durham, and parallel to it the 'banks' are wrought in the 'long wall' and 'board and end' systems of Yorkshire and Derbyshire. Cleat is little affected by fractures, or undulations of the strata. It has usually one persistent course across a large district,—the same direction often obtains in neighbouring districts, and even prevails over the whole of a great carboniferous region. Thus in Northumberland and Durham the cleat runs most generally to the north-west (true); its 'strike' is in that direction. The most general strike of the beds is to the N.N.E. The same direction of cleat is prevalent in Yorkshire and Derbyshire, and this whether the beds strike eastward, as near Leeds and Sheffield; or southward, as near Huddersfield and Chesterfield. The same direction prevails in Lancashire.

* Memoirs of Geological Survey of Great Britain, vol. ii. pt. 1, p. 156.

There are some cases in which the cleat varies in its direction from the normal strike, and degree or inclination, even (as I have been informed*) in different parts of one bed of coal. From frequent inspections of cleat in its ordinary state and near trap dykes and near faults, I conceive that no doubt can exist of its being a peculiar structure, more resembling the effect of aggregation under polar attractions than anything else. Coal affected by it is not properly 'cleavable' like slate, but actually cleft into numerous parallel, nearly vertical tables, whose general direction is remarkably uniform amidst many variations of other concomitant conditions.

Neither heat nor pressure seem to be specially indicated by the phænomena of cleat, which on the whole most resemble the jointed structure of rocks, where that is manifested on the smallest scale and in greatest regularity, *i.e.* where the dips of the strata are most uniform, and all the concomitant conditions are the most regular. Joints, like cleat, have very prevalent directions in given districts, and inclinations to the strata tending to one angular value in one bed. In parallel beds of the same mineral nature and in the same series of strata, their strike and dip are often the same. In beds of a different mineral nature joints vary in character; and in a given series of argillaceous, calcareous and coarse arenaceous rocks, we may find *many plane close joints* in the argillaceous beds, inclined $70° \pm$ to the strata; a few *large continuous fissures* in the limestone nearly perpendicular to the beds; and a varying number of *irregular rents* in the sandstone.

Addendum (1857).—Very lately Professor Haughton has instituted accurate measures and calculations founded on the distortion of fossils in cleaved rocks, and has obtained numerical results which concur with those of Mr. Sharpe and Mr. Sorby already referred to, in regard to the proof of pressure in a direction perpendicular to the cleavage plane; they, however, for the most part, do not indicate greater relative extension on the line of cleavage dip than on the line of cleavage strike†.

On the Stratigraphical Distribution of the Oolitic Echinodermata. By THOMAS WRIGHT, *M.D., F.R.S.E.*

[A communication ordered to be printed entire among the Reports.]

ALL the classes of the animal kingdom, when viewed in relation to their stratigraphical distribution, are not of the same value to the palæontologist. Some Mollusca, as the Conchifera and Gasteropoda, have a much greater extension in time than the Cephalopoda, and among the Radiata, Corals and Echinoderms may be adduced as examples of classes whose species had a limited life in time; in estimating the value of palæontological evidence, it is therefore necessary to take into consideration this important fact, which has not received the attention it is so justly entitled to.

The Echinodermata, although occupying a low position in the animal series, in a zoological point of view, still afford the palæontologist most important data for discussing questions relative to the distribution of species in time and space, for it is well known that the Silurian, Devonian, and Carboniferous rocks are all characterized by distinct forms of Crinoidea, most of

* Mr. John Buddle gave me an instance of this in the High Main coal of Newcastle, in 1834.

† Phil. Mag. December 1856.

which are limited in their range to the different stages of these great groups. It is the object of this paper to show that the species of the Oolitic Echinodermata had a limited range in time, and that the different stages of the Oolitic formations are characterized by species which are special to each.

Dr. William Smith was doubtless aware of the value of the Echinodermata in stratigraphical geology, for he carefully noted the different species known to him which characterized the secondary rocks; and it is a remarkable fact, that although our knowledge of the species of this class has been nearly quadrupled since the publication of his works *, still the outlines sketched by the hand of our great master remain nearly the same as laid out by him.

The test of the Echinodermata constitutes an internal and integral part of the body of the animal, participating in its life, intimately connected with the organs of digestion, respiration, and generation, as well as with those of vision and locomotion, and having consequently many of the distinctive characters of the organism indelibly impressed on portions of its skeleton. The individual plates which compose the columns of the test of the ECHINOIDEA, and the ossicula which form the skeletons of the ASTEROIDEA, OPHIUROIDEA, and CRINOIDEA, are organized after distinct plans; they are therefore of great value in determining the species, as the specific characters are often well preserved on even fragmentary portions of the skeleton; for this reason the remains of this class are of the highest value in stratigraphical geology, and second to no other class of the animal kingdom in importance.

In the ECHINOIDEA the body is spheroidal, oval, depressed or discoidal, and enclosed in a calcareous test or shell composed of ten columns of large plates constituting the *inter-ambulacral* areas; and ten columns of small plates constituting the *ambulacral areas*, which segments are separated from each other by ten rows of holes constituting the *poriferous zones.* The external surface of the plates is studded with tubercles of different sizes, in the different families; to these are articulated, by a kind of ball-and-socket joint, the spines, which are of different sizes, forms, and dimensions in the different families, and serve to characterize the genera and species.

At the summit of the test is the apical disc, composed of five genital plates perforated for the passage of the ovarial and seminal canals; and five ocular plates notched or perforated for lodging the eyes: in one family, the SALENIADÆ, an additional or suranal plate, composed of one or many pieces, is introduced within the circle formed by the genital and ocular plates.

There are two great apertures in the shell, one for the mouth, which is always at the base; the other for the anus, which occupies different positions on the test; in one section it is in the centre of the upper surface, directly opposite to the mouth, and surrounded by the genital and ocular plates; in a second section the vent is external to the circle of genital plates, and never opposite to the mouth, but situated in different positions in relation to that opening, being placed on the upper surface, on the sides, the border, the infra-border or the base, in the different groups.

The mouth is sometimes armed with a complicated apparatus of jaws and teeth, but it is sometimes edentulous, or provided with lobes formed of the plates of the test itself.

The ASTEROIDEA have a depressed stelliform body provided with five or more lobes or hollow arms, which are a continuation of the body, and contain prolongations of the viscera. The mouth is always below and central, and rows of tubular retractile suckers occupy the centre of the rays. The com-

* Strata identified by Organized Fossils, 4to, 1816. Stratigraphical System of Organized Fossils, 4to, 1817.

plicated skeleton is composed of numerous solid calcareous ossicula, variable as to number, size and arrangement in the different genera which they serve to characterize. Their coriaceous integument is studded with calcareous spines of various forms, and they have a spongy madreporiform body on the upper surface of the disc near the angle between two rays; reptation is accomplished by the retractile tubular ambulacral suckers.

The OPHIUROIDEA have a distinct depressed discoidal body provided with long slender arms, in which there is no excavation for any prolongation of the viscera; they are special organs of locomotion, independent of the visceral cavity, and provided with spines which are developed on their sides; the mouth is basal and central, and surrounded by membranous tentacula. The skeleton is composed of a series of plates which form the disc or centrum, and the long slender rays are sustained by numerous elongated vertebrate-like ossicula, having numerous plates or spines disposed along the borders of the rays to assist in reptation. The form, structure and arrangement of the discal plates, and of the ossicles of the rays, afford good characters for distinguishing the genera.

The CRINOIDEA have a distinct bursiform body formed of a calyx, composed of a definite number of plates, provided with five solid rays, which are independent of the visceral cavity, and adapted for prehension; they have a distinct mouth and vent, no retractile suckers, and the ovaries open at the base of the arms into special apertures. The skeleton is extremely complicated, being composed of many thousands of ossicula closely articulated together, the number, form and arrangement of which are determinate in the different families, the multiples of five being the numbers which in general predominate; the central plate of the calyx is supported on a long jointed column composed of circular, pentagonal or stelliform plates, the articulating surfaces of which are sculptured with crenulations that interlock into each other; in many genera the stem was attached by a calcareous root to the bed of sea, and supported the calyx and arms upwards like a plant; in others it appears to have been moveable, and was used as a point of suspension from submarine bodies, the calyx and arms having had a pendent position.

The mouth is central and prominent, and the vent opens near its side; the arms are mostly ramose and multiarticulate, and when extended they formed a net-like instrument of considerable dimensions.

The four orders of the Echinodermata thus briefly described are the only ones found fossil in the oolitic rocks, and of these by far the largest number of species belong to the ECHINOIDEA; for this order I have proposed the following classification, which differs in many essential particulars from that of previous authors.

As the mouth is always basal, central, subcentral, or excentral, the excentricity being invariably towards the anterior border, this aperture does not afford a character of primary importance, although when taken in connexion with others it is valuable in the definition of families.

The position of the anal opening affords a good primary character; in one section the vent opens *within* the centre of the apical disc, surrounded by the genital and ocular plates; in another section the vent opens *without* the apical disc, and is external to, and at a greater or less distance from, the genital and ocular plates: these two sections may be thus defined.

Echinoidea endocyclica.

A. Test circular, spheroidal, more or less depressed, rarely oblong; mouth central and basal; vent in the centre of the upper surface directly opposite to the mouth, and surrounded by the five perforated genital and the five ocular plates. Mouth always armed with five powerful calcareous jaws, formed of many elements disposed in a vertical direction.

Echinoidea exocyclica.

B. Test sometimes circular and hemispherical, oftener oblong, pentagonal, depressed, clypeiform or discoidal; mouth central or excentral; vent external to the circle of genital and ocular plates, never opposite the mouth, but situated in different positions in relation to that opening: four of the genital plates are generally perforated. The mouth is sometimes armed with jaws, but is oftener edentulous. The jaws are disposed in a more or less horizontal direction.

The structure of the ambulacral areas and poriferous zones, the form, number, and arrangement of the tubercles and their spines, the presence or absence of fascioles or semitæ, the size and form of the elements of the apical disc, and the position of the anus, afford collectively good characters for defining the genera.

The minute details in the structure of the plates; the size, form, and number of the tubercles on each; the form and arrangement of the pores in the zones; their proximity or remoteness from each other; the general outline of the body, which has only certain limits of variation; the character of the sculpture on the plates; the form of the areolas; the greater or less prominence of the base; the size of the tubercle; the presence or absence, the size and arrangement of the granules forming the areolar circle; the completeness or incompleteness of the same; the width of the miliary zone, the number and size of the rows of granules composing it; the length of the spines; the form of their stems; the character of the sculpture on them; the size of the head, and the prominence and milling of the ring,—are all details of structure which individually and collectively afford good specific characters, as they are persistent details which are more or less developed on every considerable fragment of the test and spines of the Echinoidea.

Taking these characters for our guidance, I have grouped the genera, already so numerous by the discovery of extinct forms, into the following natural families:—

A Table, showing the Sections and Families of the Echinoidea.

Order.	Sections.	Families.
Order ECHINOIDEA.	Section A. *Echinoidea endocyclica.* Vent within the genital plates, always opposite the mouth.	Cidaridæ. Hemicidaridæ. Diademadæ. Echinidæ. Saleniadæ.
	Section B. *Echinoidea exocyclica.* Vent without the genital plates, never opposite the mouth.	Echinoconidæ. Collyritidæ. Echinonidæ. Echinanthidæ. Echinolampidæ. Clypeasteridæ. Echinocoridæ. Spatangidæ.

A Table, showing the Stratigraphical distribution of the genera and species of the Oolitic Echinodermata.

	Oolitic Group.																
	Lower Division.										Middle Division.				Upper Division.		
	Lower Lias.	Middle Lias.	Upper Lias.	Inferior Oolite.	Fuller's Earth.	Stonesfield Slate.	Great Oolite.	Bradford Clay.	Forest Marble.	Cornbrash.	Kelloway Rock. Oxford Clay.	Lower Calc. Grit.	Coral Rag.	Upper Calc. Grit.	Kimmeridge Clay.	Portland Sand.	Portland Oolite and Purbecks.
Fam. CIDARIDÆ.																	
Cidaris Edwardsii, *Wright*		*															
—— Ilminsterensis, *Wright*			*														
—— Mooreii, *Wright*			*														
—— Fowleri, *Wright*				*													
—— Bouchardii, *Wright*				*													
—— Wrightii, *Desor*				*													
—— Bradfordensis, *Wright*								*									
—— florigemma, *Phillips*												*	*				
—— Smithii, *Wright*												*	*				
—— spinosa, *Agassiz*															*		
—— Boloniensis, *Wright*															*		
Rabdocidaris Moraldina, *Cotteau*		*															
—— maxima, *Münster*							*										
Diplocidaris Desori, *Wright*				*													
—— Wrightii, *Desor*				*													
—— Cotteauana, *Wright*				*													
Fam. HEMICIDARIDÆ.																	
Hemicidaris granulosa, *Wright*				*													
—— pustulosa, *Wright*				*													
—— Stokesii, *Wright*						*											
—— Luciensis, *d'Orbigny*							*										
—— minor, *Agassiz*							*										
—— Ramsayii, *Wright*							*										
—— Bravenderi, *Wright*							*										
—— Wrightii, *Desor*								*									
—— Icaunensis, *Cotteau*							*										
—— intermedia, *Fleming*													*				
—— Davidsonii, *Wright*																*	
—— Purbeckensis, *Forbes*																	*
Fam. DIADEMADÆ.																	
Pseudodiadema Mooreii, *Wright*			*														
—— depressum, *Agassiz*				*			*										
—— Parkinsoni, *Desor*						*											
—— pentagonum, *M'Coy*							*										
—— homostigma, *Agassiz*								*		*							
—— Bailyi, *Wright*										*							
—— vagans, *Phillips*							*			*							
—— versipora, *Phillips*													*				
—— hemisphæricum, *Agassiz*													*	*			
—— radiatum, *Wright*													*				
—— mamillanum, *Roemer*													*				
Hemipedina Bechii, *Broderip*	*																
—— Bowerbankii, *Wright*	*																
—— Jardinii, *Wright*		*															

	Oolitic Group.																
	Lower Division.										Middle Division.				Upper Division.		
	Lower Lias.	Middle Lias.	Upper Lias.	Inferior Oolite.	Fuller's Earth.	Stonesfield Slate.	Great Oolite.	Bradford Clay.	Forest Marble.	Cornbrash.	Kelloway Rock. Oxford Clay.	Lower Calc. Grit.	Coral Rag.	Upper Calc. Grit.	Kimmeridge Clay.	Portland Sand.	Portland Oolite and Purbecks.
Hemipedina Etheridgii, *Wright*			*														
—— Bakeri, *Wright*				*													
—— perforata, *Wright*				*													
—— tetragramma, *Wright*				*													
—— Waterhousei, *Wright*				*													
—— Bonei, *Wright*				*													
—— Davidsoni, *Wright*							*										
—— Woodwardi, *Wright*										*							
—— microgramma, *Wright*										*							
—— Marchamensis, *Wright*												*					
—— Corallina, *Wright*													*				
—— tuberculosa, *Wright*													*				
—— Morrisii, *Wright*															*		
—— Cunningtoni, *Wright*															*		
Pedina rotata, *Wright*				*						*							
—— Smithii, *Forbes*				*													
Fam. Echinidæ.																	
Glypticus hieroglyphicus, *Goldfuss*													*				
Magnotia Forbesii, *Wright*				*													
Polycyphus Normannus, *Desor*				*			*			*							
—— Deslongchampsii, *Wright*				*													
Stomechinus germinans, *Phillips*				*													
—— intermedius, *Agassiz*				*			*			*							
—— bigranularis, *Lamarck*				*													
—— microcyphus, *Wright*							*										
—— gyratus, *Agassiz*													*				
—— nudus, *Wright*													*				
Fam. Saleniadæ.																	
Acrosalenia minuta, *Buckman*	*																
—— crinifera, *Quenstedt*			*														
—— Lycettii, *Wright*				*													
—— pustulata, *Forbes*							*		*								
—— Wiltonii, *Wright*										*							
—— Loweana, *Wright*									*								
—— spinosa, *Agassiz*							*		*	*							
—— hemicidaroides, *Wright*							*		*	*							
—— decorata, *Haime*													*				
Fam. Echinoconidæ.																	
Holectypus depressus, *Leske*				*			*										
—— hemisphæricus, *Desor*				*													
—— oblongus, *Wright*										*							
Pygaster semisulcatus, *Phillips*				*			*						*				
—— conoideus, *Wright*				*													
—— Morrisii, *Wright*									*								
—— umbrella, *Lamarck*													*				
Fam. Echinobrissidæ.																	
Echinobrissus clunicularis, *Lhwyd*				*		*	*			*							
—— orbicularis, *Phillips*										*							
—— major, *Agassiz*										*							
—— Woodwardii, *Wright*							*										
—— dimidiatus, *Phillips*													*				

	Oolitic Group.																
	Lower Division.										Middle Division.				Upper Division.		
	Lower Lias.	Middle Lias.	Upper Lias.	Inferior Oolite.	Fuller's Earth.	Stonesfield Slate.	Great Oolite.	Bradford Clay.	Forest Marble.	Cornbrash.	Kelloway Rock. Oxford Clay.	Lower Calc. Grit.	Coral Rag.	Upper Calc. Grit.	Kimmeridge Clay.	Portland Sand.	Portland Oolite and Purbecks.
Echinobrissus scutatus, *Lamarck*												*	*				
Clypeus sinuatus, *Leske*				*			*			*							
—— Agassizi, *Wright*				*													
—— altus, *M'Coy*				*													
—— Michelini, *Wright*				*													
—— Hugii, *Agassiz*				*													
—— Solodurinus, *Agassiz*							*										
—— emarginatus, *Phillips*													*				
Fam. Collyritidæ.																	
Collyrites ringens, *Desor*				*						*							
—— bicordatus, *Desor*				*													
—— ovalis, *Parkinson*												*	*				
Hyboclypus agariciformis, *Forbes*				*			*										
—— caudatus, *Wright*				*													
—— gibberulus, *Agassiz*				*													
—— ovalis, *Wright*				*													
Fam. Echinanthidæ.																	
Pygurus depressus				*			*	*		*							
—— pentagonalis, *Phillips*												*					
—— Blumenbachii, *Koch & Dunker*													*				
—— Phillipsii, *Wright*												*					
—— giganteus, *Wright*													*				
Order ASTEROIDEA.																	
Fam. Urasteridæ.																	
Uraster Gaveyi, *Forbes*		*															
Fam. Solasteridæ.																	
Solaster Moretonis, *Forbes*							*										
Fam. Goniasteridæ.																	
Goniaster Hamptonensis, *Wright*							*										
—— obtusus, *Wright*				*													
Fam. Asteridæ.																	
Tropidaster pectinatus, *Forbes*		*															
Astropecten Hastingsiæ, *Forbes*		*															
—— Orion, *Forbes*		*															
—— Phillipsii, *Forbes*		*															
—— Cotteswoldiæ, *Buckman*						*											
—— Wittsii, *Wright*						*											
—— Forbesii, *Wright*						*											
—— arenicolus, *Goldfuss*												*					
—— rectus, *M'Coy*												*					
Luidia Murchisoni, *Williamson*		*															
Order OPHIUROIDEA.																	
Fam. Ophiuridæ.																	
Ophioderma Gaveyi, *Wright*		*															
—— Milleri, *Phillips*		*															

	Oolitic Group.																
	Lower Division.										Middle Division.				Upper Division.		
	Lower Lias.	Middle Lias.	Upper Lias.	Inferior Oolite.	Fuller's Earth.	Stonesfield Slate.	Great Oolite.	Bradford Clay.	Forest Marble.	Cornbrash.	Kelloway Rock. Oxford Clay.	Lower Calc. Grit.	Coral Rag.	Upper Calc. Grit.	Kimmeridge Clay.	Portland Sand.	Portland Oolite and Purbecks.
Ophioderma Egertoni, *Broderip*	...	...	*														
—— tenuibrachiata, *Forbes*	...	*?															
—— Griesbachii, *Wright*	...	...	...	...	...	...	...	...	*								
—— Brodei, *Wright*	...	...	*														
Ophiura Murravii, *Forbes*	...	*?															
Order CRINOIDEA.																	
Fam. PENTACRINIDÆ.																	
Pentacrinus tuberculatus, *Miller*	*																
—— basaltiformis, *Miller*	...	*															
—— scalaris, *Goldfuss*	*																
—— Goldfussii, *M'Coy*	...	*															
—— robustus, *Wright*	...	*															
—— Johnsonii, *Austin*	...	...	*														
—— dichotomus, *M'Coy*	...	...	*														
—— punctiferus, *Quenstedt*	...	...	*														
—— Phillipsii, *Wright*	...	...	*														
—— Milleri, *Austin*	...	...	...	*													
—— subsulcatus, *Goldfuss*	...	...	...	...	...	...	...	*									
—— Austenii, *Wright*	...	...	...	*													
—— subteres, *Goldfuss*	...	...	...	...	...	...	...	*									
Extracrinus briareus, *Miller*	*																
—— subangularis, *Miller*	...	*															
Fam. APIOCRINIDÆ.																	
Apiocrinus Parkinsoni, *Schlotheim*	...	...	...	...	...	...	...	*									
—— elegans, *Defrance*	...	...	...	...	...	...	...	*									
—— exutus, *M'Coy*	...	...	...	...	...	...	...	*									
Millericrinus Prattii, *Gray*	...	...	...	...	...	...	*										
—— Koninckii, *Wright*	...	...	...	...	...	...	...	...	*								
—— echinatus, *Schlotheim*	...	...	...	...	...	...	...	...	...	...	......	...	*				
	6	17	9	43	0	6	26	9	5	17	0	9	20	0	4	1	1

152 Species.

Echinoidea	110
Asteroidea	14
Ophiuroidea	7
Crinoidea	21—152

From the above Tables, it appears that the English Oolitic rocks are known at present to contain 152 species of fossil Echinodermata, of which 110 species belong to the Order ECHINOIDEA; 14 species to the Order ASTEROIDEA; 7 species to the Order OPHIUROIDEA; and 21 to the Order CRINOIDEA. All the species belonging to the families CIDARIDÆ, HEMICIDARIDÆ, DIADEMADÆ, ECHINIDÆ and SALENIADÆ, have been already figured in my 'Monograph on the British Fossil Echinodermata of the Oolitic Formations,' published by the Palæontographical Society, and the remainder will appear in due course in the future volumes of that series; an analysis of the Table shows that the species are thus distributed:—

Lias Lower	6	species.
Lias Middle	17	,,
Lias Upper	9	,,
Inferior Oolite	43	,,
Fuller's Earth	0	,,
Stonesfield Slate	6	,,
Great Oolite	26	,,
Bradford Clay	9	,,
Forest Marble	5	,,
Cornbrash	17	,,
Oxford Clay and Kelloway	0	,,
Lower Calcareous Grit	9	,,
Coral Rag	20	,,
Upper Calcareous Grit	?	,,
Kimmeridge Clay	4	,,
Portland Sand	1	,,
Marine Purbecks	1	,,

The Lias species appear to be special to the three subdivisions of that formation, so well characterized by the species of Ammonites which indicate these three zones of Liassic life. The Inferior Oolite contains forty-three species, of which forty are ECHINOIDEA, one ASTEROIDEA, and two are CRINOIDEA; of these, ten species extend into the Great Oolite, and seven species pass into the Cornbrash; the Inferior Oolite has therefore twenty-six species which up to this time have not been found in any other formation, and all the species from the Lias to the Cornbrash included became extinct before the deposition of the Kelloway rock and Oxford clay. The Fuller's earth has yielded no remains of Echinoderms; the Stonesfield slate contains six species, most of which are special to this fissile oolitic rock. The Great Oolite has yielded twenty-six species, of which nine extend into the Cornbrash, but seventeen are special to the Great Oolite stage. The eight species of the Bradford clay are mostly common to this argillaceous bed, and the Great Oolite limestone on which it rests. The Forest Marble contains seven species, of which four are common to this rock and the Cornbrash, which contains seventeen species, most of which are found in the older formations; with the deposition of the Cornbrash the lower division of the Oolites terminate, and with it all the species of Echinodermata found in these rocks became extinct.

The middle division of the Oolites contains far fewer species than the lower. The Kelloway rock and Oxford clay, so rich in Cephalopoda, have not in England, as far as I can learn, yielded any remains of Echinodermata. The Lower Calcareous grit, the Coral rag, and Upper Calcareous grit, have several species in common; of the nine species of the Lower Calcareous grit, five are common to it and the Coral rag, which contains twenty species; but I have not ascertained how many, if any, pass into the Upper Calcareous grit; in fact these three stages in reality represent only one stratigraphical zone of life.

The Kimmeridge clay up to the present time is known to contain only four species, which are all special to it. There is one species only in the Portland sand, and one in the Marine Purbeck beds. The Portland Oolitic limestone is said to contain the remains of Echinoderms, but I have not been able to obtain any of the specimens for examination.

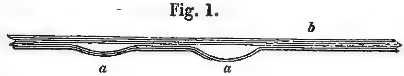
On the Tensile Strength of Wrought Iron at various Temperatures.
By WILLIAM FAIRBAIRN, *F.R.S. &c.*

ON a previous occasion I had the honour of conducting, for the Association, a series of experiments to determine the effects of temperature on the strength of cast iron. In that inquiry I endeavoured to show to what extent the cohesion of that material was affected by change of temperature, and taking into account the rapidity with which iron imbibes caloric, and the facility with which it parts with it, it is equally interesting to know to what extent wrought iron is improved or deteriorated by similar changes. In the present inquiry, as in the former on cast iron, the expansion of the metal by heat is not the question for solution. Rondelet, Smeaton and others have already investigated that subject, and it now only remains for us to determine the effects produced on the strength of malleable iron by changes of temperature, varying from $-30°$ of Fahrenheit to a red heat, perceptible in daylight.

The immense number of purposes to which iron is applied, and the changes of temperature to which it is exposed, render the present inquiry not only interesting, but absolutely essential to a knowledge of its security under the varied influences of those changes; and when it is known that most of our iron constructions are exposed to a range of temperature varying from the extreme cold of winter to the intense heat of summer, it is assuredly desirable to ascertain the effects produced by these causes on a material from which we derive so many advantages, and on the security of which the safety of the public not unfrequently depends.

Independent of atmospheric influences, another consideration presents itself in reference to the durability and ultimate stability of iron under changes much greater than those alluded to above, and this is the strength of such vessels as pans and boilers subjected to the extreme temperatures of boiling liquids on one side, and the intense heat of a furnace on the other. But even these extremes, however great, do not seem seriously to affect the cohesive strength of wrought-iron plates, nor do they appear to cause any disruption of the laminated structure which results from the system of piling and rolling adopted in the manufacture, excepting only where small particles of scoria happen to intervene between the laminated surfaces. These not unfrequently prevent a perfect welding, as the plate is compressed by passing through the rolls, and the effects of temperature are strikingly exhibited in the production of large blisters upon the surface of the plate, as shown in the annexed sketch at *a, a*. Now the reason of this is the want of solidity and homogeneity in the plate, and the consequent expansion of the lower part exposed to the greatest heat. Let us suppose, for the sake of illustration, the plate to be $\frac{3}{8}$ths of an inch thick, and the surface *b* to be the interior of a boiler-plate, and the surface *a, a* to be exposed to the action of the fire in the furnace. In this case it is evident that the temperature of the side *a, a* may be upwards of 1000°, while that of *b* is very little above 212°, or the temperature of boiling water; and supposing there be any imperfection or want of soundness in the plate, the result will be a greater expansion on the exterior surface, causing it to rise up in blisters in the manner we have de-

Fig. 1.



scribed. These defects are invariably present when the plates are not sound; but in other respects, where the bars which form the pile are clear and free from rust or scoria, and are well-welded in the rolling process, the wide difference between the temperature of one side and that of the other produces, apparently, no injurious effect on the strength of the plate. It is, however, widely different when the whole of the plates are exposed to the same degree of temperature, as in this position the strengths are increased or diminished according as the temperature approaches or recedes from the point where the strength is a maximum.

In order to show how the results were obtained, it will be necessary to describe the apparatus and the mode of conducting the experiments.

The apparatus consisted of a powerful wrought-iron lever, Plate IV. A, figs. 2 and 3, capable of imparting a force of more than 100,000 lbs., or 45 tons per square inch to the specimen to be broken. The lever is supported in a cast-iron standard or frame B, arranged for the reception of specimens of the material to be subjected to a crushing force or tensile strain. On the short arm of the lever the plates and bars (one of which is seen at *a*) were suspended by a shackle *c*, and held down to the bottom of the cast-iron standard by the rod and screw *e*; on this rod the box, *b*, was fixed, and prepared to hold a bath of oil or water, in which the iron to be broken was immersed. Below this box was a fire-grate, *d*, for heating the liquid in the bath to the required temperature, and this grate could be drawn backwards from the box *b*, when the required temperature was attained or when it became too high. The fulcrum of the lever is shown at *f*, and the scale in which the weights were placed at *g*. The cast-iron standard was firmly bolted to the heavy balks of timber upon which it stands, and the pressure on the specimen was adjusted by placing weights in the scale.

The plates experimented upon were of the form shown in fig. 4, reduced at *a*, to $2\frac{1}{2}$ inches wide, and at *b* to 2 inches wide, in order to secure fracture at the part of the plate immersed in the liquid in the bath. At each end two holes are drilled to receive the bolt which fixed them in the shackles. The wrought-iron bars were formed in a similar manner. They were $\frac{7}{8}$ inch in diameter, reduced to $\frac{3}{4}$ of an inch at *a*, and to $\frac{9}{16}$ inch, or $\frac{1}{2}$ inch at *b*. The shackles were made to clasp the bars below the shoulders so as to apply the strain requisite to cause fracture. It is evident that the weakest part of the bars being within the bath, breakage was sure to occur at that point where the temperature was raised or lowered to the required degree.

Fig. 4.

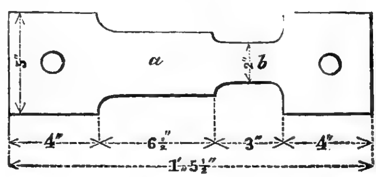
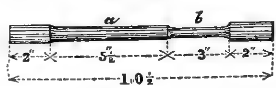


Fig. 5.



With these preparations, the experiments proceeded as follows:—the bar to be broken was fixed between the shackles of the lever; and, if necessary, the bath was filled, and the fire drawn close under it; as soon as the intended temperature was attained, the lever was let down by the crab, and weights carefully added to the scale until the bar broke. During the process the temperature was observed from time to time, and the fire adjusted accordingly, and the temperature registered in the Tables was observed immediately after the bar had given way.

Experiments to ascertain the Influence of Temperature on the Tensile Strength of Boiler Plate.

TABLE I.—Strain applied in the direction of the fibre.
Boiler plate; sectional area $=2{\cdot}02\times{\cdot}34={\cdot}6868$ sq. in.

Temperature, Fahr.	No. of experiments.	Strain applied in lbs.	Elongation in inches.	Breaking weight per square inch in lbs.	Remarks.
0°	1	18,540			For figures of the specimens experimented on, see Plate V., the numbering of the figures corresponding with that of the tables.
	2	26,940			
	3	27,780			
	4	28,620			
	5	29,460			
	6	30,300			
	7	31,140			Broke with a clear ringing noise, almost like cast iron.
	8	31,980			
	9	32,820			
	10	33,660	·14	49,009	=21·879 tons.

The temperature in this experiment was reduced to zero by a mixture of pounded ice and salt, carefully placed round the plate in order to secure the same temperature in the metal as in the bath.

TABLE II.—Strain applied across the fibre.
Boiler plate; sectional area$=2{\cdot}5\times{\cdot}313={\cdot}7825$ sq. in.

60°	1	8,190			
	2	10,140			
	3	16,860			
	4	23,580			
	5	30,300			
	6	31,980	·162	40,357	=18·001 tons.

The experiments in the above and No. III. Table were conducted at the temperature of the atmosphere. Both specimens indicated a hard brittle iron, the interior laminations having somewhat the appearance of cast iron, with a fracture widely different from that exhibited when torn asunder in the direction of the fibre.

TABLE III.—Strain applied across the fibre.
Boiler plate; sectional area $=2{\cdot}0\times{\cdot}32={\cdot}64$ sq. in.

60°	1	10,140 (1680 lbs. was added at a time till weight =)			Some steely spots in fracture.
	10	25,260			
	11	26,100			
	12	26,940			
	13	27,780	·1	43,406	=19·377 tons.

TABLE IV.—Strain applied in the direction of the fibre.
Boiler plate; sectional area $=1 \cdot 99 \times \cdot 32 = \cdot 6368$ sq. in.

Temperature, Fahr.	No. of experiments.	Strain applied in lbs.	Elongation in inches.	Breaking weight per square inch in lbs.	Remarks.
60°	1	10,140			
	2	18,540			
	3	20,220			
	4	21,900			
	5	23,580			A fissure containing cinder extended one-third of the breadth of the plate. In some parts the blade of a penknife could be introduced.
	6	25,260			
	7	26,100			
	8	26,940			
	9	27,780			
	10	28,620			
	11	29,460			
	12	30,300			
	13	31,140			
	14	31,980	·2	50,219	=22·414 tons.

In some former experiments on the tensile strength of wrought-iron plates*, the strength of the specimens was rather more uniform, and there appeared to be no difference between the strength of the plates when torn asunder in the direction of the fibre, and the strength when the strain was applied across it. Comparing Tables II. and III. with IV., we find the breaking weight in the direction of the fibre is to that across it as 22·41 : 18·67, or as 5 : 4 nearly; but it is possible that this arises from inequality in the rolling of the two specimens.

TABLE V.—Strain applied across the fibre.
Boiler plate; sectional area $=1 \cdot 99 \times \cdot 33$ sq. inch.

110°	1	25,260			
	2	26,940			Fracture very uneven.
	3	27,780			
	4	28,620			
	5	29,460	·13	44,160	=19·714 tons. The last weight was hardly on: 29,000 lbs. was probably nearer the breaking weight.

TABLE VI.—Strain applied in the direction of the fibre.
Boiler plate; sectional area $=2 \cdot 0 \times \cdot 34 = \cdot 68$ sq. inch.

112°	1	18,540			
	2	20,220			
	3	21,900			
	4	23,580			
	5	25,260			
	6	26,940			
	7	28,620		42,088	=18·789 tons.

* Philosophical Transactions for 1850, p. 677, the results of which are also quoted at page 340.

TABLE VII.—Strain applied in the direction of the fibre.
Boiler plate; sectional area $=2{\cdot}54\times{\cdot}32={\cdot}8128$ sq. inch.

Temperature, Fahr.	No. of experiments.	Strain applied in lbs.	Elongation in inches.	Breaking weight per square inch in lbs.	Remarks.
120°	1	25,260			
	2	26,940			
	3	28,620			
	4	30,300			
	5	31,140			
	6	31,980			
	7	32,400			
	8	33,660			
	9	34,500			
	10	35,340			
	11	35,760			
	12	36,180			
	13	36,600			
	14	37,020	·173	40,625	=18·136 tons.

The last three experiments, at a mean temperature of 114°, indicate a near approach to uniformity of strength, that broken across the fibre being the strongest; the very reverse of those fractured at 60°, the numbers being as 197 : 184, or as 44 : 41 nearly, showing a loss of about ·007 per cent. It is difficult to account for these changes and defects in the strengths of the plates, as most of the specimens were cut from one plate, and all of them were of the same manufacture.

TABLE VIII.—Strain applied in the direction of the fibre.
Boiler plate; sectional area $=2{\cdot}6\times{\cdot}308={\cdot}8008$ sq. inch.

212°	1	30,300			
	2	31,980	·15	39,935	=17·828 tons.

Broken in boiling water. This specimen did not break at the narrowest part of its section, which shows a serious defect in the plate.

TABLE IX.—Strain applied across the fibre.
Boiler plate; sectional area $=2{\cdot}01\times{\cdot}33={\cdot}6633$ sq. inch.

212°	1	18,540			Broken in boiling water.
	2	20,220			
	3	21,900			
	4	23,580			
	5	25,260			
	6	26,940			
	7	27,780			
	8	28,620			
	9	29,460			
	10	30,300	·11	45,680	=20·392 tons.

In Table VIII., where the specimen was drawn in the direction of the fibre, there appears to be some defect in the plate, as it gave way, not at the smallest section, but at a wider part of the plate, with a force of only

39,935 lbs. to the square inch, whereas the same plate torn asunder across the fibre sustained a force of 45,680 lbs. before breaking. This difference of strength can only be accounted for by some defect not perceptible when the fracture was examined. The difference of strength, at the temperature of boiling water, indicated by these two specimens, is as 178 : 203, or in the ratio of ·87 : 1.

Table X.—Strain applied in the direction of the fibre.
Boiler plate; sectional area $=2·0\times·34=·68$ sq. inch.

Temperature, Fahr.	No. of experiments.	Strain applied in lbs.	Elongation in inches.	Breaking weight per square inch in lbs.	Remarks.
212°	1	18,540			Broken in boiling water.
	2	20,220			
	3	21,900			
	4	23,580			
	5	25,260			
	6	26,940			
	7	27,780			
	8	28,620			
	9	29,460			
	10	30,300			
	11	31,140			
	12	31,980			
	13	32,820			
	14	33,660	·22	49,500	=22·098 tons.

Comparing this plate with that in experiment VIII., it will be seen that the power of resistance of the former is more than one-fifth greater than that of the latter, showing that there must have been some defect in the longer section of the specimen, or fracture would not have ensued at so early a period of the experiment. We cannot abandon this experiment, as no defect presented itself, if we except the highly crystallized state of the fracture, both specimens having been drawn asunder in the direction of the fibre. In these experiments it will be observed that the infusion of heat into wrought-iron plates, from zero to 212°, does not injure, but rather improves, their tensile strength.

Table XI.—Strain applied in the direction of the fibre.
Boiler plate; sectional area $=2·01\times·32=·6432$ sq. inch.

270°	1	18,540			Broken in hot oil.
	2	20,220			
	3	21,900			
	4	23,580			Broke before the last weight was fairly on; 28,320 lbs. probably nearer.
	5	25,260			
	6	26,940			
	7	27,780			
	8	28,620	·13	44,020	=19·651 tons.

From this experiment it appears that an increase of 58° of heat makes no perceptible difference in the strength of the plate. If we take the mean of the two previous experiments, in the direction of the fibre, it will be found there is no great difference between them, the mean of Tables VIII. and X. being 44,708, and Table XI. giving 44,020 lbs. to the square inch.

TABLE XII.—Strain applied in the direction of the fibre.
Boiler plate; sectional area $=2\cdot0\times\cdot32=\cdot64$ sq. inch.

Temperature, Fahr.	No. of experiments.	Strain applied in lbs.	Elongation in inches.	Breaking weight per square inch in lbs.	Remarks.
340°	1	25,260			
	2	26,940			
	3	28,620			
	4	29,460			
	5	30,300			
	6	31,140			
	7	31,980	·1	49,968	=22·307 tons.

In this experiment the plate gave way at the shackle, the bolt which held the plate tearing through the eye, and forcing away a four-sided piece as the plate was about to yield to the weight on the lever. We may therefore safely assume 31,980 or 32,000 lbs. as the ultimate strength or breaking weight of the plate.

TABLE XIII.—Strain applied across the fibre.
Boiler plate; sectional area $=2\cdot0\times\cdot34=\cdot68$ sq. inch.

Temperature, Fahr.	No. of experiments.	Strain applied in lbs.	Elongation in inches.	Breaking weight per square inch in lbs.	Remarks.
340°	1	18,540			Broken in hot oil.
	2	20,220			
	3	21,900			
	4	23,580			
	5	25,260			
	6	26,940			
	7	27,780			
	8	28,620	·15	42,088	=18·789 tons.

The mean result of experiments XII. and XIII. is 46,014 lbs., or about $20\frac{1}{2}$ tons per square inch, evidently showing that the iron is in no degree injured by a temperature ranging from zero up to 340°, and this temperature may probably be increased as high as 500° or 600° without seriously impairing the strength, as may be seen in the following Table at nearly 400°.

TABLE XIV.—Strain applied in the direction of the fibre.
Boiler plate; sectional area $=2\cdot02\times\cdot33=\cdot6666$ sq. inch.

Temperature, Fahr.	No. of experiments.	Strain applied in lbs.	Elongation in inches.	Breaking weight per square inch in lbs.	Remarks.
395°	1	18,540			Broken in hot oil.
	2	20,220			
	3	21,900			
	4	23,580			
	5	24,420			
	6	25,260			
	7	26,100			
	8	26,940			
	9	27,780			
	10	28,620			
	11	29,460			
	12	30,300			
	13	30,720	·18	46,086	=20·574 tons.

The only difference between this and the last two experiments is the increased elongation, which in the latter was 1·25, and in the former ·18 inches. However, the elongation of these short specimens cannot always be depended on, as there is considerable difficulty in ascertaining them accurately.

Table XV.—Strain applied across the fibre.
Boiler plate; sectional area $=2{\cdot}0\times{\cdot}31={\cdot}62$ sq. inch.

Temperature, Fahr.	No. of experiments.	Strain applied in lbs.	Elongation in inches.	Breaking weight per square inch in lbs.	Remarks.
A scarcely perceptible red heat.	1	8,190			
	2	10,140			
	3	11,820			
	4	13,500			
	5	15,180			
	6	16,860			
	7	18,540			
	8	20,220			
	9	21,900			
	10	23,520	·15	38,032	=16·978 tons.

The plate in this experiment was heated until it became perceptibly luminous in the shade; it was then loaded, as before, until fracture ensued. In this experiment it will be observed that a considerable diminution of strength took place in consequence of the increased temperature, clearly showing that above a certain point the tensile strength of wrought iron is seriously injured. This fact is more strikingly apparent in the next experiment, in which the temperature was raised to a dull red heat, just perceptible in daylight.

Table XVI.

In this experiment a plate of the same description as the last was raised to a dull red heat, when the weight of the lever was allowed to strain the specimen with a force of 18,540 lbs., and fracture immediately ensued. The elongation was ·23.

Sectional area of boiler plate$=1{\cdot}96\times{\cdot}31={\cdot}6076$ sq. inch.
Strain applied across the fibre.
Breaking weight per square inch $=30{,}513$ lbs.$=13{\cdot}621$ tons.

This experiment is quite conclusive as to the effects produced on wrought iron whenever it approaches a red heat. At that temperature nearly one-half its strength is lost; it becomes exceedingly ductile, and is drawn considerably in the direction of the strain before its cohesive powers are destroyed.

The greatly increased ductility of wrought-iron plates, at a dull red heat, is strikingly exemplified in the flues of boilers, whenever the water gets low, or recedes below the surface of the plates, and that more particularly if the plates are immediately over the fire; in such a position the flues readily collapse with a comparatively low pressure. In the bending of a plate, when red hot, a very small force is required; but within limits of temperature not exceeding 400°, it requires nearly the same force to produce collapse as it would at any temperature above 32°, or the freezing-point of water*.

* We hope in a short time to give a series of experiments on the resistance of wrought-iron plates and bars to a transverse and compressive force at various temperatures.

Collecting the results of these experiments, tabulated above, it will be necessary to exhibit them in a more condensed form, so as to facilitate comparison, and to deduce the laws which regulate the tensile strength of wrought iron. We may then apply the results of these experiments to a much greater variety of plates produced in the different districts of England. It will be borne in mind that the ordinary Staffordshire plates, such as those experimented upon (unless they are double-worked), are rather inferior in quality to the Shropshire and Derbyshire plates, and much more so to those manufactured at the Lowmoor and Bowling Works. Hence the comparison will only hold good between the Staffordshire plates in each case.

General Summary of Results.

No. of experiment.	Temperature, Fahr.	Breaking weight in lbs.	Breaking weight per square inch in lbs.	Breaking weight per square inch in tons.	Mean breaking weight per square inch in lbs.	Direction of strain in regard to fibre.
I.	0	33,660	49,009	21·879	49,009	With.
II.	60	31,980	40,357	18·001		Across.
III.	60	27,780	43,406	19·377	44,498	Across*.
IV.	60	31,980	50,219	22·414		With†.
V.	110	29,460	44,160	19·714		Across‡.
VI.	112	28,620	42,088	18·789	42,291	With.
VII.	120	37,020	40,625	18·136		With.
VIII.	212	31,980	39,935	17·828		With§.
IX.	212	30,300	45,680	20·392	45,005	Across.
X.	212	33,660	49,500	22·098		With.
XI.	270	28,620	44,020	19·651	44,020	With.
XII.	340	31,980	49,968	22·307	46,018	With||.
XIII.	340	28,620	42,088	18·789		Across.
XIV.	395	30,720	46,086	20·574	46,086	With.
XV.	Scarcely red	23,520	38,032	16·978	34,272	Across.
XVI.	Dull red	18,540	30,513	13·621		Across¶.

From the above Table we may deduce the following :—

Temperature, Fahr.	Drawn asunder in the direction of the fibre.		Drawn asunder across the fibre.	
	Breaking weight per square inch in lbs.	Breaking weight per square inch in tons.	Breaking weight per square inch in lbs.	Breaking weight per square inch in tons.
0	49,009	21·879		
60	50,219	22·414†	41,881	18·689*
114	41,356	18·462	44,160	19·714‡
212	44,717	19·963§	45,680	20·392
270	44,020	19·651		
340	49,968	22·307||	42,088	18·789
395	46,086	20·574		
Red.			34,272	15·299¶

* Some steely spots in fracture.
‡ Too high, fracture very uneven.
|| Too low, tore through eye.
† Fissure containing scoria.
§ Did not break at smallest section.
¶ Too high, see Table.

From the experimental inquiry into the strength of wrought-iron plates, as applied to ship-building, we have the following results* :—

	Mean breaking weight, in the direction of the fibre, in tons per square inch.	Mean breaking weight, across the fibre, in tons per square inch.
Yorkshire plates........................	25·770	27·490
Yorkshire plates........................	22·760	26·037
Derbyshire plates	21·680	18·650
Shropshire plates	22·826	22·000
Staffordshire plates	19·563	21·010
Mean	22·519	23·037

Now if we compare the ultimate strength of the Staffordshire plates in the above Table with those since experimented upon, we shall have, taking those in which the strain was applied in the direction of the fibre, for the former 19·563 tons per square inch, and for a mean of nine experiments of the latter, ranging in temperature from zero to 395°, 20·408 tons per square inch. Taking those torn asunder across the fibre, we have for Staffordshire plates in the above Table 21·010, and for those since experimented on 19·254 tons† per square inch, which on comparison give the following ratios of results :—

Staffordshire plates, torn in the direction of the fibre, at a mean temperature of 191°=20·408 tons, and those (in the above Table) at the temperature of the atmosphere, or about 60°=19·563 tons, or in the ratio of 1· : ·96 nearly, a remarkable coincidence in tensile strength in the two series of experiments.

Those torn across the fibre, at a mean temperature of 156°, gave a tensile strength =19·254 tons; those at the temperature of atmosphere 60°, as shown in the previous experiments =21·010 tons, or in the ratio of 1 : 1·091.

The above results indicate great uniformity in the ultimate strength of Staffordshire plates, which may safely be taken at 20 tons per square inch at all temperatures, between the extremes of zero and 400° Fahr., that is, under a dead weight calculated to destroy the cohesive powers of the material. To what extent these plates would resist impact, at various degrees of temperature, we have yet to determine; but assuming that iron is more liable to fracture from an impactive force at a very low temperature; it will be safer to calculate on a reduction of their resisting powers, at the lower temperatures under 32° Fahr., or the freezing-point of water.

These experiments might be multiplied to a great extent, in order to determine the strength of plates under the varied conditions of temperature in regard to compression, extension, and the force of impact; but we have already shown in former experiments, and those now recorded above, that iron is not seriously affected by those changes, and we trust the foregoing results will prove sufficient to enable the practical engineer to calculate the resisting powers of iron plates, under all the changes of temperature, from zero up to a red heat.

* Philosophical Transactions, Part II. 1850, p. 677.

† The mean temperature of nine, broken in the direction of the fibre, is 191°; and the mean temperature of five, broken across the fibre, excluding red heat, is 156°.

Experiments on the Tensile Strength of Rivet Iron.

At the time when the preceding experiments were instituted, it was considered expedient to make them on plates of ordinary quality, and of the description in general use. For this purpose Staffordshire plates were selected, as being of medium quality, such as are employed in the construction of boilers, ship-building, &c. Plates of a higher character, such as the Lowmoor and *double-worked* qualities, might have been selected; but those most in demand, and which are manufactured in large quantities, were considered more desirable, although it left untouched a question of some importance in regard to the influence of heat upon the finer qualities, generally known as "*scrap*" and "*fagotted*" iron. This description of iron is forged from old iron scrap, and rolled into bars for bolts and rivets. It is a fine ductile iron of great tenacity, and works freely under the hammer; and it was determined to apply to it the same experimental tests as had been applied to the Staffordshire plates.

From the results of these experiments, it will be seen that they indicate precisely the same law as was found to influence the Staffordshire plates, the maximum strength being at a temperature of 325°, rather higher than that indicated by the plates. This is irrespective of the superior strength of the bar iron as compared with that of the plates.

Having prepared the lever, as before, a long bar, $\frac{7}{8}$ths of an inch in diameter, was selected and cut into lengths, which were then reduced to the form shown in the annexed sketch, with shoulders to receive the shackle. The specimens, when immersed in the bath, were drawn asunder by the same process as that described for the plates.

Experiments to ascertain the Influence of Temperature on the Tensile Strength of Rivet Iron.

TABLE XVII.—Area of section =·24850.

Temperature, Fahr.	No. of experiments.	Strain applied in lbs.	Elongation in inches.	Breaking weight per square inch in lbs.	Remarks.
−30°	1	9,205			Broken in a mixture of pounded
	2	9,415			ice and crystallized chloride of
	3	11,648			calcium.
	4	10,045			Figures of some of the fractured
		* * * *			specimens will be found in
	58	15,610			Pl. IV. fig. 1, numbered to correspond with the tables.
	59	15,715	·80	63,239	=28·231 tons.

From the above it will be observed that the strength of the best quality of bar iron greatly exceeds that of the plates, being in this experiment two-fifths more, and in some experiments, at higher temperatures, nearly double that of the Staffordshire plates.

TABLE XVIII.—Sectional area =·24850.

Temperature, Fahr.	No. of experiments.	Strain applied in lbs.	Elongation in inches.	Breaking weight per square inch in lbs.	Remarks.
+60°	1	12,565			
	2	13,405			
	3	13,812			A large bright spot, like steel, in fracture.
	4	14,035			
		* * * *			
	16	15,295			
	17	15,400	·82	61,971	=27·665 tons.

There is a slight diminution in the strength of this bar as compared with the previous experiment at $-30°$, but the discrepancy is scarcely appreciable, and may easily be accounted for by inequalities in the forging or rolling of the bar.

TABLE XIX.—Sectional area =·24850.

60°	1	9,415			
	2	10,255			
	3	12,565			Drew out at shoulder.
	4	12,985			
		* * * *			
	30	15,715			
	31	15,820	·56	63,661	=28·419 tons.

The strength of the bar in this experiment is a trifle in excess of those fractured at $-30°$ and 60°. It would have been rather stronger had it been rounded at the shoulder to prevent its pulling out there, as shown in the figure. However, there is little difference in the strength of the material through a range of 90° of temperature.

TABLE XX.—Sectional area =·24850.

114°	1	10,885			Pulled out at shoulder. After between 13,000 and 14,000 lbs. had been laid on, only 105 lbs. were added at a time, as it gave more correct indications of the strength as the bars approached fracture.
	2	12,565			
	3	13,405			
	4	13,615			
		* * * *			
	41	17,500			
	42	17,605	·56	70,845	=31·627 tons.

It has already been observed that the whole of the specimens for experiment were cut from one bar, and as each experiment was conducted with great care, both in preparing the specimens and laying on the weights, we are bound by the results to believe that the increased strength of this description of iron is due entirely to the increase of temperature. In this experiment, it will be seen that the resisting power of the bar ruptured at 114° was to that of the bar ruptured at 60° (Table XIX.) as 1 : ·898.

TABLE XXI.—Sectional area =·24850.

Temperature, Fahr.	No. of experiments.	Strain applied in lbs.	Elongation in inches.	Breaking weight per square inch in lbs.	Remarks.
212°	1	12,565			
	2	12,985			
	3	13,405			
	4	13,825			
	5	14,245			
		* * * *			
	76	21,805			At this point it was discovered that the bar was cutting into the shackle; the experiment was therefore discontinued till a new shackle could be prepared, and it was then repeated.
	1	12,565			
	2	12,985			
	3	13,405			
	4	13,825			
		* * * *			
	56	19,285	·64		
Mean		20,545		82,676	=36·900 tons.

This bar tore into the shackle, so that the strain was not thrown properly on it; the experiment was therefore discontinued, and another shackle substituted with the bearing-edges steeled. When the same bar was tried again, having been injured in the previous experiment, it broke with 19,285 lbs. Under these circumstances, we have taken the mean of the two experiments $\frac{21,805+19,285}{2}=20,545$ as the breaking weight, as recorded in the Table.

TABLE XXII.—Sectional area =·19635.

212°	1	12,565			Bar defective: a large longitudinal fissure, filled with scoria.
	2	13,405			
	3	14,245			
	4	14,350			
	5	14,455			
	6	14,560	·47	74,153	=33·104 tons.

There is a progressive increase in the strength of the bars as the temperature ascends, Table XX. exhibiting an increase of 11,831 lbs., and Table XXII. an increase of 3,308 lbs. over the breaking weight at 114°. Taking the mean of the two last experiments, we have an increase of 7,569 lbs. over the breaking weight in experiment XX.

TABLE XXIII.—Sectional area =·24850.

212°	1	14,245			
	2	15,925			
	3	16,135			
	4	16,345			
		* * * *			
	39	20,020			
	40	20,125	·66	80,985	=36·154 tons.

This experiment being at the same temperature as the two last, viz. 212°, it will be proper to take the mean of the last three Tables as the breaking weight at that temperature, $\frac{82,676+74,153+80,985}{3}=79,271$ lbs. per square inch=ultimate breaking weight at 212°.

TABLE XXIV.—Sectional area =·19635.

Temperature, Fahr.	No. of experiments.	Strain applied in lbs.	Elongation in inches.	Breaking weight per square inch in lbs.	Remarks.
250°	1	10,045			
	2	10,885			
	3	11,725			
		* * * *			
	43	15,925			
	44	16,135	·6	82,174	=36·684 tons.

Here again, in the above experiment, is a perceptible increase of strength, as the temperature rises 38°, from 79,271 to 82,174 lbs. per square inch, and so in the next Table, where the increase is still greater.

TABLE XXV.—Sectional area =·24850.

270°	1	12,565			
	2	13,405			
	3	14,245			
	4	15,085			
	5	15,400			
	6	15,925			
	7	16,345			
		* * * *			
	47	20,545			
	48	20,650	·74	86,056	=38·417 tons.

The increase of 20° of temperature in this experiment gives a corresponding increase of strength of 3882 lbs. per square inch, something more than the increase exhibited in the previous experiment. There is, however, a remarkable coincidence in the ratio of the strengths as they rise with the increase of temperature, the only exceptions being those of Tables I. and XXII., but in both cases the anomaly is sufficiently explained by the state of the fracture.

TABLE XXVI.—Sectional area =·19635.

310°	1	12,565			
	2	14,245			
	3	15,085			
	4	15,295			
	5	15,715			
	6	15,820	·63	80,570	=35·968 tons.

In this experiment it will be observed that there is a falling off in tenacity with the increase of temperature from 86,056 to 80,570 lbs. per square inch. It is difficult to account for this discrepancy, as the fracture in this, as in the previous and succeeding experiments, appeared sound and free from flaws of any description.

TABLE XXVII.—Sectional area = ·19635.

Temperature, Fahr.	No. of experiments.	Strain applied in lbs.	Elongation in inches.	Breaking weight per square inch in lbs.	Remarks.
325°	1	10,045			
	2	10,885			
	3	11,725			
		* * * *			
	53	17,080			
	54	17,185	·6	87,522	= 39·072 tons.

The above bar, although of the same quality and appearance as that in the previous experiment, gives no less than 6952 lbs., upwards of three tons, greater tenacity than its predecessor. The former appeared equally tough and fibrous in the fracture, and the elongation in the same distance was rather more than in the latter, and yet it is about one-twelfth weaker.

TABLE XXVIII.—Sectional area = ·24850.

415°	1	12,565			
	2	14,245			
	3	15,085			
	4	15,925			
	5	16,765			
		* * * *			
	38	20,230			
	39	20,335	·64	81,830	= 36·531 tons.

In this experiment there is a decrease in the strength with an increase of temperature of 90°, but in the next experiment, with a further increase of 20°, the strength again rises from 81,830 to 86,056, or nearly two tons, which shows that the increase of 100° of temperature has not seriously affected the molecular constitution of the iron. This irregularity, after so constant an increase of strength, indicates that we have about reached the maximum strength of the material. We shall see hereafter that the increase of strength from −30° to 325° has been four-tenths, nearly one-half.

TABLE XXIX.—Sectional area = ·24850.

435°	1	12,565			
	2	13,405			
	3	13,812			
	4	14,035			
	5	14,245			
	6	14,665			
	7	15,085			
		* * * *			
	65	21,280			
	66	21,385	·74	86,056	= 38·415 tons.

The difference between this and the last experiment is about one-eighteenth part of the former in favour of the latter. This difference we cannot account for by an examination of the fractures; but taking the mean of the two, and comparing it with Table XXVII., it appears that we have passed the maximum strength, and recede from it in the ratio of 87,522 : 83,943, or as 1 : ·959.

TABLE XXX.—Sectional area =·24850.

Temperature raised to red heat, visible by daylight.
Broke with the weight of the lever =8,965 lbs.
Elongation =·55.
Breaking weight per square inch =36,076 lbs. =16·105 tons.

In this experiment, as in those on the plates, the tenacity of the iron is seriously injured before the temperature reaches dull red heat; and when that point is attained, it has lost more than one-half its powers of resistance to strain. At this high temperature it becomes exceedingly ductile and weak when subjected to any description of force, inasmuch as it becomes so pliable that it is immaterial whether the strain applied is compressive, tensile or torsional. Under any of these forces it is not to be depended upon at a temperature bordering upon redness.

Collecting the results of the foregoing experiments in their consecutive order into a Table, we see that the maximum strength of bars appears to be attained at a mean temperature of about 320°. This is above the temperature at which the maximum strength of the plates was attained; but it is to be remembered, that little or no change is observable in the strength of the plates, whilst that of the bars is increased nearly one-half.

This fact is worthy of notice, inasmuch as in countries where the climate is hot and never descends below freezing, the best bar iron will retain a power of resistance equal to 29 tons upon the square inch, whereas in colder and more northerly districts it would not be safe to calculate upon more than 28 tons to the square inch.

General Summary of Results.

Temperature, Fahr.	No. of experiment.	Breaking weight in lbs.	Elongation in inches.	Breaking weight per square inch in lbs.	Breaking weight per square inch in tons.	Mean breaking weight per square inch in lbs.	Remarks.
−30°	XVII.	15,715	·80	63,239	28·231	63,239	Too low.
+60	XVIII.	15,400	·82	61,971	27·665	62,816	Too low.
60	XIX.	15,820	·56	63,661	28·419		
114	XX.	17,605	·56	70,845	31·627	70,845	Too low.
212	XXI.	20,545	·64	82,676	36·900	79,271	
212	XXII.	14,560	·47	74,153	33·104		
212	XXIII.	20,125	·66	80,985	36·154		
250	XXIV.	16,135	·6	82,174	36·684	82,636	
270	XXV.	20,650	·74	83,098	38·417		
310	XXVI.	15,820	·63	80,570	35·968	84,046	
325	XXVII.	17,185	·6	87,522	39·072		
415	XXVIII.	20,335	·64	81,830	36·531	83,943	
435	XXIX.	21,385	·74	86,056	38·415		
Red heat.	XXX.	8,965	·55	36,076	16·105	35,000	Too high.

In the above Table we perceive a steady improvement in the strength of the iron from 60° up to 325°, where the maximum appears to be attained. As already noticed, this improvement does not present itself in the inferior descriptions of irons, such as the plates tested in the preceding experiments. This may arise from the different processes pursued in the manufacture, the bars being rendered fibrous and ductile, in the first instance, under the hammer, and this is further improved by reheating them and passing them between the rolls. Bar iron will thus be drawn by the hammer and rolls to from twenty to twenty-five times its original length; whilst plates, such as we have selected, never come under the hammer, and seldom exceed six or eight times the length of the original shingle after passing through the rolls.

On comparing these results with those of a similar quality of iron, viz. S.C. ♛ bar iron, experimented upon at Woolwich Dockyard, it will be found that a corresponding and progressive increase of strength is equally apparent as in the above experiments; that increase, however, arising from a different cause, namely, the repeated fracture of the bars as exhibited in the following Table:—

Mark.	First breakage.		Second breakage.		Third breakage.		Fourth breakage.		Reduced from 1·37 to
	Tons.	Stretch in 54 inches.	Tons.	Stretch in 36 inches.	Tons.	Stretch in 24 inches.	Tons.	Stretch in 15 inches.	
		in.		in.		in.		in.	
A	33·75	9·125	35·5	2·00					
C	33·75	9·250	35·25	·25	37·00	1·00	38·75		1·25
E	32·5	9·250	34·75	1·25					
F	33·25	10·500	35·50	1·12	37·25	·62	40·40	......	1·18
G	32·75	8·500	35·00	1·25	37·5	......	40·41	......	1·25
H	33·75	10·625	36·25	1·87					
I	33·50	8·375	34·50	·62	36·5	1·50			
J	33·50	9·250	36·00	·25	36·75	1·120	41·75	......	1·25
L	32·25	Defective	36·50	1·5	37·75	......	41·00	·31	1·25
M	30·25	Defective	36·50	·62	37·75	·06	38·50	·06	1·25
Mean	32·92	......	35·57	......	37·21	......	40·16	......	1·24
Mean per square inch	23·94	......	25·86	......	27·06	......	29·20	......	·90

From the above it will be seen that the mean strength of the bars was 24 tons, whilst that of the rivet iron was 28 tons per square inch, at a temperature of 60°, and that the former attained its maximum strength of 29 tons from repeated breakages, whilst the latter reached a strength of 37 tons by an increase of temperature up to 317°. These are curious and interesting facts, exhibiting a parallel increase of strength, in the one case resulting from repeated strains, in the other from increase of temperature.

The foregoing Table indicates a progressive increase of strength, notwithstanding the reduced sectional area of the bars. This fact is of considerable importance, as it shows that a severe tensile strain is not injurious to the bearing powers of wrought iron, even when repeated to the extent of four times. In practice, it may not be prudent to test bars and chains to their utmost limit of resistance; it is however satisfactory to know, that in cases of emergency those limits may be approached without incurring a serious risk of injury to the ultimate strength of the material.

It is further important to observe, that the elongations are not in proportion to the forces of extension; thus in the bar F, the elongation of a bar, 54 inches long with 33·25 tons, is 10·5 inches, giving an elongation per unit of weight and length $=\frac{10 \cdot 5}{33 \cdot 25 \times 54} = \cdot 0058$, whereas an additional weight of 2·25 tons produces an elongation of 1·25 inches in 36 inches of length of bar, giving an elongation per unit of length and weight $=\frac{1 \cdot 25}{2 \cdot 25 \times 36} = \cdot 0154$; that is, the elongation in this case is about three times that in the former.

From the experiments on rivet iron we have a mean elongation, in fourteen experiments, of ·643 inches in $2\frac{1}{2}$ inches, or $\frac{\cdot 643}{2\cdot 5}=\cdot 257$ per unit of length; and in those on the S. C. — bars, we have a mean elongation of ·274, as given in the following Table:—

Length of bar.	Elongation.	Elongation per unit of length.
in.		
120	26	·216
42	9·8	·233
36	8·8	·244
24	6·2	·258
10	4·2	·420

Hence it appears that the rate of elongation of bars of wrought iron increases with the decrease of their length; thus while a bar of 120 inches has an elongation of ·216 inch per unit of its length, a bar of 10 inches has an elongation of ·42 per unit of its length, or nearly double what it is in the former case. The relation between the length of the bar and its maximum elongation per unit, may be approximately expressed by the following formula, viz.—

$$l=\cdot 18+\frac{2\cdot 5}{L},$$

where L represents the length of the bar, and l the elongation per unit of length of the bar.

It is difficult to measure accurately the elongations in $2\frac{1}{2}$ inches, but the following Table shows the elongation per unit of weight and length at various temperatures, as exhibited in the experiments on rivet iron.

Temperature, Fahr.	Elongation per ton per inch.	Mean elongation per unit of length and weight.
−30°	·00284	·00284
+60	·00297	·00247
60	·00197	
114	·00177	·00177
212	·00173	·00162
212	·00142	
212	·00182	
250	·00164	·00178
270	·00192	
310	·00175	·00164
325	·00153	
415	·00175	·00183
435	·00192	
Red heat.	·00341	·00341

The two first experiments, at low temperatures, are rather anomalous, but the rest are more consistent, showing that the elongation per unit of length and weight is nearly the same at all ordinary temperatures, but is more than doubled at red heat.

Mercantile Steam Transport Economy. By CHARLES ATHERTON, *Chief Engineer of Her Majesty's Dockyard, Woolwich.*

[A Communication directed to be printed entire among the Reports of the Association.]

THE construction of ships and the administration of shipping affairs, involving a multiplicity of considerations of a scientific and of a practical and mercantile character connected with these arts, requires that shipping direction be regarded and treated as the subject of an exclusive science; and, of late years, the progressively extended application of steam to maritime purposes, and the prospect of its general use as an auxiliary power, have still further complicated the subject, and extended the range of mercantile acquirement which is now necessary in the prosecution of steam-ship equipment, direction, and management. It is therefore with diffidence, and with the feeling of my not possessing the combination of qualifications which is necessary to ensure adequate justice being done in all respects to the elucidation of the important subject, "Steam Transport Economy," that I enter upon the task of bringing that subject before the notice of the British Association for the Promotion of Science. I am, however, encouraged by the assuring reflection that public utility is a field in which it is an honour to labour, that lenient consideration for individual deficiencies and the helping hand of others will be extended to the most humble delvers in that field, and that credit may be earned in proportion to the roughness and obdurate nature of the spot of ground which we may have undertaken to break up, and to the perseverance by which one may at least attempt the accomplishment of the assigned task. Permit me, therefore, to remark, that my present appeal to the British Association is but a continuation of my previous efforts in the cause of steam exposition, with a view to bringing "Steam Transport Economy" within the pale of arithmetical calculation; and as I shall have occasion to refer to the enunciation of principles and to the details of calculations which have thus preceded this essay, it may be convenient that I briefly enumerate the various published statements thus referred to as forming an integral portion of this paper, and which, accordingly, I beg to hand in to the Association for the purposes of reference and record.

1st. A brief essay on 'Marine Engine Construction and Classification,' published by Weale, in 1851.

The object of this essay was to analyse the data afforded by published and authentic statements of the actual test-trial performances of various steam-ships, and ascertain, by means of such comparative analysis, what are the peculiarities or proportions of build, and what are the peculiarities of engine-construction of those vessels which have attained to the highest degrees of locomotive efficiency, thereby also scrutinising how far the popularly received notions in regard to steam-ship type and marine engine construction, supposed to be most conducive to locomotive efficiency, may be in accordance with, or in opposition to, the results of actual experience, when measured by any definite and received law.

2nd. An essay on 'Steam-ship Capability,' originally published in 1853, and of which a second edition, with supplement, was published by Weale, in 1854.

This essay was designed to demonstrate the mutual relations which subsist between displacement, power, and speed in steam-ships; especially as respects the increasing scale of engine-power by which progressive increase of speed is attained; and to show the difficulties which attend the prosecution of a steam service in which long passages are required to be performed at a high rate of speed; also to show the sacrifice which attends the employment of vessels of an inferior type of build, as compared with vessels of a superior type. The supplement published with the second edition of this essay extended the tabular calculations to embrace vessels of hypothetical magnitude, and to demonstrate a system of £ *s. d.* arithmetical calculation applicable to estimating the cost of goods conveyance per ton weight by steam-ships, based on the constructive type of the ship, the speed to be realized, and the size of ship employed to do the work. The appendix to this essay embraces a dissertation on the probable capabilities of ships of unprecedented magnitude, showing the advantage of magnitude so far as mechanical principles are concerned irrespective of mercantile considerations, and under what combinations of speed and distance without re-coaling, comparatively with the more frequent coaling depots available to smaller vessels, the mechanical advantage of magnitude becomes neutralized; also giving new tables for facilitating steam-ship calculations, by showing the cubes of numbers from 5 to 25, rising by the decimal ·01, and the cube-roots of the squares of all numbers likely to be embraced in the tonnage displacement of ships.

3rd. A paper on "Steam-ship Capability," read before the Society of Arts, London, 16th May, 1855.

The object of this paper was to expose the indefinite nature of the terms "horse-power" and "tonnage" as respects their not being what they are generally supposed to be, definite units of measurement of engine-power and ships' size; also to show the uselessness for scientific purposes of all statistical data based on nominal horse-power and nominal tonnage, and the fallacy of all calculations based on those indefinite terms, thence showing the necessity for some definite measure of power being legalized as the unit of power to be denoted by the term "Marine Horse-power," and used as the base of calculation and contract engagement in steam shipping affairs.

4th. A paper on "Tonnage Registration," read before the Society of Arts, London, January 16, 1856, with the discussions thereon.

The object of this paper was to show the insufficiency for scientific purposes of the system of tonnage registration now in force, as prescribed by the Merchant Shipping Bill of 1854, in so far that under this Act the registered tonnage of a ship affords no certain indication of the tons weight of cargo that the ship will carry, nor does it give, even approximately, the displacement with reference to any given draught; nor does the registration afford any indication of the power capable of being worked up to by the engines of steam-ships, or any other data whereby the dynamic properties or locomotive duty of vessels may be scrutinized on scientific principles. By this paper, I brought forward certain suggestions for public consideration and discussion with a view to our official registration of shipping being rendered more comprehensive for the fulfilment of the various useful purposes to which statistical registration, if complete, would undoubtedly conduce, in a scientific point of view, irrespectively of merely fiscal objects.

These papers, of 16th May 1855, and 16th of January 1856, urging the establishment and recognition of definite units as the legal admeasurement of marine engine-power and ships' tonnage, I beg respectfully to submit to the notice of the Committee appointed by this Association for the consideration of the tonnage question, of which Committee I had the honour of being named a member, but I was under the necessity of declining to take part on this Committee in consequence of my being, as above stated, committed to certain views and publicly engaged in agitating the question of Tonnage Registration amendment, with a view to supplying the deficiencies of the present system.

Having thus shown that various investigations essentially connected with the elucidation of the subject now before us, "Steam Transport Economy," have constantly and publicly engaged my attention since 1851, I may now, in the beginning of my paper, announce the proposition to which I hope to direct the attention of the British Association.

Now, what I have undertaken to demonstrate is this: that, in consequence of there being no *legalized* definitions of the terms POWER and TONNAGE as standard units of quantity applied to the prosecution of steam navigation, there is practically no *definite* measure of quantity whatever attached to those terms, even although they are so generally made use of as the base of pecuniary contracts, and that, in addition to the private evils as between buyer and seller resulting from this singular anomaly in matters of mercantile account: the public evils, resulting from nominal "horse-power" and "tonnage" being terms which cannot be scientifically recognized as expressing either the working power of marine machinery or the size of a ship, are monstrous, inasmuch as they publicly defeat science from being brought to bear on steam-ship construction and steam-ship management as a means of investigation and proof whereby to confirm the existence and establish the continued adoption of good practice where good practice does exist, and to detect error either in the construction of steamers or in the management of steamers in cases where bad types of construction and mal-administration may exist and be destructive of enterprise, which might otherwise have conduced to public good. In short, my object is to show that in consequence of the deficiencies in our national standard units of power and tonnage, and deficiencies of our statistical registration, the public are deprived of the benefits capable of being derived from science as a means of discriminating between good and bad practice in the great matter of shipping, thus enabling us to take advantage of the one and explode the other. The constructive merits of steam-ships in a dynamic point of view may be comparatively determined by the ratio that subsists between the amount of displacement that is propelled from place to place, the speed or time in which the vessel performs the given passage, and the engine-power exerted or the coal consumed in the performance of the work; yet every ship that is launched, and goes with flying colours upon the usual test-trial, is always for the day pronounced to be the most wonderful ship that ever was built; and no wonder that it is so, considering that the dynamic merits of ships are thus determined, not by any admitted rule based on the mutual relations of displacement, power, and speed, but by acclamation based on the mutual interests of all concerned, that a new ship shall be of good repute. All attempts to expose this monstrous deficiency in our nautical system by urging the importance of statistical registration, have been held up to reprobation as an interference with the shipping interests, regardless of the fact that it is the public who pay the penalty of an enhanced price of goods transport consequent on whatever deficiencies may exist in connexion with the locomotive properties of our shipping.

In justification of these remarks as to our denominations of ships' tonnage and engine-power being a delusion, subversive of all truth so far as scientific inquiry and research may be based thereon, I may be permitted to adduce the following statements:—

1st. As to tonnage registration. Although tonnage measurement for registration has been subjected to legislative revision under the Merchant Shipping Act of 1854, the term "tonnage" is still made use of in various significations. By the present law, 100 cubic feet of internal roomage, or available space for cargo, constitutes the unit of tonnage, but as respects all ships built previously to the month of May 1855, when this Act came into operation, the adoption of this law is not compulsory. Merchants have the privilege of retaining the former registration of some ships, and getting such others of their ships measured and registered under the new Act as they may think fit to select for re-registry, so that the term "tonnage" may now signify "builders' tonnage," old measure, under the Act of 1773, or tonnage under the Act of 1833, or tonnage under the Act of 1854; and these are three totally different systems of admeasurement, having no definite ratio to each other. Moreover, the unit of tonnage under the Act of 1854 being based on internal roomage *measuring up to the deck*, affords no certain indication of the displacement of a ship when loaded fit for sea, nor does it afford any assurance whatever as to the tons' weight of cargo that a ship will carry; for example, by adopting the cellular principle of build now introduced in the construction of iron ships, a ship of 10,000 cubic feet of internal roomage, or 100 tons register tonnage, may have such external displacement as would safely float with the whole internal roomage filled with iron, and therefore weighing no less than 1000 tons of dead weight, or ten times the register tonnage, and the registration of steam-ships is open to similar delusion as to their capability for weight of cargo. So much for the mercantile liberties that may possibly be introduced and taken with our statistics of exports and imports so far as they may be based on the tonnage registration of shipping under the Act of 1854.

The abortiveness for statistical and scientific purposes which has hitherto attended all legislation on tonnage registration, appears to have been occasioned by the attempt to embrace under the one term "tonnage," two things which have no fixed ratio to each other, namely, tonnage by bulk, and tonnage by weight. The law has not comprehended the double mercantile use and application of the term "ton" by providing for the separate and distinct registration of each, namely, tonnage by bulk and tonnage by weight, the capability of ships for holding bulk tonnage being dependent on internal roomage; but the capability of ships for carrying weight tonnage being dependent on external displacement, a distinction which is not noticed by the new law of tonnage admeasurement under the Act of 1854.

2nd. As to marine engine-power. Although Watt originally defined the unit of power, which he denominated horse-power, as equivalent to 33,000 lbs. weight raised one foot high in one minute of time, and invented a mechanical device or instrument called a "steam-indicator," whereby the variable pressure of the steam in the cylinder and consequently the working power of steam-engines could be readily ascertained (whence the working power so ascertained was denominated the "*indicated* horse-power"), all which arrangements of Watt put the working operation of the steam-engine originally on a scientific base, defined by a standard unit of power admeasurement, still this definite unit of power was never recognized by law, and consequently the steam-engine was no sooner applied to maritime purposes, than the rivalry of trade introduced a practice under which the nominal, or contract power of engines, did not specifically regulate the working capability of the engine delivered. Engines were not objected to by the purchaser if their working capabilities were in excess of the nominal power, and engineers themselves voluntarily supplied marine engines working up to an "*indicated* power far in excess of the *nominal*" power, for the purpose of thereby driving the new vessel at a higher rate of speed than that attained by some rival vessel with the same nominal power. Reputation for the production of fast steamers depended on beating the rival boat, not on the mode of effecting that object. The shipping interests and their working craftsmen, shipwrights and engineers, felt themselves constrained to meet their rivals in trade with their rivals' weapons; numerous devices have been adopted with a view to the development of power on board of ship by packing the greatest amount of engine-power into the least space, and undoubtedly great improvements have been made by adapting the dimensions and proportions of vessels to the service required, but still "Fame," in regard to the character of steam-ships based on speed, has been too much the result of horse-power delusive jockeyship rather than of truthful science. By the practice of trade, horse-power came to be measured by the diameter of the cylinder, without any limitation as to the capabilities of the boiler, and gradually in time a marine-engine contract was considered not to be fulfilled unless the engines were capable of working up to an "indicated horse-power" at least double that of the contract nominal power; still, however, no specific limit was assigned either by custom or by law; and at length to such a degree has competition set truth at defiance, that the working, or "indicated horse-power" of engines delivered under contract, has frequently amounted to four times the nominal horse-power actually stipulated for by the contract. These facts are fully set forth in the paper read by me before the Society of Arts on the 16th of May, 1855.

Having thus pointed out the indefinite application in steam-shipping practice of the terms "tonnage" and "horse-power," with reference to the definite terms "displacement" and "indicated horse-power," it may be still further edifying that we illustrate the anomalies liable to result when these terms are used in combination with each other, as is constantly the case in expressing and recording the ratio of tonnage to power of a steam-ship. In exposition of this matter, I may again refer to the before-mentioned paper, whereby it will be seen that I selected ten vessels, in each of which the ratio of builders' tonnage to nominal power was very nearly the same, namely, in the ratio of 100 tons of builders' tonnage to 40 nominal horse-power, or $2\frac{1}{2}$ tons of tonnage to one nominal horse-power; but on comparing the constructors' load displacement of these same ships, calculated in tons weight at 35 cubic feet of water to the ton, with the *effective* working power, based on indicator measurement, the ratio was found to be 100 tons displacement to 38 horse-power in one case, and 100 tons displacement to 281 horse-power in another.

The recorded statistics of these ten vessels would lead one to infer that they are all powered in the same proportion of engine-power to size of ship; but, in fact, they are all different, and on comparing the two extremes, one ship has no less than seven times the power of the other, in proportion to size of ship as determined by displacement. In fact, generally, the records of register-tonnage and nominal horse-power do not constitute statistical data of any value whatever for the scientific purpose of discriminating between the relative dynamic merits of steam-ships, but, on the contrary, such records and all ideas resulting therefrom are positively delusive and mischievous. The conclusion at which I would arrive from these statements is, that the very first step in any attempts to bring steam affairs within the range of arithmetical calculation, must necessarily be to establish the measure or value which we assign to our units of tonnage and power. It is only by the moral influence of such a body as the British Association that the cause of science can obtain a hearing in this matter of statistical registration applied to shipping. With reference to our units, it is, of course, desirable that the measure of the unit, to be legally recognized as the unit of power, should be nearly in accordance with the general average of practice at the time when the unit may be so established; and as at the present time (1856) the general run of marine nominal horse-power varies from two indicated horse-power to four indicated horse-power, that is from 66,000 lbs. to 132,000 lbs. raised one foot high per minute, it is submitted that the unit of marine horse-power would now be most conveniently fixed at 100,000 lbs. raised one foot high per minute. Until, however, some definite measure of the unit be legally recognized, it is considered advisable in matters of scientific inquiry like the present to adhere to the measure of the unit originally proposed by Watt, namely, 33,000 lbs. raised one foot high per minute, designating this scale of measurement as the "indicated horse-power," thus:—Ind. h.p.; and such will be the unit referred to when horse-power is spoken of in the following pages of this paper.

Now, as to the measure of the unit of tonnage by which the sizes of ships are to be spoken of and compared, we have already observed that under the Merchant Shipping Act passed in the year 1854, the unit of tonnage is based on the internal roomage of ships available for cargo; that all ships built since May 1855, are registered under this Act; but the re-measurement and re-registration of ships built previously to 1855 is not made compulsory. Shipowners have the privilege of re-registering, under the Act of 1854, such vessels as they may select for that purpose; consequently, our present registration is mixed, and the various units of tonnage-measurement thus embraced under our present tonnage-registration have no definite ratio to each other, or to the tons weight of cargo that ships will carry. The comparative merits or demerits of these various systems of registration for *fiscal* purposes need not be here discussed. Suffice it to say, that in none of these systems has any notice whatever been taken of the measurements which constitute displacement; and as displacement is an essential element in any scientific investigation as to the locomotive performance of steam-ships with reference to the power employed and speed attained, it follows that our present registration of shipping, even under the Act of 1854, does not afford statistical data of such a character as to be available for science in the matter of comparing the merits, in a locomotive or dynamic point of view, of the various models or types of form by which steam-ships have been constructed. It is submitted for the consideration of the British Association, that national advancement in maritime affairs, especially in regard to transport economy, would be promoted by our public registration of shipping in general, and of steam shipping in particular, being so systematized as to embrace not only the roomage measurement required for fiscal purposes, but also, in addition, those details of *displacement*, which in combination with the data of speed and power derived from the actual performances of ships, are necessary to scientific investigation in determining the relative dynamic merits of different types of form of steam-ships. It must be borne in mind, that it is the public, the consumers of merchandise, who must ultimately bear all the expenses connected with the transport and delivery of merchandise, whether well or ill performed. Bad ships individually enhance the average cost of imported corn and all other consumable merchandise. Bad ships also enhance the price of cotton and all other similar raw material imported for the production of export manufactures. This enhanced price restricts demand, thus curtailing the sources of employment; so that every bad ship, whether employed in the import or export trade, is, of itself, a public nuisance: a prevalent bad type of ships would be a public calamity, and progressive improvement would be a public benefit. It has been said that the interests of shipowners is in itself a sufficient guarantee for ensuring the adoption of the type of ships best adapted for mercantile steam transport economy. It is scarcely fair to base any argument on interested motives, but as that argument has been raised it must be noticed. Undoubtedly, each shipowner has an individual interest in his own ships being the best afloat, but if he does possess the best ships, it is equally his interest to keep that fact and the means of acquiring them to himself, so that the charges for freight may continue to be ruled by the inferior dynamic qualities of the average ships employed by the trade, not by the superior dynamic qualities of the best ships as possessed by himself, the difference being the shipowner's private advantage or the public's loss. It is therefore the interest of the public that all bad types of shipping be exposed and eradicated. Freight would then, as respects the quality of ships, be ruled by a scale of charges derived from the performance of a generally improved type of ships working in fair competition with each other.

Having already defined the measurement of the units by which we propose to designate the working power of the engines and the size of the ship, namely, ind. h.p. at 33,000 lbs. raised one foot high per minute, and tons weight of displacement at 35 cubic feet of water to the ton, it is now necessary that we refer to the received law or formula by which the comparative dynamic duty of steam-ships may be numerically ascertained. The formula usually adopted for obtaining the coefficient of dynamic duty of steam-ships is $\left(\frac{V^3 D^{\frac{2}{3}}}{\text{ind. h.p.}}=C\right)$, in which D is the displacement of the ship at the time of trial expressed in tons weight, V the speed (usually expressed in nautical miles per hour), and ind. h.p. the working power as ascertained by means of the indicator. The resultant number (C) deduced from this formula is termed the coefficient of dynamic performance. This coefficient (C) will be a constant number for all vessels of perfectly similar model or type of form, and of which the engines are equally effective in proportion to their gross ind. h.p.; but if the vessels be not of similar type, and the engines not equally effective in proportion to their ind. h.p., the coefficient (C) will vary, and thus the dynamic performance of different vessels will be *comparatively* ascertained. It is not our purpose in this paper to raise any question as to the scientific *rationale* or resultant accuracy of this formula; I will merely observe, that though open to criticism in several respects, the results of experience have demonstrated that this formula, when applied to any known type of ship, expounds the mutual relations of displacement, power, and speed with a degree of precision that admits of its being practically made use of for determining the resultant speed that is to be expected from any combination of power and displacement, and in like manner, any one of the three elements of the formula may be deduced from the other two being given. Further, this formula may be rendered available as a counting-house check on the working operation of steam-ships, simply by substituting the consumption of coals, expressed in cwts. per day of 24 hours (W), in lieu of the ind. h.p.; for 1 cwt., or 112 lbs., per day of 24 hours is at the rate of 4·66 lbs. per hour, which is probably about the ordinary consumption per ind. h.p. per hour, and it ought not to be exceeded. If, therefore, in lieu of the ind. h.p. we substitute the consumption of coals, calculated in cwts. per day of 24 hours, the resultant coefficient (C) will afford an approximate indication of the good or bad performance of ships, as compared one with another, and the fact of an inferior performance being thus detected, the cause to which it may be attributable, whether to inferior type of form, or foulness of bottom, or inferior adaptation of engine, or inferior construction of boiler, or inferior management on board ship, will then become the subject of professional inquiry; thus, the merchant, by aid of his counting-house statistics of displacement, time on passage of given length, and coals consumed, will be enabled to detect the fact of inefficiency, and it will then be for the professional engineer to detect and remedy the cause thereof. The annunciation of the formula, or the mercantile rule above referred to, is as follows:—Multiply the cube of the speed, expressed in knots or nautical miles per hour (V^3), by the cube root of the square of the displacement ($D^{\frac{2}{3}}$), and divide by the consumption of coals, expressed in cwts. per day of 24 hours, the resultant numeral coefficient (C) will indicate the dynamic or locomotive efficiency of the vessel; and such is the variable condition of steam-ships in present use, that the coefficient has been found to be as low in some cases as 120, whilst in other cases it has reached the number 250. The pecuniary value of gold is determined by assay; and in like manner the contract price to be paid for a steam-ship should, in some measure, be regulated by the coefficient, based on the mutual relation of displacement, speed, and coals, which may be realized on trial of the ship; for example, multiply the contract price by the numeral coefficient that may be actually realized, and divide by the coefficient that may be regarded as the *par* measure of dynamic efficiency, according as the vessels may be painted or sheathed with copper. Contracts based on this principle would constitute a check upon the production of inefficient ships, and award a premium on the construction of ships of superior merit.

The approximate trustworthiness of the formula $\left(\frac{V^3\ D^{\frac{2}{3}}}{\text{ind. h.p.}}=C\right)$ being conceded, we now have the means of pursuing our exposition of the extent to which any definite difference of type or falling off in the working condition of a ship will affect the amount of prime cost expenses incurred in the conveyance of merchandise by steam-ships. Suppose, for example, that we have ships whose coefficients of dynamic duty or index numbers (C) deduced from the formula $\left(\frac{V^3\ D^{\frac{2}{3}}}{\text{ind. h.p.}}=C\right)$ are respectively 250 and 166, which numbers correspond with 1000 and 664, if the unit of marine engine-power be taken at 4 ind. h.p., as is the case in the tabular calculations given in Atherton's 'Steam-ship Capability,' and are coefficients of dynamic duty not unusual as between different steam-ships in actual practice; in evidence of which, confirmatory of the official records whence these numbers are taken, I may refer to a tabular statement of steam-ship trials recently supplied to me by one of our most experienced firms (engineers and shipbuilders), by which statement it appears, that, adopting the formula referred to, the index numbers or coefficients of dynamic duty of eight steam-ships varied from 251 to 149, thus showing that the difference of constructive types now assumed as the base of calculation for this exposition, is not an exaggeration, but such as is common in practice. In the first place, referring to 'Steam-ship Capability,' 2nd edit. page 78, we will expose the difference of power (ind. h.p.) which would be required by two vessels, A and B, of the respective types or working conditions of service indicated by the coefficients above referred to (namely 250 and 166), supposing the vessels to be each of 2500 tons load displacement. The vessel A will be propelled at 8 knots, 10 knots, and 12 knots per hour, by 376 ind. h.p., 736 ind. h.p., and 1272 ind. h.p.; but the vessel B will require, to attain the same rate of speed, 568 ind. h.p., 1112 ind. h.p., and 1920 ind. h.p. Thus the ship B requires, in consequence of her inferiority of working condition, or type of construction, an increase of power of no less than 50 per cent. in order to attain the same rate of speed as ship A; and, be it observed, that these assumed coefficients are within the range of ordinary difference between one ship and another.

We will now show the sacrifice which such a difference of type produces in the weight of cargo which these ships of (say) 2500 tons displacement, with mean quantity of coal on board, would respectively carry on a given passage, if powered for running at the speed of 8, 10, and 12 knots per hour. For this exposition we will assume the weight of the ships themselves, as measured by the light displacement of ships, when ready to receive cargo and coal for the voyage, to appropriate 1000 tons displacement, being 40 per cent. of the load displacement. We will also assume the weight of the engine department complete at 5 cwts. per ind. h. p., and the consumption of coal to be at the rate of 4 lbs. per ind. h.p. per hour, and the length of passage, without re-coaling, to be 3250 nautical miles, being about the distance from Liverpool to New York, or to Constantinople. On these data, according as the vessels may be powered, as before shown, for being propelled at the speed of 8, 10, and 12 knots per hour, the displacement available for cargo in A will be 1270 tons, 1103 tons, and 875 tons weight of cargo; while in B it will be 1152, 900, and 556 tons weight. The consumption of coal in A will be 273 tons at 8 knots, 427 tons at 10 knots, and 615 tons at 12 knots; and in B it will be 412, 645, and 929 tons weight. Hence it appears that purely in consequence of the difference in constructive type, or working condition of the ships, the reduction of cargo in B, as compared with A, will be 9, 18, and 36 per cent., according as the speed may be, 8, 10, or 12 knots per hour; while the increase of coal, being in proportion to the increase of power, will in each case be 50 per cent. But the public evils of an inferior type, or neglected condition of ships, will be still more fully exposed, and be more definitely understood by the extra £ *s. d.* charge that must be made for freight per ton weight of goods conveyed, in order to meet the prime cost expense of conveyance. In order to work out this calculation, we must assume certain data of investment and current expense as constituting the prime cost charges of permanently establishing and upholding a commercial fleet of steam-ships; and as this is the vital point in which the public, as consumers, have a direct interest, it will be expected that I enter upon it in considerable detail, as set forth in Supplement to 'Steam-ship Capability,' 2nd edit. page 76.

In the first place, I would remark that it is only during the number of days that steamers are annually at sea conveying cargoes of goods from port to port that they earn the income that is to defray the whole annual expenditure incurred. The number of days per annum during which steamers are at sea will, of course, depend materially on the service in which they may be employed; and as it is proposed to work out our calculations with reference to a passage of 3250 nautical miles—such, for example, as the passage from England to New York or to the Black Sea—I have assumed that the vessels employed on such service may be at sea 200 days per annum. In the next place, the cost of coal is a very material item, greatly dependent on the service on which the vessels may be employed. This I have assumed at £2 per ton weight as the average cost of the yearly consumption. Next, as to the ship; I have assumed that a ship of 2500 to 3000 tons *load displacement* would be purchased from the builders as a ship of about the same amount of tonnage, builders' measurement, and that the cost of the ship, completely fitted, equipped, and furnished in all respects ready for sea, would be £25 per ton. Then, assuming the interest on investment at £5 per cent. per annum, the upholding and replacement at 10 per cent. per annum, insurance at 5 per cent. per annum, and wages and rations of officers and crew all the year round at £3 per 100 tons per week; on these data we shall have the prime cost expenses incidental to the hull amounting to £6 11*s.* 2*d.* per ton of tonnage per annum, which is 8*d.* per day sea-time, assuming the vessel to be at sea 200 days per annum, exclusive of harbour dues, lights, and pilotage, which are supposed to be the same for all ships of equal tonnage.

Next, as to the engine department:—

The average price of marine condensing engines, as now usually constructed, may be rated at £50 per nominal horse-power, and in general each horse-power nominal may be expected to work up to $2\frac{1}{2}$ ind. h.p., so that the cost of marine engines may be rated at £20 per ind. h.p. Then, assuming the interest on investment at 5 per cent. per annum on the contract cost, the upholding and replacement at 10 per cent., insurance 5 per cent., wages and rations of engineers and stokers at £5 per 100 ind. h.p. per week, consumable stores (coal excepted) £2 10*s.* per 100 ind. h.p. per week, on these data we shall have the prime cost expenses incidental to the engine department (exclusive of coal), amounting to £7 18*s.* per ind. h.p. per annum, which is 9*d.* per day per ind. h.p. sea-time, assuming the vessel to be at sea 200 days per annum.

These assumed data of pecuniary charges incidental to steam-ship transport service, as applied to mercantile purposes, combined with the mutual relations of displacement, power, and speed, which are derivable from the foregoing formula $\left(\frac{V^3 D^{\frac{2}{3}}}{\text{ind. h.p.}} = C\right)$ according to the constructive type or locomotive quality of the ship, as shown by the coefficient or index number C, enable us to make up the prime cost expenses, being the minimum at which goods can be conveyed, and which therefore should constitute the base of the estimate by which a minimum scale of freight charges should be estimated; and applying these data to the ships A and B, employed on a passage of 3250 nautical miles, as exemplified in the Supplement to Atherton's 'Steam-ship Capability,' 2nd edition, page 78, the minimum scale of freight charges per ton of goods, according as the vessels may be powered for a speed of 8, 10, or 12 knots per hour, will, on the data referred to, require to be as follows:—

	8 knots.	10 knots.	12 knots.
Ship A	£1 15 7	£2 4 6	£3 4 6
Ship B	2 7 2	3 9 8	6 16 3

The proportions in which goods, according to their respective kinds, may be made to bear freight charges so as to yield the average return per ton weight on the entire cargo, is altogether a matter of commercial discretion and management. The entire cargo must be made to yield the average return per ton weight here set forth.

Hence it appears that 12 miles speed involves about double the freight cost of the 8 miles speed with the superior ship A, and nearly three times the cost of the 8 miles speed with the ship B, and 12 miles speed with the ship B is about four times as expensive as the 8 miles speed with the ship A. Also, the extra cost to the public at which freight charges are enhanced by the inferior type or inferior working condition of ship B, as compared with the ship A, if continuously employed on the passage of 3250 nautical miles, and under the data referred to, assuming the consumption of coal to be at the rate of 4 lbs. per ind. h.p. per hour, and according as the steaming speed of both ships may be 8, 10, or 12 knots per hour, is no less than 32 per cent. at 8 knots, 56 per cent. at 10 knots, and 111 per cent. at 12 knots. Undoubtedly, the details of the data on which the foregoing calculations have been based are open to correction, and will greatly depend on their application to special services on considerations immediately connected with such special service, and cannot be generalized; but, whatever alteration of these data may be applied to the ship A must likewise be applied to B, so that, although the foregoing estimate of the actual cost expenses of freight may be considerably modified by our altering the data of the calculations, still the per-centages of difference above set forth, showing the *degree* or per-centage in which freight charges for the passage of 3250 miles are enhanced in consequence of the inferiority in locomotive properties of the ship B, as compared with the ship A, will not be much altered from the per-centages above set forth, showing an enhanced cost of freight to be paid by the public on bringing cargo, grain for instance, from the States, or from the Black Sea, to England, amounting to 32 per cent. at the 8 knots speed, 56 per cent. at the 10 knots speed, and 111 per cent. at the 12 knots speed, extra charges incurred on freight per ton of goods conveyed, and to be paid by the public, in consequence of the dynamic inferiority of ship B, as compared with ship A. It is surely in consequence of the public not being generally aware of the high scale of prime cost charges necessarily involved in a 12 miles speed (steaming speed at sea), as compared with an 8 miles speed, that such high speed is so universally demanded by the public; and it must surely be in consequence of an almost similar want of insight into the real cost of high speed on the part of directors, that obligations as to speed are so frequently incurred at a price inadequate to such service. If the public will have a progressively increasing high rate of speed, they must pay for it about in the ratio at which they purchase iron, copper, silver, gold, and diamonds, either of which may be bought too dear for common use.

The foregoing results have been based on the supposition that the consumption of fuel in both ships is at the rate of 4 lbs. per hour per ind. h.p. My own experience, however, induces me to be of opinion that this rate of consumption is but very seldom realized, and that 5 lbs. of coal per ind. h.p. per hour is much nearer in accordance with our present actual steaming practice. It is therefore important that we show to what extent the rate of transport freight expenses will be enhanced, if the service above referred to, namely 3250 nautical miles direct, be performed with an inferior construction of boiler, causing a consumption of 5 lbs. of coal per indicated horse-power per hour, instead of 4 lbs., as above calculated on. In this case, according as the speed for which the vessel may be powered is 8, 10, or 12 knots an hour (see 'Steam-ship Capability,' p. 78), the cost expenses incurred by vessel A, instead of being £1 15*s.* 7*d.*, £2 4*s.* 6*d.*, and £3 4*s.* 6*d.* per ton-weight of cargo, will now amount to £1 19*s.* 5*d.*, £2 11*s.* 4*d.*, and £3 19*s.* 1*d.* per ton-weight of cargo, this increase of prime cost freight expenses per ton of goods being 11 per cent., 15 per cent., and 22 per cent., according as the service speed may be 8, 10, or 12 knots per hour, solely in consequence of the inferiority of the boiler, or inferiority of boiler-management, causing this extra consumption of fuel; and further, if this greater consumption of coal be combined with the inferior type of vessel B, the prime cost expenses of freight per ton of goods, instead of being £1 15*s.* 7*d.*, £2 4*s.* 6*d.*, and £3 4*s.* 6*d.*, will now be £2 13*s.* 7*d.*, £4 5*s.* 5*d.*, and £9 15*s.* 2*d.*, this increase of freight cost being 18*s.* per ton, £2 0*s.* 11*d.* per ton, and £6 10*s.* 8*d.* per ton weight of cargo conveyed, or 50 per cent., 100 per cent., and 202 per cent. extra charge incurred according as the service speed may be 8, 10, or 12 knots per hour. These results show the monstrous extent, in a pecuniary point of view, to which the public are interested in the general quality of the type of ships and machinery adaptation thereto, and working condition of ships by which the mercantile transport service of the country may be prosecuted. But let us look a little further into this matter, in the hope of obtaining a more definite appreciation of the total extent in £ *s.* *d.* to which the British public are interested in having their mercantile transport service performed to the best advantage. It has been publicly stated ('Times,' June 18, 1856) that at the twelve principal ports of the United Kingdom during the year 1855, ship tonnage to the extent of 6,372,301 tons entered inwards, and 6,426,566 tons cleared outwards, making altogether 12,798,867, say $12\frac{1}{2}$ millions of tons of tonnage per annum; and since mercantile shipping will probably, *on the average*, carry dead weight of cargo to the full extent of their register tonnage, it is probable that the tons weight of merchandise constituting the cargoes of ships arriving at and sailing from the United Kingdom, amounts to no less than twelve millions of tons per annum, of which, for the purpose of illustration, we will suppose that one-sixth part, or two millions of tons, is conveyed by steam power on a passage of 3250 nautical miles, under the circumstances of the data that have been assumed as the base of the foregoing calculations; and since we have shown under these circumstances that the prime cost expenses of freight per ton of goods may be enhanced by an inferior type of ship and machinery, or inferior management thereof, to the extent of 18*s.*, £2 0*s.* 11*d.*, and £6 10*s.* 8*d.* per ton weight of goods conveyed, it follows that the extra charges for freight on the assumed quantity of two millions of tons weight per annum, will amount to the extra annual cost or public loss of £1,800,000 at 8 knots speed, £4,916,666 at 10 knots speed, and £13,666,666 at 12 knots speed, according as the type of ship and machinery by which the work is performed may be of the inferior type B, as compared with the superior type A; seeing also that it is the public interest which has to bear the brunt of our national goods transport service, being either as respects construction or working condition anything short of that degree of perfection which the application of science might achieve, is it not, therefore, of importance that our public system of statistical shipping registration should be complete, especially in those points which are essential for scrutinising the dynamic properties of steam-ships, thus leading to the recognition of good practice on the one hand, or the exposition of bad practice and consequent public loss on the other? Ships may be regarded as national implements for doing the work of the nation, and should therefore be subjected, by the aid of statistical registration, to public scrutiny, as conducive to their being upheld fit to do their work in the best manner. A shipbuilder will not allow his interests to be trifled with by the use of a blunt adze, so the public interest requires that its national transport service in the conveyance of goods should not be performed by bad ships if the statistical grindstone will obviate the evil. Nevertheless, the public statistics of British shipping afford no data available to science for promoting or even protecting from abuse the great public interests which are involved in the proper execution of its transport service, amounting probably to twelve millions of tons per annum. It is pre-eminently for the British Association to suggest the remedy for this humiliating fact.

The subject herein treated of admits of extended illustration beyond the limits of time that I may presume to occupy at a meeting of the British Association. I only profess to have broken up new ground, in showing that mercantile transport service by steam-ships admits of being brought within the range of arithmetical calculation, whereby the dynamic quality of ships, the size of ships as measured by displacement, the working quality of engines and engine-power as measured by the unit ind. h.p., and the speed to be assigned as the condition of any service, may each of them be treated as functions of calculation involving definite pecuniary considerations, constituting a system which may be denominated the "arithmetic of steam-ship adaptation to the requirements of mercantile service." By the application of these principles of calculation, I submit that errors in steam-ship construction, or neglect of its working condition, may be exposed, correction will follow, the directorial management of steam-shipping affairs, as respects steam-ship capability, will be based upon arithmetical calculation, thereby prosecuting its assigned service with confidence, and rejecting all Utopian projects that will not pay. Thus science will produce its fruit in promoting public interests, without detriment to the fair competitive pursuits of any class, by producing a sound, well-understood, and healthy condition of steam-ship management, and consequently of "Mercantile Steam Transport Economy."

Remarks by JAMES R. NAPIER, *Glasgow, on* Mr. Atherton's *Paper on Mercantile Steam Transport Economy.*

I quite agree with Mr. Atherton in regard to the indefiniteness of the term horse-power as at present used in steam-engine contracts, and in the desirableness of having a dynamical unit, or standard of power or work legalized, as well for the purpose of buying and selling machines producing power, as for that of scientific comparison. The rule or formula established by James Watt for the horse-power of condensing engines was $\frac{P \times V}{33,000}$ or $\frac{\text{foot lbs. per minute}}{33,000}$ = horse-power, where the pressure (P) and velocity (V) had either their *actual* values or fractional parts thereof. But at the present time the pressure (P) is continued at what it was in the days of Watt, viz. 7 lbs., no matter what the actual pressure may be now. And for the velocity (V) almost every engineer has a scale of his own, varying according to the length of stroke of the steam-piston; some assuming the velocities to vary as $\sqrt{}$ (of the length of stroke), others following the Admiralty rule for paddle engines assuming the velocities to vary as $\sqrt[3]{}$ (of the length of stroke). All these assumptions, moreover, have no necessary connexion with the results desired, nor with the actual results afterward obtained; nor do they answer any better the purpose either of the buyer or seller; and all the use they subserve is to fix the size of the cylinder by the very roundabout method of resolving an arithmetical or algebraical equation in which two of the three quantities, diameter, length of stroke or velocity, and horse-power required to be known.

As the term horse-power applied to steam-engines was fixed by Watt at 33,000 lbs. raised 1 foot high per minute, and as this same value is used by the Americans, the French, the Germans, and, I presume, by all nations where the history of the steam-engine is known, I should be very sorry to recommend any change as to the use of the name in any other sense than as synonymous with 33,000 lbs. per minute. I see no objection, however, to the entire abolition of the term *Nominal* Horse-Power, as it is of no use whatever to the engineer, as little to steam-engine owners, and deceitful to the public.

As I adhere to 33,000 lbs. per minute being received as a horse-power, I would object to the 33,000 being altered into 132,000, or into any other figure, without at the same time changing the name into something altogether different from Horse-Power or Marine Horse-power. I would suggest that the power be expressed in foot lbs. alone, as this is a term already known to all scientific nations. Dividing by 1,000,000, the result would be simply stated in millions of foot lbs.

As to the tonnage question, I feel I know very little about it, except that the present law is very complex, and certainly does not give what Mr. Atherton would like, viz. the displacement.

That part of Mr. Atherton's paper concerning the comparison of vessels is very important. What other writers have called the efficiency or the ratio of the power expended to the work produced, is surely a subject which all shipowners ought to be acquainted with. The formula adopted by Mr. Atherton for the efficiency or dynamical duty of steam-ships, is, I fear, too rough an approximation to be recommended for general adoption, especially when a more exact and equally simple formula is at hand, and the one also from which Mr. Atherton's adopted formula is no doubt deduced, viz. $\frac{V^3 \times \text{mid. section}}{\text{ind. h.p.}} = C$. The power in similar vessels, I here take for granted, at present varies as the cube of the velocity. This, I believe, is nearly true, and ought to vary also directly as the immersed midship section. For similar vessels the midship section no doubt varies as displacement raised to the power $\frac{2}{3}$rds; but scarcely any two vessels are similar (in the mathematical sense of the term); nor is the same vessel similar to itself when the draft of water varies.

The following Table, deduced from published statements of some of the ships of the Navy, and also from vessels built by the firm with which I am connected, shows the difficulty there would be in the use of the formula V^3 (displacement) $\frac{2}{3} = C$, from the (displacement) $\frac{2}{3}$ having no necessary connexion with the midship section:—

Comparison between Midship Sections, and (Displ.)$^{\frac{2}{3}}$.

	Mid. section.	(Displ)$^{\frac{2}{3}}$.	Ratio of mid. sec. to (disp.)$^{\frac{2}{3}}$.
Ajax	807	212·5	1000:263
Amphion	546	160·	1000:290
Arrogant	580	181·4	1000:313
Blenheim	738	198·2	1000:267
Dauntless	522	171·2	1000:328
Euphrates	570	179·25	1000:314
Hogue	820	215·	1000:261
Horatio	537	142·8	1000:266
Sanspareil	920	229·8	1000:250
Simoom	567	198·18	1000:350
Termagant	587	179·4	1000:306
Black Swan	385	140·76	1000:366
London	233	86·89	1000:373
Lady Eglinton	207	77·33	1000:373
Queen	122	44·5	1000:365
Bogota (P) very deep	330	134·51	1000:408
Victoria (P)	47	25·	1000:532
Vulcan (P)	56	26·962	1000:481
Lancefield	244	draft. 96·8	1000:397
Fiery Cross	270	12·11½ 100·2	1000:371
	331	14·11½ 117·5	1000:355
	394	16·11½ 135·08	1000:343

In the 'Fiery Cross,' at different drafts of water, there is a difference of nearly 3 per cent. in the ratio of midship section to (displacement) $\frac{2}{3}$, which might affect the coefficient C to the same extent.

The 'Victoria' and 'Vulcan' are two river steamers of nearly the same size and power, yet there is upwards of 5 per cent. of difference in the ratio of midship section to (displacement) $\frac{2}{3}$. The formula used by Mr. Atherton is, notwithstanding these remarks, exceedingly useful for commencing the designs of steam-vessels, and may be an approximation sufficiently near for most practical purposes.

In reference to the Table of the performances of steamers, which I recently gave to Mr. Atherton, it is necessary to remark that too much confidence is not to be placed in it as an exact document. Though I aimed at the truth, it is possible I may have erred in the speed which is generally on the Clyde tried between the Clock and Cumbrae lighthouses, or $13\frac{2}{3}$ nautical miles—too great a distance for maintaining a uniform speed, especially in new vessels with strange firemen, &c. I believe the statement, however, to be nearly true, and the study of it affords useful lessons. The last column shows the efficiency of the vessels by both formulas; I adhere, however, to the mid-section formula, as being the more correct.

The 'Vulcan's' speed and power is deduced from a number of trials at a measured statute mile on the Garelock. The 'Simoom's' performances I obtained from one of the Dockyards.

The 'Bogota,' a common paddle-wheel steamer employed by the Pacific Steam Navigation Company, and loaded very deeply at her trial, shows a very inferior result to that of the screw-steamer 'Black Swan' (now 'Ganges'), not deeply laden. Their displacements are nearly alike, and their speeds about equal; yet the paddle vessel (too deeply laden) requires about 60 per cent. more power than the screw.

The 'London' and 'Lady Eglinton' are two screw vessels near enough alike to be comparable. Their screws are the same diameter, but the one is more immersed than the other, which I imagine is sufficient to account for at least part of the difference in the efficiency of the two vessels.

The 'Edina' was constructed by Messrs. Barclay and Curle, and her engines by Inglis; but I was kindly invited to the trial, and got the particulars of displacement, power, and midship section from the constructors. The trials of the screw-steamer 'Lancefield' are not so satisfactory as could be desired, there being a little uncertainty as to speed. At the first trial the screw was not immersed: the result shows a very low coefficient. The speed at the other trials is uncertain, as it was taken at sea, and not in the usual way for such calculations.

I was unfortunate in not getting the particulars of the power and speed of the 'Persia' before she left the Clyde, so as to add her performances to the Table.

Letter by Mr. Atherton *on* Mr. J. R. Napier's *paper.*

To the President of Section G. *on Mechanical Science.*

Sir,—With reference to Mr. James R. Napier's remarks on my paper, "Mercantile Steam Transport Economy," I beg to submit the following observations. Mr. J. R. Napier concurs with me as to the indefiniteness of the term "nominal horse-power," as at present applied in marine engineering practice, and in the desirableness of having the unit of power, denoted horse-power, specifically defined; and he prefers that the measure originally proposed and acted upon by Watt, viz. 33,000 lbs. weight raised 1 foot high per minute, be now adopted as the statute unit of horse-power.

On this point I have merely to remark, that scientifically it is a matter of indifference what may be the statute measure of the unit, provided it be specific. In my 'Essay on Steam-ship Capability,' I based my calculations and tables on 132,000 lbs. raised 1 foot high per minute, because that was the average performance, per nominal horse-power, of the ten mail packets then employed in Her Majesty's Service. In my paper on "Mercantile Steam Transport Economy," I have suggested that 100,000 lbs., raised 1 foot high per minute, be adopted as the statute unit of horse-power, because that is, I believe, about the average present practice in the highest class of our merchant steam-shipping, and this measure of the unit would facilitate calculations; but whether 33,000, or 100,000, or 132,000, or any other number of lbs. weight, raised 1 foot high per minute, be adopted as the statute unit of horse-power, is a mere matter of convenience, a question very proper for being submitted for the consideration and recommendation of a Committee.

As to the question whether the formula $\frac{V^3 D^{\frac{2}{3}}}{\text{ind. h.p.}}$ or $\frac{V^3 \text{x mid. sec.}}{\text{ind. h.p.}}$ would be the better formula for determining the relative dynamic merits of steam-ships, these formulæ are, as respects *similar* types of *immersed* form, a mere transformation of terms, for in similar types of form the immersed midship section will vary in the same proportion as the cube root of the square of the displacement. These formulæ would therefore give proportional results. I have, however, preferred the formula based on displacement $\left(\frac{V^3 D^{\frac{2}{3}}}{\text{ind. h.p.}}\right)$, because this formula may, as I believe, be made the base of calculations as to the capability of ships for mercantile service, for which purpose the formula, based on midship section, without reference to displacement, is inadequate.

The Table of data now supplied by Mr. J. R. Napier, is a valuable addition to our statistical data, in so far that, after having determined the relative dynamic merits of the ships referred to, and classified them accordingly, the information afforded by this Table will aid in the analysis of their respective types of form. I would, however, beg to suggest that the position of the centre of gravity of the immersed midship section of each ship, expressed by its depth below the surface line, at which the displacement has been calculated, would be a very important addition to this Table, and it is hoped that Mr. James R. Napier will be able to supply it.

In fact, it is in consequence of the depth of the centre of gravity not being noticed in the formula above referred to, that I have spoken of it in my paper as "open to criticism" and probable amendment, and I shall be prepared in Committee to submit this view of the case for consideration. Requesting that this letter be read conjointly with Mr. Napier's remarks,

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

CHARLES ATHERTON.

On the Vital Powers of the Spongiadæ.
By J. S. BOWERBANK, *F.R.S., F.G.S. &c.*

Inhalation and Exhalation.

SOME years since I received from Dr. Lister of Madeira two masses of a Halichondriaceous sponge, each about 7 inches in diameter, accompanied by the information that they were portions of the same individual, and I was struck by the remarkable difference in the external appearance of the two. In one, the oscula were nearly all widely expanded, several of the orifices being nearly half an inch in diameter; while in the other piece scarcely any of them were open, the greater part being entirely closed by a stout membranous veil, which in many cases was pursed up in the centre of the area in a conical form. On writing to my friend to inquire the cause of this difference in the appearance of the two pieces of the same sponge, he informed me that the piece with the closed oscula had been dried immediately on being taken from the sea, but that the other one had been placed in a vessel of sea-water, about half an hour after removal from the sea, and placed in the sun; nearly all the orifices were then closed, and it was observed by Dr. and Mrs. Lister that a gradual contraction shortly commenced in the membranous veils of the oscula, which continued until the whole of the orifices were opened to the fullest extent, and in this condition they remained. Struck by this explanation and by some other circumstances of a similar nature which I had observed in other sponges, I felt a strong conviction that the Spongiadæ possessed the power of expanding and contracting the oscula at their pleasure while in a living condition, and I determined at the first convenient opportunity to work out this interesting problem in their natural history. I accordingly located myself at Tenby, South Wales, at the latter end of last May for the purpose.

The great cave that runs completely through beneath St. Catherine's Island at Tenby, is highly favourable to such observations as I contemplated making, as it is studded abundantly in every direction with specimens of *Halichondria panicea* and *Grantia compressa*, Johnston, and a deep orange-coloured sponge, *Hymeniacidon caruncula*, Bowerbank, MS. On my first visit to the cave, June 2nd, I carefully noted the appearance of *Halichondria panicea* and *Hymeniacidon caruncula* in the condition of repose during the period of low tide, while they were without water and fully exposed to the influence of the atmosphere. I found that in *Hal. panicea* the greater portions of the oscula were completely open, while the tubular orifices of others were either partially or completely closed. On the contrary, in fifty or sixty specimens of *Hymeniacidon caruncula* they were so completely closed that I could scarcely detect even their position on the surface of the sponge. I carefully removed several specimens of each species from the rocks to which they adhered, taking care not to injure the basal membranes of the sponges. I placed them in shallow dishes of fresh salt water, and in a short time the whole of them began to pour forth streams of water from their oscula with considerable force. I supplied these specimens with indigo rubbed up into a fine powder and infused in salt water; the rush of the particles to the outer surface of *Halichondria panicea* and *Grantia compressa* rendered them of a deep blue colour in a short time, and the ex-current streams continued steadily in action for more than an hour. I then poured off the water, that they might remain for some hours in the same condition as the specimens were in their natural locality; at 8 o'clock in the evening I filled up the dishes with fresh salt water, and in a very short time the ex-current action commenced; and I left it in full action in two specimens of *Halichondria panicea* at 11 P.M. On examining these specimens at 10 A.M. on the 3rd of June, I found that nearly the whole of the oscula, which were fully distended on the previous evening, were now nearly all closed; and the mode of closing was in some cases rather peculiar; the greatest contraction was at about half a line within the outer edge of the osculum, and by this constriction the closing was completely effected, leaving the outer part of the osculum above this constriction in the form of a shallow cup, slightly elevated above the general level of the surface of the sponge.

Of three specimens of *Hymeniacidon caruncula* placed by themselves in a saucer of sea-water, not a single osculum was apparent at 11 P.M. on the previous night; but on the following morning, June 3, at 9 A.M., several oscula in each specimen were to be seen in a full state of expansion, varying in size from one to four lines in diameter, and the ex-current streams were steadily poured forth.

The surface of the sponges exhibited a comparatively smooth and dilated appearance, and the inhalant pores were distinctly visible by the aid of a 2-inch lens. I removed these specimens from the water and placed them in a saucer; in the course of a few minutes the surface of the sponges lost the smooth distended appearance, the pores were scarcely distinguishable by the aid of the same lens, and the surface became full of corrugations. The oscula gradually contracted at about a line or half a line within the outer margin, and this slow contraction continued in action until the openings were completely closed, and a cup-shaped depression only remained to indicate the large orifices which but 10 or 15 minutes previously were steadily pouring forth the ex-current streams. The thin sharp membranous edges of the osculum shrunk into a fleshy obtuse margin to the basin-shaped depression of these organs in their closed state.

I let them remain without water from half-past 9 o'clock in the morning until half-past 1 P.M., and then replaced them in the saucer with a few fronds of green fuci, and gave them fresh sea-water. In 5 or 6 minutes there was a manifest expansion of the oscula, and they continued gradually to open; the obtuse margins became thin, sharp, and slightly projecting, and the currents were poured forth vigorously and continuously from each osculum. I triturated a little crude indigo in sea-water, and let it glide from the small palette knife over those portions of the sponges where there were no oscula; the molecules of indigo were immediately drawn forcibly down to the surface, and were retained there. I then dropped in a similar manner a few drops of the water laden with indigo, immediately over the oscula; a few molecules remained very close to the margin of the osculum, but the remainder were driven off by the powerful jet of water issuing from the osculum, and were speedily dispersed and mixed with the surrounding fluid. By these experiments the in-current and ex-current actions were rendered strikingly apparent, and it was evident that even in the immediate vicinity of the oscula the in-current action was in full operation. At a quarter past 3 o'clock the ex-current action had entirely ceased in one of the four specimens, and was very languidly continued in the others, but the oscula were still fully expanded; before an hour had elapsed, the ex-current action had apparently ceased in all the specimens; the smaller oscula were closed, but the larger ones were contracted to the extent of about half their greatest amount of expansion. I drained the water from these sponges at half-past 11 P.M., and at 10 o'clock the next morning, June 4, I filled up the saucer with fresh sea-water, but I did not detect them in action during the remainder of the day. At half-past 11 of the 4th the water was again drained from them.

June 5th.—At a quarter past 9 A.M. I put fresh water to the same group of *Hal. caruncula*; about five minutes after the oscula were slowly opened, and the ejection of the water from one of the small oscula near the middle part of the largest sponge, commenced at first slowly, and then, after the lapse of a few minutes, with such force as to produce a continued elevation of the surface of the water immediately above it, about a $\frac{1}{4}$ or $\frac{3}{8}$ of an inch above the osculum. During this action of the smaller and more simple osculum near the middle of the sponge, two large compound oscula, each consisting of three or four orifices, situated in depressions near each end of the sponge, were languidly pouring forth streams of water. Three quarters of an hour after the commencement of the projection of the ex-current streams they became still more languid in their action, and at the end of an hour they entirely ceased; the oscula in each of the groups near the ends of the sponge were entirely closed, and the small one, near the middle of the sponge in which the action had been the most forcible, alone remained partly open.

Finding that this sponge, which was 2 inches in length, 1 inch in breadth, and $\frac{3}{4}$ of an inch in thickness, was by far the most interesting and active in its habits, I determined to direct my observations more especially to its proceedings for the future, and I accordingly separated it from the others and placed it in a saucer full of salt water fresh from the sea, and put a few small green fuci along with it. In 7 minutes after immersion in the cool fresh salt water, the ex-current action again commenced slowly; the closed oscula gradually expanded, but not fully and completely, and the action was steadily and moderately sustained; at a quarter to 12 the action was so strong and vigorous as to again cause a considerable elevation of the surface of the water above the central and most active osculum of the largest sponge. It is evident, therefore, that temperature has much to do with the activity of its action, and that the animal is quickly cognisant of such changes, and is rapidly amenable to the stimulus of a fresh and cool supply of the element in which it exists; and it is equally evident that its actions are not merely mechanical or periodical, but subject to its own control, and that it can as readily avail itself of favourable circumstances for imbibing nutrition or of protecting itself from adverse circumstances, as the higher organized and more elaborately constructed classes of animals. At 12 o'clock, on returning to examine the state of affairs, I found the sponge perfectly quiescent, and some of the oscula again closed. I immediately changed the water in this case, pouring it full on the sponge in a large stream, and at 4 minutes after 12 the currents were again in full action; at 11 minutes after 12, the stream from the central osculum was so forcible as to elevate the water to a considerable extent at the surface immediately above it; at a quarter past 12 one of the large groups of oscula commenced ejecting a stream so strong as also to produce an elevation of the water immediately above it. It would appear therefore that the action of the different oscula is not simultaneous, but that each is independent, to a considerable extent, of the other. At 1 o'clock, when I left them, they were still in action, although slowly; and on my return at 3 o'clock they were all apparently quiescent, and remained so for the remainder of the day. At 11 P.M. I drained the water from them, and left them so for the night.

June 6th.—At half-past 9 o'clock I put more sea-water to them. It had stood some time in the sun, and was probably above the ordinary temperature. In about 5 minutes the ex-current action commenced, and proceeded languidly for about half an hour, and then ceased. At half-past 12 I drained the water from it, and supplied it with water fresh from the sea, and the ex-current action almost immediately recommenced, and at 1 o'clock was so forcible that the surface above the two large groups of oscula was considerably elevated by the force of the jets; at a quarter to 2 o'clock the action had entirely ceased. I drained off the water, and poured fresh water over the sponge by jerks, until I had filled the saucer; again, in a few minutes, action commenced in the large group of oscula near the largest end of the sponge, and attained sufficient force to elevate the surface of the water by the force of its jet at 6 minutes to 2 o'clock; but this time it was the only osculum in action, the smaller central one and the other large compound osculum remaining quite inert, and the central one so completely closed, that it was only by minute inspection with a 2-inch lens, and a complete familiarity with the surface of the sponge, that I could make certain of its precise position; at 20 minutes after 2 o'clock the central small osculum had opened, and was sufficiently in action to elevate the surface of the water above it; but the third, the large one at the smaller end of the sponge, was still inert, and the small oscula within the large outer orifice were closely shut. At

37 minutes past 2 the third osculum had opened, and the whole three were in strong action, each projecting a stream so strong as to elevate the surface of the water above it. This independence and inequality of action is remarkably curious. I left them in the above-described state of full action at 15 minutes to 3 o'clock. On my return at a quarter past 3, action had entirely ceased, the group of oscula at the small end of the central osculum were closely shut up, but in the group at the largest end of the sponge the mouths of the oscula were open, but apparently entirely inert. At half-past 11 P.M. I drained off the water for the night.

June 7th.—I put fresh water to the same sponge at half-past 9. No action was observed until half-past 10; it was then very languid, and ceased entirely in a very short time; at a quarter past 12 I again drained off the water, and poured fresh cool water on the sponge; in about 10 minutes the ex-current action commenced from the two large groups of oscula near the ends of the sponge, and in a very short period, about 10 minutes, the action became so strong as to produce the elevation at the surface of the water immediately above them. During this period the small osculum in the middle of the sponge was closed and entirely inert. I did not examine it again until 2 o'clock, when the action had ceased; at 11 P.M. I poured off the water as usual.

June 8th.—At 10 o'clock I poured fresh sea-water over it and filled the saucer as usual; within one minute it commenced ejecting granules of effete matter from the two large oscula, and in a few minutes the action was strong enough to produce the usual elevation at the surface of the water. I looked carefully with a 2-inch lens for the central osculum, but could not detect it, and it had all the appearance of having been permanently closed by a membrane. When in full action the membranous margins of the oscula are tense and very distinctly defined; but when the action becomes languid or ceases, the orifices contract to about half the diameter they assume in an active state, the marginal membranes lose their tension, and the edge becomes very indistinct. Previously to a general cessation of action, it will sometimes occur that one or two of the oscula of the group will assume this inert and flaccid appearance, while from one only the stream will continue to issue in full force, and this condition was assumed by the two large compound oscula this morning at 12 o'clock.

It is a remarkable circumstance, that of eighteen other specimens of the same species of sponge which were treated in precisely the same manner as the one whose history I have just recorded, three only of them had assumed ex-current action up to 12 o'clock on the 8th of June. It is evident therefore that the commencement or the cessation of action is not a merely mechanical effect, arising from temperature, or the general effect of particular circumstances, but that, as in other animals, each individual commences or ceases action as may be dictated by its especial necessities.

At 8 minutes past 12 o'clock the osculum at the large end was still in full work. At a quarter to 1 o'clock the osculum at the small end had resumed action, and in the mean time no cessation had occurred in the action at the large end. At half-past 1 o'clock I left both groups of oscula in steady action, each producing its elevated spot on the surface of the water. On my return at 4 o'clock they appeared perfectly quiescent. I immediately poured off the water and gave them fresh cool sea-water, and on looking at them again at 5 o'clock, they were in very powerful action, and the middle single osculum that had remained closed so long, had now opened and poured forth a stream that raised a considerable elevation on the surface of the water, and the osculum was fully expanded. At 5 o'clock the same osculum had ceased to act and was again completely closed, while the other two groups of oscula were still in full action.

I frequently examined the condition of the sponge until past 11 o'clock P.M., and found the ex-current action of both the large groups of oscula in full force. The action of the ex-current streams had been more vigorous and continuous than on any day since the commencement of my observations of it, and the elevation of the water at the surface above the oscula had been larger than ordinary, indicating a greater amount of force than usual. At half-past 11 P.M., when I poured off the water for the night, the two large compound oscula were in full play.

June 9.—At 10 o'clock I put fresh sea-water to the sponge, and within a minute the ex-current action was apparent at both the large groups of oscula, and in a few minutes became in full vigour. The central smaller single osculum was perfectly closed, and not the slightest appearance of it was to be detected with a 2-inch lens. The action in the two groups of oscula continued in full force until half-past 12, when the group at the small bend had ceased to act, and the smaller oscula of the group had contracted to about half their full diameter. I placed a drop of water charged with indigo immediately above this osculum, and watched the effect with a 2-inch lens, and was surprised to find that its action was reversed, and the molecules of indigo passed into it with a considerable degree of rapidity. I repeated the application of the drop of water charged with indigo several times, and the result was the same. Occasionally the ex-current action was resumed for an instant, and a large molecule of indigo would be expelled, but the next moment the in-current action would be resumed. At half-past 1 I repeated the application of the drops of water charged with indigo with the same result; when it suddenly broke forth again into strong ex-current action, elevating the surface of the water immediately above it in the usual manner, and continued thus to act. The reversal of the action in the osculum in this instance was apparently effected by the vigour of the action in the other group of oscula; the whole of these organs being more or less connected, not only by the intermarginal canals, but also by the general system of interstitial canals of the mass of the sponge.

At half-past 2 o'clock the action of both of the groups of oscula had entirely ceased. At 10 minutes to 3 o'clock I drained off the water, and put fresh sea-water to it, and the ex-current action from both groups commenced again in less than a minute, and were in full action in about 2 minutes. The action continued untill 11 P.M., when the water was drained off for the night.

June 10.—At 10 A.M. I put fresh water to the sponge. The ex-current action commenced immediately from the large groups of oscula, elevating the surface of the water as usual. The central osculum remained perfectly closed, presenting the appearance of a new membrane having been formed over its orifice, and below it on the side of the sponge I observed that a new osculum had been formed about the same size as the largest of those already existing. The stream poured from this osculum was as powerful as any of the older ones, and it elevated the water at the surface strongly, although the line of action was in a diagonal direction, and therefore passing through a greater distance than those that were ejected in nearly a straight line upward. At 11 I left the whole of these oscula in full play. On my return at 3 o'clock all action had apparently ceased. On carefully examining the state of the oscula I had left in full action, I found that the closing membrane of each was contracted in such a manner as to close each orifice all but a central opening, so small as to appear by the aid of a 2-inch lens scarcely capable of admitting the point of a pin. I drained off the water and poured fresh sea-water slowly over the sponge, and positioned it again for observation, and found that it was again in full action, having the three oscula distended to the fullest extent of their capability. At half-past 4, when I returned, they were perfectly quiescent, and the oscula had resumed the appearance I have described above, with the very minute orifice in the centre. I left them in that condition, and at 7 o'clock examined them again, when I found them still quiescent; but one of the two large groups of oscula and the new one were entirely closed, while the other osculum at the largest end of the sponge had opened to the extent of about one-third of its diameter, and the membrane presented the appearance of a series of lines or corrugations radiating from the centre to the circumference. I have since frequently observed the same appearance when the oscula have been in a half-closed condition.

I observed today that three new oscula had been opened about midway between the large group at the largest end of the sponge and the base of the sponge; these new organs entered upon their function with as much vigour as the older ones, ejecting their streams with an equal degree of force. The new osculum, formerly described as having been opened beneath the central osculum, was increased in diameter; and the central one, formerly so energetic in its action, remained completely closed.

June 11, 12, and 13.—I continued to watch closely the action of this interesting and active specimen. It continued to exhibit results very similar to those already recorded. The three new oscula beneath the group at the large end increased somewhat in diameter and acted with much force. The central osculum, up to June 13, continued completely closed, and not the slightest indication of its former existence could be discerned. Considerable alteration had also taken place in the two large groups of oscula. At an early period of my observations I sketched each of these groups carefully, that I might be under no subsequent mistake regarding them; and I was induced to do so from having observed that even during the same day the oscula in the same group varied in the relative degree of their diameter when in full action; and I have since frequently observed that sometimes the whole were fully expanded and in vigorous action, while at other times the largest osculum of the group would be very active, while the lesser ones were partially closed and very languidly in action; thus while from the large one the molecules were ejected with great force and rapidity, those from the minor ones seemed to float gently from their orifices until they came under the influence of the forcible stream flowing from the large and active osculum.

Some of the smaller oscula in each group have become apparently permanently closed, while others have assumed greater dimensions: thus the configuration of each of these large groups had become greatly modified, and the sketch of them in their former condition was anything but a faithful portrait of their present appearance.

These variations in the position and diameter of the oscula are very interesting, but are not so surprising as they may appear at the first blush. If we examine the surface of the sponge in its most distended condition while in full action, we see that immediately beneath the dermal membrane there is a complicated system of large ex-current canals, inosculating with each other in every possible direction, and forming a wide but irregular cloacal network. At any point therefore in the course of these canals oscula may be generated in accordance with the necessities of the animal, and new ones having been thus generated, a portion of the older organs becomes more or less useless, and during the cessation of action their membranous lip becomes firmly and permanently closed.

The systems of large cloacal or ex-current canals are very visible by the aid of a 2-inch lens while the sponge is distended and in full action, but in its inactive and contracted condition they are not so readily to be traced. About 1 o'clock I perforated the dermal membrane with a needle in two places, directly above one of these large canals, and immediately applied drops of sea-water charged with indigo, but no immediate result arose from this experiment. At 5 o'clock of the same day, June 13th, I observed that the punctured orifices were much smaller, and had become oval in form, and at 11 o'clock P.M. they were scarcely visible. At 10 o'clock on the following morning, June 14th, previously to placing the sponge in water, they were not visible; but after the expansion of the sponge by the inhalation of water they were barely distinguishable, but the orifices were entirely closed by membrane, apparently as thick and strong as the adjoining uninjured portions of the dermal membrane.

It is thus evident that the formation of new oscula on the lines of intermarginal ex-current canals is not due to accidental circumstances, but that they are instinctively formed or closed up in accordance with the physiological necessities of the animal. This law is also demonstrated by the fact, that when a slice of considerable dimensions was removed from the upper surface of a specimen of this species, when three large orifices were generated by the sections at right angles of as many large canals, none, either of the large orifices thus created, or of the numerous smaller ones, remained open after a lapse of twenty-two hours.

June 14.—During the whole of this day the largest osculum of the group at the small end of the sponge continued in strong and steady action; all the other oscula remaining inactive and closed.

June 15.—No traces of the punctured wounds above the large intermarginal canals were visible. The sponge commenced action at 10 o'clock A.M., when water was put to it in exactly the same manner as recorded on the 14th, and the action was confined to the single large osculum at the small end of the sponge. At half-past 11 A.M. the whole of the remaining oscula opened, and commenced pouring forth streams of water vigorously. The smaller oscula of the groups at the small end of the sponge were apparently permanently closed, and the single large osculum had much increased in diameter.

I continued my observations on this sponge from the 16th to the 28th of June, with variable results. Some days it remained perfectly inert, but it generally inhaled and exhaled water with more or less vigour for some hours each day; and I could usually induce action by pouring on it a small stream from a few inches above it, or by running the water over it for a few minutes with a spoon.

On the 29th I poured the water from it and some other specimens of the same species at 7 A.M., and placing it in a pan on fresh fuci, I brought it with me to London, where I immersed it in sea-water which I had brought with me at 7 o'clock P.M. I continued to treat it as heretofore, and on giving it some fresh sea-water on the 1st of July, it slowly commenced action from the large osculum at the small end of the sponge. On weighing it after having been immersed about an hour in water, July 1st, I found it weighed 128 grains after having been immersed in water two hours. I was induced to weigh it, from observing that it was paler in colour than usual, and had a more rugged or warted surface than customary. On the 10th of June, at 10 A.M., I had previously weighed this sponge, first, after having been out of the water the whole night, when it weighed 137 grains, and at 12 o'clock of the same day, after being in water two hours, when it weighed 144 grains, having increased in weight one-nineteenth, or rather more than 5 per cent. The difference between the first and second weighing, under similar circumstances, therefore amounted to 16 grains. It had thus lost one-ninth of its original weight.

I continued to observe daily the condition of this sponge which had previously afforded me such satisfactory results. It exhibited very little difference in appearance until the 15th of July, when it became somewhat paler in colour; after being an hour out of the water it weighed 121 grains. I continued to examine it frequently from the 15th to the 20th of July, and I found that the paleness that I had noticed on the former date, was occasioned by a gradual dissolution or change of the dermal membrane, the remains of which hung about the sponge in the form of small flocculent fragments.

This dissolution or change of the dermal membrane produced a remarkable alteration of its external features. Beneath the old dermal membrane, as I before stated, there were several large superficial canals which meandered irregularly over nearly every part of the sponge, with which the oscula were always connected; but after the dissolution of the membrane, the whole of these closed canals were uncovered, and became simply a series of deeply indented channels on the exposed surface, and no membranous oscula were any longer apparent; but in the places formerly occupied by these, there remained a series of large, irregular orifices only, without any membranous veil whatever that was apparent. Under these circumstances, the sponge presented a much more rugged and attenuated appearance than it had previously exhibited, and I accordingly weighed it again, under precisely the former circumstances, and was surprised to find that the weight was 121 grains, being precisely the same as when weighed five days previously.

From the 1st of July to the 20th I examined this sponge frequently, and often endeavoured to excite it to ex-current action by pouring water over it, but without success. On the 21st of July I omitted to replace it in the water at night, and in the morning I found it was dead, giving forth a peculiar odour that always accompanies the death of the sponge.

Adhesion of Species.

It has long been known to naturalists, through the valuable communications of Dr. Grant in the Edinburgh Philosophical Journal, vol. xiv. p. 115, that individuals of the same species of sponge growing near each other, united and became as one sponge, when by their natural extension they came in contact; and that individuals of different species under similar circumstances, however closely they might embrace each other, never became organically united. I have frequently seen these facts verified in their natural localities at Tenby, and under other circumstances. I determined therefore to endeavour to ascertain, if possible, the phænomena that were exhibited under such occasions of coalescence.

On the 4th of June, at 3 P.M., I placed nine small specimens of *Hymeniacidon caruncula* in a saucer-full of salt-water with a few green fuci in it, and I arranged the sponges gently in contact with each other. On examining them at 11 o'clock A.M. on the 5th of June, I found that five of these specimens in which the contact had been complete, were firmly cemented together. Two of them were one and a half inch in length, and three-fourths of an inch in breadth, and the others about half that size; but so strong was the adhesion, that the largest four, full of water, were readily sustained out of the water by the smallest of the united group. Twenty hours therefore had sufficed to unite them firmly.

At 3 o'clock P.M. of the 5th of June, I placed several specimens of the same sponge in contact in pairs; at half-past 11 P.M., on pouring off the water carefully, I found some of the pairs had slightly adhered to each other.

I left them in contact without further disturbance, and it is evident that adhesion will, to a certain extent, be effected in eight or nine hours, an amount of exertion of vital action that was scarcely to have been expected. At half-past 9 o'clock on the following morning, June 6th, I found the junction of the four pairs of sponges had been strongly and completely effected during the night, and while deprived of water. The united portions in two of the pairs were three-eighths of an inch in length. No traces of the lines of separation that existed on the previous day could be detected with a 2-inch lens, and the uniting membrane stretched from one to the other, without the slightest depression or indication of the former state of separation. Thus we find a strong and complete junction effected in each of the four cases in so short a time as eighteen hours.

None of these specimens when taken from the rock were compressed or otherwise injured, and in none of them were there any oscula visible. On the following morning, when supplied with sea-water after having been left exposed to the air and without water during the night, the numerous oscula made their appearance, and the ex-current action became general and very vigorous, creating currents in every possible direction at the surface of the dish of water in which they were kept.

June 7.—I examined them again at half-past 9 o'clock, and found the adhesion between the specimens had been strengthened; I gave them fresh water, but not finding any action taking place at 12 o'clock, I removed them and pickled them in bay-salt and water.

I repeated this experiment on the adhesion of individuals of the same species many times and always with the same results. Specimens of *Hal. panicea*, when placed in contact, also adhered to each other, but they did not appear to adhere either so rapidly or with so much force as in *Hym. caruncula*. When specimens of *Hal. panicea* and *Hym. caruncula* were placed in close contact, no adhesion whatever took place.

I fully expected this result, as I had often examined the two species growing closely pressed against each other on the rock, and always found that, although the contact was close and apparently forcible, no adhesion could ever be detected.

On several subsequent occasions I placed pairs of specimens of *Hymeniacidon caruncula* in contact at about 11 o'clock P.M., after draining the water from them, and in every instance I found the adhesion took place as readily without, as with immersion in water.

Reparative powers.

The remarkable activity of the vital power, as displayed in the rapidity and strength with which individuals of the same species adhered to each other, naturally led me to imagine that the power of repairing injuries would be no less great than that of simply coalescing, and I determined to investigate this branch of their economy.

June 8.—At half-past 1 P.M. I wounded a specimen of *Hymeniacidon caruncula*, rather exceeding 2 inches in length, in two places. In one case I made a clean cut across it nearly half an inch in depth; in the other I cut a notch in it about three-fourths of an inch in length, and the eighth of an inch wide and deep. At 5 P.M. a manifest alteration had taken place in the latter case. The edges of the wound at the dermal membrane were no longer angular, but were rounded off, and a very thin membrane appeared to be in course of production over the whole of the cut surface. The surfaces of the first simple incised wound could not be readily separated, and a sufficient amount of adhesion had evidently taken place within, to prevent the wounded surfaces from separating without the application of some amount of violence. At 10 A.M. of the 9th of June, I examined this specimen again, and found that the deep incised wound had entirely closed, and a firm and strong membrane had united the previously separated parts of the surface of the sponge so completely that a separation of the sides of the wound could not have been effected without a degree of violence that would have endangered the whole sponge. The large notch that had been cut on the other end of the sponge had also been completely repaired. The edges of the wound had lost all their angularity, and the sides of the cut, in which when first made there were numerous orifices arising from sections of the great canals, were now covered by the new membrane, which entirely closed all the orifices caused by the wounding of the sponge; and so complete was the reparation, that the indentation appeared to be merely one of the natural depressions of the surface of the sponge. From 11 to 12 o'clock the sponge exhibited ex-current action from its principal oscula, and among those in full action was one which had been bisected in the act of making the deep simple incision across the substance of the sponge.

On the 8th of June, at 4 P.M., I also wounded several sponges of the same species *in situ*, on the rocks in St. Catherine's cave, by cutting notches about the eighth of an inch in breadth and depth in their surface, or by cutting out conical masses from near the middle of the sponges about a quarter of an inch in diameter at the surface of the sponge; and in another case I cut a slice from the surface about three quarters of an inch in diameter, and about one-tenth of an inch in thickness at the middle of the sponge. My object in this experiment was to ascertain whether any difference in the results would arise from the very different condition under which the last and the present experiments were made.

On examining the wounded sponges in their natural localities twenty-four hours after the wounds had been made, I found the results to be precisely the same as in those that I had kept in a state of perfect quiescence; the continued action of the water upon them had not retarded the reparative process in the slightest degree, nor had the quiescent condition of those which I had retained in the dishes apparently accelerated the healing process.

June 12.—I cut off a piece from the small end of a specimen of *H. caruncula*, about $1\frac{1}{2}$ inch in length, at 12 o'clock at noon, and let it remain separated for about an hour. I then placed the two surfaces in contact in sea-water. At half-past 11 P.M. they had already united, but were evidently not strongly cemented together. I drained off the water as usual at that period, and left them without any during the night; at 11 A.M., on June 13th, they were completely and firmly united. On June 13th, at noon, with a view to ascertain whether the healing process emanated from the dermal membrane, from the interior substance of the sponge, or from both, I cut a notch, about the eighth of an inch in width, entirely round the middle of the same sponge, and then cut it asunder through the middle of the notch, replaced it in sea-water, and brought the two sides of the section in close contact, to ascertain whether the healing process would take place independent of the dermal membrane. On June the 14th, at 10 A.M., I found the two pieces firmly cemented together without contact of the dermal membrane.

June 13th.—At noon, from a specimen of *H. caruncula*, about $1\frac{1}{2}$ inch long by $1\frac{1}{4}$ broad, I cut a slice from the top of the sponge $\frac{3}{4}$ inch long by about

$\frac{1}{2}$ an inch broad, the greatest thickness being about $\frac{1}{10}$th of an inch, laying open three large ex-current canals, and numerous other small canals and cavities, and then replaced it in the water. I also cut seven other specimens in halves, and then replaced them in the water, bringing the sections into close contact. June 14th, at 10 o'clock A.M., I found the two pieces firmly cemented without contact of the dermal membrane. On examining the sponge, from the top of which I had cut off a slice at 12 o'clock, June 13, at 5 o'clock on the same day, I observed that the three great orifices arising from sections of great ex-current canals were each in process of being closed. From the circular margin of each a membrane had extended from the circumference towards the centre, very nearly closing the smallest of the orifices, and in the other two cases leaving in one a circular central orifice, one-third of the original diameter, and in the other about one-fourth of the diameter. On the following morning, June 14, these apertures were entirely closed, and over the whole of the wounded surface a new dermal membrane had been formed, which securely closed all the numerous small orifices as well as the larger ones.

The seven larger sponges which I had separated by cutting into halves, and then replaced in water with the divided parts again in close contact, were all found firmly united at 10 o'clock on the following morning, June 14th; and at June 15th, 10 A.M., the reparation of the subjects of the above experiment were so complete as to quite obliterate the traces of the separation in some of them. I therefore pickled the specimens. In other cases I cut the same species of sponges into three pieces and reversed the position of the middle piece of each, so as to render the sections unconformable; but this reversal of position, when the surfaces were brought into close contact, did not seem in the slightest degree to retard the healing process, or to render the adhesion of the pieces less firm than when placed together conformably.

Disease and Death.

July 1.—At 10 A.M. I observed in one of the specimens of *Hym. caruncula* which I had brought from Tenby to London, an appearance of disease in one of the lobes of the sponge for about half an inch from the point inwards. There was a tumid appearance of the surface tissues and a glassy opalescence in the part affected. On smelling this portion of the sponge, there was a slightly fœtid odour which did not exist in the healthy portions of it. I immediately cut off this piece about half an inch from the diseased part, and placed it in a basin by itself in sea-water. In six hours the diseased appearance had become much more evident, but the healthy part attached to it remained apparently unaffected. On examining a section from the surface of the most diseased part, I found the dermal membrane distended by an effusion of an opalescent lymph-like fluid; the sarcode in the immediate neighbourhood had lost its red colour, and the parts were apparently in a decomposing state, but the adjoining portions of the same tissue presented a healthy appearance. The separation of the diseased piece from the parent sponge, had apparently been effective in preventing the spread of the disease, as it retained its usual appearance at the section and in the other parts of the sponge during the next twenty-four hours, but shortly after that time, it began to exhibit strong symptoms of disease, and in a few hours it was evidently dead.

Nutrition.

I cannot dismiss the subject without a few words regarding the nutrition of the Spongiadæ. That they inhaled and exhaled water abundantly, has been long well known, but what the effects of the exertion of those functions were has been little noted by naturalists; and although, by the almost universal consent of zoologists, they have been received as animals, they have been denied the possession of stomach, intestines, and almost of every organ that constitutes animality, while in truth nearly the whole of the interior of the animal is one large stomachal cavity, furnished abundantly with mucous membranes, if I may so term them, covered with a coat of sarcode, analogous in every respect to the mucous lining of the intestines of the higher animals, and which performs for the sponge precisely those functions that the sarcode exerts, from *Actinophrys Sol* upwards, through every gradation of animal existence, to man, and the rest of the most elaborately constructed animals. This extraordinary substance, designated, in *Actinophrys Sol*, sarcode by Kölliker, and in the higher animals known by anatomists as the mucous lining of the intestines, is apparently an organ of very much more importance in the process of digestion than has been generally conceived. It is never deficient in any animal, from the lowest to the highest. I have examined it from living specimens microscopically in Acalepha, Actinia, Radiaria, Fishes, and in the Mouse and other small quadrupeds; and in all, it presents nearly the same appearance. It is semi-transparent, has an uneven corrugated surface, and in every instance in which I have observed it, abounds with solid and vesicular molecules of extraneous matter in a semi-digested state. Generally speaking, of the vesicular molecules, very few indeed are in a fully distended condition, and by far the greater number present every degree of collapse that can well be imagined during the dissolution of such bodies by digestion.

In the Spongiadæ there is every reason to believe that the imbibition of the molecules by this substance is precisely in the manner described by Kölliker in *Actinophrys Sol*, and from my examinations of the mucous membranes of so many classes of animals, I feel persuaded that the mucous lining of the intestines in such animals is truly the homologue of the sarcode in *Actinophrys Sol* and in the Spongiadæ.

I will not enter at the present time fully into this subject, as I trust I shall hereafter, by further investigations, be enabled to do so more completely and effectively.

In conclusion I may observe, that I have been thus particular in detailing minutely the history of the actions of the specimen of *Hymeniacidon caruncula* that has been the subject of so great a portion of this communication, as it leads us to some very interesting conclusions. We learn by the daily records of its actions, that it is neither the mere stimulus of light or even the presence of fresh water, or the abundance of its natural food, that will at all times stimulate these animals to action, as in vegetables; but that, on the contrary, they select or reject their food like other animals as their necessities may dictate; and not the least curious part of the history of this sponge, is the power it displayed to determine what parts of its organs should be called into activity, and what should be quiescent.

During the course of these observations I have frequently observed other specimens of the same species, and have tested the degree of their action or repose by the application of a few drops of sea-water charged with molecules of indigo; and in almost every case where the oscula were in the slightest degree open, I have found that although apparently inert, there usually remained a very gentle ex-current action. It will be remembered also, that in the course of the records of the action of the sponge which has formed the principal subject of these observations, the general effect of the removal of the animal from the water is the entire closing of the oscula; but that on the cessation of the full and vigorous action, the oscula while still immersed in the water do not close entirely; the orifices almost always remain more or less open, and during this condition a comparatively languid circulation continues.

These two conditions of the animal action are strongly indicative of the exertion of two distinct functions; the vigorous action being that of the period of feeding, while the gentle one indicates the breathing one only.

If, during the powerful state of action of the sponge, we introduce a few drops of water charged with indigo, the rush of the molecules to its outer surface is immediate; and if the species be *Grantia ciliata* or *compressa*, we find the sponge deeply tinctured with blue in a very few minutes. After a brief period we find a few molecules of indigo ejected from the common fæcal orifice of the sponge.

If the sponge be now removed into fresh water, the ejection of molecules of indigo continues for hours to be slowly effected. After having thus imbibed indigo, there is no amount of washing that will not injure the sponge that will remove the colouring matter; but if the sponge be removed into fresh water, it will be found to be free from colour in a period varying from twelve to twenty-four hours, the process of digestion and defecation having naturally effected its removal; and if any molecules remain on the outer surface, a very little water poured over the sponge will now usually remove them.

The strongly adhesive power inherent in the dermal membranes of sponges and in all parts of their internal structure, readily accounts for the universal habit of inosculation, not only as regards the large external branches, but the internal fibres also, and it is evident that to this active power of adherence the reticulated forms of fibrous structure is due.

Report of a Committee, consisting of Sir W. Jardine, Bart., Dr. Fleming, *and* Mr. E. Ashworth, *upon the Experiments conducted at Stormontfield, near Perth, for the artificial propagation of Salmon.*

The migrations of the Salmon between the seas and rivers have long been a subject of much interest to the proprietors of salmon fisheries, to sportsmen, and to naturalists; and the difficulty of making observations, or of obtaining accurate information, rendered the pursuit of the inquiry if possible more exciting. The experiments conducted by Mr. Shaw at Drumlanrig, and Mr. Young at Invershin, produced many valuable and important results; and being conducted with great care by practical men, entirely independent of each other, and at stations widely apart, the facts stated were entitled to every reliance. The opinions of these two men, however, were at variance on a very important point, viz. the age at which the young fry assumed their migratory dress and took their departure from the river to the sea—Mr. Shaw making it two years, Mr. Young only twelve or thirteen months.

These experiments, and the success which had attended artificial propagation in France, and the extent to which, in that country, the latter was beginning to be practised economically and for profit; the trials of Mr. Garnett at Clitheroe, and of Mr. Ashworth at Outerard in Ireland, attracted the attention of the fishermen of the Tay; and on the 19th of July, 1852, a meeting of the proprietors of that river was held at Perth to consider the subject generally. This meeting was numerously attended, and Mr. Thomas Ashworth of Poynton laid before it and explained the operations which had been recently carried on by himself and his brother, Mr. Edmund Ashworth, at their fisheries in Ireland, and recommended strongly that these should now be attempted for the Tay. The recommendation was acceded to, and the Earl of Mansfield, who was chairman of the meeting, at once gave permission to select from his estates any situation favourable for carrying on the experiments. This was the origin of the Stormontfield breeding ponds, and an excellent account of their construction, with a detail of the operations conducted in them, was brought before the Natural History Section of the British Association at their meeting in Glasgow, which led to the support of the Association, and the appointment of the Committee which has reported this year to the meeting at Cheltenham*.

To bring the subject up to the period when the Committee appointed by the British Association was prepared to act, it will be necessary to mention the principal points and results of the experiments detailed by Mr. Edmund Ashworth at Glasgow. These are extremely interesting in themselves, and are indispensable for the right understanding of the operations which were afterwards conducted and are now in operation†.

The situation for the ponds was selected at Stormontfield Mill‡, not far from the Palace of Scone. "A gentle slope from the lade which supplies the mill offered every facility for the equable flow of water through the boxes and pond. Three hundred boxes were laid down in twenty-five parallel rows, each box partly filled with clean gravel and pebbles, and protected at both ends with zinc grating to exclude trout and insects. Filtering beds were formed at the head and foot of the rows, and a pond for the reception of the fry was constructed immediately below the hatching ground. On the 23rd of November, 1853, operations were commenced, and by the 23rd of December, 300,000 ova were deposited in the boxes. The fish were taken from spawning beds in the Tay."

The process of fecundation and of depositing the ova in the boxes was conducted by Mr. Ramsbottom, who was engaged for the purpose, his practice and experience at Clitheroe and elsewhere giving confidence to his manipulations. "The ova were placed in the boxes as nearly similar to what they would be under the ordinary course of natural deposition as possible, with, however, this important advantage—in the bed of the river the ova are liable to injury and destruction in a variety of ways. The alluvial matter deposited in times of flood will often cover the ova too deep to admit of the extrication of the young fry, even if hatched. The impetuosity of the streams, when flooded, will frequently sweep away whole spawning beds and their contents§. Whilst deposited in boxes, the ova are shielded from injury, and their vivification in large numbers is thus rendered a matter of certainty, and the young fish reared in safety. On the 31st of March, 1854, the first ovum was observed to be hatched, and in April and May the

* The Committee named to watch over the experiments in progress, and those to be commenced in 1856, consisted of Sir W. Jardine, Bart.; the Rev. Dr. Fleming, Prof. Nat. Hist. Free College, Edinburgh; and Mr. Edmund Ashworth, Egerton Hall, Lancashire.

† Remarks on Artificial Propagation of Salmon, and some account of the Experiment at Stormontfield, near Perth, by Edmund Ashworth. Bolton, 1855. 8vo, pp. 8.

‡ Mr. Spottiswoode, the tenant of Stormontfield, with much liberality, also agreed to give the use of the ground and water from his mill lade, free of all remuneration; and we may add, that the interest taken by all who had any control over the locality chosen, either in the management and conducting of the experiments, or in communicating information, could not be exceeded; this of itself is a proof of the importance attached to these operations.

§ "These causes, in addition to the great destruction of ova, as well as young fry, by wild fowl, fish and insects, all tend to limit the natural increase of the salmon."

greater portion had come to life and were at large in the boxes; in June they were admitted into the pond, their average size being about an inch and a half in length. From the period of their admission into the pond the fry were fed daily with boiled liver rubbed small by the hand. Notwithstanding the severity of the winter, they continued in a healthy condition, and in the spring of the present year (1855) were found to have increased in size to the average of 3 and 4 inches in length. On the 2nd of May, 1855, a meeting of the Committee (appointed by the Tay proprietors in 1852) was held at the pond, to consider the expediency of detaining the fry for another year, or allowing them to depart. A comparison with the undoubted smolts of the river then descending seawards, with the fry in the ponds, led to the conclusion that the latter were not yet smolts, and ought to be detained. Seventeen days afterwards, viz. on the 19th May, a second meeting was held, in consequence of the great numbers of the fry having in the interim assumed the migratory dress. On inspection, it was found that a considerable portion were actual smolts, and the Committee came to the determination to allow them to depart. Accordingly, the sluice communicating with the Tay was opened, and every facility for egress afforded. Contrary to expectation, none of the fry manifested any inclination to leave the pond until the 24th of May, when the larger and more mature of the smolts, after having held themselves detached from the others for several days, went off in a body. A series of similar emigrations took place, until fully one-half of the fry had left the pond and descended the sluice to the Tay. It has long been a subject of controversy, whether the fry of the salmon assume the migratory dress in the second or third year of their existence. So favourable an opportunity of deciding the question as that afforded by the Stormontfield experiment was not to be overlooked. In order to test the matter in the fairest possible way, it was resolved to mark a portion of the smolts in such a manner that they might easily be detected when returning as grilse. A temporary tank, into which the fish must necessarily descend, was constructed at the junction of the sluice with the Tay; and as the shoals successively left the pond, about one in every hundred was marked by the abscision of the second dorsal fin. A greater number were marked on the 29th of May than on any other day, in all about 1200 or 1300. The result has proved highly satisfactory. Within two months of the date of their liberation, viz. between the 29th of May and 31st of July, twenty-two of the young fish so marked when in the state of smolts, on their way to the sea, have been, in their returning migration up the river, recaptured, and carefully examined. This fact may be considered as still further established, by observing the increased weight, according to date, of the grilse caught and examined; those taken first weighing 5 to $9\frac{1}{2}$ lbs., then increasing progressively to 7 and 8 lbs., whilst the one captured 31st July weighed no less than $9\frac{1}{2}$ pounds. In all these fish the wound caused by marking was covered with skin, and in some a coating of scales had formed over the part. Although twenty-two only are mentioned, the taking of which rests on indubitable evidence, nearly as many more are reported from distant parts; the weights and sizes of these have not been forwarded.

"The experiment at Stormontfield has afforded satisfactory proof, that a portion at least of the fry of the salmon assume the migratory dress, and descend to the sea shortly after the close of the first year of their existence; and what is far more important in a practical point of view, it has also demonstrated the practicability of rearing salmon of marketable value within twenty months from the deposition of the ova. A very interesting question still remains to be solved. At what date will the fry now in the pond become smolts? Hitherto they have manifested no disposition to migrate, and if the silvery coat of the smolt be not assumed till the spring of 1856, a curious anomaly will present itself. Some of the fry, as smolts, will, for the first time, be descending seawards, of the average weight of 2 oz.; some as grilse will be taking their second departure to the sea; and others still more advanced will even have completed their second migration, and return to the river as salmon 10 or 12 lbs. in weight. It is much to be desired, that the experiment at Stormontfield could be continued for a year or two longer, till the links in the chain of evidence now wanting to complete the natural history of the salmon should be obtained. All praise is due to Lord Mansfield for the liberal manner in which he has aided the carrying out the operations to this time, and from which he can reap little advantage, beyond the satisfaction to an enlightened mind, of promoting the interests of science and the welfare of the community.

"Since arriving in Glasgow I have received a communication from my friend Mr. Buist, in which he says,—'In my opinion, you have kept your statements within the truth, as I have got satisfactory evidence of twenty-two marked grilse being taken, besides others which have been reported; and I have no doubt many have been thrown in the heap without being noticed by the careless fishermen. There is at present a mystery as regards the progress of the young salmon; there can be no doubt, that all in our ponds are really and truly the offspring of salmon; no other fish, not even the seed of them, could by any possibility get into the ponds; now we see that about one-half have gone off as smolts in their season as grilses. The other half remain as parrs, and the milt in the males is as much developed in proportion to the size of the fish as their brethren of the same age 7 to 10 lbs. weight, whilst these same parrs in the pond do not exceed 1 oz. in weight. This is an anomaly in nature, which I fear cannot be cleared up at present. I hope, however, by proper attention, some light may be thrown upon it from our experiments next spring. The female parrs in the pond have their ova so undeveloped, that the granulations can scarcely be discovered by a lens of some power. It is strange, that both Young and Shaw's theories are likely to prove correct, though seemingly so contradictory, and the much-disputed point settled, that parrs (such as ours at least) are truly the young of the salmon.'"

We may now consider ourselves at the close of the Glasgow meeting. The Committee which is now reporting to you prepared to act, and one-half of the fish hatched in the spring of 1854 are still in the Stormontfield ponds, and under the charge of their faithful guardian, Peter Marshall. These fish are still in the state of PARR. Mr. Ashworth had arranged that a book should be kept at the ponds, in which every occurrence worthy of notice should be entered, and we shall allow that book to tell its own story:—"These parr continued, during the winter 1855–56, healthy and in good condition, but did not appear to make much advance in size until the month of *April* 1856. They were then in good condition, but not much larger than those which had been allowed to leave the ponds the previous year."

As the migratory season approached, the fish were closely watched. Peter Marshall reports, 19th March, "that the parrs in the pond continued very healthy." 19th April:—"Ponds again inspected, and some experiments tried to mark with silver rings. They were then also healthy." 26th April:—"Found that a great change had taken place upon them, and that they were fast getting into their smolt state; marked a few with the silver rings; found it to answer very well, and that the fish went off very lively on being turned into the river; fixed on a place in the river where the smolts can be intercepted for the purpose of being taken out and marked. They showed a decided tendency to go out, and from 28th April to the 24th of May, the shoals went off daily from the ponds."

It is supposed, as a fair estimate, that about 120,000 fry in all have left the ponds in May 1856, and of those 1435 have been marked, being 300 with silver rings, and 1135 by having the lower lobe of the tail cut diagonally off. The return of some of those marked fish was anxiously watched for, and on the 30th of July Mr. Buist writes to me,—"There has been a very large catch of grilses, indeed in such numbers, that the people don't take care to examine them. On 12th July we had a grilse of 3½ lbs. weight, with the lower fork cut off the tail, such as we marked in April and May, and several who were present at the marking of the smolts considered that it was one of them; another with the same mark was reported, but not produced to me." On the 7th of August Mr. Buist again writes,—"Several grilse with cut tails have been taken within the last week." Up to the time of the reading of this Report, no fish marked with rings had been taken, but when the small number marked is considered, this is not remarkable. The experiment of the first hatching may now be said to be completed. The results have been satisfactory in two ways. In showing the practicability of hatching, rearing, and maintaining in health a very large number of young fish for a period of two years, and not reckoning the original expense of the ponds at a comparatively small cost; it may be worthy of consideration, whether the "large catch" mentioned by Mr. Buist as taking place this year, may not have been, in part at least, due to the numbers that have been lately turned out. It has also been again proved, we think without dispute, that the young fish turned out as smolts return as grilses within a period of from five to ten weeks. Not so many marked fish have been taken as could have been wished; at the same time there have been sufficient to establish this fact.

We now come to the experiments of the present year, which have been conducted as carefully as possible, and we hope to be able to report what the final results may be at your next meeting; and if there is a partial migration before that time, or if a certain number of the fish now in confinement take upon them the migratory dress, then we may assume that a similar process takes place in the rivers, and that a *portion* of the broods do seek the sea, at the age of from twelve to fourteen months after they are hatched. In conducting experiments of this kind, there are always attendant circumstances not quite natural that we shall have to contend with; and it may now be urged, that the regular feeding during winter might bring the young fish sooner to maturity, or on the other side of the question, that the confinement of so many within a small compass might retard their growth. But on comparing the fish of the ponds with those in the rivers, we find a remarkable similarity and agreement of the different stages, so far as we can judge of the age of those in the rivers. If, on the other hand, we can by care, with good and regular feeding during winter, *force on*, as it were, the young, or some portion of them, to be in a fit state to migrate in twelve or thirteen months, it will be a very great point gained in the object we have in view (the artificial increase of the salmon), and it does not appear to us that this is impracticable.

In order to try over again the experiments we have just described as concluded in May last, arrangements were made at Stormontfield to fill the boxes with fresh impregnated spawn, and to take every care that this should be done with exactness. The taking of the fish for spawning was commenced on the 22nd of November, and continued until the 19th of December, 1855; in that time

183 boxes were filled, each being supposed to contain 2000 ova. On the 16th December last, Mr. E. Ashworth, on the part of the British Association Committee, accompanied by Mr. Buist of Perth, and Mr. Ramsbottom, met the fishermen at a ford near the junction of the Almond and the Tay, for the purpose of obtaining spawn. Our pond journal relates,—"When we arrived at the river they had caught two female fish, and at the next cast of the net two other female fish were taken. At the third cast they captured a male fish in fine condition, from 24 to 28 lbs. weight. We had now full opportunity of seeing the whole process of spawning performed. The female fish, after being relieved of their ova, swam away quite lively, and each were marked by punching a hole in the tail *."

The male fish proved to be one of the fish which had been caught by Mr. Ramsbottom *in December* 1853, and marked at that time by the dead fin being cut off.

On 18*th February*, 1856, Peter Marshall reports,—"The spawn all healthy, and have every appearance of coming to life."

On 3rd March. "The appearance of the spawn still continues very healthy, but not yet quite ready for hatching."

These reports were continued, and the ova that were first deposited, viz. on the 22nd of November, 1855, came to life on the *3rd* of *April*, 1856. The others in succession and those last deposited, viz. 19*th December*, were hatched on the 11th of April, showing a difference of only *eight* days in the hatching, although there was FOURTEEN between the different dates of deposition in the boxes.

Upon the dispersion or turning out the last portion of the previous brood in the end of May, the rearing pond was emptied, thoroughly cleaned out and prepared for the reception of the young fish of this year, still in the spawning boxes, but now increasing in size. On the 1*st of July* last, your Committee visited Perth, and in company with Mr. Buist and Mr. Walsh inspected the ponds. At this time a large proportion of the young fish had found their way to the rearing ponds. Some were still in the communicating race through which the water flowed gently, and a few still continued in the small pools of the spawning boxes. After the ova are hatched or come to life, the young are allowed to find their own way to the rearing pond; this they do gradually, and with the exceptions stated, had nearly all reached it. They appeared quite healthy, were feeding upon flies and other insects, and when a small quantity of their artificial food (boiled liver grated) was thrown in, they would rush towards it in shoals. The reports of the keeper since the 1st of July have been equally satisfactory,—"The young are as thriving as could be wished in every way."

This, then, is the state and condition of the experiment which your Committee consider they have under charge. Nothing further can be done until the time arrives next year, when it is supposed a part, or the whole of the

* Ova deposited in Stormontfield ponds in November and December 1855.

	Boxes.		Boxes.
1855. November 22	25	Brought forward	87
„ 23	9	1855. December 3	6
„ 24	1	„ 4	5
„ 26	3	„ 5	17
„ 27	9	„ 8	15
„ 28	6	„ 15	19
„ 30	2	„ 17	24
December 1	32	„ 19	10
Carry forward	87	Total	183

brood, may assume the migratory dress, and be ready to remove to the sea. We propose to take such measures as will allow us to watch this narrowly, and also if the migratory dress be assumed, to mark a large number before turning out.

Note to Report on Stormontfield Ponds.—The importance of artificial impregnation, and the general question of changes and migration, is also being attended to elsewhere, and we trust, that as soon as the natural history, the "rise and progress" of the Salmon shall have been completed, a similar series of experiments will be instituted, to determine that of other migratory fishes which have not yet been bred or kept in confinement. Mr. Shaw bred and reared the "*Sea Trout*" of the Solway, and we have given a series of figures of this fish from the length of an inch to a weight of $4\frac{1}{4}$ lbs. *; but the fish of the Tweed, known as the "*Bull Trout*," has never been examined through its different stages, and except those now in the Duke of Roxburghe's ponds at Floors, has never been bred in confinement.

Ponds similar in construction to those at Stormontfield were erected in 1855 by the Duke of Roxburghe near Floors, and upon writing to his Grace regarding them, every information has been kindly supplied by himself, and a detailed account, at his desire, has been drawn up by the Superintendent of the Tweed River Police; and as this bears so much upon our subject, it is thought that some extracts from it will not now be out of place:—

"The pond is situate on a small rivulet called Stodrig Burn, and is about sixty yards from the Tweed, within the policies of Floors Castle, near Kelso. The breeding boxes or troughs I caused to be made similar to those at Stormontfield, and they consist of four, laid parallel, 18 feet long, subdivided into four compartments, $4\frac{1}{2}$ feet long, the only division between the troughs being a $1\frac{1}{2}$-inch deal, instead of the gravel walk as at Stormontfield. The water, which is raised by a dam at the upper end, is made to fall into a deep trough which adjoins the breeding troughs, from which it is as equally distributed, and after flowing over the gravel, it falls into an aqueduct 18 inches wide, and which is carried round the margin of the receiving pond, which is oval-shaped, and about 30 feet long by 15 wide, in which there is about 18 inches of water, and into it the aqueduct or canal discharges itself.

"The pond was constructed in the latter months of 1853, but owing to circumstances, it was not stocked that season.

"On the 4th and 5th of March, 1855, the produce of five fish (three of them grilses) was impregnated with the milt procured from two male fish, and deposited in the hatching troughs. The spring was very cold, and the temperature of the water very low; however, the ova appeared to thrive nicely, and on the 27th of April the young were formed and moving, and from their appearance, I expected they should have been hatched in the course of another week; but when I examined them on the 4th of May, I found, to my astonishment, that not a single ovum was in a healthy hatching state, but thousands of them had in the course of the week become opake, and the backbone and eyes of the little creatures could be easily seen upon dividing the ovum with a penknife. The cause of this mishap it was impossible to trace, but there is much reason to believe that it was caused by a large quantity of lime being used as manure upon the lands through which the rivulet which supplies the ponds flows.

"On the 17th, 18th, and 19th of March this year (1856), I had a quantity of spawn dug from a shallow bank in the Tweed, near Galashiels, part of

* Illustrations of Scottish Salmonidæ.

it being the ova of the salmon, grilse, and bull trout, in about equal portions, and the whole being not less than 50,000. The ponds being in readiness, it was conveyed on the 19th of March to Kelso, in boxes filled with fine gravel or sand in a damp state, and was deposited in the breeding boxes the same day, where it remained till the 11th of April, when the young were first observed to be bursting the shell or covering of the ova. Upon examining the gravel in the boxes on the 2nd of May, I found that all the fish were hatched, and only those remained which had become addled. Since that time most of the fry left the hatching boxes, and fell back into the aqueduct, from which most of them have passed into the receiving pond, where they now remain. They have as yet received no artificial food, but they appear quite healthy, and are growing as well as could be desired. There is a great difference in the size and appearance of them: the largest are about $1\frac{1}{2}$ inch long, while some of them are not over half the size, and the colour of some is much lighter than of others, which no doubt arises from the different kinds of ova which were placed there."

The fishing season in the Tay is now closed for this year, and none of the ringed grilse have been recovered; but Mr. Buist writes to me,—"Since I last wrote (7th August) several grilse with the tail mark have been taken, and a number of salmon have been taken during the season with *last year's grilse mark* upon them. The two last taken were 13 and $19\frac{1}{2}$ lbs." Next season, therefore, our ringed fry may yet appear as salmon, although they have not been captured this year in their grilse state. "Our young brood are thriving well; but as in former cases, they are already showing a great disparity in size."

Provisional Report on the progress of a Committee appointed at the Meeting in Glasgow, September 1855, *to consider the question of the Measurement of Ships for Tonnage, consisting of the following Gentlemen:*—Mr. J. R. Napier, Mr. John Wood, Mr. Allan Gilmore, Mr. Charles Atherton, Mr. James Peake, and Mr. Andrew Henderson (Reporter).

As the first-named Member of the Committee on Tonnage Measurement, it becomes my duty to report progress in the matters referred to us, and in so doing, I beg to premise my report with the remark, that I was induced to propose this Committee from having had the honour of reading a paper on Ocean Steamers, Clipper Ships, and their descriptive measurement, to the Association at their Meeting at Liverpool (vide page 152 to 156 of Report, 1854). While at Glasgow, in 1855, a new shipping bill having come into operation, I found that the extreme interest then publicly taken in the general question of Government interference in shipping affairs seemed to render this Committee expedient.

The serious and important character of the subject thereby involved, and the consequent responsibility imposed on all individuals who may take a prominent part in this matter, have operated as an obstacle to the immediate establishment and working operation of this Committee. In the first place, I beg to notice that the subject of Tonnage Registration, as connected with our national statistics of shipping, had been brought to the notice of the public, both at the Institution of Civil Engineers by myself, in 1853, and at the Society of Arts, by Mr. Charles Atherton, in a manner which has fully set forth the importance of the subject, and shown that legislative enactment will be necessary in order to correct the deficiencies of our present tonnage registration of shipping: the subject, having been thus brought before the public in its most serious and important aspect, has apparently induced several of the gentlemen proposed for this Committee to decline the task thus expected of them.

The absence from Glasgow of many interested in the subject rendering previous communication impracticable, the President and officers of the Mechanical Section deeming it desirable that the three scientific bodies before whom the subject had been brought should participate in the investigation, Mr. John Scott Russell was nominated to represent the British Association; and it being also considered expedient to follow the precedent of the Tonnage Committee of 1849, comprising shipowners, shipbuilders, officers of the Royal Navy, Merchant Service, and Trinity House, gentlemen connected with Lloyd's Register, and their surveyors, with several naval architects and engineers, there were proposed Mr. Allan Gilmore, Mr. John Wood, and Mr. James R. Napier, representing the shipowners and shipbuilders of Scotland; Mr. C. Atherton and Mr. J. Peake, the latter professions, with the understanding that they were to seek the cooperation of others.

Accordingly, application was made to noblemen, officers and engineers connected with the Navy, the Society of Arts, and Institution of Civil Engineers, the shipowners' societies of London and Liverpool, the Committee of Lloyd's Register of Shipping, and to shipbuilders; although many of these gentlemen of scientific attainments and practical experience offered to participate in the investigation, difficulty and delay occurred from some of the members of the Committee being resident in distant parts of the country, while for the deposit of papers and plans for references by the Committee, no provision had been made even in the metropolis; the only means of bringing them under consideration, was the forwarding copies of them to the principal ports, that the members might elicit the opinion of the Local Marine Boards and shipowners.

With this view application was made to the Board of Trade for copies of Acts and Parliamentary papers bearing on the question, to be submitted to the members of the Committee of the British Association in their investigation of Tonnage Measurement.

The official reply was, that the Board of Trade "do not consider that the law of tonnage measurement requires alteration, or that the subject requires further investigation with any view of amending the law." "Most of the papers to which you refer are published, and can be purchased. Those which have not been published, and which are among the records of this office, My Lords cannot part with; but you are at liberty to inspect and take copies of the plans which you have yourself submitted to the Board."

In addition to these delays and the difficulties thrown in the way by the routine of a public office, Mr. Allan Gilmore and Mr. John Wood of Glasgow, expressed a desire to withdraw from the Committee; and Mr. Scott Russell's engagements, especially in connexion with the construction of the great ship for the Eastern Steam Navigation Company, have so engrossed his time and attention as to have put it out of his power to take that interest in this question which has hitherto so laudably characterized his exertions in the cause of science, in connexion with the labours of the British Association.

Mr. Atherton also declined on the ground that the public agitation of the question referred to, in which during the past year he was engaged before the Society of Arts, disqualified him for the time being from taking part on this Committee; consequently, Mr. James R. Napier and Mr. James Peake were the only parties available for cooperation with myself (Mr. Henderson) in this matter, and it has therefore been considered most advisable, under the circumstances above referred to, not to officiate in our collective capacity as a Committee of the British Association, but simply to give our individual aid in promoting the discussions which have thus sprung up.

With this view, I have myself taken a personal interest in the discussion of the tonnage registration question before the Society of Arts, as exemplified by the documents submitted herewith, showing a large amount of statistical data on steam-ship performances, which has been collected by me since I originally brought it before the Institute of Civil Engineers in 1847, with the view of collecting in the archives of that Institution, statistics of the progress of improvement in our mercantile marine.

The papers comprise my view as to tonnage measurement, as laid before the Board of Trade in 1850 and in 1852, and as to steam navigation and the speed realized by mail steamers as laid before Parliament in 1851, papers read before the Institution of Civil Engineers in 1853, the British Association in 1854, and published by the Society of Arts in 1855; together with the discussions that have taken place in the Journal of that Society, in 1856, on Mr. Atherton's paper on Tonnage Registration. The system of measurement I proposed to the Board of Trade in 1850, being exemplified by a *pro forma* certificate of survey appended to the paper, as well as by a tabular analysis of the proportion and displacement of different ships and modes of measurement, including the paper read before the Association last year, and subsequent information, as well as proposed new rules, will be printed complete, before submitting them to the consideration of any committee or authority that will investigate the whole question.

Mr. James R. Napier has, I understand, during the past twelve months, collected much statistical information on the trial performances of steam ships, and Mr. Peake has taken the opportunity of drawing public attention to the question of the mode of measurement most available for shipping operations; by these means I beg to bring to the notice of the General Committee, that the individual labours of Mr. Atherton, Mr. Napier, Mr. Peake, and myself, have now contributed materially to the elucidation of the subject referred to, thereby facilitating any further effort that may be decided on; and the favourable manner in which Mr. Atherton's paper on the analogous subject of "Mercantile Steam Transport Economy" has been received at the Mechanical Section of the Association, affords every prospect of the labours of this Committee being now prosecuted under far more encouraging prospects of public support and cooperation, on the part of the shipping interests themselves, than has hitherto been the case.

As an example of the benefit to be derived from public discussion, I may refer to the numbers of that popular work, the 'Mechanics' Magazine,' published during the months of April, May, and June last, in which, after fully investigating the subject of the deficiencies of our present tonnage registration for scientific purposes, the Editor has been pleased to announce the following admitted deficiencies and proposed corrections of our present system for the consideration of its numerous readers:—

"First. That the tonnage, measurement, and registration of vessels has never been brought before Government in any other than a purely fiscal point of view.

"Secondly. That Government in legislating on tonnage registration has not contemplated the scientific features of the case, nor those which bear on the sea voyage.

"Thirdly. That undoubtedly there is a point beyond which ships cannot be safely loaded.

"Fourthly. That undoubtedly it would be desirable, if possible, to fix limit to the degree to which ships may be loaded.

"Fifthly. That as respects the draft of water at which ships leave port, let the Board of Trade have, if it so please, properly authorized officers to note and record the facts.

"Sixthly. We should see with satisfaction a competent committee appointed by Government, or by the British Association, with a view of ultimately, if need be, acting on the Government, to take into consideration the foregoing points."

Such being the declaration of opinions expressed by the Editor of one of our most popular periodicals devoted to science, in respect to the deficiencies of our present system of statistical registration of tonnage, it is respectfully submitted that good and sufficient cause is shown for the re-appointment and further continued labours of the Committee on this subject; and that under such indications of the public appreciation of the utility of such labours, there can be no doubt of such amendments of the present system being desired as will conduce to public good.

It may be in the recollection of members, that at the meeting of the British Association at Liverpool, in 1854, the recommendations of the General Committee included one, "That it was expedient for the advancement of naval architecture, that a portion of the intended museum at Liverpool should be appropriated to this subject." Little progress having been yet made with the museum at that port, while the want of such an establishment for the record and disposal of papers and models added to the difficulties of the Committee of 1855, it is with satisfaction I have to state that such difficulties may be considered removed for the future, by the considerate offer of the Chairman of the Crystal Palace Company, Mr. Arthur Anderson, to lend the Naval Gallery of the Palace in any manner that can aid the objects of the Committee, or ventilate the subject.

Considering that there are already collected at the Crystal Palace Naval Gallery models of ships and steamers, fishing-boats and life-boats, both English and foreign, ancient and modern, and that a comparison can be there made of the rapid improvement in shipping and steam-vessels since the old tonnage law was abandoned, the great desideratum being that on the six points enumerated, the question shall be better understood; and also the necessity for the investigation and re-examination of our system of measurement and registration; and that vast advantages would thereby accrue to our mercantile marine, it is hoped that this appeal to the British Association will not be in vain.

ANDREW HENDERSON.

Cheltenham, August 8, 1856.

On Typical Forms of Minerals, Plants and Animals for Museums.

PROFESSOR HENSLOW gave the results of the labours of the Committee The lists which had at present been obtained had been printed in the last volume of the 'Transactions.' They were still incomplete, but Prof. Henslow hoped they would be complete for every department before the next meeting. He exhibited some specimens of a new method of mounting mineral specimens. This consisted in placing them in any required position on a small stand of clay, which being at first soft, gradually hardened and became a firm support to the object. The cement employed was liquid glue, *i. e.* shell-lac dissolved in naphtha.

Interim Report to the British Association on Progress in Researches on the Measurement of Water by Weir Boards. By James Thomson, *C.E.*

Belfast, August 6, 1856.

Having at last year's meeting of the Association read in the Mechanical Section a short paper on the Measurement of Water by Weir Boards, and having been requested by the General Committee to prepare a Report on the same subject, I beg now to state that I have in the mean time been collecting information for the purposes of that Report. My professional engagements have occupied me necessarily so much as to oblige me to defer for this year the detailed prosecution of the subject and the preparation of the Report in full. I have, however, the gratification of stating, that, with special reference to the researches entrusted to me by the Association, the President of the Athenæum of Boston, United States, Mr. Thomas G. Cary, has generously sent to me, with the request that it be presented to the British Association on his behalf, a valuable book containing accounts of experiments recently carried out on a very grand scale in America, on the measurement of large bodies of flowing water by means of weir boards and by other methods, and on the performance of Turbine Water Wheels.

The work is entitled "Lowell Hydraulic Experiments," by James B. Francis. In reference to the experiments, Mr. Cary, the donor of the book, states in his letter to me,—" These experiments, made under the direction and at the expense of the Associated Companies of Lowell near Boston, who employ Mr. Francis as the engineer for their cotton and woollen factories, have cost about £4000 sterling; and they make part in a series of investigations which have cost those Companies £15,000."

In the Report which I hope to submit to the British Association, I shall have much occasion for reference to these important experiments, and, for this purpose, I think it right to retain the book in my hands at present.

As the expenses incurred in reference to the researches have been but small, and chiefly for the procuring of books, I do not desire to draw, for them, on the fund of £10 placed at my disposal by the Association ; and as my intention is not to conduct experiments on the subject myself, but chiefly to give a review of the most important experiments and deductions which have been made by others, I do not think it necessary to ask for a renewal of the grant.

James Thomson.

On Observations with the Seismometer. By R. Mallet, *C.E., M.R.I.A.*

A Provisional Report was presented. The author is continuing his researches at Holyhead.

On the Progress of Theoretical Dynamics. By A. Cayley, *M.A., F.R.S.*

A Provisional Report was presented. The author proposed to deliver in the complete Report in 1857.

Report of a Committee appointed by "The British Association for the Advancement of Science," to consider the formation of a Catalogue of Philosophical Memoirs.

The Committee were appointed—on the occasion of a communication from Professor Henry of Washington, containing a proposal for the publication of Philosophical Memoirs scattered throughout the Transactions of Societies in Europe and America, with the offer of cooperation on the part of the Smithsonian Institute, to the extent of preparing and publishing, in accordance with the general plan which might be adopted by the British Association, a catalogue of all the American Memoirs on Physical Science—to consider the best system of arrangement, and to report thereon to the Council.

The Committee are desirous of expressing their sense of the great importance and increasing need of such a catalogue.

They understand the proposal of the Smithsonian Institute to be, that a separate catalogue should be prepared and published for America.

In the opinion of the Committee,—

The Catalogue should embrace the Mathematical and Physical Sciences, but should exclude Natural History and Physiology, Geology, Mineralogy, and Chemistry, which would properly form the subject-matter of a distinct catalogue or catalogues. The difficulty of drawing the line would perhaps be greatest with regard to Chemistry and Geology; but the Committee would admit into the Catalogue memoirs not purely Chemical or Geological, but having a direct bearing upon the subjects of the Catalogue.

The Catalogue should not be restricted to memoirs in Transactions of Societies, but should comprise also memoirs in the Proceedings of Societies, in Mathematical and Scientific Journals, in Ephemerides and volumes of Observations, and in other collections not coming under any of the preceding heads. The Catalogue would not comprise separate works.

The Catalogue should begin from the year 1800.

There should be a catalogue according to the names of authors, and also a catalogue according to subjects; the title of the memoir, date, and other particulars to be in each case given in full, so as to avoid the necessity of a reference from the one catalogue to the other.

The Catalogue should, in referring to a memoir, give the number as well of the last as of the first page, so as to show the length of the memoir.

The Catalogue should give in every case the date of a memoir (the year only), namely, in the case of memoirs published in the Transactions of a Society, the date of reading, and in other cases the date on the title-page of the volume. Such date should be inserted as a distinct fact, even in the case of a volume of transactions referred to by its date.

The Catalogue should contain a list of volumes indexed, showing the complete title; in the case of transactions, the year to which the volume belongs, and the year of publication; and in other cases, the year of publication, and the abbreviated reference to the work.

The references to works should be given in a form sufficiently full to be easily intelligible without turning to the explanation of such reference.

The author's name and the date should be printed in a distinctive type, so as to be conspicuous at first sight; and generally the typographical execution should be such as to facilitate as much as possible the use of the Catalogue.

As to the Catalogue according to the authors' names, the memoirs of the same author should be arranged according to their dates.

As to the Catalogue according to subjects, the question of the arrangement is one of very great difficulty. It appears to the Committee that the scheme of arrangement cannot be fixed upon according to any *à priori* classification of subjects, but must be determined after some progress has been made in the preliminary work of collecting the titles of the memoirs to be catalogued. The value of this part of the catalogue will materially depend upon the selection of a proper principle of arrangement, and the care and accuracy with which such principle is carried out. The arrangement of the memoirs in the ultimate subdivisions should be according to their dates.

The most convenient method of making the Catalogue would appear to be, that each volume to be indexed should be gone through separately, and a list formed of all the memoirs which come within the plan of the proposed Catalogue. Such list should be in triplicate, one copy for reference, a second copy to be cut up and arranged for the Catalogue according to authors' names, and another copy to be cut up and arranged for the Catalogue according to subjects.

The Committee have endeavoured to form an estimate of the space which the Catalogue would occupy. The number of papers in a volume of transactions is in general small, but there are works, such as the 'Comptes Rendus,' the 'Astronomische Nachrichten,' the 'Philosophical Magazine,' &c., containing a very great number of papers, the titles of which would consequently occupy a considerable space in the Catalogue. Upon the whole, the Committee consider, that, excluding America, they may estimate the number of papers to be entered at 125,000; or since each paper would be entered twice, the number of entries would be 250,000. The number of entries that could conveniently be brought into a page 4to (double columns), would be about 30, so that, according to the above estimate, the Catalogue would occupy ten quarto volumes of rather more than 800 pages each.

It appears to the Committee that there should be paid Editors, who should be familiar with the several great branches respectively of the Sciences to which the Catalogue relates; but that the general scheme of arrangement and details of the Catalogue should be agreed upon between all the Editors, and that they should be jointly responsible for the execution. It would of course be necessary that the Editors should have the assistance of an adequate staff of clerks.

The principal scientific transactions and works would be accessible in England at the Library of the British Museum, and the libraries of the Royal Society and other Philosophical Societies. It would be the duty of the Editors to ascertain all the different works which ought to be catalogued, and to procure information as to the contents of such of them as may not happen to be accessible.

The Catalogue according to authors' names would be the most readily executed, and this catalogue, if it should be found convenient, might be first published. The time of bringing out the two catalogues would of course depend upon the sufficiency of the assistance at the command of the Editors; but if the Catalogue be undertaken, it is desirable that the arrangement should be such, that the complete work might be brought out within a period not exceeding three years.

13th June, 1856.

A. Cayley.
R. Grant.
G. G. Stokes.

NOTICES AND ABSTRACTS

OF

MISCELLANEOUS COMMUNICATIONS TO THE SECTIONS.

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MATHEMATICS AND PHYSICS.

MATHEMATICS.

On the Polyhedron of Forces. By J. T. GRAVES, *M.A., F.R.S.*

IF any number of forces, represented in number and magnitude by the faces of a polyhedron, and in direction perpendicular to those faces, act upon a point, they will keep it in equilibrium. The above is the proposition which is called by the writer "the Polyhedron of Forces." It has probably occurred to many, that the well-known geometrical representation in magnitude and direction of a system of balanced forces acting upon a point by the sides of a closed polygon is so simple and complete that nothing needs to be noted beyond the polygon of forces. What is commonly called the parallelopipedon of forces—which is the elementary theorem in solid space analogous to the parallelogram of forces—represents by the diagonal of a parallelopipedon the resultant force, which balances the three forces represented by the areas. But there the separate forces are represented by lines. The writer was led more than ten years ago to the representation of forces by areas in making researches respecting complex numbers with a new imaginary symbol. He has mentioned the result here enunciated to several mathematicians, to whom it has appeared familiar, and who have believed that it must have been already published; but the writer has searched for it in collections of memoirs and works on statics, and has been unable to find it in print. He has, accordingly, been advised by a very learned scientific friend to occupy it, if it has not been already appropriated. With this view, he takes this opportunity of publishing it to the British Association.

On the Congruence $nx \equiv n+1$ (mod p). *By* JOHN T. GRAVES, *M.A., F.R.S.*

As is well known to those who have studied foreign works on the theory of numbers, the expression

$$a \equiv b \text{ (mod. } c)$$

denotes that $a-b$ divided by c is a whole number. When this relation has place, a and b are said to be congruent with respect to the modulus c, and the relation itself is called a congruence.

Mr. J. T. Graves shows, from elementary principles of the theory of numbers, that in the congruence

$$nx \equiv n+1 \text{ (mod. } p),$$

if p be a prime number, and if n be made to assume, in regular ascending order, all values from 1 to $p-1$ inclusive, x will be found to have, in some order or other, all values from 2 to p inclusive.

Taking, for example, the modulus 7, the congruence

$$nx \equiv n+1 \pmod{p}$$

is a type of the six congruences (mod. 7),

$$1 \,.\, 2 \equiv 2$$
$$2 \,.\, 5 \equiv 3$$
$$3 \,.\, 6 \equiv 4$$
$$4 \,.\, 3 \equiv 5$$
$$5 \,.\, 4 \equiv 6$$
$$6 \,.\, 7 \equiv 7,$$

in which, while to n are given successively the values $1 \,.\, 2 \,.\, 3 \,.\, 4 \,.\, 5 \,.\, 6$, we give to x the corresponding values 2, 5, 6, 3, 4, 7.

From this simple theorem Mr. J. T. Graves derives Wilson's famous theorem, namely,—

"When p is a prime number, we have

$$1 \,.\, 2 \,.\, 3 \,\ldots\, (p-1) \equiv -1 \pmod{p}."$$

It is easy to see that the congruence $(p-1)x \equiv p$ is solved by making $x=p$, and hence, by the preceding theorem, it is possible to find among the quantities $2 \,.\, 3 \,.\, 4 \,\ldots,$ $p-1$, distinct values, including all numbers from 2 to $p-1$, for $x_1, x_2, x_3, \ldots x_{p-2}$, such that

$$1 \,.\, x_1 \equiv 2$$
$$2 \,.\, x_2 \equiv 3 \quad \ldots\ldots\ldots \quad \text{(a)}$$
$$3 \,.\, x_3 \equiv 4 \quad \ldots\ldots\ldots \quad \text{(b)}$$
$$\ldots\ldots$$
$$\ldots\ldots$$
$$(p-2)x_{p-2} \equiv p-1.$$

If, as is allowable, we substitute $1 \,.\, x_1$ for the factor 2 in the left-hand member of congruence (a), we get

$$1 \,.\, x_1 \,.\, x_2 \equiv 3. \quad \ldots\ldots\ldots \quad \text{(c)}$$

Again, if we substitute $1 \,.\, x_1 \,.\, x_2$ for the factor 3 in the left-hand member of congruence (b), we get

$$1 \,.\, x_1 \,.\, x_2 \,.\, x_3 \equiv 4\,;$$

and proceeding similarly, we find

$$1 \,.\, x_1 \,.\, x_2 \,.\, x_3 \ldots x_{p-2} \equiv p-1 \equiv -1, \quad \ldots\ldots \quad \text{(d)}$$

but by Mr. J. T. Graves's theorem,

$$1 \,.\, x_1 \,.\, x_2 \,.\, x_3 \ldots\, x_{p-2} \equiv 1 \,.\, 2 \,.\, 3 \ldots\, (p-2)(p-1).$$

Hence we have by (d),

$$1 \,.\, 2 \,.\, 3 \ldots\, (p-2)(p-1) \equiv -1. \quad \text{Q.E.D.}$$

For example, with respect to modulus 7, we obtain in this manner the six congruences,

$$1 \equiv 1$$
$$1 \,.\, 2 \equiv 2$$
$$1 \,.\, 2 \,.\, 5 \equiv 3$$
$$1 \,.\, 2 \,.\, 5 \,.\, 6 \equiv 4$$
$$1 \,.\, 2 \,.\, 5 \,.\, 6 \,.\, 3 \equiv 5$$
$$1 \,.\, 2 \,.\, 5 \,.\, 6 \,.\, 3 \,.\, 4 \equiv 6,$$

the last congruence being equivalent to

$$1 \,.\, 2 \,.\, 3 \,.\, 4 \,.\, 5 \,.\, 6 \equiv -1 \pmod{7}.$$

Wilson's theorem is thus exhibited as the last of a series of minor theorems.

In introducing the subject of his paper, Mr. J. T. Graves took occasion to point out that the late Mr. Peter Barlow's valuable work 'On the Theory of Numbers,' published in 1811, which is the only elemenary text-book of note in our language specially directed to that subject, is not sufficient for the requirements of modern English students.

Two Memoirs.—I. *On a Theorem in Combinations.* II. *On a particular Class of Congruences.* By HENRY M. JEFFERY, *M.A., Second Master of Pate's Grammar School, Cheltenham.*

I. *A Theorem in Combinations.*

1. It is proposed to determine the number of combinations of n things taken severally 1, 2, 3, ... n together, where there are p of one sort, q of another, r of another, &c.

We will begin by examining a simple case, where there are three quantities, a, b, c.

The product of the factors

$$(1+ax+a^2x^2)(1+cx),$$

or

$$1+(a+c)x+(a^2+ac)x^2+a^2cx^3,$$

contains the combinations of the three quantities taken 1, 2, 3 severally together.

Their numbers in each case are found by equating a, c to unity; or

$${}_3C_1=2;\quad {}_3C_2=2;\quad {}_3C_3=1;$$

subject to the above restriction, that two of the three quantities are equal.

The same process of reasoning is easily extended to the general case, as proposed.

The product of the factors

$$\begin{aligned}&(1+ax+a^2x^2+\dots\dots+a^px^p\\ \times&(1+bx+b^2x^2+\dots\dots+b^qx^q)\\ \times&(1+cx+c^2x^2+\dots\dots+c^rx^r)\\ \times&\dots\dots\dots\dots\end{aligned}$$

contains the combinations of the n quantities taken severally 1, 2, 3, .. n together, viz. in the coefficients of x, x^2, x^3 .. x^n.

The number of the combinations in each case is found by equating a, b, c .. to unity.

Hence any particular combination ${}_nC_k$ is found by finding the coefficient of that power of x in the expansion of

$$(1+x+x^2+..+x^p)(1+x+x^2+..+x^q)(1+x+x^2+..+x^r)\dots\dots(A)$$

whose index is k.

Or the rule may be otherwise conveniently stated: ${}_nC_k=$ the coefficient of x^k in the expansion of

$$\frac{1-x^{p+1}}{1-x}\cdot\frac{1-x^{q+1}}{1-x}\cdot\frac{1-x^{r+1}}{1-x}\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot$$

2. It is important to observe that, subject to these restrictions,

$$C_{n-k}={}_nC_k,$$

as is proved by the circumstance, that x and 1 may be interchanged in the above formula (A) without altering its value.

Hence we conclude that there is no necessity for investigating the coefficients of powers of x beyond $\frac{n}{2}$ if n be even, or beyond $\frac{n-1}{2}$ if n be odd.

This consideration vastly diminishes the labour of expansion.

3. The total number of possible combinations is found by equating x to unity in the formula (A), and subtracting 1 from the result, since 1 is the first term in the expansion involving no power of x, and therefore cannot denote the number of any combination.

Hence the number required is

$$(p+1)(q+1)(r+1)\ldots\ldots-1;$$

which is a known theorem.

4. *Example*: To find the number of combinations that can be formed of the letters of the word "*Notation*" taken severally 1, 2, 3, ... 8 together.

There are two n's, two o's, two t's, one a, one i.

The numbers required are found by expanding, at least as far as x^4,

$$\frac{(1-x^3)^3\,.\,(1-x^2)^2}{(1-x)^5}=(1-x^3)^3(1-x^2)^2\,.\,(1-x)^{-5}$$

$$=(1-3x^3+\ldots\ldots)(1-2x^2+x^4)$$

$$\times(1+5x+15x^2+35x^3+70x^4+\ldots)$$

$$=1+5x+13x^2+22x^3+26x^4+\ldots\ldots$$

The series can now be completed by aid of the theorem

$$C_{8-k}={}_8C_k:$$

$$1+5x+13x^2+22x^3+26x^4+22x^5+13x^6+5x^7+x^8.$$

The total number of possible combinations

$$=5+13+22+26+22+13+5+1=107=3\,.\,3\,.\,3\,.\,2\,.\,2-1,$$

as might have been obtained at once by the formula

$$(p+1)(q+1)(r+1)\ldots-1.$$

This example was selected to contrast the tentative method used in 'Lund's Companion to Wood's Algebra,' p. 111, London, 1852, in the particular case of $k=3$.

I quote the author's words:—

"Here are five *different* letters: the number of combinations of five letters, 3 together, where no letter recurs $=\frac{5\times4}{1\times2}=10$.

"Also there are two n's, two o's, and two t's, *each* of which pairs may be combined with each of the other four letters, and form four combinations of three, making altogether $3\times4=12$ such combinations where the letters recur,

$\because$ number required $=10+12=22$."

5. To find the number of permutations of n things taken 1, 2, 3, .. n together, when n consists of groups of identical quantities, p of one sort, q of another, r of another, &c.

In the following solution we shall denote ${}_1P_1$, ${}_2P_2$, .. ${}_rP_r$ by powers of P, viz. P, P^2, ... P^r, and *subject* P *to the laws of indices*.

In order to see more clearly the method and notation that will be adopted, let us examine the familiar case of four different quantities, a, b, c, d. The permutations are contained in the coefficients of the several powers of x in the expansion of

$$(1+Pax)(1+Pbx)(1+Pcx)(1+Pdx),$$

or

$$1+(a+b+c+d)\mathrm{P}x+(ab+ac+ad+bc+bd+cd)\mathrm{P}^2x^2$$
$$+(abc+abd+acd+bcd)\mathrm{P}^3x^3+abcd\mathrm{P}^4x^4.$$

The number of the permutations in each case is given by the coefficients of the several powers of x in the expansion of

$$(1+\mathrm{P}x)^4 \text{ or } 1+4\mathrm{P}x+6\mathrm{P}^2x^2+4\mathrm{P}^3x^3+\mathrm{P}^4x^4.$$

That is,

$${}_4\mathrm{P}_1=4\mathrm{P}=4:\ {}_4\mathrm{P}_2=6\mathrm{P}^2=12:\ {}_4\mathrm{P}_3=4\mathrm{P}^3=24:\ {}_4\mathrm{P}_4=\mathrm{P}^4=24.$$

Next consider the case of a, a, c, d.

The permutations are contained in the coefficients of the powers of x in the expansion of

$$\left(1+a\,.\,\mathrm{P}x+\frac{a^2}{1\,.\,2}\,.\,\mathrm{P}^2x^2\right)(1+c\,.\,\mathrm{P}x)(1+d\,.\,\mathrm{P}x),$$

or

$$1+(a+c+d)\,\mathrm{P}x+\left(ac+ad+cd+\frac{a^2}{1\,.\,2}\right)\mathrm{P}^2x^2$$
$$+\left(\frac{a^2\,.\,\overline{c+d}}{1\,.\,2}+acd\right)\mathrm{P}^3x^3+\frac{a^2cd}{1\,.\,2}\,\mathrm{P}^4x^4.$$

The justice of this conclusion may be seen by examining the mode of formation of each coefficient.

The number is found by equating a, c, d to unity:

$$1+3\mathrm{P}x+\tfrac{7}{2}\mathrm{P}^2x^2+2\mathrm{P}^3x^3+\tfrac{1}{2}\mathrm{P}^4x^4.$$

Hence

$${}_4\mathrm{P}_1=3:{}_4\mathrm{P}_2=7:{}_4\mathrm{P}_3=12:{}_4\mathrm{P}_4=12.$$

The general theorem may be expressed as follows:—

${}_n\mathrm{P}_k=$ the coefficient of x^k in the expansion of

$$\left(1+\mathrm{P}x+\frac{\mathrm{P}^2x^2}{1\,.\,2}+\,.\,.\,+\frac{(\mathrm{P}x)^p}{\underline{|p}}\right)$$
$$\times\left(1+\mathrm{P}x+\frac{\mathrm{P}^2x^2}{1\,.\,2}+\,.\,.\,+\frac{(\mathrm{P}x)^q}{\underline{|q}}\right)$$
$$\times\left(1+\mathrm{P}x+\frac{\mathrm{P}^2x^2}{1\,.\,2}+\,.\,.\,+\frac{(\mathrm{P}x)^r}{\underline{|r}}\right)$$
$$\times\ \ldots\ldots$$

where P is subject to the law of indices.

We may observe that

$${}_n\mathrm{P}_n=\frac{\mathrm{P}^n}{\underline{|p}\,.\,\underline{|q}\,.\,\underline{|r}\,.\,.}=\frac{\underline{|n}}{\underline{|p}\,.\,\underline{|q}\,.\,\underline{|r}\,.\,.};$$

a well-known theorem.

6. The total number of permutations of n things taken 1, 2, 3 ... n together is

$$\left(1+\mathrm{P}+\frac{\mathrm{P}^2}{1\,.\,2}+\,.\,.\,+\frac{\mathrm{P}^p}{\underline{|p}}\right)$$
$$\times\left(1+\mathrm{P}+\frac{\mathrm{P}^2}{1\,.\,2}+\,.\,.\,+\frac{\mathrm{P}^q}{\underline{|q}}\right)$$
$$\times\left(1+\mathrm{P}+\frac{\mathrm{P}^2}{1\,.\,2}+\,.\,.\,+\frac{\mathrm{P}^r}{\underline{|r}}\right)$$
$$\times\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ -1,$$

where it must be observed that P and its various powers have no meaning, until the expansion has been effected.

7. *Ex.* "Notation."

The number of permutations in each case is contained in the expansion of

$$\left(1+Px+\frac{P^2x^2}{1.2}\right)^3.(1+Px)^2,$$

or

$$\tfrac{1}{8}\{(1+Px)^8+3(1+Px)^6+3(1+Px)^4+(1+Px)^2\}$$

$$=1+5Px+\frac{23}{2}P^2x^2+16P^3x+\frac{59}{4}P^4x^4+\frac{37}{4}P^5x^5+\frac{31}{8}P^6x^6+P^7x^7+\frac{P^8}{8}x^8.$$

In this case, therefore,

$$_8P_1=5:\ _8P_2=23:\ _8P_3=96:\ _8P_4=354:\ _8P_5=1110:\ _8P_6=2790:$$
$$_8P_7=5040:\ _8P_8=5040.$$

To test these results, examine $_8P_3$.

There are five different letters, *n, o, t, a, i,* whose permutations taken three together = 60.

There are twelve groups of the form "*nno*," each of which may be permuted three times, or there are thirty-six permutations of this form. In all 60+36=96.

8. It is presumed that a general method is preferable to the tentative process, which requires considerable acuteness in detecting the several groups, and leaves a liability to error after all. Hence it is hoped that this theorem, which supplies a desideratum in every-day algebra, may be worthy of the attention of the Meeting.

II. *A particular Class of Congruences.*

1. If Σ_m denote

$$1^m+2^m+3^m+\ldots+(p-1)^m,$$

where p is a prime number,

$$\Sigma_m \equiv o \ (\text{mod.}\,p.);$$

unless $m=r(p-1)$, when

$$\Sigma_{r(p-1)} \equiv (p-1).$$

2. If a, b, c, d denote four of the series $1, 2, 3, \ldots \overline{p-1}$,

$$\left.\begin{array}{l}\Sigma(a^{p-1})\equiv(p-1);\ \Sigma(a^{p-1}b^{p-1})\equiv 1\\ \Sigma(a^{p-1}b^{p-1}c^{p-1})\equiv(p-1);\ \ \Sigma(a^{p-1}b^{p-1}c^{p-1}d^{p-1})\equiv 1\end{array}\right\}(\text{mod.}\,p.).$$

---

1. If p is prime, the congruence

$$\overline{x-1}\,.\,\overline{x-2}\ldots\ldots\overline{x-p+1}-(x^{p-1}-1)\equiv o \ (\text{mod.}\,p.)$$

has $\overline{p-1}$ roots $1, 2, 3, \ldots \overline{p-1}$: and since this congruence is only of the $(p-2)$th degree in x, the coefficients of the several powers of x are separately congruous to p. Hence we have

$$s_1\equiv o,\ s_2\equiv o,\ \ldots\ s_{p-2}\equiv o,\ s_{p-1}\equiv -1,$$

where s_1 denotes the sum of the roots,

s_2 .... taken two and two,

....

s_{p-1} .... their product.

The above paragraph contains Serret's demonstration of Wilson's theorem.

Now observing the meaning of Σ_m, we have from the theory of equations the following relations between the symbols Σ and s in the equation

$$x^{p-1}-s_1\, x^{p-2}+s_2\, x^{p-3}- \dots +s_{p-1}=0.$$
$$\Sigma_1-s_1=0.$$
$$\Sigma_2-s_1\,\Sigma_1+2\,s_2=0.$$
$$\Sigma_3-s_1\,\Sigma_2+s_2\,\Sigma_1-3\,s_3=0,$$
$$\dots\dots\dots = \dots$$
$$\Sigma_{p-1}-s_1\,\Sigma_{p-2}+s_2\,\Sigma_{p-3}-\dots +(p-1)s_{p-1} \quad =0.$$
$$\Sigma_p \quad -s_1\,\Sigma_{p-1}+s_2\,\Sigma_{p-2}\dots\dots +s_{p-1}\,\Sigma_1 \quad =0.$$
$$\dots\dots\dots = \dots$$
$$\Sigma_{2p-2}-s_1\,\Sigma_{2p-3}+s_2\,\Sigma_{2p-4}- \dots +s_{p-1}\,\Sigma_{p-1}=0.$$
$$\dots\dots\dots = \dots$$

Hence we establish the following congruences;—

$$\Sigma_1=s_1\equiv o \text{ (mod. } p.)$$
$$\Sigma_2\equiv -2\,s_2\equiv o\dots\dots$$
$$\dots\dots\dots$$
$$\Sigma_{p-2}\equiv o.$$
$$\Sigma_{p-1}\equiv -(p-1)s_{p-1}\equiv p-1.$$
$$\Sigma_{2p-2}\equiv -s_{p-1}\,\Sigma_{p-1} \equiv p-1.$$
$$\dots\dots\dots$$
$$\Sigma_{r(p-1)}\equiv -s_{p-1}\,\Sigma_{(r-1)(p-1)}\equiv p-1.$$

2. To prove the second proposition, we will premise the following congruence :—

$$\frac{\overline{p-1}\,.\,\overline{p-2}\dots\overline{p-r}}{1\,.\,2\dots r}\equiv \pm 1 \text{ (mod. } p.),$$

if p is prime, according as r is even or odd.

For $\dfrac{\overline{p-1}\,.\,\overline{p-2}\dots\overline{p-r}}{1\,.\,2\dots r}$ is always an integer;

$$\therefore \frac{\overline{p-1}\,.\,\overline{p-2}\dots\overline{p-r}\mp 1\,.\,2\dots r}{1\,.\,2\dots r} \text{ is an integer,}$$

and is therefore a multiple of p, since p is a prime greater than any of the factors of the denominator.

3. $\Sigma(a^{p-1})\equiv p-1\equiv -1$, as has been proved above.

$$\Sigma(a^{p-1}\,b^{p-1})\equiv\frac{(\Sigma_{p-1})^2-\Sigma_{2p-2}}{1\,.\,2}-\frac{(p-1)^2-(p-1)}{1\,.\,2}\equiv\frac{(p-1)(p-2)}{1\,.\,2}\equiv +1$$

$$\Sigma(a^{p-1}\,b^{p-1}\,c^{p-1})\equiv\frac{(\Sigma_{p-1})^3-3\Sigma_{2p-2}\,\Sigma_{p-1}+2\,\Sigma_{3p-3}}{1\,.\,2\,.\,3}$$

$$\equiv\frac{(p-1)^3-3(p-1)^2+2(p-1)}{1\,.\,2\,.\,3}\equiv\frac{\overline{p-1}\,.\,\overline{p-2}\,.\,\overline{p-3}}{1\,.\,2\,.\,3}\equiv -1.$$

$$\Sigma(a^{p-1}\,b^{p-1}\,c^{p-1}\,d^{p-1})$$
$$=\frac{(\Sigma_{p-1})^4-6\,\Sigma_{2p-2}\,.\,(\Sigma_{p-1})^2+8\,.\,\Sigma_{3p-3}\,.\,\Sigma_{p-1}+3(\Sigma_{2p-2})^2-6\Sigma_{4p-4}}{1\,.\,2\,.\,3\,.\,4}$$

$$\equiv\frac{(p-1)^4-6(p-1)^3+11(p-1)^2-6(p-1)}{1\,.\,2\,.\,3\,.\,4}\equiv\frac{\overline{p-1}\,.\,\overline{p-2}\,.\,\overline{p-3}\,.\,\overline{p-4}}{1\,.\,2\,.\,3\,.\,4}$$

$$\equiv +1.$$

4. From observing the symmetry of formation

$$\Sigma(a^{p-1}) \equiv \frac{p-1}{1} \equiv -1$$

$$\Sigma(a^{p-1}\, b^{p-1}) \equiv \frac{\overline{p-1} \cdot \overline{p-2}}{1 \cdot 2} \equiv +1$$

$$\Sigma(a^{p-1}\, b^{p-1}\, c^{p-1}) \equiv \frac{\overline{p-1} \cdot \overline{p-2} \cdot \overline{p-3}}{1 \cdot 2 \cdot 3} \equiv -1$$

$$\Sigma(a^{p-1}\, b^{p-1}\, c^{p-1}\, d^{p-1}) \equiv \frac{\overline{p-1} \cdot \overline{p-2} \cdot \overline{p-3} \cdot \overline{p-4}}{1 \cdot 2 \cdot 3 \cdot 4} \equiv +1,$$

and observing that

$$\frac{\overline{p-1} \cdot \overline{p-2} \ldots\ldots\ldots \overline{p-r}}{1 \cdot 2 \ldots\ldots r} \equiv \pm 1,$$

one cannot help guessing at the general theorem

$$\Sigma(a^{p-1}\, b^{p-1}\, c^{p-1} \ldots\ldots k^{p-1}) \equiv \pm 1 \text{ (mod } p.),$$

according as the number of factors $a, b, c, \ldots k$ is even or odd.

But the process of determining the value of $\Sigma(a^p\, b^q\, c^r \ldots\ldots k^t)$ in terms of the sums of powers of the roots is so laborious, that the law, which seems to exist, has not been verified beyond four factors.

The theorems might have been multiplied indefinitely; but two only have been selected, as being the most striking in their results.

5. Numerical examples:—

$$1+2+3+4 = 10 \equiv 0 \text{ (mod. 5)}$$

$$1^2+2^2+3^2+4^2 = 30 \equiv 0$$

$$1^3+2^3+3^3+4^3 = 100 \equiv 0$$

$$1^4+2^4+3^4+4^4 = 354 \equiv 4$$

$$\ldots\ldots\ldots\ldots\ldots\ldots$$

$$1^8+2^8+3^8+4^8 = 72354 \equiv 4$$

$$\ldots\ldots\ldots\ldots\ldots\ldots$$

$$1^4 2^4+1^4 3^4+1^4 4^4$$

$$+2^4 3^4+2^4 4^4+3^4 4^4 = 26481 \equiv 1 \text{ (mod. 5)}$$

$$1^4 2^4 3^4+1^4 2^4 4^4$$

$$+1^4 3^4 4^4+2^4 3^4 4^4 = 357904 \equiv 4.$$

$$1^4 2^4 3^4 4^4 = 331776 \equiv 1.$$

On a New Method of Treating the Doctrine of Parallel Lines.
By Prof. STEVELLY.

The author stated that from the days of Euclid to the present, all geometricians admitted that Euclid's twelfth axiom was a property to be proved, and not an axiom to be assumed as self-evident; but hitherto no satisfactory and sufficiently elementary proof of it had been adduced. He then showed that, by defining parallel lines to be "when two lines in the same plane were both perpendicular to the same line, they should be called parallel," all the properties of parallel lines as proved by Euclid could be shown to belong to these, by two supplementary propositions. The second of these was, that the line joining any two points along parallel lines, assumed at an equal distance from the line to which both are perpendicular, formed right angles with each of the parallel lines. The author then went through the series of geometrical proofs, which would, however, be unsuited to our report, concluding with the proof of the twelfth axiom of Euclid.

Models to illustrate a new Method of teaching Perspective. *By* H. R. Twining.

The object of this communication is to explain the principles of perspective in such a manner as may enable those who draw to distribute their objects not only in a correct manner, but in one agreeable to the eye. The method affords an intermediary step between those rules which are demonstrated by diagrams in the usual treatises, and those appearances which characterize natural objects themselves. The chief difficulty in enabling an audience to follow out the principles of perspective when applied to solid objects is, that every individual sees these from a different position; so that such an explanation of the effect observed as is adapted to one individual cannot suit another. Mr. Twining's method aims at overcoming this difficulty by placing an image (with which each individual is supposed to identify himself) in the exact spot which the observer ought to occupy, and which serves to mark the true focus of the picture.

Light, Heat, Electricity, Magnetism.

On various Phænomena of Refraction through Semi-Lenses producing Anomalies in the Illusion of Stereoscopic Images. *By* A. Claudet, *F.R.S.*

The paper had for its object to explain the cause of the illusion of curvature given to pictures representing flat surfaces, when examined in the refracting or semilenticular stereoscope. The author showed that all vertical lines seen through prisms or semi-lenses are bent, presenting their concave side to the thin edge of the prism, and as the two photographic pictures are bent in the same manner and by the same cause, the inevitable result of their coalescence in the stereoscope is a concave surface produced by the necessity of converging the optic axes more to unite the ends and less to unite the centres of the two curved lines; more convergence giving the illusion of nearer distance, and less convergence of further distance. The only means to avoid this defect is to examine the two pictures in order to employ the centre of the lenses, which do not bend straight lines; but as the centre does not refract laterally the two images, their coincidence cannot take place without placing the optical axis in such a position that they are nearly parallel, as if we were looking at the moon, or a very distant object. This is an operation not very easy at the first attempt, but which a little practice will teach us to perform. Persons capable of using such a stereoscope will see the pictures more perfect, and all objects in their natural shape.—Mr. Claudet presented to the Meeting a stereoscope made on this principle, and many of the members present could see perfectly well with it. The author explained the cause of another defect which is very often noticed in examining stereoscopic pictures, viz. that the subject seems in some cases to come out of the openings of the mountings, and in some others to recede from behind,—this last effect being more favourable and more artistic. Mr. Claudet recommended photographers when mounting their pictures to take care that the opening should have their correspondent vertical sides less distant than any two correspondent points of the first plane of the pictures, which could be easily done by means of a pair of compasses, measuring those respective distances. To illustrate the phænomenon of vertical lines, bent by prisms, forming by coalescence concave surfaces, Mr. Claudet stated that if holding in each hand one prism, the two prisms having their thin edges towards each other, we look at the window from the opposite end of the room, we see first two windows with their vertical lines bent in contrary directions; but by inclining gradually the optical axes, we can converge them until the two images coalesce, and we see only one window; as soon as they coincide the lateral curvature of the vertical lines ceases, and they are bent projectively from back to front: we have then the illusion of a window concave towards the room, such as it would appear reflected by a concave mirror.

On some Dichromatic Phænomena among Solutions, and the means of representing them. By J. H. Gladstone, *Ph.D., F.R.S.*

This paper was an extension of Sir John Herschel's observations on dichromatism, that property whereby certain bodies appear of a different colour according to the quantity seen through. It depends generally on the less rapid absorption of the red ray as it penetrates a substance. A dichromatic solution was examined by placing it in a wedge-shaped glass-trough, held in such a position that a slit in a window-shutter was seen traversing the varying thicknesses of the liquid. The diversely coloured line of light thus produced was analysed by a prism; and the resulting spectrum was represented in a diagram by means of coloured chalks on black paper, the true position of the apparent colours being determined by the fixed lines of the spectrum. In this way the citrate and comenamate of iron, sulphate of indigo, litmus in various conditions, cochineal, and chromium, and cobalt salts were examined and represented. Among the more notable results were the following:—A base, such as chromic oxide, produces very nearly the same spectral image with whatever acid it may be combined, although the salts may appear very different in colour to the unaided eye. Citrate of iron appears green, brown, or red, according to the quantity seen through. It transmits the red ray most easily, then the orange, then the green, while it cuts off entirely the more refrangible half of the spectrum. Neutral litmus appears blue or red, according to the strength or depth of the solution. Alkalies cause a great development of the blue ray; acids cause a like increase of the orange, while the minimum of luminosity is altered to a position much nearer the blue. Boracic acid causes a development of the violet. Alkaline litmus was exhibited so strong that it appeared red, and slightly acid litmus so dilute that it looked bluish purple; indeed, on account of the easy transmissibility of the orange ray through an acid solution, the apparent paradox was maintained that a large amount of alkaline litmus is of a purer red than acid litmus itself. Another kind of dichromatism was examined, dependent not on the actual quantity of coloured material, but on the relative proportion of the solvent, and diagrams of the changing appearances of sulphocyanide of iron, of chloride of copper, and of chloride of cobalt were exhibited.

On the Stratified Appearance of the Electrical Discharge. By W. R. Grove, *M.A., F.R.S.*

Mr. Grove communicated some additional facts connected with a phænomenon first observed and published by him in the 'Philosophical Transactions' for 1852, viz. the striated or stratified appearance in the electric discharge in rarefied gases and vapours, particularly that of phosphorus. M. Ruhmkorff, M. Quet, and Dr. Robinson had, subsequently to Mr. Grove, experimented on the subject. No satisfactory *rationale* of it has hitherto been given. Mr. Grove has, however, observed that the mode of breaking contact has a marked influence on the phænomenon, which would lead to the belief that it is due to the intermittent character of the discharges. If, for instance, the arm of the contact-breaker be made to rest on a slight spring placed underneath it, the bands become narrower. If a single breach of contact be effected, most observers have remarked that the effect is still perceptible; but it is very difficult to effect a single breach of contact. The fusion of the metals at the point of contact, with the vibration accompanying the movement, occasions a double or triple disruption. The best mode is to place two stout copper wires across each other, and with a firm hand draw one over the other, until the end of the former parts company with the latter; when this is well done the striæ are, in the majority of cases, not observed. Of all the substances which had been tried, the vapour of phosphorus succeeds best, and with this is seen a remarkable effect on the powder or smoke of allotropic phosphorus (which is always formed when the striæ are observed): this smoke traverses from pole to pole, from the negative to the positive side, showing, unless there be some latent optical deception, a mechanical effect of the discharge under the circumstances.—The phænomenon was exhibited to the members of the Section in the committee-room, which had been darkened for the purpose.

On the Law of Electrical and Magnetic Force. By Sir W. S. Harris, *F.R.S.*

The author prefaced the exposition of the views he himself had adopted, after elaborate experimental research on the subject, by stating that the discovery of the beautiful and comprehensive law of universal gravitation by Newton had predisposed all physical inquirers to entertain the notion that every other force associated with ordinary matter was subject to a similar law. The forces of electricity and magnetism were especially considered as coming under a like law, and a great variety of experimental inquiries were instituted to verify the conjecture. Cavendish, after Œpinus, was certainly the first philosopher who investigated experimentally and threw light on this question. This appears by his celebrated paper in the 'Philosophical Transactions' for 1772, and likewise by his unpublished manuscripts, which had descended to the Earl of Burlington, and had been placed by that nobleman in the hands of the author; and, he might add in passing, were open to the inspection of any inquirer engaged in these researches, and contained matter of the most important kind. The author then pointed out several well-known and acknowledged truths in these sciences which were due to the researches of Cavendish. He then pointed out the influence which the researches of Coulomb had exercised on the universal philosophic world, particularly after the writings of the celebrated Poisson, Laplace, Biot. and others had given form and currency to his views and principles. Such a galaxy of eminent names, and so wide a reception of Coulomb's theoretical views, the author considered to be calculated to discountenance and discourage much critical inquiry as to their soundness, and to immerse us in a kind of philosophical orthodoxy very unfavourable to a more complete knowledge of these unseen, yet astonishing powers of Nature which we daily experience. The author then went on to illustrate the law of the inverse square of the distance as relating to forces emanating from one central point and to other emanations from a centre, and to point out how far this might safely be relied upon as applicable to the electrical and magnetic forces of attraction and repulsion; and stated that the object of the present communication, which the author submitted with all due diffidence, was to investigate the physical condition under which these forces manifest themselves,—what are the general laws of the operation of such forces,—how far we may safely consider them as central forces, such as gravity, or whether they are to be considered more in the light of forces, operating between surfaces distinctive in their character and in their ordinary relations to common matter. He then pointed out one essentially distinctive character of these forces. In gravitation, the attracted body, as far as we can observe, remains in the same physical condition before and during all the changes of distance and force to which the bodies are naturally subjected. But in the phænomena of electrical and magnetic attraction and of repulsion, the very first step was that the body acted upon had its physical condition changed; and this change again, by a kind of reflex influence, affected what had been the instant before the physical condition of the body producing the change; and thus, during the action and its changes, new physical conditions of both had to be investigated and taken into consideration, that is, if we wish truly to interpret the facts. The author then, with well-arranged apparatus, proceeded to illustrate, by some striking experiments, both electrical and magnetic, the truth and importance of these general views: he endeavoured to explain the peculiar electrical conditions under which the forces of electricity and magnetism might be expected to vary in the inverse duplicate ratio of the distances, but which conditions being interfered with, other laws of force might become developed, as found by many eminent philosophers of the last century, distinguished by their great skill in experimental physics. The author concluded by some observations on the use of the proof plane and the torsion balance, and showed with what great caution the proof plane should be applied as a means of deducing results to serve as data for mathematical analysis.

On the Unequal Sensibility of the Foramen Centrale *to Light of different Colours. By* J. C. Maxwell.

When observing the spectrum formed by looking at a long vertical slit through a simple prism, I noticed an elongated dark spot running up and down in the blue, and following the motion of the eye as it moved *up and down* the spectrum, but refusing to pass out of the blue into the other colours. It was plain that the spot belonged both to the eye and to the blue part of the spectrum. The result to which I have come is, that the appearance is due to the yellow spot on the retina, commonly called the *Foramen Centrale* of Soemmering. The most convenient method of observing the spot is by presenting to the eye in not too rapid succession, blue and yellow glasses, or, still better, allowing blue and yellow papers to revolve slowly before the eye. In this way the spot is seen in the blue. It fades rapidly, but is renewed every time the yellow comes in to relieve the effect of the blue. By using a Nicol's prism along with this apparatus, the brushes of Haidinger are well seen in connexion with the spot, and the fact of the brushes being the spot analysed by polarized light becomes evident. If we look steadily at an object behind a series of bright bars which move in front of it, we shall see a curious bending of the bars as they come up to the place of the yellow spot. The part which comes over the spot seems to start in advance of the rest of the bar, and this would seem to indicate a greater rapidity of sensation at the yellow spot than in the surrounding retina. But I find the experiment difficult, and I hope for better results from more accurate observers.

On a Method of Drawing the Theoretical Forms of Faraday's *Lines of Force without Calculation. By* J. C. Maxwell.

The method applies more particularly to those cases in which the lines are entirely parallel to one plane, such as the lines of electric currents in a thin plate, or those round a system of parallel electric currents. In such cases, if we know the forms of the lines of force in any two cases, we may combine them by simple addition of the functions on which the equations of the lines depend. Thus the system of lines in a uniform magnetic field is a series of parallel straight lines at equal intervals, and that for an infinite straight electric current perpendicular to the paper is a series of concentric circles whose radii are in geometric progression. Having drawn these two sets of lines on two separate sheets of paper, and laid a third piece above, draw a third set of lines through the intersections of the first and second sets. This will be the system of lines in a uniform field disturbed by an electric current. The most interesting cases are those of uniform fields disturbed by a small magnet. If we draw a circle of any diameter with the magnet for centre, and join those points in which the circle cuts the lines of force, the straight lines so drawn will be parallel and equidistant; and it is easily shown that they represent the actual lines of force in a paramagnetic, diamagnetic, or crystallized body, according to the nature of the original lines, the size of the circle, &c. No one can study Faraday's researches without wishing to see the forms of the lines of force. This method, therefore, by which they may be easily drawn, is recommended to the notice of electrical students.

On the Theory of Compound Colours with reference to Mixtures of Blue and Yellow Light. By J. C. Maxwell.

When we mix together blue and yellow paint, we obtain green paint. This fact is well known to all who have ever handled colours; and it is universally admitted that blue and yellow make green. Red, yellow, and blue, being the primary colours among painters, green is regarded as a secondary colour, arising from the mixture of blue and yellow. Newton, however, found that the green of the spectrum was not the same thing as the mixture of two colours of the spectrum, for such a mixture could be separated by the prism, while the green of the spectrum resisted further decomposition. But still it was believed that yellow and blue would make a green, though not that of the spectrum As far as I am aware, the first experiment on the subject is that of M. Plateau, who, before 1819, made a disc with alternate sectors of prussian blue and gamboge, and observed that, when spinning, the resultant tint was not green, but a neutral gray, inclining sometimes to yellow or blue, but never to green. Prof. J. D. Forbes of Edinburgh made similar experiments in 1849, with the same result. Prof. Helmholtz of Königsberg, to whom we owe the most complete investigation on visible colour, has given the true explanation of this phænomenon. The result of mixing two coloured powders is not by any means the same as mixing the beams of light which flow from each separately. In the latter case we receive all the light which comes either from the one powder or the other. In the former, much of the light coming from one powder falls on particles of the other, and we receive only that portion which has escaped absorption by one or other. Thus the light coming from a mixture of blue and yellow powder, consists partly of light coming directly from blue particles or yellow particles, and partly of light acted on by both blue and yellow particles. This latter light is green, since the blue stops the red, yellow, and orange, and the yellow stops the blue and violet. I have made experiments on the mixture of blue and yellow *light*—by rapid rotation, by combined reflexion and transmission, by viewing them out of focus, in stripes, at a great distance, by throwing the colours of the spectrum on a screen, and by receiving them into the eye directly; and I have arranged a portable apparatus by which any one may see the result of this or any other mixture of the colours of the spectrum. In all these cases blue and yellow do *not* make green. I have also made experiments on the mixture of coloured powders. Those which I used principally were "mineral blue" (from copper) and "chrome-yellow." Other blue and yellow pigments gave curious results, but it was more difficult to make the mixtures, and the greens were less uniform in tint. The mixtures of these colours were made by weight, and were painted on discs of paper, which were afterwards treated in the manner described in my paper "On Colour as perceived by the Eye," in the 'Transactions of the Royal Society of Edinburgh,' vol. xxi. part 2. The visible effect of the colour is estimated in terms of the standard-coloured papers:—vermilion (V), ultramarine (U), and emerald-green (E). The accuracy of the results, and their significance, can be best understood by referring to the paper before mentioned. I shall denote mineral blue by B, and chrome-yellow by Y; and B_3 Y_5 means a mixture of three parts blue and five parts yellow.

Given Colour.			Standard Colours. V.	U.	E.	Coefficient of brightness.
B_8	, 100	=	2	36	7	 45
B_7 Y_1	, 100	=	1	18	17	 37
B_6 Y_2	, 100	=	4	11	34	 49
B_5 Y_3	, 100	=	9	5	40	 54
B_4 Y_4	, 100	=	15	1	40	 56
B_3 Y_5	, 100	=	22	− 2	44	 64
B_2 Y_6	, 100	=	35	−10	51	 76
B_1 Y_7	, 100	=	64	−19	64	 109
Y_8	; 100	=	180	−27	124	 277

The columns V, U, E give the proportions of the standard colours which are equivalent to 100 of the given colour; and the sum of V, U, E gives a coefficient, which gives a general idea of the brightness. It will be seen that the first admixture of yellow *diminishes* the brightness of the blue. The negative values of U indicate that a mixture of V, U, and E cannot be made equivalent to the given colour. The experiments from which these results were taken had the negative values transferred to the other side of the equation. They were all made by means of the colour-top, and were verified by repetition at different times. It may be necessary to remark, in conclusion, with reference to the mode of registering visible colours in terms of three arbitrary standard colours, that it proceeds upon that theory of three primary elements in the sensation of colour, which treats the investigation of the laws of visible colour as a branch of human physiology, incapable of being deduced from the laws of light itself, as set forth in physical optics. It takes advantage of the methods of optics to study vision itself; and its appeal is not to physical principles, but to our consciousness of our own sensations.

On the Form of Lightning. By James Nasmyth, *F.R.A.S.*

Mr. Nasmyth said, that, observing that the form usually attributed to lightning by painters and in works of art was very different from that which he had observed as exhibited in nature, he was induced to call attention to it. He believed the error of the artists originated in the form given to the thunderbolt in the hand of Jupiter as sculptured by the early Greeks. The form of lightning as exhibited in nature was simply an irregular curved line, most generally shooting from the earth below to the cloud above, and often continued from the cloud downwards again to another distant part of the earth. This appearance, he conceived, was the result of the rapid passage of a point of light which constituted the true lightning, leaving on the eye the impression of the path it traced. In very intense lightning, he had also observed offshoots of an arborescent form to proceed, at several places, from the primary track of the flash. But in no instance among the many thunder-storms whose progress he had most attentively watched, had he ever observed such forms of lightning as that usually represented *in works of art*; in all such, the artists invariably adopt a conventional form, namely, that of a zigzag combination of straight lines as indicated in fig. 1; whereas the *true natural* form of a primitive flash of lightning appears to Mr. Nasmyth to be more correctly represented by an intensely crooked line, as indicated in fig. 2; and on several occasions he has observed it to assume the forked or branched form indicated in fig. 3; but, as before said, never in the zigzag dovetail of fig. 1. Mr. Nasmyth also remarked, that in the majority of cases he had observed that the course of the flash was from the earth *upwards* towards the heavens. He used the term "primitive flash" to distinguish it from "sheet lightning," which is generally the reflexion on light diffused from a *hidden* primitive flash.

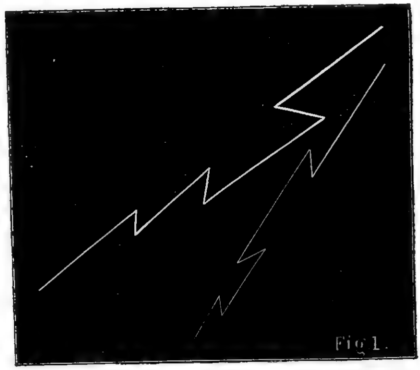


Fig. 1.

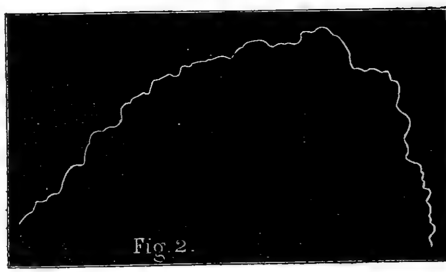


Fig. 2.

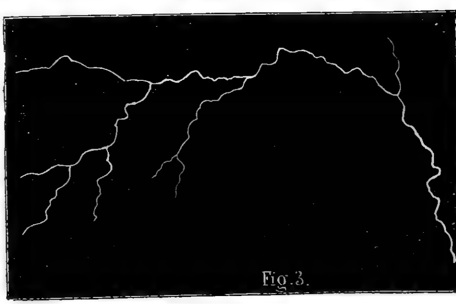


Fig. 3.

On Fresnel's *Formulæ for Reflected and Refracted Light. By the* Rev. Baden Powell, *M.A., F.R.S. &c., Savilian Professor of Geometry, Oxford.*

The author having recently published in the 'Philosophical Magazine' (July and August 1856) a detailed review of the various questions respecting the *demonstration* of these well-known and important formulæ, and their applications, is anxious to put before the Section a short summary of the whole case, and to elicit, if possible, a more complete discussion of the questions arising out of it, more especially as some views recently taken would seem calculated to set aside the whole reasoning hitherto adopted on the subject, and to involve the whole application and interpretation of the formulas in doubt.

The whole of these investigations is founded on the following principles:—

(1) The law of *vis viva* (m and m_i being the simultaneously vibrating masses of æther without and within the medium; h, h', h_i the amplitudes of the incident, reflected, and refracted rays),

$$m(h^2-h'^2)=m_i h_i^2.$$

(2) The law of equivalent vibrations as given by Maccullagh (i and r being the angles of incidence and refraction, I the plane of incidence),

$$h+h'=h_i \text{ vibrations } \textit{perpendicular} \text{ to I.}$$

(3) $$h+h'=h_i\frac{\cos r}{\cos i} \text{ vibrations } \textit{parallel} \text{ to I.}$$

(4) Another form of this law, the second case of which was adopted by Fresnel

$$h-h'=h_i \text{ .... } \textit{perpendicular} \text{ to I.}$$

(5) $$h-h'=h\frac{\cos r}{\cos i} \text{ .... } \textit{parallel} \text{ to I.}$$

(6) Maccullagh's hypothesis of equal densities, giving

$$\frac{m}{m_i}=\frac{\sin 2i}{\sin 2r}.$$

(7) Fresnel's hypothesis of increased density in the more refractive medium, giving

$$\frac{m}{m_i}=\frac{\sin r\cos i}{\sin i\cos r}.$$

(8) Maccullagh's hypothesis of vibrations *parallel* to the plane of polarization.

(9) Fresnel's hypothesis of vibrations *perpendicular* to the plane of polarization.

From these assumptions are directly deduced formulas whose general types are

$$\frac{h'}{h}=\frac{\sin(i-r)}{\sin(i+r)}, \quad \text{..........} \quad (H)$$

$$\frac{k'}{k}=\frac{\tan(i-r)}{\tan(i+r)}, \quad \text{..........} \quad (K)$$

whence h_i and k_i follow from (1) by (2), (3), or (4), (5). Also k' becomes $=0$, and changes sign at the incidence of polarization.

The several hypotheses give these formulas with different signs, and consequently with different values of h_i k_i.

(A) Combining Nos. 1, 2, 3, 6, 8, gives

(α) ...... $+h$ and $+h'$ ...... parallel to I } Maccullagh.
(β) ...... $\pm k$ and $+k'$ ...... perpendicular }

(B) Combining Nos. 1, 2, 3, 7, 9, gives

(α) ...... $+h$ and $-h'$ ...... perpendicular—Fresnel.
(β) ...... $\mp k$ and $+k'$ ...... parallel.

(C) Combining Nos. 1, 4, 5, 7, 9, gives

(α) ...... $+h$ and $+h'$ ...... perpendicular—Fresnel.
(β) ...... $\pm k$ and $+k'$ ...... parallel.

Thus, proceeding in all cases on the principle of *vis viva*, and that of the mechanical equivalence of the incident, reflected, and refracted vibrations,—on the hypothesis of *equal* densities,—of vibrations *parallel* to the plane of polarization,—and of Maccullagh's law of equivalence, we have Maccullagh's formulas (H) and (K). (A.)

On the hypothesis of *increased* density,—of vibrations *perpendicular* to polarization, and Maccullagh's law of equivalence, we have Fresnel's formula (H), but a formula (K) differing from Fresnel's in the signs. (B.)

On the same hypotheses, but taking that form of the law of equivalence which Fresnel adopted in one instance, we have (H) differing from Fresnel's in sign, and (K) the same as Fresnel's. (C.)

The theoretical principles seem as yet to furnish no guide to a choice between these assumptions; but the results of experiment must be appealed to.

The only known experimental results which bear upon the question between these several formulæ and the hypotheses on which they are deduced, are—

I. Professor Stokes's result of the change of plane of vibration and polarization in diffraction, which sets aside absolutely the hypothesis of vibrations *parallel* to the plane of polarization, and by consequence Maccullagh's formulæ (A), and the hypothesis of *equal densities* on which they are founded.

II. The result of Arago, Fresnel and Brewster, as to the change of plane of polarization by reflexion; the new plane being, at small incidences, on the *opposite* side of the plane of incidence to that of original polarization; while *after* passing the incidence of complete polarization it comes to the *same* side. This requires formulas which give h' and k' of *opposite* signs at small incidences, and of the *same* sign after the polarizing incidence, which is only the case with Fresnel's *original* formulas (B, α) and (C, β), and excludes those on the other hypotheses, (B, β), and (C, α).

III. The result of Dr. Lloyd from his interference fringes, where at the extreme oblique incidence the incident and reflected ray are in opposite phases; this requires both h' and h, as also k and k', to be of opposite signs at great incidences, which agrees *only* with Fresnel's *original* formulas (B, α) and (C, β).

But these inferences assume *the correctness of the reasoning on the symbols* as hitherto adopted, both by the original investigators referred to, and also in the elementary treatises of Mr. Airy and others. Some suggestions lately made in order to bring the *other* formulas into accordance with the facts, can only do so by setting aside the validity of the entire reasoning just referred to. These suggestions turn on the geometrical change in position which (in the case of vibrations parallel to the plane of incidence) the directions of the vibrations undergo, with the change of position of the ray, in passing from small to large incidences, so that if they accord in the first instance they will (from this cause alone) be opposed in the second.

On the other hand, the *original* formulas of Fresnel are still deficient in respect to their *direct* deduction from *any one* of the above-mentioned hypotheses; they will only follow from partially adopting *two* of them, viz. (B, α) and (C, β).

A suggestion for deducing them on another principle has been since made by the author in the 'Philosophical Magazine,' October 1856.

On a Modification of the Maynooth Cast Iron Battery. By W. Symons.

A recent paper by Professor Callan in the 'Philosophical Magazine' on a cast iron battery which he states to be equal in power to Grove's nitric acid battery, will probably induce many persons to adopt this very cheap but cumbrous metal. The battery now exhibited is an improvement on one published by the author in the 'Pharmaceutical Journal' for February 1853, and its recommendations are compactness, as it can be moved as one mass; and simplicity and economy of construction, as one wooden screw is sufficient for 10 or 12 pairs. The construction was minutely described, and two arrangements of plates were shown, one adapted for a Wedgewood trough with cast-iron plates on each side of each zinc plate, and the other fitted up in a similar manner to a battery described by Martyn Roberts, in which he proposes to use both sides of both plates: such an arrangement may perhaps be advantageous where the resistance is very small, but from a few experiments with the battery shown, it appears to be far from economical where the resistance is equal to that required for the decomposition of water. Six pairs on each plan were fitted up with similar plates and with acid of the same strength, but the arrangement in which the pairs were isolated in a Wedgewood trough, liberated three or four times the amount of gases in the voltameter, as the arrangement on Martyn Roberts' plan. The battery, when arranged as the author proposes, will be one compact mass, which can be readily moved in and out of the cells; this will probably more than compensate for the loss by the action of the acid on the iron surface not exposed to the zinc, as the battery need only be kept in the acid when actually at work; and this loss may perhaps be further prevented by covering the outside of the iron with a resinous mixture; but should the cast-iron cell suggested by Callan be preferred, they can be easily cast with the addition required in this arrangement. As cast-iron plates 5 inches square can be procured for 2*d*. each at any foundry, and no binding screws are required, this battery will probably be found much cheaper and quite as efficient as any published, and especially adapted for experimentalists who make their own apparatus, who will know how to appreciate the cheap and easy method for making the connexions. A more detailed account, with an engraving of this battery, may be seen in the 'Chemist' for November 1856.

On Dellman's *Method of observing Atmospheric Electricity. By* Professor William Thomson, *M.A., F.R.S., Glasgow.*

Extract from letter addressed to General Sabine:—"During my recent visit to Creuznach I became acquainted with Mr. Dellman of that place, who makes meteorological, chiefly electrical, observations for the Prussian Government, and I had opportunities of witnessing his method of electrical observation. It consists in using a copper ball about 6 inches diameter, to carry away an electrical effect from a position about two yards above the roof of his house, depending simply on the atmospheric 'potential' at the point to which the centre of the ball is sent; and it is exactly the method of the 'carrier ball' by which Faraday investigated the atmospheric potential in the neighbourhood of a rubbed stick of shell-lac, and other electrified bodies ('Experimental Researches,' Series XI. 1837). The whole process only differs from Faraday's in not employing the carrier ball directly, as the repeller in a Coulomb-electrometer, but putting it into communication with the conductor of a separate electrometer of peculiar construction. The collecting part of the apparatus is so simple and easily managed that an amateur could, for a few shillings, set one up on his own house, if at all suitable as regards roof and windows; and, if provided with a suitable electrometer, could make observations in atmospheric electricity with as much ease as thermometric or barometric observations. The electrometer used by Mr. Dellman is of his own construction (described in Poggendorff's 'Annalen,' 1853, vol. lxxxix., also vol. lxxxv.), and it appears to be very satisfactory in its operation. It is, I believe, essentially more accurate and sensitive than Peltier's, and it has a great advantage in affording a very easy and exact method for reducing its indications to absolute measure. I was much struck with the simplicity and excellence of Mr. Dellman's whole system of observation on atmospheric electricity; and it has occurred to me that the Kew Committee might be disposed to adopt it, if determined to carry out electrical observations. When I told Mr. Dellman that I intended to make a suggestion to this effect, he at once offered to have an electrometer, if desired, made under his own care. I wish also to suggest two other modes of observing atmospheric electricity which have occurred to me, as possessing each of them some advantages over any of the systems hitherto followed. In one of these I propose to have an uninsulated cylindrical iron funnel, about 7 inches diameter, fixed to a height of two or three yards above the highest part of the building, and a light moveable continuation (like the telescope funnel of a steamer) of a yard and a half or two yards more, which can be let down or pushed up at pleasure. Insulated by supports at the top of the fixed part of the funnel, I would have a metal stem carrying a ball like Dellman's, standing to such a height that it can be covered by a hinged lid on the top of the moveable joint of the funnel, when the latter is pushed up; and a fine wire fixed to the lower end of the insulated stem, and hanging down, in the axis of the funnel to the electrometer. When the apparatus is not in use, the moveable joint would be kept at the highest, with its lid down, and the ball uninsulated. To make an observation, the ball would be insulated, the lid turned up rapidly, and the moveable joint carrying it let down, an operation which could be effected in a few seconds by a suitable mechanism. The electrometer would immediately indicate an inductive electrification simply proportional to the atmospheric potential at the position occupied by the centre of the ball, and would continue to indicate at each instant the actual atmospheric potential, however variable, as long as no sensible electrification or diselectrification has taken place through imperfect insulation or convection by particles of dust or currents of air (probably for a quarter or a half of an hour, when care is taken to keep the insulation in good order). This might be the best form of apparatus for making observations in the presence of thunder-clouds. But I think the best possible plan in most respects, if it turns out to be practicable, of which I can have little doubt, will be to use, instead of the ordinary fixed insulated conductor with a point, a fixed conductor of similar form, but hollow, and containing within itself an apparatus for making hydrogen, and blowing small soap-bubbles of that gas from a fine tube terminating as nearly as may be in a point, at a height of a few yards in the air. With this arrangement the insulation would only need to be good enough to make the loss of a charge by conduction very slow in comparison with convective loss by the bubbles; so that it would be easy to secure against any sensible error from defective insulation. If 100 or 200 bubbles, each $\frac{1}{10}$ inch in diameter, are blown from the top of the conductor per minute, the electrical potential in its interior will very rapidly follow variations of the atmospheric potential, and would be at any instant the same as the mean for the atmosphere during some period of a few minutes preceding. The action of a simple point is (as, I suppose, is generally admitted) essentially unsatisfactory, and as nearly as possible nugatory in its results. I am not aware how flame has been found to succeed, but I should think not well in the circumstances of atmospheric observations, in which it is essentially closed in a lantern; and I cannot see on any theoretical ground how its action in these circumstances can be *perfect*, like that of the soap-bubbles. I intend to make a trial of the practicability of blowing the bubbles; and if it proves satisfactory, there cannot be a doubt of the availability of the system for atmospheric observations."

[Addition, Feb. 1857.]—The author has now made various trials on the last-mentioned part of his proposal, and he has not succeeded in finding any practicable self-regulating apparatus for blowing bubbles and detaching them one by one from the tube. He has seen reason to doubt whether it will be possible to get bubbles so small as those proposed above, to rise at all; but he has not been led to believe that, if it is thought worth while to try, it will be found impracticable to construct a self-acting apparatus which will regularly blow and discharge separately, bubbles of considerably larger diameter, and so to secure the advantages mentioned, although with a proportionately larger consumption of the gas.

On the other hand, he finds that, by the aid of an extremely sensitive electrometer which he has recently constructed, he will be able, in all probability with great ease and at very small cost, to bring into practice the first of his two plans, constructed on a considerably smaller scale as regards height than proposed in the preceding statement.

On Printing Photographs, with suggestions for introducing Clouds and Artistic Effects. By E. VIVIAN, *M.A.*

The object of this paper was to point out the deficiencies in the chiaroscuro of photographic pictures, occasioned by the discrepancy between the actinic and the visual ray, and also the importance of introducing artistic effects in accordance with the laws of composition.

The former of these is well known, yellow being the focus of light in the scale or colour, whilst it is the darkest in the photographic image, the greatest intensity of chemical action in the spectrum being in the violet, and even beyond the range of light. The defects of composition in ordinary nature are not so generally admitted, but, to the artist's eye, few scenes are capable of producing a good picture, without, at least, the concentration and balance of light and shadow, which are only seen under rare and peculiarly favourable circumstances. Attention to this latter point is the more necessary in most photographic pictures from their reduced size, which requires them to be viewed at a distance from the eye, much beyond the technical "distance of the picture," the rays thus entering the retina from all parts at nearly the same angle, instead of those from the centre being full and direct, and those from the extremities weakened by obliquity, as would be the case if the picture were the size of life.

The remedy proposed was the employment of a second artificial negative, similar to the tint stone in double lithography. In preparing this, a sheet of transparent tracing paper is laid upon the original photograph, and all those portions which are to form the high lights are stopped out with opake colour, the clouds being formed with washes by a camel-hair brush, and the fine tracery of architecture, &c. with a reed pen or crowquill. Whilst the positive impression is still sensitive, this tint paper is to be accurately fitted on, either by the eye, or points in the frame, and exposed again to the light, until flat tones of the requisite depth are produced. The sky may be graduated by moving a shade over the surface, allowing the horizon to be least exposed, the effect of which is to produce the utmost delicacy in the force of the clouds as they recede in the perspective, however rudely drawn. A still more perfect method is to commence with a good negative photograph of natural clouds, proceeding as before with the details of the picture.

The first object should be to throw a flat tint over all those portions which, from being blue, have printed too light, as the sky, slate roofs, and all polished surfaces, as water, leaves of evergreens, &c., which reflect the blue of the sky. This alone will often produce a pleasing picture from a very unsatisfactory negative, light objects relieved by a dark sky, and the deep tones of water, especially in sea pieces, being amongst the most effective objects in nature, but which are quite lost in ordinary photography. The effect must be left to the skill of the artist, shadows of clouds, with the toning down of obtrusive or offensive features being amongst the most obvious means employed to improve the composition, without interfering with the truth of the original outlines. The most powerful effects of moonlight, sunrise, or sunset may thus be produced, with reflexions in still water, or the gleams and ripple of a breeze; the foam and sharp lines of a cataract may, by stopping out high lights on the original negative, be also substituted for the dull mass which ordinarily represents falling water.

The difficulty of reversing the lights of the clouds by using dark colour, may, if preferred, be avoided by substituting Chinese white tinged with yellow, the transparent paper being laid upon the dark sky of the negative.

A tint paper thus produced may be used for any number of impressions, and, if the details of the picture are satisfactory, skies alone may be adapted to many different negatives, especially if drawn of more than the requisite extent, so as to apply such portion as is suitable to the composition of each picture.

Many other suggestions were offered, such as inverting the negative to produce reflexions, when taken from the level of the water, the introduction of foregrounds, cattle, &c., by using both the object and the matrix from which it was cut, so that the lines should exactly coincide. Methods were also shown by which the printing of parts of a photograph may be retarded so as to bring up the more opake portions. The most effectual of these was to attach a sheet of transparent tracing paper over the back of the negative and to stump over the weaker parts, so as when seen by transmitted light the whole should be in due gradation. The dispersion of ray through the thickness of the glass is found sufficient to prevent any trace of this artificial shading. With paper negatives the same result may also be produced by partial waxing.

On the Construction and Use of an Instrument for determining the Value of Intermittent or Alternating Electric Currents for purposes of Practical Telegraphy. By Wildman Whitehouse.

In the prosecution of some electrical studies, requiring an estimate of the values of different magneto-electric currents, Mr. Whitehouse found that the ordinary galvanometer was totally inadequate to indicate the required results.

However suitable that instrument might be for a continuous or voltaic current, and within a very limited range, yet the problem before him involved the numerical estimate of currents of the widest range and of the shortest duration.

It therefore occurred to Mr. Whitehouse that the amount of magnetic force developed by the current in its passage through fine wire surrounding an electro-magnet, seemed to offer the most ready, and at the same time the most practical mode of attaining the object;—an idea which received confirmation from the fact, that whenever such currents were used in telegraphy, they were always received upon and made to actuate electro-magnets.

He therefore wound an electro-magnet with fine wire, placing its poles very near to a keeper of soft iron, poised in the manner of a lever steelyard and loaded to any given weight; the current either lifted or did not lift the given weight, and this was the test of what Mr. W. proposed to call its "value" in telegraphy.

So delicate was this test that he had been able to determine accurately the "value," as it may be termed, of a current too feeble in its energy, and too brief in its duration, to give the slightest indication of its presence on one of the most sensitive "detectors" usually employed in critical telegraphic operations.

He had actually weighed with accuracy a current whose force was represented by $\frac{7}{10}$ths of a grain; and on the other hand currents with a wide range of quantity and intensity, and of varying amounts of force up to no less than 600,000 grains.

Mr. Whitehouse then described in detail the principle and construction of the instrument. The reels of fine wire were so arranged as to be easily removeable, in order to substitute others carrying wire of different gauges, or even without this change any two reels might be either joined up in series for intensity or in parallel currents, which thereby halved the length while it doubled the area of conducting wire.

Mr. Whitehouse then illustrated its uses and practical capabilities.

1st. It had contributed valuable aid in the analysis of several forms of induction coils, varying in size and construction; it not only estimated in grains the value of each secondary current thus produced, but approximatively determined their relative amounts of quantity and intensity, by noting the arrangement of wire which gave the best result.

2ndly. It speedily indicated the advantage of using induction coils in pairs rather than singly, under which head some surprising results were given, the near presence of an unexcited iron bar augmenting the value of the current in the coil under observation.

3rdly. It would evidently afford the means of practically determining a point of considerable interest in the comparison of voltaic and magneto-electric currents, to the solution of which Mr. Whitehouse had pledged himself: this was to ascertain the economico-practical limits of battery series; because the penetrating power or intensity and value of currents so produced might hereby be accurately compared with the force of coil currents educed from batteries of much simpler and less wasteful construction, consisting only of one or two elements, instead of hundreds.

4thly. It had, conjointly with the use of a pendulum and automatic recording arrangements, led to the production of a series of curve diagrams, representing a minute analysis of any given current, denoting its force, however variable, in the several fractions of a second of time.

5thly. It had enabled Mr. Whitehouse, with the assistance and cooperation of Mr. Bright of the Magnetic Company, after weighing the value, upon short circuit, of the currents from many of their magneto-instruments, so as to determine their average value, to weigh the same currents after working through various distances, from 40 to 320 miles of subterranean and submarine wires; thus showing with certainty and minute accuracy the loss due to the combined influence of resistance, induction and defective insulation.

Lastly. It had done good service in working out the laws relating to induction in submarine circuits; and some striking illustrations were given in conclusion.

Working upon a 498 mile length of very perfectly insulated cable-wire, the phenomena of induction and retardation, of charge and discharge, as originally described by Faraday, were exhibited in a remarkable manner.

A current, lifting 18,000 grains on short circuit, was sent into the long wire, the further end of which was insulated; but on cutting off the battery, and instantly discharging the wire to earth through the same instrument, it gave a lifting power of 60,000 grains; so strikingly cumulative was the tendency of this gigantic Leyden jar. While, if both ends of the wire were discharged to earth simultaneously, a lift of 96,000 grains was obtained, thus realizing as a return, more than five times the amount which the battery gave on short circuit. Again: A feeble magneto-current of only 4 grains was adequate to work a telegraphic receiving instrument, a sensitive galvanometer being placed in the same circuit; but this latter gave most uncertain indications of value; its unsteady movements ranged wider with slow and feeble currents, and indicated a lesser value for stronger currents, which followed more rapidly in succession, all which however were accurately pourtrayed by the new instrument. Again: A pair of induction coils, excited by six small Smee cells, gave 27,000 grains; the mere addition of a soft iron armature at one end augmented this to 43,000, while a similar one at the other end increased the current's value up to 47,500.

Mr. Whitehouse called it a "Magneto-electrometer" from its special adaptation to the measurement of magneto-electric currents, while the terms galvanometer, voltameter, and electrometer sufficiently indicated for these instruments their connexion with other forms of electricity.

The desirability of a definite and common standard of comparison was insisted on, and Mr. Whitehouse promised to set aside for this special use the most accurately finished and perfect instrument he could obtain, for the free use of any fellow-labourers in the same field.

The Law of the Squares—is it applicable or not to the Transmission of Signals in Submarine Circuits? By WILDMAN WHITEHOUSE.

Referring to the proceedings of this Section last year at Glasgow, the author quoted Prof. W. Thomson's paper on this subject, where he stated "that a part of the theory communicated by himself to the Royal Society last May, and published in the 'Proceedings,' shows that a wire of six times the length of the Varna and Balaklava wire, if of the same lateral dimensions, would give thirty-six times the retardation, and thirty-six times the slowness of action. If the distinctness of utterance and rapidity of action practicable with the Varna and Balaklava wire are only such as not to be inconvenient, it would be necessary to have a wire of six times the diameter; or better, thirty-six wires of the same dimensions; or a larger number of small wires twisted together, under a gutta-percha covering, to give tolerably convenient action by a submarine cable of six times the length." The author then stated, that circumstances had enabled him to make very recently a long series of experiments upon this point, the results of which he proposed to lay before the Section; adding, that an opportunity still existed for repeating these experiments upon a portion of cable to which he could obtain access, and that he was ready to show them before a committee of this Section in London, if the important nature of the subject should seem to render such a course desirable. Although the subject of submarine telegraphy had many points of the highest importance requiring investigation, and to the consideration of which he had been devoting himself recently, Mr. Whitehouse proposed to confine his remarks on this occasion to the one point indicated in the title, inasmuch as the decision of that one, either favourably or otherwise, would have, on the one hand, the effect of putting a very narrow limit to our progress in telegraphy, or, on the other, of leaving it the most ample scope. He drew a distinction between the mere transmisssion of a current across the Atlantic (the possibility of which he supposed everybody must admit) and the effectual working of a telegraph at a speed sufficient for "commercial success;" and we gathered from his remarks that there were those ready to embark in the undertaking as soon as the possibility of "commercial success" was demonstrated.

The author then gave a description of the apparatus employed in his researches, of the manner in which the experiments were conducted, and, lastly, of the results obtained. The wires upon which the experiments were made were copper, of No. 16 gauge, very perfectly insulated with gutta percha—spun into two cables, containing three wires of equal length (83 miles), covered with iron wires and coiled in a large tank in full contact with moist earth, but not submerged. The two cables were subsequently joined together, making a length of 166 miles of cable, containing three wires. In addition to this, in some of the latest experiments he had also the advantage of another length of cable, giving with the above, an aggregate of 1020 miles. The instruments, one of which was exhibited, seemed to be of great delicacy, capable of the utmost nicety of adjustment and particularly free from sources of error. The records were all made automatically, by electro-chemical decomposition, on chemically prepared paper. The observations of different distances recorded themselves upon the same slip of paper; thus, 0, 83, and 249 miles were imprinted upon one paper, 0, 83, 498 miles upon another slip, 0, 249, 498 upon another, and 0, 535, 1020 upon another. Thus by the juxtaposition of the several simultaneous records on each slip, as well as by the comparison of one slip with another, the author has been enabled to show most convincingly that the law of the squares is not the law which governs the transmission of signals in submarine circuits. Mr. Whitehouse showed next, by reference to published experiments of Faraday's and Wheatstone's (Philosophical Magazine, July, 1855), that the effect of the iron covering with which the cable was surrounded was, electrically speaking, identical with that which would have resulted from submerging the wire, and that the results of the experiments could not on that point be deemed otherwise than reliable. The author next addressed himself to the objections raised against conclusions drawn from experiments in "Multiple" cables. Faraday had experimented, he said, upon wires laid in close juxtaposition, and with reliable results; but an appeal was made to direct experiment, and the amount of induction from wire to wire was weighed, and proved to be as one to ten thousand, and it was found impossible to vary the amount of retardation by any variation in the arrangement of the wires. Testimony also on this point was not wanting. The Director of the Black Sea Telegraph, Lieut.-Col. Biddulph, was in England, and present at many of the experiments. He confirmed our author's view, adding, "that there was quite as much induction and embarrassment of instruments in this cable as he had met with in the Black Sea line." The author considers it therefore proved, "that experiments upon such a cable, fairly and cautiously conducted, may be regarded as real practical tests, and the results obtained as a fair sample of what will ultimately be found to hold good practically in lines laid out *in extenso*. At the head of each column in the annexed Table is stated the number of observations upon which the result given was computed,—every observation being rejected on which there could fall a suspicion of carelessness, inaccuracy, or uncertainty as to the precise conditions; and, on the other hand, every one which was retained being carefully measured to the hundredth part of a second. This Table is subject to correction, for variation in the state of the battery employed, just as the barometrical observations are subject to correction for temperature. Of this variation as a source of error I am quite aware, but I am not yet in possession of facts enough to supply me with the exact amount of correction required. I prefer, therefore, to let the results stand without correction.

Amount of Retardation observed at various distances. Voltaic Current. Time stated in parts of a Second.

Mean of 550 observations.	Mean of 110 observations.	Mean of 1840 observations.	Mean of 1960 observations.	Mean of 120 simultaneous observations.	
83 miles. 08	166 miles. ·14	249 miles. ·36	498 miles. ·79	535 miles. ·74	1020 miles. 1·42

"Now it needs no long examination of this Table to find that we have the retardation following an increasing ratio, that increase being very little beyond the simple arithmetical ratio. I am quite prepared to admit the possibility of an amount of error having crept into these figures, in spite of my precautions; indeed, I have on that account been anxious to multiply observations in order to obtain most trustworthy results. But I cannot admit the possibility of error having accumulated to such an extent as to entirely overlay and conceal the operation of the law of the squares, if in reality that law had any bearing on the results. Taking 83 miles as our unit of distance, we have a series of 1, 2, 3, 6, and 12. Taking 166 miles as our unit, we have then a series of 1, 3, and 6. Taking 249 miles, we have still a series of 1, 2, and 4, in very long distances. Yet even under these circumstances, and with these facilities, I cannot find a trace of the operation of that law." The author then examined the evidence of the law of the squares, as shown by the value of a current taken in submarine or subterranean wires at different distances from the generator thereof, which he showed were strongly corroborative of the previous results. He next examined the question of the size of the conducting wire; and he had the opportunity of testing the application of the law, as enunciated by Prof. Thomson last year. The results, far from confirming the law, are strikingly opposed to it. The fact of trebling the size of the conductor augmented the amount of retardation to nearly double that observed in the single wire. The author, however, looked for the *experimentum crucis* in the limit to the rapidity and distinctness of utterance attainable in the relative distances of 500 and 1020 miles. 350 and 270 were the actual number of distinct signals recorded in equal times through these two lengths respectively. These figures have no relation to the squares of the distance. "Now, if the law of the squares be held to be good in its application to submarine circuits, and if the deductions as to the necessary size of the wire, based upon that law, can be proved to be valid also, we are driven to the inevitable conclusion that submarine cables of certain length to be successful must be constructed in accordance with these principles. And what does this involve? In the case of the Transatlantic line, whose estimated length will be no less than 2500 miles, it would necessitate the use, for a single conductor only, of a cable so large and ponderous, as that probably no ship except Mr. Scott Russell's leviathian could carry it,—so unwieldy in the manufacture, that its perfect insulation would be a matter almost of practical impossibility,—and so expensive, from the amount of materials employed, and the very laborious and critical nature of the processes required in making and laying it out, that the thing would be abandoned as being practically and commercially impossible. If, on the other hand, the law of the squares be proved to be inapplicable to the transmission of signals by submarine wires, whether with reference to the amount of retardation observable in them, the rapidity of utterance to be obtained, or the size of conductor required for the purpose, then we may shortly expect to see a cable not much exceeding one ton per mile, containing three, four or five conductors, stretched from shore to shore, and uniting us to our Transatlantic brethren, at an expense of less than one-fourth that of the large one above mentioned, able to carry four or five times the number of messages, and therefore yielding about twenty times as much return in proportion to the outlay. And what, I may be asked, is the general conclusion to be drawn as the result of this investigation of the law of the squares applied to submarine circuits? In all honesty, I am bound to answer, that I believe nature knows no such application of that law; and I can only regard it as a fiction of the schools, a forced and violent adaptation of a principle in Physics, good and true under other circumstances, but misapplied here."

Astronomy, Meteors, Waves.

On the Tides of Nova Scotia.
By the Rev. Professor Chevallier, *B.D., F.R.A.S.*

The observations to which reference is made were taken by a tide-gauge fixed upon a wharf at the north end of the naval yard at Halifax. The tides there are small in amount, the spring tides rising from 6½ to 9 feet at Halifax, and 8 feet at Sambro Isle, twelve miles south of that place. The tides themselves appear to be quite regular; but in addition to the ordinary tide-wave there occurs a series of undulations succeeding each other at intervals of twenty minutes or half an hour, the difference of elevation and depression rarely exceeding 6 inches, and being usually much less. They are more perceptible near low water; but occur at all times of tide, and are very distinctly marked upon the curve traced by the self-acting tide-gauge. The question to be considered is, what is the cause of these small waves? 1. They do not arise from any influence which the casual swell of the sea might exercise upon the tide-guage: for the rise and fall of one of these waves very seldom takes less time than a quarter of an hour, and often requires half an hour, or even three-quarters of an hour. 2. They do not arise from undulatory motion in the whole waters of the harbour. In order to examine this question, Mr. Edgcumbe Chevallier, the storekeeper in Halifax Dockyard, went to Sambro, ten or twelve miles south of Halifax, and entirely clear of the harbour, and erected upon Power Island a temporary gauge, with which he took the height of the water every five minutes for the whole day. Having laid off the results in a form similar to that employed with the fixed tide-gauge at Halifax, it was found that every irregularity at Halifax was preceded ten or fifteen minutes by a larger irregularity at Sambro. These observations show that the irregular waves do not arise from the peculiar form of the harbour at Halifax. 3. At about sixty miles eastward from Halifax, outside Sable Island, the Gulf-stream runs in nearly a north-eastern direction with considerable velocity; and between Sable Island and the land a counter-current runs nearly in a south-western direction. One of these currents would elevate the surface of the sea near the middle of the currents; and such an elevation of the surface over which the tide-wave is propagated might give rise to undulations similar to those observed. I am informed, however, that the undulations in question are observed on the western side of Nova Scotia, to which any effect of those two currents could not extend. 4. Although the tides at Halifax and on the neighbouring coast are small, that part of the ocean is near the indraught of the Bay of Fundy, where the peculiar form of the coast and its position with reference to the great tide-wave of the Atlantic give rise to a local tide of excessive magnitude. Such a tide, especially when reverberated from coast to coast in a comparatively narrow inlet, might not improbably give rise to perceptible undulations in a neighbouring part of the sea. If this be the cause, it might be expected that a similar effect should be noticed where a tide of the like nature takes place. The Bay of Avranches is a locality of this kind, and the island of Jersey appeared to be a place where any undulations of the tide might probably be noticed. The extreme difference between high and low water at St. Helier's is 42 feet, and the difference of height of the mean high and low water is 36 feet. On inquiry, I find that about ten years since a tide-guage was fixed at St. Helier's, but observed only at high water, when irregularities were observed of the same kind as those noticed at Halifax. This seems to give probability to the opinion that the irregularities observed in the tide at Halifax may be connected with the unusual tides in the Bay of Fundy. But whether they arise from this source, or are to be traced to some great reciprocating motion to which the waters of the Atlantic may be subject, the phænomenon deserves to be studied, as likely to lead to a more extended knowledge of the hydrodynamical conditions of our globe.

Working Model of a Machine for polishing Specula for Reflecting Telescopes and Lenses. By Richard Greene, *M.D.*

The polishing machine, the model of which I have now the honour of laying before the British Association, scarcely deserves the name of an invention, inasmuch as the public have for some years been in possession of a very beautiful machine, invented by William Lassell, Esq. of Liverpool, and most ably constructed by my very talented friend James Nasmyth, Esq. of Patricroft foundry. It will no doubt occur to most persons acquainted with the very superior specula produced by both these gentlemen with that machine, why trouble the Association with an imitation of that invention?

This question is solved by the weighty argument of the three letters *£ s. d.* The polishing machine of Mr. Lassell is constructed entirely of metal, is quite out of the power of any amateur to construct, requires to be bolted to wall, can scarcely be turned by hand power, weighs at least three or four hundredweight, and from the great care and accuracy required in its construction, costs, I think, £70, while a light portable machine on the principle of this model can, without any difficulty, be made by any handy amateur with a common foot lathe for less than 70*s.*, and need not weigh 90 pounds. The only machine I ever made on this principle is amply powerful to polish specula of 12 or 14 inches aperture; its fly-wheel is only 2 feet diameter, weighing about 45 lbs., and such a fly-wheel can always be found at the old iron stands for six or eight shillings: all the spindles are common bar iron with the journeys turned on them, and all the bearings are of box-wood, which is far better than bell-metal, as neither heating, wearing, or scarcely ever requiring oil.

In that beautiful machine of Mr. Lassell, the axis of the table which carries the speculum is in the same line with the axis of the slow crank, which by two systems of gearing rotating round a fixed toothed wheel, the pin of the quick crank carries the centre of the polisher with an epicycloidal motion over the surface of the speculum. This machine effects the same object simply by a crank rotating in a circle, but the centre of the table which carries the speculum, can be moved at pleasure more or less distant from the centre of that circle. This simple sliding of the axis of the table out of the line of the axis of the crank, causes the centre of the polisher to describe over the face of the speculum the exact figure the more complex machine produces.

When first I contemplated the construction of a polishing machine on this very simple principle, I never intended to do anything more than to imitate exactly the motions which produced such happy results in the hands of its talented inventor. In carrying out my design, it became obvious, that, by adding three or four more pulleys, at a cost of less than half so many shillings, the machine (in addition to the proved movements of Mr. Lassell's machine) was invested with a power enabling an experimenter in that most interesting branch of practical science, to try the effect of a vast variety of motions for figuring, which the more complex machine is not capable of producing. A few of these motions have been transferred to paper, by substituting for the iron sliding box (which by its pin moves the polisher) a wooden sliding box carrying a pencil, and in place of the speculum these pieces of paper were laid on the table and held there with weights on their corners. The figures are extremely regular and of every conceivable variety of curve.

Several specula of $4\frac{1}{2}$, 7, and $8\frac{1}{2}$ inches have been repeatedly polished and repolished with this machine, and in no instance has a really bad figure been the result. Of course some were better than others; but I believe it will be admitted by all who have trodden this very difficult but interesting path of practical science, that a very fine figure is as much entitled to be enrolled in the chapter of accidents, as a really fine chronometer, which no care in its construction can possibly ensure. If the cause of the imperfection of a speculum be ascertained, and it is found to be decidedly spherical or hyperbolical, the former can with certainty be removed by increasing the excentricity of the table, and the latter by diminishing it. Very frequently, however, it happens that the different zones of a speculum, as tested by diaphragms, have their foci coincident, yet the speculum does not perform well, from a want of uniformity in the curvature. In these cases I have derived great advantage from placing the centre of the speculum a little excentric as regards the centre of the table, so that in working the excentricity (which is the slow crank in Lassell's) is continually varying from the *sum* of the two excentricities, to their difference, the mean excentricity remaining unchanged. Latterly, indeed, I have always employed the double excentricity. A few remarks upon the formation of the polisher will bring this description to a close. Mr. Lassell recommends making the polisher of *two* pieces of light wood glued together, with their grain at right angles; in his hands it has certainly performed wonders, but as it is liable to warp with hygrometric changes in the atmosphere, it is as well totally to prevent such warping by employing three, instead of two pieces of board, making the two outside pieces at right angles to the centre piece as regards their grain. To make the furrows in the pitch so that they shall not fill up in polishing, is extremely difficult by the ordinary process of pressing the pitch while in a soft state with the edge of a ruler, as the pitch forced out of the furrows is heaped up on the edges of the squares, leaving a hollow in the centre of each square; in working it is forced back again, and it is absolutely necessary that the furrows should remain open during the entire process of polishing. I prefer covering the surface of the polisher with squares of wood about $\frac{1}{8}$ inch in thickness and $\frac{1}{4}$ an inch apart, stuck on with hot pitch or glue, and a nail in the centre. The polisher being held with the face down, the squares are covered over with a brush dipped in the pitch (not very hot), and repeating the operation until a proper thickness be obtained; when made in this way the furrows will never fill up except the pitch be much too soft.

On the Physical Structure of the Earth. *By* Professor HENNESSY.

After some preliminary observations as to the impossibility of accounting for the earth's figure, without supposing it to have been once a fused mass, the exterior of which has cooled into a solid crust, the process of solidification of the fluid was described. The influence of the convection and circulation of the particles in a heterogeneous fluid was shown to be different from what would take place in a homogeneous fluid such as usually comes under our notice. As the primitive fluid mass of the earth would consist of strata increasing in density from the surface towards the centre, its refrigeration would be that of a heterogeneous fluid, and the process of circulation would be less energetic in going from its surface towards its centre. Thus the earth would ultimately consist of a fluid nucleus enclosed in a spheroidal shell. The increase in thickness of this shell would take place by the solidification of each of the surface strata of the nucleus in succession. If the matter composing the interior of the earth is subjected to the same physical laws as the material of the solid crust coming under our notice, the change of state in the fluid must be accompanied by a diminution of its volume. The contrary hypothesis had been hitherto always assumed in mathematical investigations relative to the form and structure of the earth. The erroneous supposition that the particles of the primitive fluid retained the same positions after the mass had advanced in the process of solidification as they had before the process commenced, had been tacitly or openly assumed in all such inquiries until it was formally rejected by the author*, who proposed to assume for the fluid similar properties to those exhibited by the fusion and solidification of such portions of the solidified crust as are accessible to observation. The results to which the improved hypothesis has led, show that it fundamentally affects the whole question, not only of the shape and internal structure of the earth, but also of the various actions and reactions taking place between the fluid nucleus and the solid shell. If the process of solidification took place without change of volume in the congelation of the fluid, the strata of the shell would possess the same forms as those of the primitive fluid, and their oblateness would diminish in going from the outer to the inner surface. If the fluid contracts in volume on passing to the solid state, the remaining fluid will tend to assume a more and more oblate figure after the formation of each stratum of the shell. The law of density of the nucleus will not be the same as that of the primitive fluid, but will vary more slowly, and the mass will thus tend towards a state of homogeneity as the radius of the nucleus diminishes by the gradual thickening of the shell. The surface of the nucleus, and consequently the inner surface of the shell, will thus tend to become more oblate after each successive stratum added to the shell by congelation from the nucleus. This result, combined with another obtained by Mr. Hopkins, proves that so great pressure and friction exist at the surface of contact of the shell and nucleus as to cause both to rotate together nearly as one solid mass. Other grounds for believing in the existence of the great pressure exercised by the nucleus at the surface of the shell were adduced. If the density of the fluid strata were due to the pressures they support, and if the earth solidified without any change of state in the solidifying fluid, the pressure against the inner surface of the shell would be that due to the density of the surface stratum of the nucleus, and would therefore rapidly increase with the thickness of the shell. Contraction in volume of the fluid on entering the solid state would diminish this pressure, but yet it may continue to be very considerable, as the coefficient of contraction would always approach towards unity. The phænomena of the solidification of lava and of volcanic bombs were referred to in illustration of these views, and their application was then shown to some of the greatest questions of geology. The relations of symmetry which the researches of M. Elie de Beaumont seem to establish between the great lines of elevation which traverse the surface of the earth, appear to Prof. Hennessy far more simply and satisfactorily explained by the expansive tendency of the nucleus which produces the great pressure against the shell than by the collapse and subsidences of the latter. The direction of the forces which would tend to produce a rupture from the purely elevatory action of the pressure referred to would be far more favourable to symmetry than if the shell were undergoing a distortion of shape

* Philosophical Transactions, 1851, part 2.

from collapsing inwards. The nearly spherical shape of the shell would also greatly increase its resistance to forces acting perpendicularly to its surface, so as to cause parts to subside, while the action of elevatory forces would not be resisted in the same manner.

On the Eclipse of the Sun mentioned in the First Book of Herodotus. By the Rev. Dr. Edward Hincks.

The author maintained that the eclipse of the 18th of May, 603 B.C., was that which terminated the Lydian war, and that from this celebrated eclipse and his knowledge of the period of 223 lunations, Thales had predicted the eclipse of the 28th of May, 585 B.C. Herodotus, he thought, had confounded the two eclipses with which the name of Thales was connected.

Previously to the publication of Mr. Baily's paper in 1811, it was generally believed by astronomers that the eclipse of 603 B.C. satisfied the conditions of that which terminated the war, the field of battle being supposed to be in the neighbourhood of Kars. Now that Mr. Baily's arguments against this eclipse have been shown to be erroneous, the author regretted that recent writers had neglected it; the elements of it having never been calculated with the improved lunar tables now in use.

On an Instrument to illustrate Poinsôt's *Theory of Rotation. By* J. C. Maxwell.

In studying the rotation of a solid body according to Poinsôt's method, we have to consider the successive positions of the instantaneous axis of rotation with reference both to directions fixed in space and axes assumed in the moving body. The paths traced out by the pole of this axis on the *invariable plane* and on the *central ellipsoid* form interesting subjects of mathematical investigation. But when we attempt to follow with our eye the motion of a rotating body, we find it difficult to determine through what point of the *body* the instantaneous axis passes at any time,—and to determine its path must be still more difficult. I have endeavoured to render visible the path of the instantaneous axis, and to vary the circumstances of motion, by means of a top of the same kind as that used by Mr. Elliot, to illustrate precession*. The body of the instrument is a hollow cone of wood, rising from a ring, 7 inches in diameter and 1 inch thick. An iron axis, 8 inches long, screws into the vertex of the cone. The lower extremity has a point of hard steel, which rests in an agate cup, and forms the support of the instrument. An iron nut, three ounces in weight, is made to screw on the axis, and to be fixed at any point; and in the wooden ring are screwed four bolts, of three ounces, working horizontally, and four bolts, of one ounce, working vertically. On the upper part of the axis is placed a disc of card, on which are drawn four concentric rings. Each ring is divided into four quadrants, which are coloured red, yellow, green, and blue. The spaces between the rings are white. When the top is in motion, it is easy to see in which quadrant the instantaneous axis is at any moment and the distance between it and the axis of the instrument; and we observe,—1st. That the instantaneous axis travels in a closed curve, and returns to its original position in the body. 2ndly. That by working the vertical bolts, we can make the axis of the instrument the centre of this closed curve. It will then be one of the principal axes of inertia. 3rdly. That, by working the nut on the axis, we can make the order of colours either red, yellow, green, blue, or the reverse. When the order of colours is in the *same* direction as the rotation, it indicates that the axis of the instrument is that of *greatest* moment of inertia. 4thly. That if we screw the two pairs of opposite horizontal bolts to different distances from the axis, the path of the instantaneous pole will no longer be equidistant from the axis, but will describe an ellipse, whose longer axis is in the direction of the *mean axis* of the instrument. 5thly. That if we now make one of the two horizontal axes less and the other greater than the vertical axis, the instan-

* Transsactions of the Royal Scottish Society of Arts, 1855.

taneous pole will separate from the axis of the instrument, and the axis will incline more and more till the spinning can no longer go on, on account of the obliquity. It is easy to see that, by attending to the laws of motion, we may produce any of the above effects at pleasure, and illustrate many different propositions by means of the same instrument.

On the Constancy of Solar Radiation. By Professor PIAZZI SMYTH, *F.R.S.E.*

Having lately recomputed all our earth-thermometric observations from the year 1838 to 1854 inclusive, I am able to offer to the Association a few particulars respecting a cosmical question, on which many speculations have been ventured, but no exact numerical particulars ascertained,—I mean the constancy in amount of heat radiated from the sun.

These earth-thermometers have been observed once a week during the whole period alluded to, and are admirably adapted to equalize temporary meteorological variations, and to give good mean results.

Their bulbs (filled with alcohol) are buried in the porphyry rock of the hill at the several depths of 3, 6, 12, 24 French feet, and their tubes are long enough to rise to the surface of the ground where the scales are placed, and may be read off to ·01 of a degree Fahrenheit. This set of thermometers was one of those which were established in and about Edinburgh in 1837 for the British Association, under the care of Prof. J. D. Forbes, and it is the only one of them which has survived more than half the period which has elapsed. The excellence and completeness of the burial of the bulb of every thermometer is vouched for by the length of time which the wave of summer heat is found to occupy in reaching each bulb in succession according to its depth. Thus the 3-feet thermometer has its maximum in August; the 6-feet ditto in September; the 12-feet ditto in October; and the 24-feet ditto in December or January. Again, from the annual range decreasing with the depth, as the 3-feet thermometer, annual range = 15° ; the 6-feet ditto, annual range = 9°·8 ; the 12-feet ditto, annual range = 4°·6 ; and the 24-feet ditto, annual range = 1°·2. And when it is added that each weekly observation is carefully corrected for the effect caused by the difference between the temperature of the bulb, and of the several parts of the stem and scale, it will be seen, I trust, that the annual means of such observations must be worth some attention. They are as follow:—

Annual means of Thermometers.

Year.	t_1.	t_2.	t_3.	t_4.
1838	46°·94	46°·16	45°·39	44°·81
1839	46·69	46·15	45·67	45·33
1840	46·77	46·44	46·02	45·68
1841	46·78	46·48	46·06	45·70
1842	46·88	46·81	46·78	46·85
1843	47·14	46·92	46·49	46·18
1844	47·21	47·11	46·83	46·44
1845	47·06	46·56	45·97	45·57
1846	47·29	47·60	47·76	47·78
1847	47·59	47·33	46·88	46·60
1848	47·38	46·97	46·42	46·02
1849	47.25	46·86	46·61	46·52
1850	47·24	47·00	46·69	46·49
1851	47·40	47·26	47·02	46·80
1852	47·55	47·48	47·28	47·05
1853	47·48	47·03	46·50	46·10
1854	47·41	47·18	46·92	46·75

On these thermometers two heating forces are evidently acting, one from without and residing in the sun, the other from within from the supposed molten centre of the earth. Let us dispose of this one first. From the immense comparative thickness of the bad conducting rock between the lowest of our thermometers and any part of the earth where its substance can be fluid with heat, and be capable of assuming more sudden changes of position or temperature than a solid can, we may safely in a first examination consider the internal or terrestrial effect as constant at each depth for the whole period from 1838 to 1854. The effect is small, but very sensible, as thus :—

Mean of each Thermometer for the whole period, from 1838 to 1854.

t_4	3-feet thermometer	46°·27
t_3	6 ,,	46·55
t_2	12 ,,	46·94
t_1	24 ,,	47·24

where we find each thermometer to tell the same story of, and to point to, a heated terrestrial centre, even by approaching so small a space as 3 feet; and on the whole they show an increase of 1° Fahr., with 21 feet of difference of depth for the internal influence, or the terrestrial source of surface temperature. Subtracting the differences between t_4 and the other thermometers from each in turn, we obtain the following Table, wherein the terrestrial effect being eliminated, the variations from cosmical influences become more apparent :—

Year.	t_1.	t_2.	t_3.	t_4.
1838	45°·97	45·49	45°·11	44°·81
1839	45·72	45·48	45·39	45·38
1840	45·80	45·77	45·74	45·68
1841	45·81	45·81	45·78	45·70
1842	45·91	46·14	46·50	46·85
1843	46·17	46·25	46·21	46·18
1844	46·24	46·44	46·55	46·44
1845	46·09	45·89	45·69	45·57
1846	46·32	46·93	47·48	47·78
1847	46·62	46·66	46·60	46·60
1848	46·41	46·30	46·14	46·02
1849	46·28	46·19	46·33	46·52
1850	46·27	46·33	46·41	46·49
1851	46·43	46·59	46·74	46·80
1852	46·58	46·81	46·00	47·05
1853	46·51	46·36	46·22	46·10
1854	46·44	46·51	46·64	46·75

If these numbers be projected with the times, the curves they form are most interesting, for they contain appearances of periodical waves distributed over a secular swell, with so long a period, that only a small portion of it appears in the seventeen years.

If then we can depend on our observations being strictly cleared of every instrumental and terrestrial cause of disturbance which can logically affect their accuracy, we have at once an indication of our sun being amongst the number of variable stars. Can we then depend on them to this extent? The only possible room that I can see for doubt, is the question of the constancy of the zero-points of the thermometers; and having no means of inquiring into this practically, I can only combine with the general experience of the unalterability of spirit-thermometers, with the very thick glass bulbs and tubes here employed, after a certain period, the particular observations by Professor J. D. Forbes on a thermometer made at the same time as our set, and in the same manner, and filled with the same spirit. The result of examination was, that after nine years no appreciable change (certainly not $\frac{1}{50}$th of a degree) was found.

This is very satisfactory; and if further evidence be required that there is some natural and cosmical cause acting on our thermometers, tending to produce an effect, certainly very similar to what an alteration in the zero-points might do, we have such evidence in special features of difference between the curves of the several thermometers. Thus while t_4 and t_3, by the rapid and uniform rise of their curves at the beginning of the period, lead one to suspect the possibility of something instrumental affecting them, yet it may be that the observations were commenced at the bottom of one of the temperature waves, of which there are evidently three, with a nearly sexennial period between 1838 and 1854. If this latter be the true explanation, then inasmuch as t_2 is retarded in its indications on t_4 and t_3 by two or three months, it ought to show in 1838 by so much the temperature of the opposite slope of the wave, and its curve should not reach its maximum depression so pointedly in 1838 as those of t_4 and t_3. On looking at it, we find t_2 fulfilling these expectations perfectly, for its curve, instead of rising up steeply from 1838 to 1839, is nearly level.

But there is still another proof: t_1 ought to exhibit the retarded effects of t_2 in a still greater degree, if the continued rise of t_4 and t_3 in 1838–39 and 1840 be due to a cosmical cause, and not to an instrumental defect that would act on all the thermometers alike. Now t_1 does precisely what it should do on such a hypothesis; for instead of being only level like t_2 for 1838–39, it is even depressed, having its minimum in the latter year.

Similarly, it will be found through the whole of the period of our observations, that by their regulated differences from each other depending on the effect of the several depths of non-conducting matter covering each of them, the several thermometers serve to confirm each other, as really indicating changes in the mean temperature of the surface of the earth, such as can hardly be attributed to any cause but the variations in the development of solar light and heat.

In this case the ascertainment of the period of the secular wave must be of the utmost importance; for its summit may bring us years warmer than any that have been felt in our own day, and the bottom of it seasons with cold in corresponding severity.

On a Collimator for completing the Adjustments of Reflecting Telescopes. *By* Professor G. Johnstone Stoney, *M.A.*

This paper described an accessory to large reflecting telescopes, designed to assist in adjusting their mirrors at night with more ease and accuracy than hitherto. In general construction the new collimator resembles the telescopes made use of by engineers; it differs only so far that provision must be made for sufficiently illuminating the wires or an artificial star, and that its large lens should have a focal length f, determined by the equation

$$\frac{1}{f}=\frac{1}{d}-\frac{1}{F},$$

where F is the focal length of the telescope to be adjusted, and d is the distance from the centre of the large lens of the collimator to the cross wires. If this instrument be placed in the usual position of the eye-pieces, the illuminated cross wires, and the image of them which will be formed, may be viewed in it, and if these be now brought into coincidence by the adjustment of the mirrors, the line from the intersection of the cross wires to the centre of the large lens of the collimator will be the optic axis of the telescope; *i. e.* this ray, after reflexion from the small mirror will, if produced backward, pass through the centre of curvature of the large mirror. A slight addition to the arrangement would ensure that this axis should also pass approximately through the vertex of the large mirror; but it was supposed that, so far as the optical performance of the telescope is concerned, this would be found a needless refinement if the collimator be employed only to complete adjustments already approximately made by the usual methods, and if the small mirror be properly supported.

The experiments which had been made showed that this latter condition was one of much importance and required that the support of the small mirror should be very stiff, and that the small mirror should be counterpoised at the end of it. The small mirror is usually supported by a single arm placed edgewise, in order to intercept but little light; a second bar, also placed edgewise, and forming a small angle with the first, had been found sufficient to make the arrangement capable of resisting flexure and vibration in a surprising degree, and, as the angle may be reduced so far that both bars can be attached to a slide carrying the eye-pieces, it is also more convenient than the steadying wire which has been sometimes employed.

The facility and accuracy offered by the use of the new collimator are such, that it was suggested that in some instances it might be desirable to make arrangements for adjusting the telescope after every considerable change of altitude. If the collimator were to be thus frequently employed, a beautiful contrivance made use of by Lord Rosse might with much advantage be adapted to it, by mounting it and one or two of the eye-pieces in a slide so that any one of them could in a moment be brought opposite to the cone of rays. A slide moving on a centre was recommended. Since the tilt of the large mirror will thus become of less importance, we may henceforth admit for its support arrangements which introduce more tilt than those at present in use, and thus the solution of what now remains the most difficult problem of large reflecting telescopes may possibly be facilitated.

On Phænomena recently discovered in the Moon. By J. Symons, *M.A.*

On the reasons for describing the Moon's Motion as a Motion about her axis. By the Rev. W. Whewell, *M.A., D.D., F.R.S.*

Meteorology.

On the Causes of Great Inundations. *By* Thomas Dobson, *B.A., of St. John's College, Cambridge.*

The principal *special causes* which tend to produce great inundations in a country are, the inclination and the lithological character of the surface of the basins drained by the rivers of the country.

Where the subsoil of a river-basin is composed chiefly of porous and therefore permeable materials, as oolite, loose gravel, &c., the rain will be absorbed almost as fast as it falls, and will reach the river gradually, after returning to the surface through springs.

But where the subsoil is generally compact and impermeable, as clay, granite, &c., the rain will flow over the surface with more or less velocity, according to the greater or less inclination of the surface to the horizon.

So far, therefore, as the geological character of a river-basin is concerned, the tendency to inundation due to that basin will be measured by the difference between the areas of the permeable and of the impermeable superficial strata, and by the inclination of the sides of the basin to the horizon.

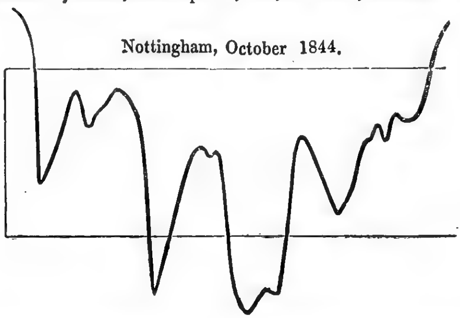
The *general cause* of great inundations in the countries forming the western seaboard of Europe, is the easterly progressive motion of the cyclones, or revolving storms, of the North Atlantic Ocean.

Starting from the Caribbean Sea and the Gulf of Mexico, and sweeping during a considerable portion of their early course along the warm surface of the Gulf-stream, they collect the vapours so copiously generated in southern latitudes and finally precipitate them on the high lands and mountain chains of Europe. In general, several cyclones follow each other in rapid succession, so that the continued rains at length saturate the earth, and floods and inundations ensue.

I shall illustrate these remarks on the *general cause* of European inundations by a brief meteorological history of the great inundations in France in October 1844, October 1846, and in May and June of the present year.

1844.—The tracks of the cyclones of October 1844 have been determined by Mr. Redfield. The first passed over the West Indian Islands on the 1st and 2nd of

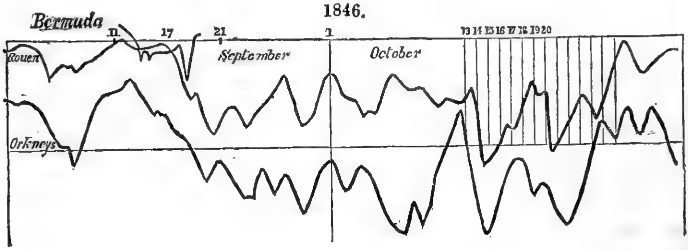
October. The second was the "great Cuba hurricane," which destroyed more than a hundred ships at Havannah, Jamaica, &c. The loss at Havannah alone was estimated at £1,000,000. Its diameter already exceeded 1000 miles. Passing over Cuba on the 3rd and 4th of October, it skirted the coasts of the United States, and struck off eastward into the North Atlantic Ocean at Newfoundland on the 8th of October. Smaller cyclones, waterspouts, &c., as usual, followed in its rear.



The barometer in Britain, as shown by the annexed curve, distinctly recognizes the arrival of each member of this chain of aërial eddies. Tempests, rains, unusually heavy floods, and destructive inundations marked their progress over France, Germany, Italy, &c.

1846.—On the 10th of September, 1846 (Col. Reid, 'Development of the Law of Storms,' p. 371), a great cyclone formed between the islands of Trinidad, Marguerita, Grenada, and Tobago. "As it advanced, its force increased, until it became a tempest of a furious kind. Passing to the westward of Bermuda, it blew there a hard gale on the 17th and 18th, with the centre a little to the eastward of Newfoundland, where it did great damage to the town of St. John's, and was felt as far as 19° W., 50° N. on the eastern side of the Atlantic." We have here evidence that this cyclone came from the West India Islands to the mouth of the English Channel. The barometric readings given by Col. Reid show that the south-eastern margin passed over Bermuda between the 13th and 20th of September. The accompanying barometric curves for Rouen and the Orkneys during September and October 1846, prove that the front of this cyclone first affected the barometer at Rouen on the 17th of September.

This was followed by a series of cyclonic paroxysms, of which the most violent has been examined in detail by Mr. Redfield. It began in the Caribbean Sea on the 6th of October, and passed over Havannah on the 11th, wrecking more than 100 ships, and sending the mercurial column down to 27·70 inches. On the 12th nearly the whole town of Rey West, in Mexico, was destroyed, and twenty ships driven ashore. On the 13th it swept over Washington and New York, and started across the Atlantic from Newfoundland on the 14th of October.



These dates indicate approximately the position of the central area, which may have a diameter of 100 miles, while the whole cyclone probably extends more than 2000 miles, for the barometer shows that the front often strikes the British Islands about the same time as the rear is leaving Newfoundland.

Here then was an uninterrupted series of cyclones, which, beginning among the tropical heats of the West Indies, crossed the Atlantic in succession and maintained a continuous discharge of storms and unprecedently heavy rains in Britain, France, Germany, and Italy, from the 17th of September to the end of October.

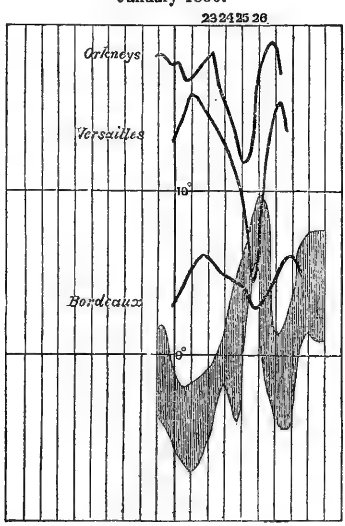
On the 30th of September a destructive tempest passed over Sicily and Italy. Seven villages near Messina were destroyed by storms and inundations. At Portici many houses fell and fifteen persons perished. The village of St. Firmin was engulphed and many lives lost. From the 15th to the 18th of October a tempest raged over the whole Continent. During that period there fell ·153 m. (6 inches) of rain at Montbrison, in France. On the 16th, the village of Schledorf, three leagues from Munich, was utterly destroyed by a storm of wind, rain, and lightning. On the 18th the great rivers of France overflowed; the Loire rose 6·94 mètres (7½ yards) above its mean height, and a general inundation ensued, the most destructive since that of the 13th of November, 1790.

In the Tyrol, it rained incessantly from the 28th to the 31st of October, and the River Elsch inundated the country.

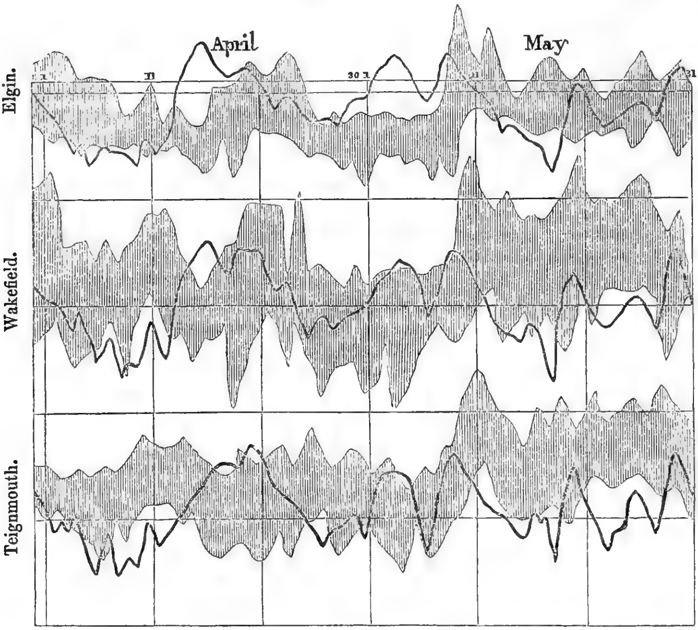
On the western coasts of Britain and Ireland, the rear of the last cyclone produced a hurricane from N.W., which occasioned great loss of life and property on the 22nd and 23rd of October.

1850.—Before considering the inundations of 1856, it will be useful to show that the elevated temperature which invariably accompanies the southern half of a cyclone,

January 1850.



may sometimes exert a powerful influence in promoting an inundation by suddenly melting the snows accumulated on the mountains during the winter. On the 26th of January, 1850, a *warm rain* began to fall at Paris, and melted the snows at the sources of the Seine and its affluents so rapidly as to produce an extraordinary flood. The annexed barometrical curves for the Orkneys, Versailles, and Bordeaux, show the presence at that time of a cyclone of moderate dimensions, the central track passing between the Orkneys and Versailles. The outer southern margin passes over Bordeaux, where the wind is light. At Versailles the thermometric curves show that the warm S.W. wind raised the temperature 12° C., and the cold N.W. wind afterwards produced a corresponding depression. These curves are good types of the general actions of the barometer and thermometer during the transit of a cyclone.



1856.—In order to determine as accurately as possible the various phases of the weather in Great Britain during the months of April and May, 1856, I have constructed the curve of barometric pressure, and the curves of maximum and minimum temperature (the latter on the scale of 20° F. to an inch) from the observations during these months, at eight stations of the British Meteorological Society; viz. Elgin, Anstruther, and Makerstoun, in Scotland; Stonyhurst, Wakefield, Canterbury, and Teignmouth, in England; and Lampeter, in Wales. From these I have selected to accompany this paper the curves for Wakefield, where observations are made night and day at equal intervals of six hours, and those for Elgin and Teignmouth, the extreme stations to the North and South respectively.

These curves indicate, as in the case of the inundations of 1846, a succession of cyclones, of storms of wind and rain, producing floods of increasing height and violence, until the culminating disastrous inundations at the end of May and in the beginning of June.

Two cyclones, either of enormous extent or of slow progressive motion, occupy the whole month of April. The first ended about the 15th, and caused great floods in the Garonne, and other large rivers of France. The second cyclone had passed over by the 2nd of May. An abrupt depression of the mercury, accompanied by heavy easterly gales, shows the passage of a cyclone between the 3rd and 8th of May; the central track lying to the south of Britain. From the 8th to the 20th of May, a deep cyclonic depression occurs. Physical phænomena happen during this period, which frequently characterize the passage of cyclones in tropical countries. On the 10th of May there was a heavy earthquake at Saint Rabier, in the canton of Terras-son, by which a mountain was precipitated into a ravine. On the same day great storms devastated Rhenish Bavaria; a destructive waterspout fell in the commune of Dembach, and the Garonne and other rivers of France again overflowed. On the 12th of May a waterspout fell at Givry, St. Denis; and another at Beaume on the 15th.

In Britain the temperature rose 20° F. on the 9th, with the S.W. wind, and continued high until the end of the month. Several accounts from the south and west of France mention the powerful influence of the south and south-west winds at this time in melting the snows on the mountains.

The barometric curve shows that the centre of the cyclone passed on the 18th, a day signalized by great storms at London, Rouen, and in the South of France. At Nantes on that day, the wind blew violently from the S.W. and then shifted suddenly to the northward, a well-known indication of the passage of the centre of a cyclone.

From the 20th to the 30th of May, the faithful barometer registers the passage over Britain of the northern margins of two closely-allied cyclones, whose centres lay far to the southward. In each case the wind veers from S.E. through E. to N.E., and the depressions increase in depth towards the south.

A very heavy thunder-storm passed over England on the 22nd of May; at Bradford Moor a man was killed by lightning; the Midland Railway was flooded and several villages inundated. At Leeds the river Aire overflowed, and two lives were lost.

On the 25th of May two men were killed by lightning during a thunder-storm, at Strabane, in Scotland.

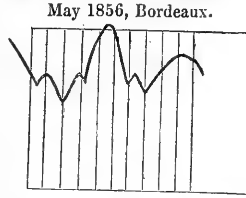
On the 29th of May, Brighton, Hastings, Portsmouth, and all the South Coast of England, were visited by a violent storm of thunder, lightning, rain, and hail.

Such were the effects in Britain, which was merely grazed by the northern margins of the two associated cyclones. The effects were much more disastrous in countries farther south, which lay nearer to the centres of the cyclones. Violent storms of wind, hail, and rain traversed France, Austria, Italy, and Spain. The enormous falls of rain deluged the countries already saturated by the previous inundations of the middle of May. At Lyons it rained continuously for forty-six hours, from 7 P.M. of the 29th to 5 P.M. of the 31st of May. At Ainay, the rain measured in this interval was ·30 m. ($11\frac{3}{4}$ inches), and at Aux Brotteaux it was ·22 m. ($8\frac{1}{2}$ inches). These rains were general over the western countries of Europe. An indication of the easterly progress of these cyclones is given by an account of a great storm which broke over Ratisbon on the afternoon of the 31st of May, accompanied by a waterspout. Great damage ensued at Ratisbon. Scarcely one house in Lichtenfels was uninjured, whole roofs were carried away, and the strongest trees uprooted.

The numerous cyclone-tracks determined by Redfield and Reid all tend to pass to the northward of Great Britain, and this agrees with the well-known predominance of south-westerly and westerly gales here. But the barometric curves, and the winds, prove that the centres of the twin-cyclones of May 20 to 30 lay far to the south of England.

Now, as cyclones invariably move, more or less, *from* the equator *towards* the pole, their track must have been through latitudes unusually low, at a season of the year when the sun has a high northern declination. This passage through an atmosphere of an elevated temperature, and therefore abounding in vapour, will account for the altogether abnormal quantities of rain which they precipitated on southern Europe.

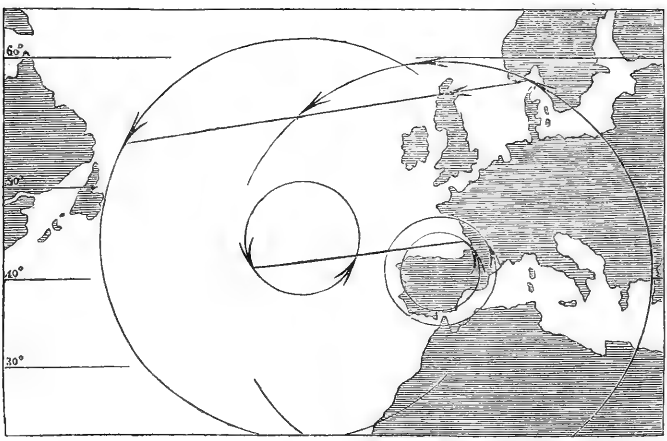
May 1856, Bordeaux.



M. Abria, Dean of the Faculty of Sciences of Bordeaux, having most obligingly forwarded to me a copy of his Meteorological Observations, taken four times daily, from May 20th to June 6th, I am enabled to determine approximately, as in the annexed sketch, the positions of the centres of the twin-cyclones of the end of May.

The first cyclone declared its approach at Bordeaux on the 21st by "a very strong" S.E. gale, with thunder and lightning. The centre, therefore, lay to the south of Bordeaux. Where the two cyclones impinge upon and interfere with each other, the S.W. wind of the second neutralizes the N.E. wind of the first; the wind is feeble and the mercury rises. Nevertheless, the S.W. prevails on the 25th; this changes to W., and finally to N.W. on the 28th and 29th with almost continual rain. These winds show that the centre of the second cyclone passed to the north of Bordeaux, and therefore between Bordeaux and Teignmouth.

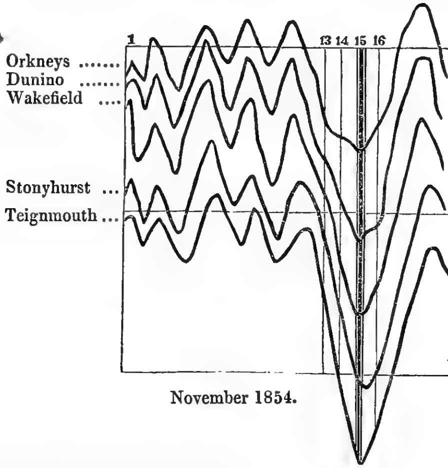
In neither of these cyclones is the central barometric depression so extreme as is usual in the great winter storms. This may probably arise from the confusion or juxtaposition of the central spaces.



On the Balaklava Tempest, and the Mode of Interpreting Barometrical Fluctuations. By T. Dobson, *B.A. of St. John's College, Cambridge.*

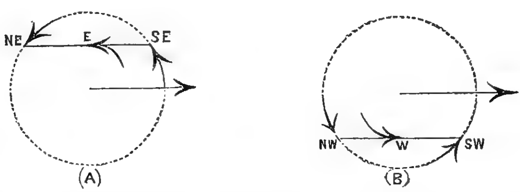
In the month of November, 1854, the passage of a storm over the British islands caused a considerable depression of the barometric column, beginning on the 11th of November and ending on the 19th, as shown by the barometric curves which accompany this paper. During four consecutive days of this period of diminished atmospheric pressure, there occurred in the coal mines of Britain six fatal explosions, at the following places:—on Nov. 13, at Old Park Colliery, Dudley, Worcestershire; Nov. 14, Cramlington Colliery, Northumberland; Nov. 15, Bennett's Colliery, Bolton, Lancashire; Birchey Coppice Colliery, Dudley; and Coalbrook Vale Colliery, Monmouthshire; Nov. 16, Rosehall Colliery, Coatbridge, N.B. These facts alone render this storm worthy of especial attention, independently of the notoriety which it has acquired from its disastrous effects on the allied fleets and armies in the Crimea. The meteorological circumstances which characterized the Balaklava tempest have been determined with unusual care and skill, from a very great number of observations at stations spread over the whole surface of Europe, by M. Liais, of the Imperial Observatory at Paris. In all probability, many years will elapse before a great storm on land is subjected to an examination so rigorous and complete as that undertaken by M. Liais, in the present instance. This storm may therefore be adopted as the most satisfactory test that we are likely to have for some time to come of the correctness of the principles of interpretation which I have already applied to barometric fluctuations in my report on the relation between explosions in coal mines and revolving storms,—principles which flow directly from the nature of cyclones.

For the observations with which I have constructed the barometrical curves for November, 1854, at Teignmouth in Devonshire, Stonyhurst in Lancashire, Wakefield in Yorkshire, and Dunino in Scotland, I am indebted to Mr. Glaisher, the able



November 1854.

Secretary of the British Meteorological Society. The curve for the Orkney Islands is from observations published in the 'Philosophical Magazine.' At Wakefield and Stonyhurst observations are made four times a day, at the other stations twice a day. The cyclonic interpretation in this case would be—First, that the curves indicate the passage of a cyclone, of which the central track lay to the southward of England. This is inferred from the gradual increase of the barometric depression from the Orkneys in the north to Teignmouth in the south, and depends on the fact that the height of the mercurial column decreases continuously from the circumference to the centre of a cyclone. This inference is confirmed by the observation that the wind blew from the eastward at all the above-mentioned stations. Secondly, that the cyclone was progressing to the eastward. This is derived from observing that at each station the wind began at S.E. while the mercury was falling, veered to E. when the mercury was lowest, and then to N.E. as the mercury rose. If the wind had



veered from S.W. through W. to N.W., as it does most frequently in British storms, and the barometric depressions had increased from Teignmouth towards the Orkneys, the interpretations would have been, that the depression was caused by a cyclone travelling eastward, of which the central track lay to the north of Scotland. In the first case (A), the explanation would be that the chord (S.E., E., N.E.) passed over the British islands, and the chord (S.W., W., N.W.) in the second case (B). Such deductions are both obvious and satisfactory to persons whose knowledge of nautical technicalities has enabled them to appreciate the demonstrations of the rotatory and progressive motions of Atlantic cyclones, given by Redfield, Reid, &c. M. Liais having favoured me with an opportunity of studying his unpublished charts of the Balaklava tempest, I have found therein a distinct and impressive confirmation of the correctness of the method of interpreting barometric fluctuations according to the laws of cyclonology. These charts fully establish the truth of the inferences derived above from the contemporaneous barometric curves in Britian. They prove that the Balaklava tempest was a cyclone, moving to the eastward, along a central track which lay to the southward of Britain. It is known that during their transit from the Gulf of Mexico to the western coasts of Europe, across the comparatively uniform surface of the ocean, cyclones preserve an approximately circular form. The excellent charts of M. Liais, at the same time that they exhibit the progress of the storm day by day, from the shores of Britain across the continent of Europe, to the Caucasian mountains and the borders of the Caspian Sea, show also the remarkable modifications produced in the normal condition of the cyclone by mountains and other irregularities of the surface of the land. Thus, for example, a portion of the cyclone is delayed nearly twenty-four hours in passing the Alps. The consequence of this and similar obstructions is, that what was nearly a circular atmospheric wave while crossing the ocean, takes the form of a much elongated and somewhat distorted ellipse on land, enveloping an elliptical central area of maximum barometric depression, which extends, on one chart, from Dantzic in the Baltic to Varna in the Black Sea. Around this central space the wind still blows continuously in the direction peculiar to the cyclones of the northern hemisphere. In the case therefore of the Balaklava tempest, whose nature has been determined with much greater exactness than that of any other tempest on land, we have unequivocal testimony that the principles of cyclonology may be safely applied to interpret the fluctuations of the barometer in Great Britain.

On a Model of a Self-Registering Anemometer. Designed and Constructed by R. Beckley, *of Kew Observatory. Described by* Mr. Welsh.

In this model Mr. Beckley has adopted Dr. Robinson's method of measuring the velocity of the wind by the rotation of a system of hemispherical cups, the direction being indicated by a double wheel-fan like the directing vane at the back of a windmill. A stout tubular support carries the whole of the external part of the instrument, including the measurer of velocity, the direction vane, and a rain-gauge. This support is so made that it can be easily adapted to the roof of any building upon which it may be necessary to mount it. All the rotatory parts of the anemometer run upon friction balls. The shaft of the apparatus for measuring the movement of the wind, by means of a diminishing train of wheels, is made to turn a cylinder upon which is wrapped a sheet of paper of the kind used for "metallic memorandum books," this paper having the property of receiving a trace from a style of brass. The sheet of paper is divided into two sections, upon one of which is recorded the motion of the wind and upon the other the direction. As the cylinder is being turned by the action of the wind, a clock carries a pencil along the cylinder at a uniform rate of 12 inches in the twenty-four hours. To the lower end of the direction shaft is attached a spiral of such a figure that equal angles correspond to equal increments of radius; the edge of this spiral consists of a thin slip of brass, which touches the paper and records the direction of the wind on a rectilinear scale. When the sheet of paper is unwrapped from the cylinder after twenty-four hours, the motion of the wind and the direction are both found projected in rectangular co-ordinates.

With reference to anemometric observations at sea, Mr. Welsh read the following extract from a letter which he had addressed to the Chairman of the Kew Committee, describing a method of making allowance for the effect of the ship's motion upon the observed velocity and direction of the wind:—"By means of a portable Robinson's anemometer, provided with a means of observing the total number of turns made by the rotating part in any given time, observe the *apparent* velocity of the wind and record it in knots per hour. By an anemoscope of any kind register the *apparent* direction of the wind. From the log-book take the rate and direction of the ship's motion. On a slate or other similar surface *scratch* a permanent compass circle. Set off from the centre of the circle, on the radius of the direction of the ship's head, by any convenient scale, the number of knots per hour the ship is going; from this point draw a pencil line parallel to the direction of the wind as observed by the anemoscope (*i. e.* the *apparent* direction *to* which the wind is *going*); set off on this line the number of knots per hour as shown by the anemometer; draw a line from the centre of the circle to this last point. The length of this line by the scale adopted gives the *true* velocity of the wind, and its direction (carried backwards) shows the point *from* which the wind is *coming*. A parallel ruler divided on the edge is all that is required besides the slate. It would be easy enough to contrive some mechanism to save the trouble of drawing lines, but it would not, I believe, be any real simplification, and would increase the expense. The train of indicating wheels might be so arranged that they at once indicate knots per hour without reference to tables, and can be readily set to zero for a fresh observation."

On a remarkable Hail-Storm in North Staffordshire. With some Casts of the Hailstones. By R. Garner.

This storm, which came from the N.W. in the afternoon of the 22nd of July last, between four and five o'clock, continued with great violence for about half an hour,—some of the masses of ice which fell being $1\frac{1}{2}$ inch in diameter, and of course doing corresponding injury, for instance, breaking more than twenty large squares of glass in the rather small house of his (the writers's) next-door neighbour, and those of his own Wardian case. Most of the hailstones seemed to have nodulated nuclei, containing numerous particles of air, and externally to these were formed irregular conglomerations of ice, looking like a mass of imperfect but transparent crystals. The storm was attended with gusts of wind and thunder, and was of a very limited and defined extent; but to the south of the writer's residence, about four miles away, near the Barlaston Station, a violent wind from an opposite direction, S.W. or S.S.W., occurred at the same hour, without rain or hail, the ravages of which could afterwards be traced for a length of two miles, with a breadth of only from 50 to 100 yards. Oaks were deprived by it of their largest limbs, poplars broken at the height of 8 or 12 feet from the ground, and an alder, 50 feet high, was uprooted and carried some distance. The clouds were extremely dark for a great extent of country. An artist took some casts of such hailstones as he picked up, by no means the largest. These the writer exhibited with a drawing.

On Isothermal Lines. By Professor Hennessy, *M.R.I.A.*

After some preliminary remarks as to the general influence of the distribution of land and water on the forms of isothermal lines, the author proceeded to discuss the distribution of these lines in islands. By considering an island situated so as to have its shores bathed by a warm oceanic current, if the influence of direct solar radiation be obstructed, it appears that the isothermals would be closed curves surrounding the centre of the island and having some relation to its coast line. The influence of ranges of mountains, and in general of inequalities in the surface of the island, as well as the modifying action of general winds, and the resulting changes in the shapes of the isothermals, were explained. By the introduction of solar radiation, it now follows from the mathematical theory of heat that the entire quantity of heat received by a unit of surface of the island will depend on two principal terms: one, a function of the distance of the point from the coast, and capable of being expressed in some cases as a function of the difference of latitude of that point and the nearest point on the coast; and, secondly, of a term depending on the latitude and on an elliptic function of the second order having for its modulus the sine of the inclination of the equator to the ecliptic. It hence follows that the effect of solar radiation will be to transport the centres of all the closed isothermals towards the pole of the hemisphere in which the island is situated. Some of the lines may thus ultimately terminate at the coast with their convex sides turned towards the equator, while others may still continue as closed curves in the interior. If the influence of difference of latitude and direct solar radiation were greatly predominant compared to other causes affecting the temperature of the island, the isothermals might all terminate on the coast. If the continents may be considered as immense islands so circumstanced, they become subjects for the application of these views.—Prof. Hennessy then proceeded to show that the isothermals of Ireland strictly conformed to his theory. On discussing the observations collected and arranged by Dr. Lloyd in his 'Memoir on the Meteorology of Ireland,' it appears some of its isothermals are actually closed curves, while others terminate at points on the coast, the shortest being closest to the equator. The physical structure of Ireland, and the difference of nearly 4° between the temperature of the seas bathing its shores and the air above them, rendered it probable, *à priori*, that Ireland should present a good example for the application of the theory. From the general nature of his views, Prof. Hennessy anticipated that the discussion of observations in other islands would lead to their further confirmation; and it would ultimately follow, that not only are isothermals sinuous in their shapes and not generally parallel to the equator, but that many would be found which do not at all circumscribe the axis which joins the opposite poles of the earth.

On an Instrument for observing Vertical Currents in the Atmosphere. By Professor Hennessy.

The author said he had been led to devise this instrument when offering an explanation, printed in the 'Proceedings of the Royal Irish Academy,' of certain abnormal phænomena sometimes observed on the surface of Lough Erne. The instrument is constructed like a common wind-vane, but instead of the fixed tail, a circular disc is placed vertically on an axis passing through the branches of a fork at the tail end. This disc is pierced about half-way between its centre and circumference so as to admit another axle, to the ends of which are firmly attached two light rectangular discs. These discs are always in a horizontal position, whatever may be the position of the circular disc, for each of them has ap endulum attached to its centre by which the centre of gravity is kept considerably below the axle. These discs, therefore, cannot be acted on by a wind which blows horizontally. The position of the circular disc will thus very clearly show whether any given current has an upward or a downward tendency. The application of this instrument to the study of mountain winds was pointed out, as well as to assist in studying some of the undulatory movements of the atmosphere. In the trials which have been already made with it, Prof. Hennessy stated that it gave satisfactory results. The instrument is of course not an anemometer, but simply a kind of universal anemoscope, for it shows both the horizontal and vertical directions of a current.

On Negretti *and* Zambra's *Mercurial Minimum Thermometer. By* John Lee, *LL.D., F.R.S.*

Dr. Lee exhibited the thermometer to the Section, and pointed out the advantages of a thermometer of mercury in preference to alcohol, which is subject to unequal expansion at different degrees of heat; it is a desideratum that all thermometers in a meteorological observatory should be constructed with one fluid, and that mercury, the recognized standard measurer of heat. The thermometer has been tried at the Observatory of Greenwich; by Mr. Glaisher, the Secretary of the British Meteorological Society; Mr. E. J. Lowe of the Beeston Observatory, and several other eminent meteorologists; some instances have occurred in which errors in the alcohol minimum thermometer have been corrected by the observations made by the mercurial minimum thermometer.

Dr. Lee made some remarks upon a pamphlet recently printed by Dr. Herbert Barker, of Bedford, on the relative value of the Ozonometers of Dr. Schönbein and Dr. Moffat, based upon daily observations made for eighteen months at Bedford, and he drew the attention of the audience to the following points:—1. Whether ozone observations have generally been conducted by them in their meteorological observations? 2. Whether they use Schönbein's or Moffat's test papers, or both? 3. Whether they have noticed the difference between those which the Bedford observations those of Mr. Glaisher in various parts of London, and those at Hartwell House Observatory indicate? 4. Whether they will without delay add the Ozonometer to their instruments, as so much interest and importance belongs to the mysterious agent, Ozone, which is carrying on its, at present, incomprehensible effects on the atmosphere, in order that they may be recorded?

On a New Method of making Maximum Self-Registering Thermometers. By JOHN PHILLIPS, *M.A., F.R.S., Reader in Geology in the University of Oxford.*

Thermometers constructed after this plan were first exhibited by Prof. Phillips, accompanied by a description, at the Oxford Meeting of the Association in 1832. In consequence of a careful examination by Mr. Welsh, of the principle on which they were arranged, attention was again called to the subject. The principle of the instrument is the employment of a certain portion of the column of mercury, detached as a *marker*. The length of this is capable of a great range of adaptation, to suit the objects of experiment; when set to work, the instrument is independent of change, by time or chemical action, and as delicate in operation and as free from error as the best ordinary thermometer can be made. Mr. Phillips constructed many twenty-five years since, some of which remain in excellent state to this day. The length of the marker was varied at pleasure, by means of a second hollow ball blown at the extremity opposite the ball containing mercury. The longer this marker is left, the easier is its flow : *at a certain small length,* depending on the diameter of the tube, it will remain without turning in any position, and requires strong shaking to change its place. Mr. Welsh constructed some in a manner superior to that formerly employed by Prof. Phillips, and reported in very favourable terms on the accuracy and permanency of the instrument. Thus encouraged, Mr. Casella had undertaken to adapt the thermometer to different purposes in meteorology and philosophical research, but without changing in any degree the essential character of the instrument. Among the examples on the table was one which was planned by Prof. Phillips for special researches on limited sources, or areas, of heat, with small bulb, fine bore, and *short detached marking column.* Thus made, the thermometer may be used in any position, vertical, inclined, or horizontal, and the *short detached marking column* will retain its place with such firmness that instruments may be carried far, or even agitated much, without losing the registration.

Observations with the Aneroid Métallique and Thermometer, during a Tour through Palestine, and along the shores of the Dead Sea, October and November 1855. *By* HENRY POOLE.

During a recent tour through Palestine, I carried an Aneroid Métallique, and though I would not presume to say that the results of observations made with it are quite correct, yet as the readings in many instances are close approximations to the calculations of Lynch and other travellers, I wish to draw attention to that instrument as affording an easy mode of obtaining approximate levellings of heights in unsurveyed countries. It is light, and can be easily carried by a strap over the shoulder. From the rackwork being visible, a readjustment can easily be made when required upon ascending high mountains.

A table of corrections is, however, required, and which I found must be additive with an increase of temperature (being the reverse of mercurial barometers and vacuum aneroids), as indicated by the variation in the readings at different temperatures at the same localities, as recorded in the accompanying Table.

In Dent's tables, 85 feet are calculated for the difference of each tenth of an inch of the barometer; this, multiplied by 39·37 inches, equal to a metre, gives 33·46 feet, or 33½ feet in common practice, as the multiple of each division in the Aneroid Métallique. In practice I found it very nearly correct; for instance, there are forty-seven steps with a 6-inch rise going down into the Tomb of the Virgin Mary in the Valley of Jehosophat equals 23·5 feet, and by aneroid I read a difference of 7 millimetres × by 33·5=23·45 feet; again, the minaret of the Church of Ascension on the top of the Mount of Olives measured 36·5 feet,—by aneroid the difference was 11 millims. × 33·5=36·85 feet. If the aneroid were mounted with a vernier scale, the observations could be more closely read off. I particularly mention these comparisons of the aneroid with actual measurements, as they gave me confidence in it at the time, and also because I found on my return to London that I had arrived very nearly to the same results as Lieut. Lynch up to 2000 feet above the level of the Mediterranean Sea; and also in the depression of the Dead Sea, 1313·5 feet by aneroid, while Lynch made it 1316·7 feet by level, and Capt. Symonds calls it 1312 feet. There is also a variation in the line of the Dead Sea level at different seasons of the year, for I found at Ras Em Barghek three distinct lines of drift-wood one above the other; opposite Usdum the line of salt incrustations was 40 yards, and the line of drift 70 yards distant from the edge of the sea; while along the west side of the peninsula "El Lisan," a reef of rocks was exposed about a quarter of a mile distant from the shore, which does not appear to have been noticed by Lieut. Lynch's party; I therefore think I must have been there when the water was unusually low. I found the temperature of the Dead Sea at the north end 82° Fahr. at 5 A.M., and 83° Fahr. at the south end at 4 P.M. River Jordan, and brooks on the Lisan, and at the Ghor, 64° each. Brine spring 90°, where *Lebia* were caught near the sea-shore. Wady Em Barghek, temperature 76°. Spring at Engedi, 83°. At Ain Terabêh the sea was 80°; also a brine spring close to the shore, and the freshwater spring was 79°: in it were a number of *Lebia* swimming about, the largest appearing to be about 3 inches. A sulphurous smell was observed on passing the white hills south of Sebbeh near Wady El Mahras, at Birket el Khalil, but not at other places. It often blew hard during the day, but the waves never appeared to be more than two feet high, and the sea quickly went down after the wind ceased. Several nights were quite calm, but I never observed any phosphorescence on the water.

The table of observations with the dry- and wet-bulb thermometer were made by the same instrument, as unfortunately I had broken two others, and there were not any to be bought in Jerusalem; I therefore obtained the lower or wet-bulb temperatures by wetting the bulb, and waving the instrument about in the shade. The vapour arising from the Dead Sea, when looked at from the heights of Ain jidi and Ghomran, had the same appearance as the fumes produced at brass castings.

Comparative Readings of Aneroid Métallique at different Temperatures at same Localities.

1855.	Time.	Locality.	Fahr.	Aneroid.	
	h m		°		
Oct. 26.	2 05 P.M.	Nebi Mousa	89	77·17	
	8 00 P.M.	ditto	78	77·47	
27.	4 00 A.M.	ditto	67	77·50	33 millims. in 22 degrees.
30.	9 15 P.M.	Hebron	56	69·27	
31.	8 15 A.M.	ditto	51	69·38	11 millims. in 5 degrees.
Nov. 1.	4 30 P.M.	Bed of Dervish ...	80	73·88	
	6 00 P.M.	ditto	77	74·00	
	8 00 P.M.	ditto	74	74·10	
2.	8 10 A.M.	ditto	64	74·20	32 millims. in 16 degrees.
	12 35 A.M.	Usdum	89·5	80·06	
	7 30 P.M.	ditto	76	80·41	35 millims. in 135 degrees.
3.	6 00 A.M.	ditto	75	80·39	
4.	6 45 A.M.	ditto	76	80·40	
	8 15 A.M.	ditto	79	80·44	
5.	8 45 A.M.	ditto	79	80·62	or 33·938 inches.
	3 00 P.M.	Ghor	90	80·10	
	5 10 P.M.	ditto	86	80·13	
	8 10 P.M.	ditto	85	80·22	12 millims. in 5 degrees. Gale
6.	10 00 A.M.	ditto	90	80·44	of wind.
8.	3 35 P.M.	ditto	99	79·70	
	8 30 P.M.	ditto	61	80·20	
	6 00 A.M.	ditto	60	80·24	54 millims. in 33 degrees.
6.	4 30 P.M.	El Lisan...........	72	79·99	
	12 15 P.M.	ditto	66	80·30	31 millims. in 6 degrees. Gale
7.	10 25 A.M.	ditto	81	80·31	of wind 8 P.M.
	7 45 P.M.	ditto	73	80·30	
8.	6 45 A.M.	ditto	72	80·21	
	9 15 A.M.	ditto	86	79·94	27 millims. in 14 degrees.
9.	7 30 P.M.	Em Barghek	83	79·83	
	10 15 A.M.	ditto	83	79·90	
10.	1 30 A.M.	ditto	81	79·96	
	6 30 A.M.	ditto	78	80·00	10 millims. in 5 degrees.

Thermometrical Readings near the shore of the Dead Sea.

Date.	Time.	Locality.	Fahr.		Dew-point.	Centigrade.		Force of vapour.		Relative Humidity.	Remarks.
			Dry.	Wet.		Dry.	Wet.	Ins.	Mills.		
	h. m.										
Oct. 27	5 30 A.M.	North of Dead Sea.	70°	64°	58°·25	21°·11	17°·78	·5148	13·08	·70	Bulb wetted with Dead Sea water.
Nov. 2.	2 00 P.M.	Usdum.........	90	71	59·03	32·22	21·67	·4732	12·03	·32	114 feet above Dead Sea.
3.	1 35 P.M.	ditto......	87	72	62·40	30·55	22·22	·5795	14·72	·45	
4.	9 30 A.M.	ditto......	82	65	53·44	27·78	18·33	·3905	9·93	·35	
	11 40 A.M.	Em Barghek	84	66	54·12	28·89	18·89	·4023	10·22	·34	281 feet ditto.
5.	5 10 P.M.	Ghor	86	71·5	62·08	30·00	21·94	·5795	14·73	·47	
6.	10 00 A.M.	ditto......	90	67	52·51	32·22	19·44	·3519	8·94	·25	
11.	8 45 A.M.	Sebbeh.........	82	68	58·48	27·78	20·00	·4960	12·60	·45	563 feet ditto.
	2 00 P.M.	ditto......	90	70	57·40	32·22	21·11	·4668	11·85	·33	
12.	12 42 A.M.	Engedi.........	86	74	66·20	30·00	23·33	·6106	17·24	·55	710 feet ditto.
13.	4 30 P.M.	Ain Terabeh...	84	67·5	54·95	28·89	19·72	·4677	11·87	·40	710 feet ditto.
Comparative Observations at Alvaston, Derby.											
1856. Aug. 3.	2 00 P.M.	Alvaston	84	72	64·08	28·89	22·22	·6228	15·82	·54	About 250 feet above sea.
5.	11 00 A.M.	ditto......	73	64	55·34	22·78	17·78	·4768	12·11	·59	

Levellings by Aneroid Métallique from the Mediterranean Sea by Joppa, to Samaria, through Jerusalem. October 1855.

Distance in Miles.	Names of Places.	Height by Lynch.	Height in feet above sea.
0¼	Joppa Hotel	....	67
4	Tomb of Joseph	....	93
11½	Convent at Ramleh (Arimathea)	230	244
17	El Kubal	543	445
21	Bab Wady Ain	965	857
22¼	Terebith Tree (Wady Beit Hanina)	....	1232
21	Church Aboo Gosh (Emmaus)	1989	1892
25½	Ain Dilbeh	2024	2047
28¼	Bridge, Keulonich	1954	1527
31	Bottom of Hezekiah's Pool, Jerusalem	2610½*	2061
36	Valley of Mount Gibeon	....	2231
40	Bicrah	....	2254
42	Bethel	....	2401
45	Khafa arno	....	2200
46½	Ain y Bruk	....	1766
48	Ain el Hara mich, "Robber's spring"	....	1803
50	Ridge near Singel	....	2020
52	El Lubban, "Leboneh"	....	1424
56	Top of Hill	....	1640
58	Brook near Burin	....	1290
64	Jacob's Well	....	1347
64	Summit of Mount Gerizim	....	2408
65	Nablous, "Shechem"	....	1464
71	Wady Sebastich	....	800
71¼	Summit of Hill Samaria	....	1233
72	Village of Sebastieh	....	1120

* The precise locality in Jerusalem to which Lieut. Lynch levelled is not known.

Levellings by Aneroid Métallique from Jerusalem through Hebron to the Dead Sea, compared with the level of the Mediterranean Sea at Joppa.
November 1855.

Distance in Miles.	Names of Places.	Height in feet with Mediterranean Sea.
0	Jerusalem, at Hezekiah's Pool	2061
2	Elijah's Convent	2207
3	Rachel's Tomb	2111
6½	Vale of Artas, at junction of Wadies...	1860
7	Ditto, Meshallum's house	1896
7¾	Aqueduct at Pools of Solomon	2144
8	Upper Pool, ditto...	2251
9	Ridge	2361
10	Wady em Bir, or wells	2298
13	Ridge	2596
14½	Khan Khul	2716
17	Camp at Hebron, near Lazaretto	2402
	Tomb, "Cave of Makpelah"	2368
	Abraham's Oak, valley of Eshcol	2502
	Ain es Lin	2586
	Temple ruins at Mannè	2800
19	Ridge	2438
19½	Valley	
20	Ridge	2402
22½	Ruins of Ziph on left hand (1 mile off)	2294
24½	Ruins Em Sirkan...	2304
27	Birket el Kurmel (Carmel)	2234
29½	Ain Tawana	2074
30	Ridge	2227
31½	Ridge	1779
33	Tawan, Camp of the Djahalins	1759
35	Bir Tabaca	1501
38	Ridge	1521
39	Wady	1340
42	Ridge	1424
43	Wady el Mahras, or Drippings	1156
45	Ridge	1447
46	Ermeli (view of Dead Sea)	1702
47	Wady	986
48¼	Ridge	1106
49	Plain	931
50	Bed of Dervish (found a coin)	895
52	Wady of Bazaar	533
53½	Passed near a supposed crater	298
55½	Nejeb (view of Dead Sea)	4
56¾	Tower, El Zuweireh	− 968
58	Camp at Usdum	−1176
59	Shore of Dead Sea (Lynch, −1316·7; Symonds, −1312)	−1313·5
	Summit of "El Lisan," or the Peninsula...	−1063·5

Levellings from Jerusalem to Dead Sea by Nebi Mousa.

6	Road branches to Jericho	705
7½	Durbez zuar	708
8½	Ridge with flints	607
9	Junction of Wadies	209

Distance in Miles.	Names of Places.	Height in feet with Mediterranean Sea.
10	Vertical Chalk	353
10½	Dry Wady	273
11½	Chalk	353
12	Pointed rocks	286
13	Ridge (red-coloured limestone)	— 156
14	Nebi Mousa (bituminous limestone)	— 329½
15½	Ridge	— 288
17	Base of mountain	— 781
18½	Plain	—1080
20	Dead Sea	—1313½

Levellings by Aneroid Métallique along the west shore of the Dead Sea, commencing at the south end from Usdum to Jericho. November 1855.

Distance in Miles.	Names of Places.	Height in feet with Mediterranean Sea.	Height in feet above Dead Sea.
0¼	Cave in middle of Mount Usdum	—1200	114
2	Ascent at back of Usdum	— 930	384
3	North end of Usdum	—1200	114
4½*	Brine-spring (temp. 90°)	—1284	30
4½	Fish in gully of ditto	—1311	3
6½	Wady Em Barghek	—1033	281
6¾	Old Fort, ditto	— 932	382
7	Hill close to shore	—1065	249
8	Wady Em Dûn, or Wild Goats...	—1120	194
11	White lime-rocks	— 884	430
12	Wady Sebbeh	— 851	463
12¼	North bank of ditto	— 784	530
13¾	Ascent to Mosada	— 322	992
	Top of ditto, by sextant	+ 98	1412
14	Camp at Sebbeh	— 751	563
15	Wady El Mahras, or Drippings....	—1006	308
17	Wady El Kehabrâ, or Spies	—1271	43
19	Birket El Khalil (Abraham's salt)	—1314	0
21	Plain of Ain jedi (Engedi)	—1190	124
21½	Spring near Tower on ditto (temp. 83°)	— 604	710
22	Camp in Wady	—1056	258
24	Ras Mersed	—1114	200
25	Wady Khmeid	—1314	0
26	Mountain pass	—1074	240
27	Ditto, ditto	— 805	509
28	Wady Ta amri	—1209	105
28½	Ridge	— 574	740
29	Upper ridge...	— 440	874
29¾	Ain Terabeh, or " Morass "	—1274	40
30	Springs with reeds	—1314	0
32	Springs with reeds and fish (temp. 79°)	—1314	0
33½	Wady Kedron, or En Nar...	—1200	114
34	Mountain ridge	— 584	730
34¼	Ditto, ditto	— 088	1226
34½	Table-land	— 25	1289

* The Brine-spring issues out of the rocks about 100 yards distant from the shore of the Dead Sea; and the fish " Lebias " were caught in this spring at three yards' distance from the shore of the Dead Sea, and to which they had free access.

Distance in Miles.	Names of Places.	Height in feet with Mediterranean Sea.	Height in feet above Dead Sea.
37	Ridge	+ 26	1340
38	Heights above Ghomran	− 161	1153
38½	Camp at ditto	− 309	1005
39	Edge of cliff, ditto	− 363	951
39	Foot of ditto, ruins and graves	−1076	238
39¼	Base of chalk hills, with graves	−1214	100
39½	Shore of Dead Sea	−1314	0
42	Plain of Jordan	− 808	506
40	Mouth of Jordan river	−1314	0
44	Pilgrim's bathing-place, ditto	−1210	104
45½	Jericho Tower	− 798	516
	From Jericho to Jerusalem.		
2	Foot of mountains	− 590	724
3	Ridge	− 86	1228
6	Ridge	+ 303	1616
7	Khan Khatrude	+ 682	1995
7½	Plain of the Robbers	+ 471	1784
9	Ridge	+ 755	2068
12	Road turns off to "Nebi Mousa"	+ 705	2018
15	Apostles' fountain	+1254	2567
16	Lazarus's Tomb, Bethany...	+1803	3116
17	Church of Ascension, Mount of Olives	+2138	3451
17½	Tomb of Virgin Mary, Valley of Jehoshaphat...	+1834	3147
18	Hezekiah's Pool, Jerusalem	+2061	3374

Note.—Since the reading of the above paper before the British Association at Cheltenham, Mr. Poole has been in Westmoreland, and taken the heights of several mountains in the Lake District with the Aneroid Métallique.

In the Table below, the first column shows the height by calculation, allowing 33·5 feet per millimetre as adopted by him in Palestine. The second column is calculated by Delcros's formula, giving corrections for temperature and latitude. The third column shows the heights furnished by Colonel James, Chief of the Ordnance Survey of Great Britain, and which were obtained from him since the aneroid levellings were calculated.

The Ordnance survey thus confirms most satisfactorily the correctness of the aneroid, when corrected by Delcros's formula, up to a height of 3000 feet.

Unfortunately the temperatures at the time of observation were not kept in Palestine, and therefore Delcros's formula cannot be now used for those readings, and the heights given in the original paper are proportionally too low

Levellings by Aneroid Métallique in the Lake District, taken from Iveing Cottage, Ambleside, which is calculated at 80 feet above Windermere Lake (128 feet above the sea by Colonel James), or Station at 208 feet above the sea. September 1856.

Levellings by calculation, 33·5 feet per millimetre, with 208 feet added for height of Station above the sea.		Delcros's Formula.	Colonel James's Ordnance Survey.	Difference.
Helvellyn	2734	3056	3117	−61
Fairfield	2566	2837	2861	−24
Highstreet	2452	2693	2722	−29
Wansfell (not quite at top, 30 feet assumed)...	1524	1649	1598	+51
Kirkstone pass, boundary line	1400	1487	1466	+21
House at ditto	1383	1470	......	+ 4
Loughrigg Fell, or Ewe Crag	1032	1123	1101	+22

On a Meteor seen at Cheltenham on Friday, August 8th.
By the Rev. C. Pritchard, *F.R.S.*

The author stated, that on leaving the Meeting of the Association on Friday evening, about 8 p.m., the friend who was with him suddenly exclaimed, "There is lightning!" But observing that the light continued, he turned round, and saw a beautiful meteor moving, nearly in a vertical circle, nearly through α Lyræ,—commencing about eight diameters of moon below α Lyræ, and extending through about ten diameters,—commencing, in fact, in a line drawn through Jupiter and the lower of the three stars in Aquila. It was very *decided* and persistent, with rose-coloured scintillations, taking a serpentine course, and lasting for fully forty seconds. No further meteors were observed that night; but on the following night he observed six others, about the same hour,—all having their vanishing points near, or below, the horizon, and, in the vertical circle, through α Lyræ. The former meteor was seen by other friends, and also at Tewkesbury, and its decided persistency and violet colour remarked upon at the time.

Continuation of Meteorological Observations for 1855, *at Huggate, Yorkshire.*
By the Rev. T. Rankin.

The atmospheric wave of November was twelve days in passing; coldest day, 13°, February 18; hottest day, 73°, July 13; lowest point of the barometer, 28·160, March 3; highest point, 30·460; rain, 23·570 inches; eclipse of the sun visible only a few seconds; in the evening a large meteor exploded and discharged coloured scintillations like a rocket. On the evening of October 21, the whole atmosphere had the appearance of the hull of a ship, with the white planks all distinct from stem to stern. The ends were N.W. and S.E. The N.W. end was like pieces of amber, and the S.E. end a beautiful purple. The common observation of the oldest labourers is, that when the wind blows across the ends of the ship, heavy rain will soon come. In the present case, the wind blew obliquely across the ends, and, according to the common prognostic, there was soon a heavy fall of rain. Winds: E., 11 days; W., 36 days; N., 5 days; N.E., 39 days; N.W., 30 days; S.E., 6 days; S.W., 25 days. Weather: clear days, 117; rain, 51; frost, 28; white frost, 29; snow, 18; mist, 7; fog, 4; thunder, 8 days.

On a Thermometer for Measuring Fluctuations of Temperature.
By B. Stewart. *Communicated and described by* Mr. Welsh.

If a bulb be blown between two thermometric glass tubes of unequal bores, and the instrument be filled with mercury in the same manner as an ordinary thermometer, and laid horizontal or nearly so, it will be found that contractions from cold take place only in the narrow bore, and expansions from heat only in the wide one. The reason of this seems to be, that while the temperature remains the same the mercury is kept at rest, and prevented from retreating from the small bore into the bulb, by friction; but when a motive force is supplied by a change of temperature, the motion of the mercury takes place in that direction in which it is most aided by capillary action. It was suggested by Mr. Welsh to the author that such an instrument might be used to measure fluctuations of temperature. And the author thinks it might be applied to measure with exactness the power of a source of radiant heat; for, by alternately interposing a screen between this instrument and the source of heat, and withdrawing the same screen, the effect of the source on the mercury would be multiplied by the number of times this operation was performed. In constructing such an instrument, care must be taken that the tubes used are quite free from dirt or moisture, and that they are not bent, but form one straight line, the bulb being in the middle, and swelling out symmetrically from both its extremities. The best proportion between the capacities of the bores is perhaps about 1 to 4, and the best arrangement of bores seems to be one suggested by Mr. Welsh, viz. a round bore for the wide tube, and a flat or elliptical bore for the narrow one, the greatest diameter of which equals the diameter of the wide bore. In graduating, if, when the instrument is vertical, the narrow bore being beneath, the mercury fills the bulb and rises in the wide bore, then the wide bore may be pointed off at different temperatures like an ordinary thermometer; but if under these circumstances the mercury does not rise in the wide bore, then, in order to point off the wide bore, the instrument must be laid horizontally in a dish of water, and compared with a standard thermometer at different temperatures; the extremity of the mercury in the narrow bore being always kept at a fixed point. When the wide bore has been pointed off, we may, by running the mercury along, find what length of the narrow bore corresponds to a certain length of the wide one, and thus be enabled to point off the narrow bore. In using the instrument it should be kept nearly horizontal, and there is probably for each instrument a small range of inclination, for every position within which its peculiar action holds, but beyond which it is interfered with by gravity. Before graduating such an instrument it should be ascertained whether it is likely to answer, and the best test seems to be to lay it horizontal, exposing it to changes of temperature of the same nature with those which it is intended afterwards to measure;—if its action be perfect, the mercury will eventually be found to have retreated into the bulb from the narrow bore; but should it have stopped at any point, the action will only be perfect up to that point. If this demands too much time, it may be tested by repeatedly applying to the bulb of an instrument so placed a few drops of slightly warmed water.

On the Climate of Torquay and South Devon. *By* E. Vivian, *M.A.*

Mr. E. Vivian, of Torquay, laid before this Section the statistics of the meteorology of Torquay and South Devon contrasted with those of the average of England, as given in the Reports of the Registrar-General, to which he is a contributor. The observations on which they were based extended from 1842 to 1856, but the comparative statement was confined to the last six years. The following was the general summary:—

	Mean Temperature.	Maximum Temperature.	Minimum Temperature.	Mean Daily Range.	Quarterly Range.	Days of Rain.	Inches of Rain.	Grains of vapour in cubic foot of Air.	Do. required to saturate do.	Mean Humidity.
Torquay...	50°·3	76°	27°	9°·9	15°	155	27·8	3·4	·9	·76
England...	48·3	83	15	14·5	46	170	25·5	3·4	·7	·82

He explained the principles upon which the cool summers and mild winters of South Devon and Cornwall are to be accounted for, namely, the equable temperature of the sea with which the peninsula is surrounded. He had observed the surface water in Torbay to be as much as 21 degrees above the *minimum* temperature of the air in winter, and 13 degrees below the *maximum* in summer. He also accounted for the equable hygrometrical condition of the air by the same cause—the temperature of the sea being frequently above the dew-point in winter and below it in summer. He reviewed the inaccuracies in several medical publications, which had raised a prejudice against South Devon as a summer residence as being too relaxing, while the exact contrary is shown by these observations. He exhibited a set of his newly invented meteorological instruments for obtaining all the really important elements of climate by one daily, weekly, or monthly observation, especially self-registering hygrometers; one for the *maximum* and *minimum* difference of the wet- and dry-bulb thermometers, the other for registering their average difference during any period of time.

Instructions for the Graduation of Boiling-point Thermometers, intended for the Measurement of Heights. By J. Welsh.

Let the thermometer be in the first instance filled with a sufficient quantity of mercury to allow the point 82° Fahr. to be where the point 212° is desired ultimately to be. Let a chamber be made at the top of the tube about 3 inches above the point 212°; or, if the thermometer is required to have a chamber at the top when finally completed, let there be two chambers made with sufficient space between them to allow of the tube being there sealed by a blowpipe flame. By comparison with a standard thermometer, set off the points 82°, 72°, 62°, 52°, 42° (but not 32°). The scale may then be divided, adopting the mark 82 as corresponding to 212·00; 72 to 201·87; 62 to 191·74; 52 to 181·61; 42 to 171·48. The *graduation* of the scale should then be verified by comparison with a standard thermometer at different points from 37° to 87° Fahr., and a table of errors of *graduation* thus obtained. A sufficient quantity of mercury must now be separated from the main mass until the top of the column stands in boiling water at the proper reading. The superfluous mercury having been lodged in the upper chamber, may be removed by sealing up the tube between the two chambers. If it is not possible to detach exactly the proper quantity of mercury to make the column stand at the true temperature of boiling water, the difference should be added as a further constant correction to the table already found by comparison with the standard. The following determination of the corrections to a thermometer, constructed on this principle by Messrs. Negretti and Zambra, will serve as an example of the accuracy which may be attained by this method.—

Reading of Standard.	Reading of Boiling-point Thermometer.		Standard reading after withdrawal of mercury.	Final correction.
	Observed.	Including final error at 212°.		
42·00°	171·76°	171·61°	171·48°	—·13°
47·00	176·80	176·65	176·54	—·11
52·00	181·85	181·70	181·61	—·09
57·00	186·99	186·84	186·67	—·17
62·00	191·97	191·82	191·74	—·08
67·00	196·98	196·83	196·80	—·03
72·00	202·08	201·93	201·87	—·06
77·00	207·19	207·04	207·94	—·10
82·00	212·29	212·14	212·00	—·14

On Barometrical and Thermometrical Observations at Scarborough. By Captain Woodall, *M.A.*

CHEMISTRY.

On the Composition of Paraffine from different sources. By Thomas Anderson, *M.D., F.R.S.E. Regius Professor of Chemistry in the University of Glasgow.*

Some seven years since the author commenced the investigation of Rangoon petroleum, but being at the time engaged in other researches, the subject was abandoned after some experiments and analyses of the paraffine it contains had been made. More recently his attention had been directed to this substance in examining the paraffine obtained during the distillation of coal. He found that Boghead coal yields two distinct kinds of paraffine, one highly crystalline after fusion, the other a granular mass resembling bleached wax. The former melted at 114° Fahr., the latter at 126°. That obtained from Rangoon petroleum melted at 142°, and from peat at 116°. All these varieties gave on analysis the same results, the numbers obtained being—

	Coal. Crystalline.				Coal. Granular.	
Carbon	85·08	85·14	85·12	85·09	85·28	85·00
Hydrogen	15·33	15·11	...	15·23	15·38	15·36
	100·41	100·25		100·32	100·66	100·36

	Peat.		Rangoon Petroleum.
Carbon	85·23	84·95	85·15
Hydrogen	15·16	15·05	15·29
	100·39	100·00	100·44

These analyses lead to the conclusion that all varieties of paraffine are not carbohydrogens of the C_nH_n series, as is commonly supposed, but lend support to Lewy's view, according to which some of them belong to the C_nH_{n+2} series. This is rendered obvious by the comparison of the mean analytical result with the calculation for the former series and for the formula $C_{40}H_{42}$, which comes very close to the analytical results.

	Expt.	Calculation. CH	Calculation. $C_{40}H_{42}$
Carbon	85·10	85·71	85·10
Hydrogen	15·23	14·29	14·90
	100·33	100·00	100·00

The latter formula is a purely empirical one, and is simply the nearest approach to the experimental numbers, which, however, might be equally well expressed by $C_{42}H_{44}$, or even $C_{44}H_{46}$. The author has tried in vain to obtain some means of determining the rational formulæ of the different paraffines, but without success. They are all acted upon by chlorine with the formation of turpentine-like substitution compounds, in which the proportion of chlorine differs.

The author leaves it an open question whether these paraffines are radicals or the hydrurets of radicals, his object being to show that the term paraffine has a very wide acceptation, embracing not only the cerotene and melene obtained from wax, which belong to the C_nH_n series, but also a great variety of other compounds.

On a new combination of Carbon, Oxygen and Hydrogen, formed by the Oxidation of Graphite; and on the Appearance of Carbon under the Microscope. By Professor Brodie, *F.R.S.*

On the Incrustations of Blast Furnaces.
By Professor F. Crace Calvert, *F.C.S.*

During a journey which I made twelve months ago in Shropshire, in which I visited certain iron-works, my attention was drawn to large incrustations which gradually formed at the mouth of blast furnaces, and which had acquired such a size as nearly to shut up the mouth of the furnaces, and as they proved a great annoyance, it was thought proper that they should be removed.

To do this, the mass in the furnace was allowed to fall eight or ten feet from the mouth of the furnace, the blast was then taken off and the incrustations removed, some of which were placed in my hands for analysis, and which I found to be composed as follows;—

Oxide of zinc	94·33
Peroxide of iron	2·10
Silica	0·45
Carbon	2·45
Sulphur	0·67
	100·00

As the presence of zinc was the source of very great injury to the iron-master, not only in consequence of its forming incrustations, but also on account of a certain quantity of it finding its way into the cast iron and thereby rendering it very brittle, I was requested by the proprietor of these furnaces to examine the various materials that were employed, and try to find out in which of them existed the compound of zinc which gave rise to these several incrustations.

Having failed to discover any blende or calamine in the limestone used, I next examined the iron ores, and found that the 'under penny-stone' (a name given in Shropshire to the ironstone nodules which are employed there nearly exclusively) contained small black crystals, which proved, on analysis, to be *sulphuret of zinc or blende.*

Since this observation was made by me, E. W. Binney, Esq., F.R.S., has placed a very interesting paper in my hands (published in 1852), in which he describes the presence of the sulphurets of lead and zinc "as existing in the druses or hollows of ironstone nodules occurring in coal-measures, which seem to indicate that metals had in some instances been precipitated from aqueous solutions, or segregated from semifluid masses."

But it would appear probable, from the recent researches of Messrs. Fremy, Deville, and Senarmont, that the blende has formed itself in the druses by the action of a volatile sulphuret on the oxide of zinc which had been deposited in those druses after they had been formed in the ironstone.

In examining the coals employed, I found in the lowest strata which bear the name of "Court Bandles Coal" in the neighbourhood of Coalbrook Dale, a large quantity of white metallic scales disseminated through the mass of coals, exactly in the same manner as pyrites are observed in the same substance. The presence of such scales having not yet been observed, I analysed them, and found them to be composed of galena mixed with a little blende.

I think that the presence of the blende and galena in the iron mineral and in the coals, clearly indicates that in the neighbourhood there must be veins or lodes of the sulphurets of these two metals.

On the Salts actually present in the Cheltenham and other Mineral Waters. *By* J. H. Gladstone, *Ph.D., F.R.S.*

The Cheltenham waters have been analysed by many distinguished chemists, and the experiments of Messrs. Abel and Rowney leave nothing to be desired in point of accuracy, that is to say, as far as the amounts of chlorine, carbonic acid, soda, lime, &c. are concerned; but the author contended that the usual method of arranging the results of analysis, as so much chloride of sodium, so much carbonate of lime, &c., was utterly fallacious. The rule of 'combining the strongest base with the strongest acid' is purely empirical, and almost incapable of application, since our knowledge is very vague as to which is stronger and which weaker; but the rule is also false, if it be true, as the author has found it to be wherever proof was possible, that "where two or more binary compounds are mixed under such circumstances that all the resulting bodies are free to act and react, each electro-positive element arranges itself in combination with each electro-negative element in certain constant proportions."

The method of determining the salts actually present in a water by evaporating it down and exhausting the residue successively with æther, alcohol and water, is also fallacious, for the state of combination of the acids and bases may materially alter when crystallization is taking place.

The paper of Messrs. Abel and Rowney contains indications that the salts are not actually present in the Cheltenham waters in the manner in which they are arranged in their lists of analyses. Thus so carefully had these chemists experimented, that they observed there was not sufficient free carbonic acid to retain in solution the lime and magnesia which, according to the usual principles, they supposed present in the form of carbonates. Hence they imagined them dissolved by the alkaline salts, and add, "We have satisfied ourselves by direct experiment, that the solubility of carbonate of lime is much increased by the presence of chloride of sodium and sulphate of soda." Now all this is the necessary consequence of the law of reciprocal affinity, as the lime, instead of monopolizing the carbonic acid, will unite more or less with the other acids present, forming salts soluble in water.

The author was fully aware that analytical chemists themselves did not profess the method complained of to be absolutely correct; but he feared that the semi-scientific and the general public were deceived by it, and that chemists also often came to believe there was some truth in their own arbitrary mode of expressing the results of analysis.

Notes on Nitroglycerine. By J. H. Gladstone, *Ph.D., F.R.S.*

The author had made several observations on this remarkable explosive liquid, which had been first exhibited by Dr. De Vrij at the Ipswich meeting of the Association; but the recent research of Mr. Railton had forestalled him, and left little for him to bring before the public. However, he felt convinced that nitroglycerine was not always uniform in its properties, and was perhaps various in its composition. Thus a liquid produced by immersing glycerine (in the hydrated state in which it is found in commerce) in a mixture of one part of fuming nitric acid and three parts of sulphuric acid, was found to be easily exploded by a blow with a hammer, or when heated rather strongly in a test-tube, giving rise to much flame and noise, with the evolution of much nitrous gas; while a liquid produced in a precisely similar manner from the same glycerine, but after it had been rendered anhydrous, did not explode by a blow with a hammer, and burnt without noise when very strongly heated. Again, some explosive nitroglycerine was allowed to decompose spontaneously till only about one-half was left; this remaining portion was non-explosive. Each variety, when exposed to a bath of solid carbonic acid in alcohol, froze, becoming at first viscous, and then assuming an appearance similar to that of the fatty acids at the ordinary temperature. This substance, like other nitrous acid substitution products, is liable to slow spontaneous decomposition. This had been several times observed: one specimen exposed for some weeks to the light of the summer sun, gave off abundance of red fumes, and separated into two liquids, between which long crystals of oxalic acid formed. The upper liquid contained the products of decomposition, being in fact an aqueous solution of nitric and oxalic acids, with a large quantity of ammonia, a little prussic acid, and traces of two or three slightly acid or neutral bodies, which could not be identified.

On the Conversion of Tannin into Gallic Acid. By John Horsley.

It is several years since I first noticed the facts which I now bring before your notice. I have never yet heard or read of the practical application of the agent in the manufacture of gallic acid in the manner I now suggest.

Every chemist is aware that the quantity of gallic acid naturally contained in the gall-nut is very small compared with the tannin (*alias* tannic acid), and that the gallic acid of commerce is a manufactured article, being obtained by what is called the fermentation process, which consists in the saturation of the bruised galls with water and exposing the mass to the air for a period of several weeks or even months, when decomposition sets in, a mould collects, and small yellow crystals of gallic acid are observable, evidently the result of the oxidation of the tannin. The gallic acid is then dissolved out by boiling the mass in water, and crystallizes from the concentrated liquid on cooling.

It occurred to me to make experiments by keeping powdered galls in contact for some time with liquid acids, such as sulphuric, sulphurous, nitric, and acetic acids, but with diluted sulphuric acid only did I perceive any change produced; small white tufts or nodules of gallic acid being observed soon to protrude themselves, so to speak, to the surface of the dried cake.

I have lately, for the purpose of drawing up this paper, made further experiments, of which these are specimens. I merely moistened the powdered galls with the diluted acid and exposed the mixture in an evaporating dish to the full action of the sun, and in a few hours signs of intestine motion began to manifest themselves and crystalline white tufts were forming; these white tufts gradually increased from day to day, and became more apparent as the mass dried. It is necessary to renew the application of moisture from time to time, so as to promote the growth of gallic acid.

In proof of the above, I likewise treated *pure* tannin by triturating it with dilute sulphuric acid, and in a very short time white crystalline tufts of gallic acid were visible.

A New Method of instituting post-mortem researches for Strychnia. By John Horsley.

The following will be found an exceedingly simple and successful method of obtaining strychnia, in cases where it is practicable, from the tissues of the body.

The weather at the time of making these experiments being very hot, the effluvia evolved from so much putrefying animal matter, induced me to adopt some means for remedying the annoyance. I therefore thought of a solution of ordinary chloride of lime (bleaching liquid), but fearing lest that agent should decompose or destroy the strychnia, I first tried its effect on a weak acetic solution of strychnia, and was surprised to find that a milky white precipitate of a chloride, possibly a hypochlorite of strychnia, ensued, insoluble even on the addition of a large quantity of acetic acid. This precipitate, when drained on a filter and dried, is freely soluble in alcohol, which seems to be its best spirituous solvent, but did not readily dissolve in dilute sulphuric acid even with the aid of heat. Its best acid solvent is glacial acetic acid. It is also soluble in alkaline liquors.

This result gave me such confidence, that I at once proceeded to operate on animal matter. I therefore took some of the putrid liquid in which the liver of a dog poisoned by strychnia had been boiled, which liver had not hitherto yielded me any strychnia. I purposely introduced a little of the alkaloid, boiled the whole a few minutes, and when cold, added the liquid chloride of lime in excess, or till all soluble matter (animal or otherwise) was precipitated, and then filtered it through a cloth. No trace of bitterness could be detected in the liquor.

The drained precipitate of fibrine, gelatine, caseine, and strychnia was next dried in a water-bath, then powdered, digested in alcohol acidified with acetic acid, heated, filtered, and evaporated to the consistency of a syrup: by this time the whole of the smell of chlorine will have been given off, and acetate of strychnia obtained, which can be purified in the usual way, by precipitation with an alkali, &c.

Testing for Strychnia, Brucia, &c. By John Horsley.

The author tried the effects of a precipitant formed of one part of bichromate of potash dissolved in fourteen parts of water, to which were added afterwards two parts in bulk of strong sulphuric acid, upon a solution of strychnine, which was entirely precipitated in the form of a beautiful golden-coloured insoluble chromate. The *decolorization* of a solution of either the chromate or bichromate of potash was effected by gradually adding a solution of the acetate of strychnia, when chromate of strychnia was precipitated. Scarcely a trace of bitterness was left in the filtered liquor.

The author claimed as his own, this mode of *the application* of the chromic salt and the acid. He diluted thirty drops of a solution containing half a grain of strychnia with four drachms of water. When six drops of a solution of bichromate of potash were added, at each drop crystals were at once formed, and the decomposition was complete when the whole were mixed together. Though the half-grain of strychnia was split up into millions of atomic crystals, each atom as effectually demonstrated the chemical properties of the poison as a pound in weight could have done. The chemical reaction with these crystals was next shown by spreading out a drop of the liquid chromate of strychnia upon an evaporating dish, and adding a drop or two of strong sulphuric acid.

Amorphous chromate of strychnia may be obtained from neutral chromate of potash; nacreous or crystalline, from the bichromate; and, thirdly, in the regular crystalline state with a *weak* chromic acid solution: fine spiculæ are first formed, and next (which is the peculiar characteristic of strychnia) small cubic crystals studding the sides of the glass.

The salts of brucia and of lead alone *appear* to afford results in anywise similar. The chromates of strychnia and of brucia become (contrary to that of lead) *dark coloured* by exposure to sunlight.

Chromate of strychnia is changed to deep *purple*, and then to *violet* and *red* on application of sulphuric acid. But chromate of brucia shows only an *orange-red* colour; and being more soluble, no crystals can be obtained by means of the weak acid solution mentioned. Chromate of lead also is in the amorphous or powdery state, and developes no *colour* with sulphuric acid.

The following new tests disprove the fallacy entertained, that the non-detection of strychnia in the body of J. P. Cooke was owing to the presence of antimony.

Mix one part of a saturated solution of the yellow cyanide of potassium (12 grains to each drachm of water) with two parts of solution of acetate of strychnia; or take thirty drops of solution of strychnia diluted with sixty or ninety drops of water; drop in *one* minim only of the ferrocyanide of potassium, and agitate the mixture, and an abundance of minute yellowish-white crystals of the ferrocyanide of strychnia is formed. Again, lay a little of the dried ferrocyanide of strychnia upon a small portion of powdered protosulphate of iron; drench both with water; the deep blue of the iron is first shown: add one or two drops of strong sulphuric acid, and then stir in a minute portion of powdered chromate of potash; the *purple* and *violet* colour of strychnia at once appears.

In the next test, a solution of the ammonio-sulphate of copper is *discoloured* by gradually adding a solution of strychnia and by boiling the mixture; crystals of strychniate of copper with a little ammonia will be formed; *decolorize* these when dry, by sulphuric acid; add chromate of potash *ground in* by a glass rod, and strychnia will be revealed.

On a New Method of extracting the Alkaloids Strychnia and Brucia from Nux Vomica without Alcohol. By JOHN HORSLEY.

The usual modes of obtaining strychnia from nux vomica are, besides being more or less expensive owing to the alcohol used, far from satisfactory. This, in a toxicological point of view, is particularly the case, on account of the small quantity of strychnia naturally contained in the nut; and as the production of the alkaloid for its characteristic colour-test is a matter of importance, I have been induced to make several experiments on the different methods in use, and it appears to me that the simplest and best is that which I now propose, viz. to make an acetic extract by kneading up, say a quarter of a pound of nux vomica with an equal quantity of commercial acetic acid, and thinning the pulpy mass with two or three pints of cold water, allowing it to digest for a few days. The clear liquor must then be decanted off and an equal quantity of fresh water poured on the mass to digest for a day or two longer, or till all soluble matter is extracted. The clear liquor is then to be decanted, and the remainder thrown on a flannel filter. The liquid which passes through should be mixed with the former decanted liquors and evaporated to a syrupy consistence (about three or four ounces). When this is cold, dilute it with an equal quantity of water, add liquor ammoniæ in excess, and set it by for a day or two that the strychnia may crystallize out, which is known by the various little white tufts which collect within the fluid as well as on the sides of the glass vessel. When the crystallization is complete, the dark green supernatant fluid is to be passed through a calico filter; and the residuum with the crystals adhering to the vessel collected thereon, must be left to drain; the dark green mass consisting of strychnia and brucia with resinoid matter is next to be scraped off and well dried in a water-bath, digested in hot diluted acetic acid, and the solution filtered. The strychnia and brucia may be thrown down by potassa, or the strychnia *only* by the addition of a solution of chromate of potassa, when a chromate of strychnia will be obtained free from brucia provided the solution which retains the brucia be tolerably acid.

This chromate of strychnia being collected on a filter and well drained, can easily be *de*chromatized by digestion in liq. ammoniæ, and the strychnia obtained of a more or less *snowy whiteness*.

The quantity of strychnia actually contained in the nux vomica has not, I believe, been accurately ascertained, at least if I may judge from Professor Taylor's work on Poisons, where that gentleman represents it at about $\frac{5}{10}$ or $\frac{1}{2}$ a grain per cent. I cannot help thinking that the exhaustion in that case must have been but imperfectly performed, as my own experiments show that nearly twice that quantity is capable of being extracted; for in my first concentration of the liquor from a quarter of a pound of nux vomica I obtained as follows:—

From the	1st	concentration	11	grains of	strychnia
,,	2nd	,,	4	,,	,,
,,	3rd	,,	2	,,	,,
			17 grains.		

This difference in quantity is necessary to be borne in mind by the medical practitioner when prescribing the extract and other preparations of nux vomica.

Experiments on Animals with Strychnia, and probable reasons for the non-detection of the Poison in certain cases. By John Horsley.

The author next related his experiments on three white rats with strychnine. To each rat was given a quarter of a grain of powdered strychnia. In little more than an hour a quarter-grain dose was given to the largest rat, and in about another hour half a grain more was given to the same animal. At 4 o'clock the next morning they were all alive, having eaten bread and milk, but shortly after 7 o'clock they were all dead, one having lived just twelve hours after taking the quarter-grain dose.

In about three hours afterwards not the least indication of strychnine could be obtained by the usual tests, and all traces of bitterness were lost. Every portion of their bodies gave the same negative results. Was, then, the strychnia decomposed in the organism, and its nature changed, as Liebig intimated?

The strychnine might have been absorbed into the albumen or other solid animal matter, and thus abstracted from the fluid, forming perhaps by coagulation in the blood, a solid albuminate as in the case of the glairy white of egg with strychnia, the full quantity of the alkaloid not being recoverable.

In his second experiment the author gave full three-quarters of a grain to a *wild* rat, which was killed by a dog four or five days afterwards, exhibiting but little of the effects of the poison; the palms of the feet having œdematous swellings, and one of the fore-feet being contracted. In the third experiment, Mr. H. gave a pill of two grains of strychnia wrapped in blotting-paper, to a full-sized terrier dog. It was apparently well for at least five hours, but in the morning was found dead, as though asleep. When taken up, blood flowed freely from its mouth. The right ventricle and auricle of the heart contained no blood; the left was full of partly liquid, partly clotted blood. The stomach was detached with both orifices closed. On incision, the paper wrapper, so far from being reduced to a pulp by the action of the stomach, was found in the same state as when the pill was given, and contained nearly all the strychnine.

None of the absorbed strychnia could be detected in the blood or elsewhere after the most careful experiments.

Mr. H. subsequently made experiments proving the great probability that a more or less insoluble compound of organic or animal matter is found in combination with strychnia.

On the Products and Composition of Wheat-Grain. By J. B. Lawes, *F.R.S., and* Dr. Gilbert.

On the Detection of Strychnine. By Stevenson Macadam, *Ph.D., F.R.S.E., F.C.S., Lecturer on Chemistry in the Medical School, Surgeons' Hall; in the School of Arts; and to the Pharmaceutical Society of Great Britain, Edinburgh.*

Four points were sought to be determined by the present investigation.

(1) Can strychnine which has been administered as a poison be thereafter detected in the animal system?

(2) Will antimony, morphine, coniine, or other chemical agent, conceal strychnine, when such has been given to the animal?

(3) Will time, with its host of putrefying agents, so far destroy strychnine as to render its detection unlikely or impossible? And

(4) Can strychnine which has been given to the animal in minimum doses remain in its organism in such quantity as afterwards to be isolated and recognized?

In examining animal matter for strychnine, the author has found the following process eminently serviceable, and confidently commends it to the notice of analysts as a method which can be depended upon. The animal matter, when solid, is chopped into minute fragments, and treated with a dilute solution of oxalic acid. After standing twenty-four hours, during which time the mass is repeatedly agitated, the whole is filtered through muslin. The contents of the filter are well washed with water, and the washings added to the filtrate. The liquid so obtained is heated to ebullition, when albuminous matters separate, and whilst warm, is filtered through paper. Animal charcoal is added to the filtrate, and, after repeated agitation during twenty-four hours, the supernatant liquid is decanted off, and the charcoal received on a paper filter, where it is well washed with cold water. The charcoal now retaining the strychnine is allowed to dry spontaneously, thereafter placed in a flask, drenched with alcohol, and the whole kept for two hours at a temperature short of ebullition. The alcoholic extract is separated by filtration from the charcoal, and is evaporated down to dryness in a porcelain vessel, at a water-bath heat. The residue so obtained will generally be found in a fit condition to be at once tested for strychnine, by means of bichromate of potash and sulphuric acid; but should such not be the case, a few drops of oxalic acid solution are again added, and the process repeated from the action of charcoal onwards. Proceeding in this manner, the author has many times succeeded in detecting strychnine in the various organs of an animal destroyed by means of it. In a few instances, hydrochloric acid and acetic acid were severally employed instead of the oxalic acid, but were found unsuitable. Tartaric acid, however, gives results equally successful with those yielded by oxalic acid.

When this investigation commenced, it was still an open question as to the possibility of strychnine being absorbed and retained in the animal system. Accordingly, in the first trials, large doses were gradually given, so as to afford every chance of the strychnine being afterwards found.

A Horse received 24 grains of strychnine in small doses at repeated intervals during one hour and fifty minutes, when a large dose of 12 grains was given. Tetanus came on in two hours from the commencement of the experiment, and the animal died in one minute thereafter. Strychnine was detected in (1) the contents of the stomach, (2) the muscle, (3) the blood, and (4) the urine.

A large Police Dog partook of four bread pills, each containing $\frac{1}{12}$th of a grain of strychnine, at intervals of about a quarter of an hour each. In fifteen minutes afterwards 3 grains of strychnine were given, and in other fifteen minutes another dose of 3 grains. Tetanic spasms commenced in one hour and forty-five minutes after the first dose was administered, and the animal died in thirteen minutes. Strychnine was found in (1) the intestines, (2) the blood, (3) urine, and (4) muscle. The other parts of this animal were not examined.

Three Mice were poisoned with strychnine by the author's assistant, Mr. John J. J. Kyle, who afterwards examined them according to Stas' process, substituting chloroform for ether. He detected the alkaloid in the stomachs and intestines thrown together, but not in the muscle and other organs.

The suggestion lately advanced, that antimony and other substances are capable of destroying, retaining, or concealing strychnine, when such has been administered as a poison, does not seem to possess any foundation. A White Dog which had been under treatment with tartar emetic for four days, receiving four $\frac{1}{4}$th of a grain doses each day, was poisoned with 1 grain of strychnine, and died in forty minutes; and, when tested, the poison was found in every organ. A Black Dog, similarly treated with tartar emetic, received $1\frac{1}{2}$ grain of strychnine along with 12 grains of extract of hemlock, died in one hour and two minutes, and when examined yielded evidence of the poison having passed into nearly every part of its system. A Terrier Dog, poisoned by $1\frac{1}{2}$ grain strychnine and 3 drops coniine, gave the same positive result. A Cat, to which half a grain of strychnine and 2 grains of muriate of morphia were given, died in fifty-six minutes, and afforded evidence of strychnine in six different parts.

The effect of time in causing the destruction of the strychnine has also occupied the attention of the author. Several parts of the Horse which had been buried for four weeks, as also other parts which had lain above ground for three weeks, including the stomach itself, and which were in an advanced stage of decomposition, on being tested, showed the presence of strychnine. A Duck also poisoned by strychnine, and which lay above ground for three and a half weeks (by which time maggots in abundance were crawling in and through it), yielded strychnine. Further, the remains of a Dog destroyed two and a half years ago by strychnine, as also those of another Dog poisoned three and a half years ago by the same substance, still yielded satisfactory indications of the agent by means of which they came by their death.

As strychnine, like other organic substances, is liable to change in the animal system, it is of importance to know how far minimum doses may be given which in days may prove fatal and yet be thereafter discovered. A Skye Terrier received $\frac{1}{8}$th of a grain of strychnine, was seized with tetanus in three hours, died in twelve hours, and notwithstanding the smallness of the dose, and the length of time the vital powers could act upon it, yet strychnine was satisfactorily discovered in all the more important organs. Again, a Terrier Dog was fed on the flesh of the horse for fourteen days, received each day 2 lbs. of food undoubtedly containing strychnine, lived and thrived on the poisoned flesh, and when afterwards destroyed by strychnine (unfortunately so), yielded such a comparatively large proportion of strychnine, that the author came to the conclusion that this excess of strychnine must have been stored up in the tissues of the animal whilst it was partaking of the flesh of the horse, containing the minimum of minimum of doses of strychnine.

In summing up these remarks on the detection of strychnine, the author deduces from the results of the experiments, the following conclusions:—

(1) That, when administered to the animal, strychnine is absorbed and retained in its system.

(2) That strychnine is not sensibly destroyed in the animal system during life, nor by the partial decomposition of the animal tissue consequent on death.

(3) That minimum doses of strychnine may cause the animal to exhibit but partially, or not at all, the physiological effects, but such doses are the most favourable for the chemist; so that, as the physiological evidence decreases, or sinks to a minimum, the chemical proof increases or rises to a maximum.

(4) That tartar emetic, muriate of morphia, extract of hemlock, and coniine, may retard or relieve the spasms, but they do not in the slightest degree hinder the chemical isolation and detection of strychnine.

(5) That, by proper treatment, strychnine can be separated from organized tissue and organic matter in general, as easily as any other poison—arsenic not excepted—and much more easily than most other poisonous substances.

(6) That, when isolated, strychnine can be distinguished by a special test, which is unerring and most delicate, and which will detect the merest trace.

(7) That the decomposition or natural decay of the animal frame *may* in ages cause the complete destruction of the strychnine; but in this, time will no more easily blot out all traces of strychnine than it will obliterate the mark of the knife of the assassin.

On a Series of Descriptive Labels for Mineral Collections in Public Institutions. By the Rev. W. Mitchell *and* Prof. J. Tennant.

Note on the Alkaline Emanations from Sewers and Cesspools. By William Odling, *M.B., F.C.S., L.R.C.P., Professor of Practical Chemistry, &c., Guy's Hospital.*

Sewer and cesspool water was distilled. The powerfully alkaline distillate was supersaturated with hydrochloric acid, and precipitated with bichloride of platinum in the usual manner. The resulting platinum salt was crystallized, and then burnt with chromate of lead. The liberation of a large amount of carbonic acid proved the carboniferous character of the alkali. The platinum salt yielded the same per-centage of platinum as the platino-chloride of methylamine.

On the Detection of Antimony for Medico-Legal Purposes. By William Odling, *M.B., F.C.S., L.R.C.P., Professor of Practical Chemistry, &c., Guy's Hospital.*

By Reinsch's process, antimonial deposits upon copper can be obtained from solutions which, on account of their dilution, are unaffected by sulphydric acid. The ·001th of a grain of dry tartar emetic, under a dilution of half a million times, gives a complete metallic coating to one square inch of copper surface. By the same process, other metals than antimony, arsenic, and mercury can be deposited as brilliant metallic coatings upon copper. The characters of the various deposits, and the circumstances under which they form, vary somewhat. Cadmium precipitates copper completely from cupric solutions; but, on the other hand, from cadmic solutions cadmium is readily precipitable upon copper. The deposit of antimony upon copper is best identified by boiling the coated foil in a weak and faintly alkaline solution of permanganate of potash, until the whole of the liquid is destroyed, filtering, acidifying the filtrate, and treating it with sulphydric acid, when the characteristic orange-coloured antimonial sulphide is produced.

On the Compounds of Chromium and Bismuth. *By* W. R. PEARSON.

On Engraving Collodion Photographs by means of Fluoric Acid Gas. *By* CHARLES POOLEY, *Cirencester.*

In this paper the author set forth the means he had adopted in order to obtain engraved impressions of collodion photographs on glass. He divided the process into four steps:—

1st. The preparation of the plate.
2nd. The treatment of the picture.
3rd. The application of heat to the picture.
4th. The exposure of the picture to the influence of fluoric acid gas.

In the preparation of the plate, Mr. Pooley found it necessary to use new glass, and strong collodion well iodized, and also to deposit as much pure silver as possible, for which purpose he developed with protosulphate of iron and acetic acid, although he thought other agents would answer the purpose equally well.

The author then proceeded to show that the great obstacle he had to contend with, was the presence of the film of collodion covering the glass; but this was overcome by submitting the plate to a high temperature, which gave to the silver a white, frosted appearance, and attenuated the film of collodion so much as to make it permeable to the action of the gas. The picture was then exposed to the influence of the dry, warm vapour of fluoric acid, and in 20 to 40 seconds the operation was completed.

Having washed off the film, a fine etching becomes visible, so delicate in its markings, and yet so perfect, that the unassisted eye is unable to discern all its beauties. It requires a lens to make out all the minutiæ of detail correctly.

The author then adverted to a remarkable fact which he had observed in the character of the engraved picture, namely, that the portions of the glass on which the silver had been deposited were those on which the action of the gas first took place, the unsilvered parts being unaffected by it. This circumstance, which appears to be at variance with our notions of the ancient claims of fluoric acid for silica, opens a new field for investigation. The author refrained from offering an explanation of this interesting question, but left it as a subjeet for future consideration.

On the Gases of the Grotto del Cave. *By the* Rev. C. PRITCHARD, *M.A., F.R.S.*

On the Corrosive Action of Smoke on Building Stones. *By* Professor A. VOELCKER, *Ph.D., F.C.S.*

On the Composition of American Phosphate of Lime. *By* Professor A. VOELCKER, *Ph.D., F.C.S.*

On Basic Phosphates of Lime. *By* Professor A. VOELCKER, *Ph.D., F.C.S.*

On Albuminized Collodion. *By* W. SYKES WARD, *F.C.S.*

Immediately after the publication of M. Taupenot's process, I proceeded to experiment on it, under the impression that it possessed many advantages over the dry photographic processes then known, and that the further investigation of it was likely to lead to results of the highest interest, both practically and theoretically. In these respects I have not been disappointed, and I can most decidedly recommend the adoption of the process to all photographers, as well to those who are not afraid of a little trouble in the manipulation of preparing their own materials and plates, as to those who, preferring the artistic choice of subjects, would rather commit the preparation and subsequent development of plates to assistants, or to professional photographers.

I have to acknowledge the assistance of several friends, Members of the Leeds Photographic Society, of whom some worked conjointly with me, and of others who freely communicated to me their experience in working the albumen process.

The modification of the original process which I have adopted, consists, first, in using only one bath for both the first and second sensitizing of the plate. This bath is composed of about 35 grains of nitrate of silver per ounce, with about 10 per cent. of the commercial acetic acid known as Beaufoy's acid. Secondly, in using a very fluid collodion somewhat highly iodized and not containing any bromide, and in using albumen without any other addition than a bromide and sufficient water for its solution. I use about 4 grains of bromide of potassium for the white of each egg, but the particular bromide, or the precise quantity, does not appear to be very material. And, thirdly, in drying the coating of albumen by suspending the plate in a wire cradle attached to a long thread over a heated iron plate, and keeping the prepared glass plate in rapid rotation until dry, so as in the first instance to throw off the superfluous albumen by the centrifugal force, and then to cause the plate to dry equally from the centre.

I use a similar method of drying after the second sensitizing, but without heat if the plates are to be kept more than a day or two.

By adopting these manipulations, I have been able to prepare plates up to 17 inches by 13 as free from blemishes and with very little more trouble, than if collodion alone had been used.

I have always preferred to develope the picture by gallic acid, using a cold, nearly saturated solution, with the addition of about 4 minims per ounce of a solution of nitrate of silver, 30 grains per ounce with about 30 minims of acetic acid, *i. e.* rather less acidified than the bath solution. This generally developes the picture in about an hour and a half; but if the picture be faint from over-exposure, or slow in developing from under-exposure, an addition of double or treble the quantity of aceto-nitrate solution should from time to time be added. A greater quantity of silver in the first instance appears to retard the development.

Small plates may be more speedily developed by pyrogallic acid, but with large plates I find gallic acid preferable, both on the score of economy, and that with pyrogallic acid constant care is required in watching the development and in preventing the spoiling the result by a muddy deposit.

The theoretical advantages of this process appear to me to be, that, compared with other processes, it permits quite as great, and I think a much greater latitude in the time of exposure; that whilst the rapidity is as great as can be desired (except for the instantaneous effects, which are only practicable with wet collodion), an exposure for many hours or even days may be given for feebly illumined objects; that the use of an iodide in the collodion and a bromide in albumen, give a great increase of sensibility, in like manner as the accelerating effect by the alternate use of iodine and bromine in the Daguerreotype; that the image is formed on the plane on which the combined films of collodion and albumen coalesce together, and where alone there is a combination of iodide and bromide of silver; thus, although it is necessary that the plates should be very carefully cleaned to procure the perfect adherence of the film of collodion, neither impurities on the surface of the glass plate, nor on the upper surface of the albumen, are increased during the development of the image; that the drying the plates by heat prevents almost entirely the blistering of the plates, which has been found so great a disadvantage in the process as published by M. Taupenot.

Note.—Subsequent experiments have shown the use of a bromide alone in the albumen to be fallacious.

On a New Process for Making and Melting Steel. *By* P. J. Worsley.

This process, invented by Dr. Gurlt, is interesting as an example of the method of applying fuel, known as the gas-fuel method, by which the useful portions of the fuel are brought to bear while all impurities are left behind. This latter advantage is peculiarly applicable to iron and steel making, as the chief impurities in these metals are derived from the fuel. Dr. Gurlt exposes iron-ore to a current of gas, of which a small proportion is burnt to give the necessary heat. A short exposure merely reduces, a longer carbonizes, so that either malleable iron, steel, or cast iron can be obtained at will. By applying gas-fuel to a reverberatory furnace, and blowing in air by pipes over the bridge, a true blowpipe flame is obtained, by which the highest heat possible is attained, and also by the regulation of the wind the atmosphere of the furnace may be kept either neutral, oxidizing or reducing at will. With such a furnace Dr. Gurlt hopes to melt steel in large quantity without injury to its quality. The gas is obtained by burning the fuel in a close deep fire-box by means of a blast of air at the bottom.

On the Use of the Gramme in Chemistry. By HENRY WRIGHT.

GEOLOGY.

On Gold in India. By Lieut. AYTON, *Bombay Artillery.*

On Fossils from the Crimea. By WILLIAM H. BAILY, *Geological Survey of Great Britain.*

THE fossils which formed the subject of this communication belong, with one exception, to the Invertebrata, and were principally collected in the southern part of the Crimea, by Captain C. F. Cockburn, of the Royal Artillery. They comprise a series from the Monastery of St. George and gorge of Iphigenia, consisting of fossils from the Jurassic and oldest deposits; also others from the tertiaries resting immediately upon them; and from the volcanic or eruptive rocks which have disturbed and broken up some of these strata, together with a set of well-preserved newer tertiary Mollusca from the Quarantine Harbour. The Museum of Practical Geology has also received from Major Cooke, of the Royal Engineers, a suite of somewhat similar forms of Steppe limestone fossils from the Redan, and near the dockyard of Sevastopol, and some interesting Jurassic Brachiopoda from Balaklava. It possesses also from Lieutenant-Colonel Munro, and Lieutenant-Colonel Charles Lygon Cocks, of the Coldstream Guards, other specimens of the Steppe limestone containing fossils, obtained from the ground before Sevastopol, upon which the allied armies were encamped, and volcanic and mineral specimens from the sea-coast.

These instructive collections, including a series of fossils from the various strata of the Crimea, formerly presented by the Imperial School of Mines at St. Petersburgh, enable us to add to the published lists of fossils from that country seventy-four species.

The geology of this peninsula having been described in detail by M. Du Bois de Montpéreux, M. Huot in the work of Demidoff, M. Hommaire de Hell, and by Sir R. I. Murchison and M. de Verneuil in the 'Geology of Russia and the Ural Mountains,' a slight sketch of the formations represented in that country only is necessary before proceeding to the remarks upon the fossils.

The most ancient deposits of the Crimea are those at the base of the Jurassic formation, described as black schists, composed of hard, soft, and ferruginous beds, which are probably equivalent to the Trias, or New Red Sandstone appearing in the Valley of Baidar and other localities, and on the coast, where they are superimposed by the Lias. Overlying the schists of the Lias are the Jurassic rocks, which extend along the southern sea-coast from Balaklava to the vicinity of Theodosia or Kaffa, a length of about 100 miles. This mountain-chain of hard and crystalline limestones, pierced and broken into by volcanic eruptions of greenstone, porphyry, &c., is, with its associated strata, analogous to that of the Caucasus, and proceeds in a direction E.N.E. to S.S.W., its highest point being the Tchatir Dagh or Tent Mountain, of an elevation of 5135 feet. The Bay of Balaklava is enclosed on both sides by steep and rugged rocks of the Jurassic formation, composed of compact red and grey limestones, in which are clefts filled with a reddish clay. These limestones and clays contain numerous organic remains, the most abundant of which are corals and Encrinital joints.

At the foot of the chain towards the north, the lower division of the Cretaceous series, or "Neocomien," may be well observed, its horizontal beds resting unconformably either upon the Jurassic limestones, or upon the shales at their base, the intermediate subdivisions being absent. Upon these beds repose the Upper Cretaceous, composed of shales (probably equivalent to the Gault), Upper greensand, Chalk marl, and White chalk. On the eastern coast the Hippuritic and Senonian subdivisions rest immediately on the disturbed Jurassic beds, the intermediate subdivisions being absent. The Cretaceous series does not occupy much space in the Crimea, being enclosed between the nummulitic deposits and the Jurassic limestone, taking the same direction, and extending from Kaffa to Cape Chersonese on the south-west coast. The soft calcareous rock of Inkermann, from which the beautiful white stone used in constructing most of the public buildings of Sevastopol was obtained, is very easily worked, but becomes harder and more durable by exposure to the atmosphere. From comparison of its fossils, it appears to be identical with the Upper chalk.

The Lower Tertiary or Eocene is represented by the Nummulitic formation, which, like the cretaceous series, is elevated by the mountainous region of the coast, and disposed in long bands following its contour. This formation commences in the environs of Theodosia, continuing to the north, near to Karas-ubazar, Simferopol, and Baktchi Serai, terminating at the south-west coast near Sevastopol.

The Upper Tertiary formation includes the older and newer Caspian or Steppe limestone, the former of which subdivisions, or older Caspian, occupies the northern and greater portion of the peninsula at Eupatoria, Sevastopol, &c., including the chief limestones round Kertch, and the deposits of the cliffs of Kamiesch Boroun and Taman. These limestones and sands, associated in some localities with volcanic ashes, tufa, &c., occur in various conditions as shelly and oolitic limestones of marine and freshwater origin, being more or less fossiliferous. The Heracleotic Chersonesus is, as it were, a shred of the Steppe limestone; the Bay of Sevastopol exhibiting a succession of formations from the most recent of these tertiaries through the nummulitic limestone and chalk. The newer Caspian occupies the still more northern extremity of the Crimea, extending to Perekop, Kherson, and the shores of the Sea of Azof. The environs of Kertch and Taman are the most favourable localities to observe its characters, and here the fossils are in good preservation. The existence of coal has been often rumoured, but on examination the supposed coal has proved to be lignite of very ordinary quality.

Deposits of hydrate and phosphate of iron have been met with near to Kertch, Taman, and other parts of the Crimea. A foundry was formerly established near Kertch, and the iron was worked by M. Gourieff. From an analysis by Hussein Effendi, of the Government School of Mines, it gave but 19·234 per cent.

After describing the new species, the following summary of fossils collected from each formation was read, viz.:—

Lower Secondary—Jurassic Group.

	Known species.	New species.	Total.
Amorphozoa	0	1	1
Zoophyta	10	0	10
Echinodermata	4?	?	9
Mollusca: Brachiopoda	7	4	11
Conchifera	6	2	8
Gasteropoda	1	1	2
Cephalopoda	15	0	15
	43	8	56

Upper Secondary—Cretaceous Group.

Amorphozoa	5	
Zoophyta	11	
Echinodermata	9	
Polyzoa	8	
Brachiopoda	14	
Conchifera	49	
Gasteropoda	9	
Cephalopoda	19	
Total	—	124

Older Tertiary—Nummulitic.

Foraminifera	2		
Echinodermata	3		
Conchifera	8		
Gasteropoda	10		
Total	—		23

Newer Tertiary—"Falunian" (D'Orbigny).

Amorphozoa	0	2	
Conchifera	27	30	
Gasteropoda	19	34	
	—	—	
	46	66	112

Species before described	236	Total number of species collected	320
New species	74		

Remarks on the Fossils.

On referring to the table of Jurassic fossils, it was shown that the most numerous classes represented in the Crimea from that formation are the Zoophyta, Brachiopoda, and Cephalopoda—the Conchifera and Gasteropoda being the fewest. In the lowest class, the Amorphozoa—a group of rare occurrence in this formation—a new form of Sponge has been collected by Capt. Cockburn, from the red Jurassic limestone near the Monastery of St. George. Of the Zoophyta nearly all the specimens received have been identified with species found in the coralline and inferior oolite of this country. The Echinodermata are principally spines belonging to the genus *Cidaris*; with these are joints of crinoids (Apiocrinites) from near Balaklava, and portions of stems of Pentacrinites from the interior of the Crimea. Of the Brachiopoda, the characteristic lias species, *Terebratula numismalis*, has been obtained from Woronzoff Road. Four are new species—two of these belonging to the genus *Rhynchonella*; others of the same genus have been identified with inferior oolite and marlstone species. In the lias shales of the Woronzoff Road were found several specimens of a bivalve, identified with *Astarte complanata* (Roemer), together with a new form of *Cardium* allied to an inferior oolite species. The Gasteropoda are represented only by a large species of *Natica* from the red limestone near the Monastery of St. George, and a fragment of *Nerinea*, probably *N. grandis*, from the village Djanatai. The Cephalopoda, of which the Ammonites belong mostly to the fimbriated group, have been described by M. d'Orbigny, together with one species of Belemnites from Kobsel and Biasali.

In the list of Cretaceous fossils are included those mentioned by M. Du Bois de Montpéreux in his table of fossils from the Neocomian to the chalk found at Baktchi Serai; from the Neocomian of that locality he tabulates sixty-five species. The Upper Cretaceous, including the Upper greensand, Chalk marl, and Upper chalk, are richest in Conchifera, of which there are thirty-two species. Many of these were collected by Capt. Cockburn from the Upper chalk of Inkermann, several of them being identical with characteristic chalk fossils. Associated with these were found many specimens of a large *Crania*, identified with the *Crania spinulosa* of Nilsson, and most probably the same species as that mentioned by Du Bois in his table under the name of *Crania nummulus* from Baktchi Serai.

From the Nummulitic formation, belonging to the Older Tertiary, only twenty-three species are known, most of these being included by M. Du Bois in his table of cretaceous fossils. The Nummulites are referred by M. d'Orbigny to two species only, viz. *Nummulites nummularia* and *N. mamilla* from near Simferopol. Three species of Echinoderms from this formation are mentioned in M. d'Orbigny's 'Prodrome de Paléontologie,' a remarkable form of which, the *Conoclypus conoideus*, is in this collection, from near Simferopol; it has also been described as from near the River Salghir. Of Conchifera eight species are tabulated, the most characteristic of which is the *Ostrea gigantica* (Brander). Ten species of Gasteropoda are also noticed, one of them being the *Cerithium giganteum*, a large cast of which, together with the last-named oyster from Simferopol, is also in this collection.

The list of Newer Tertiary, or Steppe limestone fossils, includes those described by

M. Deshayes in the third volume of the 'Memoirs Geol. Soc. of France,' from Tertiary deposits in the neighbourhood of Kertch; the majority of them are, however, from near Sevastopol. The classes represented, with the exception of two new species of Amorphozoa, are entirely composed of species of Conchifera and Gasteropoda, in nearly equal proportions, more than half of which are new. Of the peculiar forms of *Cardium* resembling the present Aralo-Caspian types, thirty-one species are tabulated, including those described by M. Deshayes, as found associated with bands of iron-ore before alluded to. Several of these are in the collection of the British Museum from the same locality; also twelve species of *Trochus*, some of them being in beautiful preservation, and mostly collected by Capt. Cockburn from the Quarantine Harbour, Sevastopol. Six of these are identified with species figured in the fine work of M. Hommaire, and described by M. d'Orbigny from the Tertiary of Kichinev in Bessarabia, and contemporaneous deposits.

On the Origin of Siliceous Deposits in the Chalk Formation. By J. S. Bowerbank, *F.R.S., F.G.S. &c.*

Some years since the author read at the Geological Society of London, a paper on the origin and structure of the siliceous deposits of the chalk and greensand formations, and subsequently one on the spongeous origin of moss, agates, &c., in which he advocated the doctrine of the derivation of nearly the whole of the flints and cherts from various species of sponges that existed in the ancient oceans.

The principal proofs adduced at that time in favour of the views then enunciated, were to a great extent derived from the microscopical evidence afforded by sections of such siliceous bodies. The object of the present communication is to strengthen and confirm those views by the production of evidence derived from information recently acquired, regarding the habits and manner of growth of the recent Spongiadæ. In the opinion of the author, the whole of the numerous strata of nodular and tabular flints are derived from vast quantities of sponges that existed in the seas of those periods; the attraction of the animal matter of the sponges inducing the deposit of the silex, which in the first instance is always in the form of a thin film surrounding the skeleton of the sponge, and from which successive crops of chalcedonic crystals proceed until the solidification of the whole is effected.

The tabular beds of flint are accounted for on the presumption that the sponges originating the deposit grew on a more consolidated bottom than the tuberous ones, and that they therefore developed themselves laterally instead of perpendicularly, as many species of recent sponges are in the habit of doing, and that approaching and touching each other, they united and thus formed extensive and continuous beds instead of numerous isolated specimens. The author illustrated this part of his subject by producing four recent sponges of the same species, which having been placed in close contact while in the living state, became firmly united to each other within eighteen hours, and ultimately formed but one sponge.

The occurrence of the shells of bivalves and of echinoderms filled with flint or chert, was accounted for on the principle of their having been previously filled with living sponges, and subsequently fossilized by the deposit in the spongeous tissue of silex held in solution in the water; in illustration of which the author produced specimens of recent bivalve shells in a closed condition, which were completely filled with recent sponges.

The loose specimens of fossil sponges contained in the Wiltshire flints were explained on the same principle; but their not adhering to each other, the author stated, was in accordance with the law that always obtains among the recent Spongiadæ, that although individuals of the same species of sponge always adhere on being brought in close contact, those of different species never unite under such circumstances, and specimens of recent sponges, one species completely enveloping the other, but without the slightest adherence between them, were exhibited.

The author concluded his paper by applying the same principles to the siliceous deposits of the whole of the geological formations of aqueous origin, and by expressing his opinion that the geological office of the Spongiadæ in creation is that of inducing the deposit of siliceous matter held in solution in the ocean, as the Corallidæ assist in the consolidation of the calcareous matter.

On some New Species of Corals in the Lias of Gloucestershire, Worcestershire, and Warwickshire. By the Rev. P. B. Brodie, *M.A., F.G.S.*

The object of this communication is rather to indicate the occurrence of some new and undescribed species of corals in the Lias, than to describe them in detail. They are generally rare in the Lias, the sea in which it was deposited being unfavourable to the growth of Polyparia. A species of *Cyathophyllum* and a *Flustra* have been found by Mr. C. Moore in the Upper Lias of Ilminster, in Somersetshire, in addition to those figured in the 'Memoirs of the Palæontographical Society.' From the Lias marlstone of Northamptonshire a form belonging probably to the Fungidæ is in the collection of the late Hugh Strickland, Esq. I have in my collection several specimens of the genus *Montlivaltia*, which I discovered in the shales of the Lower Lias, in Gloucestershire, and one or two occur in the same beds in Oxfordshire. From the Lower Lias near Cheltenham, I obtained a small coral, which appears to be a species of *Turbinolia*. I have met with a few species of *Isastrea* both in Worcestershire and Gloucestershire, and in one case in sufficient numbers to show the existence of an ancient coral reef: most of them are highly solidified, but in others the cells are soft and crumbly, a condition very different to that of most of the liassic *Isastreæ*. In the Isle of Skye there is a group of corals belonging to this genus nearly a foot in thickness in the lower division of the Lias.

On a New Species of Pollicipes *in the Inferior Oolite near Stroud, in Gloucestershire. By the* Rev. P. B. Brodie, *M.A., F.G.S.*

The Lepadidæ are usually rare in a fossil state, and the specimen which I found at Selsley Hill, near Stroud, appears to be a distinct species from the *Pollicipes ooliticus* in the Stonesfield slate. On comparing the scutum two valves of which are entire, with the same valve of *P. ooliticus*, there is a sufficient difference to warrant the conclusion that it belongs to a different species. A small valve of another, and probably a distinct species, has been detected in the Lias at Campden, in Gloucestershire, by Mr. Gavey, the oldest remains of a Cirripede yet discovered.

On the Basement Beds of the Oolite. By Professor James Buckman, *F.L.S., F.G.S.*

The object of this paper was to show that the Pisolite or its equivalents formed the true base of the Inferior Oolite as established by Murchison, Strickland, and the Cotteswold geologists, but in opposition to a theory recently started by Dr. Wright, in which he places certain bands of ferruginous stone resting on the "Inferior Oolite sands" of the Ordnance Surveyors with the Upper Lias, a theory which he attempts to support from the presence of a number of Cephalopoda therein contained, some of which are truly liassic, but the majority are peculiar to the so-called 'Cephalopoda bed.'

The Professor contends that the bed is oolitic in structure, and as regards the fossils, only a small per-centage belong to the Lias, as may be seen from the following

Analysis of the Fossils of the Cephalopoda-bed of the so-called Upper Lias.

	Species.		Species.
Ammonites	15	Common to Lias	5
Belemnites	3	,, ,, ,,	3
Gasteropoda	1	,, ,, ,,	0
Lamellibranchiata ..	21	,, ,, ,,	0
Brachiopoda	3	,, ,, ,,	3
Inferior Oolite	43		11

Thus giving a total of forty-three species, only eleven of which are liassic, and of these several extend a considerable way upwards in the oolitic series.

The author further contended, that as much as from sixty to eighty feet below the 'Cephalopoda bed,' at the very base of the "Inferior Oolite sands," a band of ferruginous oolite had been worked by Mr. John Lycett, of Minchinhampton, which was full of fossils of the Inferior Oolite forms,—a fact not adverted to by the learned Doctor, as he was then unaware of the bed. This may be summed up as follows:—

Analysis of Fossils from the bottom of the Inferior Oolite Sands at Nailsworth.

	Species.		Species.
Ammonites	2	Common to Lias	0
Belemnites	1	,, ,, ,,	1
Gasteropoda	5	,, ,, ,,	0
Lamellibranchiata ..	20	,, ,, ,,	3
Brachiopoda	2	,, ,, ,,	1
Inferior Oolite	30		5

Here, then, if fossil evidence is to be relied on, the sands far below the Inferior Oolite should be added to that rock rather than a portion of the Inferior Oolite to be abstracted and added to the Lias, an argument which was further supported by reference to the fauna of the Cornbrash, in which out of about sixty-five species, twenty-one, including even Cephalopoda, were identical with the common species of the Inferior Oolite.

The author's general conclusion was, that as the Inferior Oolite sands mark a change in the physical conditions under which the unctuous blue lias clays were deposited, which was immediately followed by a corresponding change of animal life, therefore the natural separation of the Lias and Oolite should commence with these sands: by so doing we have a boundary-line which all can recognize both lithologically and palæontologically; whereas by adopting Dr. Wright's view, we separate a bed of true oolitic structure into two parts in obedience to the dictum of a small minority of fossils peculiar to lower strata which one must always meet with at points of oscillation.

On the Oolite Rocks of the Cotteswold Hills.
By Professor Buckman, *F.L.S., F.G.S.*

On the Igneous Rocks of Lundy and the Bristol District.
By R. Etheridge, *F.G.S.*

On some New Fossils from the ancient Sedimentary Rocks of Ireland and Scotland. By Professor Harkness, *F.G.S.*

Hitherto the only fossils which have been obtained from the oldest fossiliferous strata of Ireland, the Cambrian rocks of the county of Wicklow, consist of two forms of *Oldhamia*, viz. *O. radiata* from the purple slates of Brayhead, and *O. antiqua* from the drab shales of Carrick M'Rielly. Associated with the former, last summer, the author found evidences of the existence of Annelidæ in the form of burrows, and also sinuous tracks on the surfaces of some of the purple slates. These tracks and burrows appear to be among the earliest we possess, which show the occurrence of this tribe of animals.

Among the black graptolitic shales of Moffatdale, at Dobbs Lin, the author has also met with specimens of *Beyrichia complicata*, a crustacean which occurs in the Lower Silurian rocks of England and the continent of Europe.

On the Jointing of Rocks. By Professor Harkness, *F.G.S.*

In the Devonian strata of the south of Ireland the rocks manifest jointing in a very perfect state. The master-joints, which are very prominent, have a north and south direction, and, in the language of Professor Sedgwick, might be termed lip-joints; joints of a similar nature are also seen intersecting the carboniferous limestone, where they are even more prominent than in the Devonians, having frequently the aspect of stratification, and being, like the Devonian joints, perpendicular. Besides these perpendicular master-joints, the carboniferous limestone is also intersected by two other series of jointings, the one nearly horizontal, and the other inclined at about 46°, also running north and south. These two latter jointings are not so persistent as the master-joints, and are, in some cases, only local.

The great uniformity of the master-joints and their great parallelism over large areas, would induce the conclusion that they result from some uniform cause operating over a great space.

The theory which attributes joints to shrinkage would not be sufficient to account for these master-joints.

These seem rather to have originated from the application of a mechanical force applied in one direction. This force was probably that which gave the middle and upper palæozoic strata of the south of Ireland their east and west strike of rolls,—the force being applied either to the north or south, the rocks having a tendency to extend themselves at right angles to the direction of the force, and consequently breaking, from their rigidity, into parallel lines which we recognize as joints. The origin of the other two forms of jointing is by no means apparent, but this may probably have been the same cause operating locally in different directions at a subsequent period to that which produced the master-joints.

On the Lignites of the Giant's Causeway and the Isle of Mull. *By* Professor HARKNESS, *F.G.S.*

The Giant's Causeway affords, in connexion with its basalts, beds of lignite, and in the Isle of Mull we have the same circumstances occurring. The lignite of the former locality retains its woody nature to a great extent, and this exhibits sufficient of its original structure to admit of the determination of the forms of vegetables to which this substance owes its origin. The only changes which the structure of this substance has undergone, result from compression, which has brought the sides of the woody cells in immediate contact, and in some instances so lacerated the tissue as to give this, in longitudinal section, a somewhat spiral arrangement. Sometimes, however, the longitudinal section gives this tissue in its perfect state, and when this is the case, pitted vessels, of a coniferous character, are seen on the sides of the cells.

The size of these cells, and their relative distance from each other, would lead to the conclusion that the trees forming this lignite are nearly allied to those which are found forming the mass of lignite mentioned by His Grace the Duke of Argyll as occurring associated with the basalts of the Island of Mull. In the latter locality the lignite presents itself in two conditions, the one in a state of nearly pure coal, the other having more of a woody aspect.

The vegetable fibre of the Mull lignites is often sufficiently distinct to manifest its internal structure, and would support the inference as to the similarity in age of these deposits, and those of the Giant's Causeway. The fossil evidence, as this is shown by the nature of the lignites, supports the conclusion of His Grace the Duke of Argyll, adopted by Sir Charles Lyell, that the traps of Mull and the Giant's Causeway belong to the same geological epoch, that epoch being the Miocene.

On the Relative Distribution of Land and Water as affecting Climate at different Geological Epochs. *By* Professor HENNESSY, *M.R.I.A.*

The views developed in this paper were partly deduced from the principles advanced by the author in his memoir on isothermal lines. As all the investigations on terrestrial temperatures which he has undertaken will be printed elsewhere, it is unnecessary to do more than state some of the conclusions of this paper.

1. The distribution of land and water most favourable to high general terrestrial temperature all over the globe is that of the existence of land, not in great continents, but in islands evenly distributed over the earth's surface.

2. Under such conditions the isothermal lines in the islands would generally approach the character of closed curves, and the temperature in the higher latitudes would decrease in advancing from the coasts to the interior of an island.

3. If these views are correct, some differences might be expected between some of the fossils representing the organized beings of the interior of such islands, and those distributed about the coasts.

Notice of some Minerals from the Isle of St. Thomas. *By* Dr. H. B. HORNBECK.

On the South-easterly Attenuation of the Oolitic, Liassic, Triassic, and Permian Formations. By Edward Hull, *A.B., F.G.S.*

The subject of this paper is partly of a local, and partly of a general character.

Sir R. I. Murchison having called the attention of the Section to the Map of the Geological Survey (No. 44) just completed, and embracing the region of the Cotteswold Hills, together with the liassic plains of Gloucester and Moreton, the author proceeded to point out the remarkable diminution in thickness which the rocks of the Cotteswold Hills undergo in their extension to the borders of Oxfordshire.

Taking as points of comparison Leckhampton Hill near Cheltenham, and Burford in Oxfordshire, distant from each other about twenty miles, it was shown that the same beds, which at the former locality have an aggregate thickness of 624 feet, at the latter have dwindled down to the twenty-ninth part of this amount. The formations included in this computation range from the marlstone to the Fuller's earth, and may be tabulated as follows:—

		Leckhampton Hill. Feet.	Burford. Feet.
	Fuller's earth	25	absent.
Inferior oolite.	Ragstones	38	10
	Freestones (including oolite marl)	188	absent.
	Pea grit	38	absent.
Ferruginous sands, &c.		20?	absent.
Upper lias shale		200	5
Marlstone, or middle lias		115	6
	Total	624	21

From this table it would be observed that the *ragstones* of the inferior oolite, including a bed remarkable for the abundance of *Clypeus sinuatus*, forms the most constant zone of the inferior oolite, and that at the eastern limits of the district it is the sole representative of the formation. This fact tends to show that this terminating zone was deposited in a sea of greater depth and tranquillity than that of the lower members of the formation; an hypothesis, which is also borne out by differences in the state of the included organisms. For while the *freestones* everywhere present the phænomena of false bedding, and are to a great extent composed of organic debris, the stratification of the *ragstones* is always regular, and the organic remains in good preservation, though frequently occurring as moulds and casts.

Passing on to the consideration of the formations which underlie the marlstone or middle lias, Mr. Hull proceeded to show from analogy the strong probability that the lower lias forms no exception to the law of easterly attenuation, which obtains in the case of the upper and middle members of the liassic group; and that consequently under Burford the lower lias would be found of comparatively small depth. From these premises, he also drew the conclusion, that further in the same direction, *e. g.* under the city of Oxford, all the strata already alluded to must be on the point of disappearing.

It was next shown that the trias of Central England undergoes a similar south-easterly attenuation, so that, while in Lancashire, Cheshire, and Shropshire, the Keuper and Bunter attain their greatest development, in the counties to the eastward bordering on the lias, these formations are greatly reduced in thickness. With regard to the Permian formation, it was not possible to speak with equal certainty, as it has been found, through the researches of the Government Geological Surveyors, to vary rapidly in thickness. Thus while it is almost or altogether absent around the Leicestershire coal-field, it appears in considerable force on the flanks of the coal-field of Warwickshire.

Attention was then called to the fact, that on the borders of France and Belgium, and in the "Bas-Boulonnais," all the secondary formations between the coal-measures and the chalk in the former case, and the great oolite in the latter, are altogether absent*. This fact was shown to bear out the hypothesis of the author, and to lead to the supposition that under some parts of Oxfordshire and Northamptonshire the coal-formation may lie at depths not inaccessible to human agency.

* Description Géognostique du Bassin du Bas-Boulonnais, par M. Rozet, 1828.

Lastly, in order to obviate the objection that the coal-formation itself might have thinned out in the same direction as the superincumbent formations, Mr. Hull endeavoured to show that the manner of its formation, and that of the secondary strata, were altogether different; for while (as had been shown by Mr. Godwin-Austen) the ancient coal basin included the greater part of the British Isles, France and Belgium forming one almost uninterrupted coal-growth; on the other hand, the development of the new red sandstone and lias proved that they are formed of sediment derived from *north-westerly sources*, and that consequently, as the distance from these sources increased, the quantity of sediment diminished. Hence it was argued, that while under Oxfordshire the strata between the great oolite and the coal-measures might be very thin, the thickness and quality of the coal-seams would not necessarily have deteriorated.

On the Alteration of Clay-slate and Gritstone into Mica-schist and Gneiss by the Granite of Wicklow, &c. *By* J. Beete Jukes, *M.A., F.R.S.*

The granite of the south-east of Ireland, extending from Dublin Bay into the county of Kilkenny, is intrusive as regards the Lower Silurian rocks, and sends veins into them. The Lower Silurian rocks generally are composed of dull earthy slates interstratified with fine-grained gritstones commonly not more than an inch in thickness, but sometimes two or three feet. The main granite range is not a true geological axis, as it does not bring up the lowest beds of the district, and forms only a partial geographical axis as it is breached through by the valley of the Slaney.

Wherever granite appears at the surface, it metamorphoses the surrounding slaty rocks and changes them into schistose rocks (mica-schist, &c., and gneiss).

The dull earthy slates are found on approaching the granite to acquire a "glaze" or silvery lustre not only externally but internally, as it is as apparent in the rock when ground to powder or triturated into mud or silt as in the mass of the rock. This micaceous lustre increases as we approach the granite, till within half a mile (more or less) of its general boundary nothing can be found but schistose rocks, often containing crystals of garnet, andalusite, staurolite, schorl, &c. Simultaneously with this change in mineral structure the rocks are affected by a folding or corrugation, crumpling both slates and grits, evidently the result of a mechanical force. The foliation of the mica-schist is most usually parallel to the original stratification of the rock, as shown by these grit-bands.

In the cases observed where the foliation crossed the beds, and ran parallel to the cleavage, the plates of mica were smaller and more interrupted than when parallel to the bedding, their development being apparently interfered with by the changes of texture in the original lamination of stratification.

The surface boundary of the granite is very undulating and irregular, and many large patches of schistose rock are found within it, resting on, and apparently dipping down into the granite. The original surface of the granite appears to have had rather a gentle general slope, but to have been very uneven, having many hollows and protuberances.

Although the lowest beds of the Silurian rocks are not brought up by the granite, yet the beds near it dip every way from it at angles not often exceeding 30°, and the patches of schistose rock lying within the general boundary of the granite dip towards that boundary. The graphite is probably continued under the adjacent slates with a similarly gentle slope and irregular surface; especially on the eastern side, where many smaller bosses appear at the surface between the main range and the sea. These smaller bosses produce alteration in the slates through which they appear, exactly similar to that of the main range, though of proportionately less extent.

At Polmounty near New Ross, thick beds of grit interstratified with shale were observed converted into alternations of fine-grained gneiss and mica-schist, and near Graiguenamanagh a dark gneiss was seen, in which crystals of common felspar as large as the thumb were imbedded, forming a true porphyritic gneiss, which is yet nothing more than an altered Silurian gritstone or an arenaceous slate rock.

The very general occurrence of *mica* in these schistose rocks results probably from the varied mineral composition of different well-characterized micas, so that true mica (of some kind or other) is more likely to be produced than any other mineral. Independently of this, however, it was asked if mica, such as it occurs in mica-schist, might not often rather be the result of the physical condition of other mineral combinations, than those forming well-characterized micas; whether those combinations were definite minerals, or only indefinite mixtures of silicates of alumina with other silicates?

Finally, it was stated as the general result, that no one could examine the district without arriving at the conclusion, that as perfect mica-schist, gneiss, &c. as can be found in any so-called primitive district, has been produced by the metamorphosis of earthy clay-slate by the granite, and without being convinced that all schistose rocks, even the most crystalline gneiss, had a similar metamorphic origin.

On some Fossil Fishes from the Strata of the Moselle. By J. E. Lee.

On an Elephant's Grinder from the Cerithium Limestone. By J. E. Lee.

On the Time required for the formation of "Rolled Stones." By M. Moggridge.

The uncertainty which prevails as to the period required for the reduction of rough stones to the condition of "rolled" pebbles, has led me to make the following observations at a place where the time occupied in that process is susceptible of proof,—at least as regards the maximum.

Limeslade Bay is the second inlet of the sea to the west of the Mumble Point in Glamorganshire. It runs into the land to the depth of 206 yards, 56 of which are covered by shingle. The width at the mouth is 80 yards; and in the broadest part, a little below the bottom of the shingle, 103. Hard firm sand of an average width of 20 yards occurs from low water to the shingle; on each side of which are large and rugged rocks filling up the rest of the inlet. It would not appear therefore that the action of the sea can be peculiarly violent here, more especially when we consider that the general bearing of the little fiord is N. 10° E. and S. 10° W., the prevailing winds being westerly, and the western promontory somewhat overlapping the eastern.

The sea occupies the southern end, and at the northern is the Mumble hill (carboniferous limestone), through which, nearly in continuation of the line of the inlet, runs a lode of dark peroxide of iron, first opened at this end in 1846, the refuse stones being thrown into the little bay already described, somewhat below high-water mark.

Of these stones the smaller are now generally completely rounded; while some, which from their size or configuration remained stationary, have their under sides unaltered, *i. e.* rough as when quarried, and the exposed portions ground down and rounded, presenting in fact the appearance of large "rolled stones" split through the middle. I have measured (July, 1856) two of the latter.

No. 1 is of calcareous spar; the underside flat and rough, 1 ft. 1 in. by 1 ft. 1 in., over the rounded part 2 ft.

No. 2 is limestone; under side 1 ft. 2 in. by 1 ft. 4 in., over 2 ft.

The effects produced by the attrition appear to be irrespective of the toughness or resisting power of the material; calcareous spar, carbonaceous limestone, and the dark peroxide of iron being found occasionally in the same stone, and equally worn down.

The general result to be deduced from the above may be thus stated;—that on a beach not more than usually exposed to the action of the sea, ten years sufficed for the formation of "rolled stones."

On the Skin and Food of Ichthyosauri and Teleosauri. By Charles Moore, *F.G.S.*

In clearing specimens of the former genus dark patches of matter have been frequently seen, in association with which thousands of minute black hooks may be noticed by the aid of the lens. These have been supposed to be portions of the outer skin of the Ichthyosaurus covered by the hook-shaped processes referred to. It was stated by Mr. Moore that out of twenty-three saurians in his museum he had traced these black patches in not less than sixteen; but that as in every instance they were connected with the stomach of the saurian, the conclusion was forced upon him that they were not portions of skin, but were to be accounted for by supposing that the Ichthyosauri had fed upon naked cephalopods, allied to the cuttle-fish. On continuing his investigations on the subject, Mr. Moore proved that there were many cephalopods existing with the Ichthyosaurus that would supply these hooks, and that they were frequently to be found on the fleshy arms of the *Onychoteuthis* and allied genera. Mr. Moore exhibited to the Meeting the body of a small saurian, which at this distant time had its soft skin entire; and appealed to it in confirmation of his opinion, that the black patches containing these hooks were no portion of its outer covering. In conclusion, Mr. Moore produced some of the dark matter taken from the stomach of one of his Ichthyosauri, and stated that he could show to the Meeting, that although it had through so many ages been lying in the stomach of this ancient creature, and had been mixed with other food, it could be no other than what was once the fluid ink of a cuttle-fish; a fact, which was demonstrated to the Meeting, by his showing them that it retained its colouring matter almost as perfectly as if it had been taken from a recent sepia. Of the genus *Teleosaurus* a very beautiful example was shown to the Meeting, which, like the Gaviæ of the present day, was covered with bony scutes or scales. In clearing this specimen, Mr. Moore was fortunate enough to make an incision into its stomach, in which, though so long a period had elapsed since it had taken its last meal, there was still to be seen there, in perfect preservation, a small fish of the genus *Leptolepis*.

On the Middle and Upper Lias of the West of England. By CHARLES MOORE, *F.G.S.*

Sections were given of these beds at Ilminster, their most westerly point, from whence they were traced to Yeovil, where they were shown to become extremely thin, and to be covered up by the sands of the Inferior Oolite, from whence they were traced to Bath and to the neighbourhood of Cheltenham, where they were shown to be of considerable thickness. In noticing the organic remains of the Middle Lias, Mr. Moore called attention to the Brachiopoda in these beds, and exhibited many of the original specimens of this class published by the Palæontographical Society. The attention of the meeting was also directed to a series of microscopic shells of the family Foraminifera, nearly 150 species of which were shown by Mr. Moore to have existed during the deposition of the Middle and Upper Lias. From the latter beds a magnificent series of organic remains was exhibited, chiefly consisting of Saurians, Fishes, Crustacea, and Insects. Mr. Moore amused the Section by informing them what animals were contained in certain stones, which, on being broken, presented the animals indicated.

On the Bone Beds of the Upper Ludlow Rock, and base of the Old Red Sandstone. By Sir R. I. MURCHISON, *F.R.S.*

Sir Roderick Murchison gave an account of certain additional discoveries made in those strata, which, whether they pertain to the uppermost beds of the Silurian rocks, or to the lowest junction strata of the Old Red Sandstone, have been grouped under the term of "Tilestones." In his original description of the upper Ludlow rocks he had described a layer, near their summit, as being characterized by the remains of bones of fishes, principally the defences of *Onchus*, with jaws and teeth, and numerous small coprolitic bodies. He also formerly noticed, in several localities, the occurrence of a still higher bed, which seemed to form a passage into the Old Red Sandstone, and in which remains of terrestrial plants occurred. He had further pointed out, that the Upper Ludlow Rock was the lowest stratum in which the remains of Vertebrata were discovered,—an observation which has remained uncontroverted till the present day,—no remains of true fishes having yet been detected in more ancient strata in any part of Europe. In an ascending order, on the other hand, it was well known that Ichthyolites augmented rapidly; and the object of the present communication is to show how the recent observations of Mr. Richard Banks, of Kington, and of Mr. Lightbody, of Ludlow, have made us acquainted with the presence of fish remains in thin layers a few feet *above* the original bone-bed of the Upper Ludlow Rock.

The lower of these overlying beds, which, according to sections exhibited, occurs both at Kington and Ludlow, was recently inspected by Sir Roderick, accompanied by Professor Ramsay, Mr. Aveline, and Mr. Salter. It is a greyish or yellowish flag-like sandstone, the lowest course of which, at Kington, contains many spines of *Onchus*, with *Lingula cornea*. This thin layer, and another softer one, full of remains of *Pterygotus*, and with two species of *Pteraspis*, are there surmounted by bluish-grey building-stone, with Pterygotus, *Lingula cornea*, &c. These beds are covered by others, less massive, which contain fragments of plants and large *Pterygoti*, and graduate upwards insensibly into more micaceous sandstones, often splitting into tiles. The *Lingula cornea* and *Trochus helicites*, together with species of *Modiolopsis*, and hitherto the small *Beyrichia Klödeni*, all considered characteristic of the uppermost Ludlow rock, prevail throughout these strata, with occasional carbonaceous matter and traces of land vegetation; clearly indicating a graduation towards the younger formation of Old Red Sandstone. The last-mentioned fish-bed is probably of similar age to the stratum which Sir R. I. Murchison described as occupying the summit of the Silurian system in Clun Forest and other places. A stratum of this age has recently been laid open by the cutting of the railroad north-east of the town of Ludlow, and exhibits a grey rock beneath passing up into an overlying micaceous reddish sandstone and red marl: large fragments of *Pterygotus* are here associated with remains of fishes and the *Lingula cornea*.

The succession is more clearly traceable on the right bank of the Teme, opposite Ludlow and below Ludford, where the Ludlow rocks with the old bone-bed are overlaid by micaceous brownish-red sandstones and red marls, with true cornstones, exposed in the bed of the river, which are again followed by other marls and sandstones, surmounted by a band of coarse, greenish-grey micaceous sandstone, containing remains both of fishes and of *Pterygotus*. The fish remains consist of distinct jaws and teeth and fin defences of *Onchus*, the heads of a *Cephalaspis*, together with the *Lingula cornea*.

The genus *Pterygotus* having now been found throughout the Upper Silurian rocks, can no longer be considered characteristic of the transition beds between the Silurian and Devonian; and as the genera *Cephalaspis* and *Pteraspis* are now known to extend their downward range to the very verge of the true upper Ludlow strata, our views concerning the zoological characters, which separate the two formations, may be settled accordingly. As regards the frontier of the Silurian rocks in England, the phænomena present no ambiguity; for all the strata, from the *lowest* bone-bed of the true Ludlow rock, which contains so many species of shells of Silurian age, to the *uppermost* of the above-mentioned fish-beds with the *Lingula cornea*, do not exceed 40 or 50 feet in thickness,—the upper part of the series with the *Cephalaspis* and *Pteraspis*, constituting a true mineral and zoological passage into the Old Red Sandstone. In conclusion, the author observed, that if applied either to the top of the Upper Ludlow Rock or to the base of the Old Red Sandstone exclusively, the word "*tilestones*" might mislead; but if generally to the beds of transition between the two deposits, it is still a convenient term.

Description of an ancient Miner's Axe recently discovered in the Forest of Dean. In a letter to Richard Beamish, *F.R.S.* *By* Robert Mushet.

The accompanying relic was found as follows. Some miners were engaged at an iron-mine, near Lambsquay, in turning over some of the refuse iron-ore, which had been put aside centuries ago as not rich enough in iron to be suited for the Bloomary Forges then in use. At a depth of upwards of sixteen feet, and under a very old and decayed lime tree, which had grown over the spot, the axe was discovered amongst the refuse iron-ore. The handle was broken to pieces and lost, before the axe itself was noticed, a circumstance much to be regretted. The spot where the axe was discovered, was free from moisture, except that incidental to rainy weather, and therefore the axe itself must have been wet and dry just as the weather varied. On trying the point of the axe with a file, it proved to be iron, and not steel, so that its date must have been earlier than that of the use of steel for mining purposes.

The iron-ore surrounding the axe, was a mixture of hydrated peroxide of iron and carbonate of lime, mixed with common loam, and the axe itself is covered with concretionary carbonate of lime and hydrated peroxide of iron. But the extraordinary circumstance connected with this discovery is the fact, that the wooden handle originally inserted into the eye of the axe, has become converted into pure hydrated peroxide of iron, precisely similar to the ordinary brush iron-ore peculiar to the Forest of Dean, except that in the centre of the handle, on the underside of the eye, a portion of soft woody fibre remains, and on the upper side there appear the two small iron wedges by which the helve was tightened to the axe. Thus a piece of wood (probably ash) has been replaced by hydrous oxide of iron, composed of

Peroxide of iron	81·63
Water	18·37

Or more probably it is the subhydrate, containing only 10·5 per cent. of water, and which is the proportion contained in the forest brush-ore. Two reedy specimens, taken from the solid vein of iron-ore, near the spot where the axe was found, accompany the latter, and in their appearance they present some analogy to the converted portion of the axe-handle.

I believe that this relic of antiquity is well worthy of the notice of the British Association about to meet in Cheltenham, and I have therefore enclosed it, and the reedy specimens, in a box, to be forwarded to you.

On the Dichodon cuspidatus, *from the Upper Eocene of the Isle of Wight and Hordwell, Hants. By* Professor Owen, *F.R.S.*

Prof. Owen communicated the results of examinations of additional specimens of jaws and teeth of the *Dichodon cuspidatus*, which he had received since his original Memoirs on that extinct animal in the 'Quarterly Journal of the Geological Society,' vol. iv. (June 1847). The first specimen described supplied the characters of the last true molar tooth of the lower jaw, which had not been previously known. This tooth has six lobes, the additional posterior pair being less than the normal ones, and more simple. The inner surface of the inner lobe has an accessory cusp at the back part of its base, but not at the fore-part as in the other lobes. The length of the last lower molar was nine lines, that of the first and second molars being each six lines. A specimen of the *Dichodon cuspidatus* from the Hordwell Sands, in the British Museum, supplied the characters of the permanent incisors, canine, and three anterior premolars of the upper jaw: all these teeth closely correspond in form with the corresponding deciduous teeth, but are of larger size. Finally, a portion of the lower jaw of an aged specimen of Dichodon, in the British Museum, showing the effects of attrition on the last molar tooth, was described, and the results of this additional evidence confirmed the conclusions of the author as to the generic distinction of the *Dichodon.*

Additional Evidence of the Fossil Musk-Ox (Bubalus moschatus) *from the Wiltshire Drift. By* Professor Owen, *F.R.S.*

This evidence consisted of mutilated crania, but with the horn-cores complete, of both male and female Musk-Ox.

Drawings of the specimens of the natural size of the fossils were exhibited, and the characters were pointed out which, in the author's opinion, confirmed his opinion of the fossil being of the same species as the recent Musk-Ox of Arctic America (*Bubalus moschatus*).

The fossils were associated with remains of the *Elephas primigenius, Rhinoceros tichorinus,* and teeth of bovine, cervine, and equine quadrupeds. They were discovered by Charles Moore Esq., F.G.S., of Bath.

On a New Species of Anoplotherioid Mammal (Dichobune Ovinum, *Ow.*) *from the Upper Eocene of Hordwell, Hants, with Remarks on the Genera* Dichobune, Xiphodon, *and* Microtherium. *By* Professor Owen, *F.R.S.*

The author exhibited drawings of an entire lower jaw with the dentition nearly complete of a fossil herbivorous quadruped, of the size of the *Xiphodon gracilis* of

Cuvier, from the Upper Eocene marl at Binstead, Isle of Wight, Hampshire; and pointed out the characters by which it differed from the known nearest allied fossils. The total length of the lower jaw was 5 inches 11 lines; the extent of the molar series of teeth 2 inches 11 lines, and that of the three true molars 1 inch 3¼ lines.

The near equality in height of the crowns of all the teeth, and their general character, show that the animal belonged to that group of the Anoplotherioid family which includes the genera *Dichobune* and *Xiphodon*.

It has the same dental formula as the Anoplotherioid and Anthracotherioid quadrupeds, viz.

$$i\,\frac{3-3}{3-3},\quad c\,\frac{1-1}{1-1},\quad p\,\frac{4-4}{4-4},\quad m\,\frac{3-3}{3-3}=44.$$

It differs from the genus *Dichodon* in the absence of the accessory cusps on the inner side of the base of the true molars, and both from *Dichodon cuspidatus* and *Xiphodon gracilis*, in the minor antero-posterior extent of the premolar teeth: it corresponds with the *Dichobune leporinum*, Cuv., in the proportions of the premolars and in the separation of the canine and anterior premolar; and to this genus, therefore, the new fossil was referred. Its size and proportions indicate its specific distinction from previously defined species of *Dichobune*. The name proposed for this species is *Dichobune ovinum*. The specimen forms part of the series of fossils in the British Museum.

On a Fossil Mammal (Stereognathus Ooliticus) *from the Stonesfield Slate. By* Professor Owen, *F.R.S.*

Prof. Owen exhibited, by favour of the Rev. J. P. B. Dennis, M.A., a portion of a lower jaw, with three molar teeth, of a small mammal, from the oolitic slate of Stonesfield, Oxfordshire, for which the name of *Stereognathus Ooliticus* had been proposed; and after a minute description of the characters of the bone and teeth, he entered upon the question of its probable affinities. These could only be judged of by the peculiarities of certain molar teeth of the lower jaw of the unique fossil. Those teeth presented the singular complexity of six cusps or cones upon the grinding surface, in three longitudinal pairs, the crown of the tooth being quadrate, broadest transversely, but very short or low. The jaw-bone presents a corresponding shallowness and thickness. The cusps are sub-compressed: the outermost and innermost of the three hinder ones are oblique, and converge towards the middle of the crown, being overlapped by the outermost and innermost of the three front cones. The three molar teeth occupy the extent of 4½ lines, or 1 centimetre; each tooth being 3 millimetres in fore and aft extent, and nearly four millimetres in transverse extent. After a comparison of these molars with the multicuspid teeth of the Rat, the Hedgehog, the Shrews and Galeopitheci, the author showed that the proportions, numbers, and arrangement of the cusps in those Insectivora forbad a reference of the Stereognathus, on dental grounds, to that order. The same negative result followed a comparison of the fossil oolitic mammal with the sex-cuspid teeth with the eocene *Hyracothere*, *Microthere* and *Hyopotamus*; but in these the resemblance was presented only by the teeth of the upper jaw. The lower molar teeth of the *Chœropotamus*, to which the author deemed those of the *Hyracotherium* would most closely approximate, when discovered, showed a rudiment of the intermediate cones between the normal pairs of cones. The proportional size and regularity of the form of the cones of the grinding teeth of the *Stereognathus* give a quite different character of the crown from that of the multicuspid molars of the Insectivora, and cause the sex-cuspid crown of the oolitic mammal to resemble the pente-cuspid and quadri-cuspid molars of the before-cited extinct Artiodactyle genera. Prof. Owen concluded, therefore, that the *Stereognathus* was most probably a diminutive form of non-ruminant Artiodactyle, of omnivorous habits.

On the Scelidotherium leptocephalum, *a Megatherioid Quadruped from La Plata. By* Professor Owen, *F.R.S.*

The extinct species of large terrestrial sloth indicated by the above name, was first made known by portions of its fossil skeleton having been discovered by Charles

Darwin, Esq., F.R.S., at Punta Alta, Northern Patagonia. These portions were described by the author in the appendix to the 'Natural History of the Voyage of H.M.S. Beagle.' The subsequent acquisition by the British Museum of the collection of Fossil Mammalia brought from Buenos Ayres by M. Bravard, has given further evidence of the generic distinction of *Scelidotherium*, and has supplied important characters of the osseous system, and especially of the skull, which the fragments from the hard consolidated gravel of Punta Alta did not afford. The best portion of the cranium from that locality wanted the facial part anterior to the orbit, and the greater part of the upper walls; sufficient, however, remained to indicate the peculiar character of its slender proportions, and hence Professor Owen has been led to select the name *leptocephalum* for the species, which is undoubtedly new. The aptness of the epithet 'slender headed,' is proved by the author's researches to be greater than could have been surmised from the original fossil; for the entire skull, now in the British Museum, exhibits a remarkable prolongation of the upper and lower jaws, and a slenderness of the parts produced anterior to the dental series, unique in the leaf-eating section of the order *Bruta*, and offering a very interesting approximation to the peculiar proportions of the skull in the Ant-eaters. The original fossils from Patagonia indicated that they belonged to an individual of immature age: the difference of size between them and the corresponding parts in the British Museum, depends on the latter having belonged to full-grown individuals: the slight difference in the shape of the anterior molars seems in like manner to be due to such an amount of change as might take place in the progress of growth of a tooth with a constantly renewable pulp. Professor Owen finds at least no good grounds for inferring a specific distinction between the fossils of the old animal from Buenos Ayres, and the younger specimen from Patagonia. The author then proceeds to give a detailed anatomical account of the fossil bones in the British Museum, instituting a comparison between them and the bones of other large extinct animals, especially those of the Edentate order. The Scelidothere was a quadruped of from eight to ten feet in length, but not more than four feet high, and nearly as broad at the haunches, the thigh-bones being extraordinarily broad in proportion to their length. The trunk gradually tapered forwards to the long and slender head. The fore-limbs had complete clavicles, and the rotatory movements of the fore-arm. All the limbs were provided with long and strong claws. The animal had a long and muscular tongue, and it is probable that its food might have been of a more mixed nature than that of the Megatherium. But it was more essentially related to the Sloths than to the Ant-eaters. In conclusion, the author remarks, that as our knowledge of the great Megatherioid animals increases, the definition of their distinctive characters demands more extended comparison of particulars. Hence in each successive attempt at a restoration of these truly remarkable extinct South American quadrupeds, there results a discription of details which might seem prolix and uncalled for, but which are necessary for the proper development of the task of reproducing a specimen of an extinct species.

These details of the osteology and dentition of the *Scelidotherium leptocephalum*, it is the intention of the author to communicate, with the requisite illustrations, to the Royal Society of London.

On the Beekites found in the Red Conglomerates of Torbay. *By* W. Pengelly, *F.G.S.*

Perhaps the most interesting things found in the red Triassic conglomerates of Torbay are the Beekites, so named from the late Dr. Beeke, Dean of Bristol, by whom, it is believed, they were first noticed. They vary in size from half an inch to a foot, but the more common dimensions are from three to six inches in mean diameter. Their surfaces are covered with chalcedony, generally arranged in tubercles, each of which is not unfrequently surrounded by one or more rings, and occasionally the same ring invests two or more tubercles, or sets of rings.

The interior of the Beekite is calcareous. In most instances the nucleus is undergoing decomposition and is only partially attached to the shell; sometimes it is entirely detached, and rolls about within the cavity when shaken; not unfrequently it is reduced to a dark-brown or iron-grey powder, which effervesces in acids.

The nucleus appears to be always a fossil, and is either a sponge, a coral, a shell, or a group of shells—generally spiral univalves—all of well-known *Devonian* forms. The organic structure is frequently preserved on the inner or concave surface of the enveloping crust, even when the nucleus is reduced to powder. Occasionally organic traces are discernible on the exterior surface of the chalcedony, but such cases are not frequent. Some of the nuclei are slightly siliceous, but in no case more so than ordinary limestones are.

Beekites which have fallen from the cliff, and have been for some time exposed to the action of the waves, are much abraded, while those taken at once from the rock above the reach of the sea have not the least marks of friction; hence it may be inferred that the chalcedony has been deposited on the nuclei since they became immoveable, that is since the conversion of the ancient triassic sea-beach into a conglomerate rock.

Beekites are found in every part of the Torbay conglomerates, which extend along the coast from two and a half to three miles, but they are considerably more abundant at Livermead Head, and at and near Paignton harbour, than elsewhere in the district; but though rocks of the same age and character prevail throughout a great part of the south-east of Devonshire, no Beekites have been found beyond the district named; indeed, so far as is at present known, they appear to be *peculiar* to Torbay.

On whatever surface chalcedony is deposited, it appears in most cases to take a tubercular arrangement; hence the tubercles on the surface of the Beekite. From a careful examination of all the facts of the case, it seems probable that after the formation of the triassic conglomerate some of the calcareous pebbles in it underwent decomposition; that water holding chalcedony in solution, and passing through the rock, deposited the chalcedony on the nucleus: the nucleus in some cases continued to decompose, by which it was wholly or partially detached from its envelope, and not unfrequently reduced to dust. Suppose the decomposition to have commenced at various points or centres on the surface of the pebble, the chalcedony deposited at these points would form central tubercles; let the decaying process extend from and around these centres, the chalcedony deposited around each tubercle would form a ring; in like manner a succession of rings might be formed, until they touched, after which a more comprehensive circle might invest two or more of the systems already formed, until the whole surface would be covered.

On the Correlation of the North American and British Palæozoic Strata. By Professor H. D. Rogers, *Boston, U.S.*

On the Origin of Saliferous Deposits. By Professor H. D. Rogers, *Boston, U.S.*

On the Great Pterygotus (*Seraphim*) *of Scotland and other Species. By* J. W. Salter, *F.G.S., of the Geological Survey of Great Britain.*

This paper was in some measure a continuation of one published in the Quarterly Geological Journal for 1855, describing some new and large crustacean forms from the uppermost Silurian rocks of the south of Scotland.

They were described under the name of *Himanthopterus*, and were supposed to differ from the published fragments of the great *Pterygotus* by the lateral position of the large simple eyes.

In the general shape of the body, however, the terminal joints and tail, in the want of appendages to the abdomen, as well as in the form and number of the swimming feet, mandibles, maxillæ and antennæ, there was found to be on further examination the closest resemblance between *Himanthopterus* and the great *Pterygotus*. And the resemblance has been carried still further by the favourable collocation of all the known specimens from the Scotch collections, which have furnished nearly all the portions; and also the head. This is now found to be exactly like that of *Himanthopterus*, and to have *lateral*, not *subcentral* eyes, as represented by other authors.

The two genera are therefore identical, and the group, as now constituted, includes a number both of small and moderate-sized crustacea, along with some which were far larger than any living species, and which certainly attained a length of six or eight feet.

The collections made by the Scottish geologists,—those in Lord Kinnaird's cabinet, and in the Watt Institution, Dundee,—in connexion with other specimens obtained by Mr. Banks of Kington and Messrs. Lightbody and Cocking of Ludlow, show that that *Pterygotus* was an elongate crustacean, with a comparatively small head and sessile compound eyes; and having but few appendages, of which the large chelate antennæ are most remarkable, being a foot long, and only four-jointed,—the terminal joints forming a strong serrated claw. The large mandibles were fully six inches long: the maxillæ were either one or two pairs, with six-jointed palpi; and the great swimming feet consisted of six joints, of which the terminal ones were modified for swimming; the basal joints are great foliaceous expansions with crenulate edges, which possibly assisted, like the first joints of the legs in *Limulus*, in mastication.

The singular piece called "Seraphim" by the workmen, is not, as formerly supposed, a portion of the carapace, but in all probability the hypostome on the under side of the front of the head, the central prong of which is really free, being the labrum itself. The plate would be analogous to a similar piece on the under surface of the head of the Trilobite,—of *Apus, Limulus,* and many other crustacea. No argument seems necessary to show that it was not a portion of the upper surface, as indicated by Mr. Page in his communication to the Section last year, since we possess the carapace entire, and it is like that of all the other nine or ten species.

From the explanation given by Mr. Huxley in the memoir above referred to, there is a general resemblance both in form and structure to the small Stomapod Crustaceans, *Mysis* and *Cuma,* minute forms, which are now arranged very low down among the Decapods, and which are frequently ornamented with a sculpture very similar to that of the fossils. There is even a yet greater resemblance in form to the larvæ of the common crab. If this be accepted, the coincidence in essential structure between such minute and embryonic forms and these gigantic denizens of the old seas becomes most remarkable and interesting, as bearing on the course of development of life throughout geological epochs.

On some New Palæozoic Star-fishes, compared with living Forms. By J. W. Salter, *F.G.S.*

The object of the communication was chiefly to exhibit some new forms of *Asteridæ,* from the Upper Silurian rocks; and others which have all the aspect of *Ophiuridæ,* but are essentially distinguished by the number of ossicles which go to form a single segment of the arms—the lower surface showing a double row of flat plates, and the upper also being composed of two rows of plates, while the *Ophiuridæ* have a single plate above, and one below.

There is, however, the closest similarity to the latter family in the length of the arms and the restriction of the disc (*Protaster*, Forbes)*.

The Star-fish proper belong to three and probably to more genera, all remarkable for their membranous texture.

In the great length of the spines on the margin, *Palæocoma* resembles *Pteraster,* Müll., while in the pentagonal form and simply plated integument of another genus (*Palasterina*), there is a much nearer approach made to *Asteriscus* or *Palmipes* than to any other type of living star-fish. One of the latter had been described from Sweden.

A Lower Silurian form, originally described by Forbes as *Uraster,* has the disc little developed or quite absent, but better specimens show it to have had but two rows of suckers, and the avenues bordered by very large plates. This is also apparently allied to *Asteriscus,* and I find that the name *Palæaster* has been proposed by Prof. Hall for the genus, which is represented by five or six species.

The genera are,—

1. Palæaster (*Hall*), without disc, avenues deep. Upper and Lower Silurian . . 6 sp.
2. Palasterina (*M'Coy*), pentagonal, disc moderate, plated. Upper Silurian . . 2 sp.
3. Palæocoma (*Salter*), disc loosely reticular, avenues very shallow. Upper Silurian. 5 sp.

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4. Protaster (*Forbes*), disc small, arms long, extended, with two plates above and two below. Upper and Lower Silurian . . . . 4 sp.

There appear to be other forms yet undescribed.

* Later observations (1857) have led the author to believe this genus to be a true Ophiurid, but of a new group.

Description of a Working Model to illustrate the formation of "Drift-bedding" (a kind of false stratification). By H. C. Sorby, *F.G.S.*

This model was constructed to explain the manner in which that kind of false stratification, for which the author has proposed the term "drift-bedding," is produced by the sandy material being drifted along on the bottom, till the depth of the water becomes so much greater, that the velocity of the current is not sufficient to wash it any farther. It then accumulates in stratula, inclined to the horizontal plane at angles, the value of which depends upon various circumstances. In the model, the drifting effect of the current was intimated by a kind of coarse screw, which, when turned round, carried forward the sand, supplied from a bag, along a groove, from which it fell into a space with a glass front, where it accumulated at the angle of rest. Being a mixture of heavy black fine grains of specular iron and coarser white quartz sand, it became sorted by moving the screw alternately quickly and slowly, and thus accumulated in black and white bands; whereas, if it was moved with a uniform velocity, no such bands were produced, but the coarse white particles collected at the bottom. These effects, thus produced experimentally by an irregular or uniform forward moving action of the screw, are precisely the same as what the author had previously deduced to have been generated in strata of various geological periods by currents of varying velocity; and the appearance of the structure, thus formed in the model, so closely agrees with what is so commonly met with in sandy rocks, that no one can doubt how it originated. Such models may now be procured of Messrs. Chadburn Brothers, Sheffield.

On the Magnesian Limestone having been formed by the alteration of an ordinary calcareous deposit. By H. C. Sorby, *F.G.S.*

It is well known that crystals of calcareous spar are in some cases found changed into dolomite, and that corals and other calcareous organisms are often altered in a similar manner, and their organic structure obliterated. It is therefore clearly proved that such a change may take place in calcareous rocks. Portions of the carboniferous and Devonian limestones have also frequently experienced this change, and it has so taken place along joints and veins, that no explanation appears probable, but the long-continued action of some soluble magnesian salt.

When thin sections of such rocks are examined with the microscope, some trace of the fragments of organic bodies of which they were composed may be seen in some cases, but in many the original mechanical structure has been entirely obliterated by the change, and there is now only a peculiar crystalline structure, chiefly due to the more or less interfering action of minute rhombohedrons. The same is seen in thin sections of the Permian dolomite; so that a considerable portion, if not the whole, appears, like other limestones, to have been derived from comminuted and decayed calcareous organisms, and to have been subsequently altered into dolomite. If such be the case, the author suggested that probably this alteration was effected by the infiltration of the soluble magnesian salts of the sea-water, under some peculiar conditions not yet clearly explained, during the period when it became so far concentrated that rock-salt was frequently deposited; and that the calcareous salt removed during the change had, by decomposition with the sulphates of the sea-water, given rise to the accumulations of gypsum. In support of this, it is an important fact, that some very solid dolomite does even now still contain about one-fifth per cent. of salts soluble in water, consisting of the chlorides of sodium, magnesium, potassium and calcium, and sulphate of lime, doubtless retained in the minute fluid cavities, seen with the microscope to exist in great numbers. These, like those in most crystals formed from solution, must have been produced at the same time as the dolomite, and caught in some of the solution then present, which is thus indicated to have been of a briny character.

A process the very reverse of that just described is now taking place by the action of dissolved gypsum, by which sulphate of magnesia, frequently efflorescing on the surface of the rock, and carbonate of lime are produced; and this may perhaps, in some cases, explain why the upper beds of the Permian limestone are now more calcareous than the lower.

On the Microscopical Structure of Mica-Schist. *By* H. C. Sorby, *F.G.S.*

The examination of thin transparent sections of mica-schist and the allied rocks shows that there exist two very marked varieties, characterized by the manner in which the flaky crystals of mica are arranged. In one they lie more or less closely in the plane of the alternating layers of different mineral composition, and, when these are bent into complicated contortions, they also continue to coincide with them; whilst in the other variety they lie in one particular plane, and, instead of varying in direction in sharp contortions, they still remain throughout more or less closely in the same general line. This structure then is similar to cleavage in a contorted slate rock; and its direction in like manner coincides with the axis planes of the contortions, and varies from the general direction in the same particulars. One structure is as if chemical and crystalline changes had occurred in a rock that possessed no slaty cleavage, the arrangement of the particles due to stratification having caused the crystals of mica to be formed in its plane, which may or may not have been subsequently contorted. For this the author proposes the term "stratification foliation," to distinguish it from the other that may be called "cleavage foliation," which is as if the rock had been compressed in such a manner as to alter the ultimate structure and develope slaty cleavage, before the large crystals of mica were formed. Then, when the subsequent crystalline changes occurred, the minute flakes of mica, placed more or less closely in the plane of cleavage by the change in the dimensions of the rock, grew up into larger crystals in the same general line of cleavage. The distribution of these two kinds of mica-schist follows general laws similar to that of cleaved and uncleaved slates. For instance, in the coast section south of Aberdeen, most of the rocks possess cleavage foliation, whereas in the Loch Lomond district there is simply stratification foliation.

The author particularly argued that the peculiarities in the rocks having cleavage foliation cannot be explained except by supposing that they have been metamorphosed stratified rocks; for their structure so clearly shows the effects of both stratification and slaty cleavage, and that the cause of the separation into layers of different mineral composition is pre-existing stratification, and is in no way analogous to that which produced the cleavage of slates—that the cleavage foliation is the effect of previously existing cleavage, and not that slaty cleavage is a partially developed foliation.

Attention was also drawn to the vast numbers of minute fluid cavities, containing water, that occur in the quartz layers in mica-schist; being analogous to those found almost invariably in crystals formed from solution, and not in those produced by simple fusion. These indicate that the metamorphic changes have been due to an aqueous process, or else minute globules of water could not thus have been caught in the solid crystals during their formation. Probably an elevated temperature was also concerned in the change, but not heat alone and a simple partial fusion.

In mica-schist there is often a peculiar structure, which in many cases might easily be confounded with slaty cleavage. This is when the rock has been so bent into sharp crumples or small contortions, that planes of weakness or actual joint fractures have been produced. These may be so close as to appear just like slaty cleavage to the naked eye, but are seen with the microscope to be quite distinct; being finite divisions, and not an ultimate structure as it is. Both occur occasionally in the same clay-slate, and then give rise to what has been described as double-cleaved slate.

On some Phænomena in the Malvern District.
By the Rev. W. S. Symonds, *M.A., F.G.S.*

On the Rocks of Dean Forest. *By the* Rev. W. S. Symonds, *M.A., F.G.S.*

Researches in Kent's Cavern, Torquay, with the original MS. Memoir of its first opening, by the late Rev. J. Mac Enery *(long supposed to have been lost), and the Report of the Sub-Committee of the Torquay Natural History Society.* *By* E. Vivian, *M.A.*

A communication was made to this Section by Mr. Vivian, in continuation of that which had been given before the Ethnological Section, and extracts were read from the Rev. J. MacEnery's original memoir, which gives a most graphic account of the first discovery of fossil remains in the cavern, and which is thus referred to by Professor Owen in his 'Fossil Mammalia:'—Perhaps the richest depository of bears hitherto found in England is that called Kent's Hole near Torquay. It is to the assiduous researches of the Rev. Mr. MacEnery, that the discovery of the various and interesting fossils of this cave are principally due, and some of the rarest and most valuable of this gentleman's collection have been recently acquired by the British Museum. M. de Blainville frequently cites 'A description of the cavern of Kent's Hole, Devonshire,' which he supposes to have been published by Mr. MacEnery, but which he regrets that he had not been able to procure. I have been assured by Dr. Buckland that Mr. MacEnery never published such a work, and it is most probable that the drawing or lithographic impressions, shown by Mr. MacEnery to Professor Blainville, were those designed to illustrate the forthcoming second volume of the 'Reliquiæ Diluvianæ.'" Mr. Vivian had recovered the original rough notes of this memoir, which had been disposed of at the sale of Mr. MacEnery's collection, and proposes shortly to edit it with annotations in a connected form.

The following extract is a specimen of the geological portion of the work:—

The Bear's Den.—" A curtain of stalactite, with depending clusters of spar at certain intervals, and corresponding eminences on the floor, was the picture this chamber presented when we first saw it. It was floored through its entire extent with a continuous sheet of stalagmite, siliceo-calcareous and crystalline, so difficult to penetrate, that after repeated attempts we abandoned it in despair; at length, availing ourselves of cracks that traversed it, like the divisions in a pavement, we succeeded in ripping it up. All we had hitherto observed vanished in interest before this disclosure. The first flag that was turned over, exhibited in relief groups of skulls and bones adhering to the stalagmite. Each successive flag repeated the same spectacle. It is to be regretted that their size prevented us from transferring them at once, as they were found, to our museums; for while they lay in the chamber awaiting their removal, some persons, who had heard of the discovery, broke into the cavern, and either tore away or disfigured the masses. Sufficient, however, have been preserved to give an idea of the accumulation and character of the remains in this quarter.

"The remains of Bear prevail here to the exclusion of all others, of all ages, and of all periods down to their encasement in the mud; some of the teeth have the most dazzling enamel, and the bones retain their natural freshness, as if derived from animals in high health destroyed for the sake of their skeletons; others, on the contrary, are of a darkish brown, with the texture of the bone decayed from long exposure, and only kept together by the calcareous and ferruginous matter with which they are saturated; even the enamel is of a greenish tinge. Owing to the induration of their earthy enclosure or their encrustation by stalagmite, few were extracted entire. Two skulls were buried in the stalagmite as in a mould, and were brought away in that state. The spar has formed into a variety of specular crystals in their chambers. The skulls were severed in two; the front separated from the occiput and found apart, the other parts of the skeletons lay about in all directions without any order; generally we were able to trace the natural relation of the parts in some instances; but in no case were they or the skulls broken or gnawed like those in other parts. The long bones were found generally entire, and when found broken, it was only mechanically, from pressure. In no instance have they exhibited indications of being broken or gnawed by the jaws of carnivorous animals for the sake of their flesh or marrow. In fine, they were precisely in the state of bones that belonged to animals that died by a natural death on the spot during a succession of ages, whose remains had long laid about on the surface, subject to be trampled upon by the feet of their own species that made this branch their haunt. In this respect this section of the cavern resembles the caves of Germany, in the predominance of the Bear, in the identity of the species, and in the unbroken condition of the remains. It is worthy of remark, that the remains of the *Ursus cultridens* do not appear here any more than among the Bears in the German caves, though they do, as we shall see, in the other chambers with bones of Elephants. To enhance the wonder of this anomalous scene, there appeared, and there still exist attached to the under surface of one of the pyramidal mounds in this chamber, lumps of *Album Græcum*;

but of other traces of the presence of the Hyæna there is not a shadow, nor indeed of any other animal, except in its outskirts, as shown by the fractured jaws of *Ursus spelæus* and *cultridens*. In the German caves we know that the remains of the Hyæna generally accompany those of the Bear, and under such circumstances as to warrant the inference that certain species, at least, if not all, lived in good intelligence together. In the centre of this chamber there was a double floor of stalagmite, between which was interposed a stratum of rubble sparry pipes, a black flint knife and spots of charcoal, with shells of mussel and oyster, but no red marl or its usual contents. The rest of the floor was regularly stratified in red and white laminæ, exhibiting no vestiges of adventitious matter or of interruption. The position of the rubbly stratum occurring half-way down the section of the stalagmite, inclines me to refer it to the same cause and epoch as the seam containing the Bears' remains at the entrance of the Arcade of which we have already spoken."

On the Evidence of a Reef of Lower Lias Rock, extending from Robin Hood's Bay to the neighbourhood of Flamborough Head. By Capt. WOODALL.

Capt. Woodall called attention to the fact that this reef joined the land at the point where the lower lias is thrown up in contact with the inferior oolite of that part of Yorkshire. He produced a specimen, which he had obtained twenty miles to the south-east of Robin Hood's Bay, from a depth of 20 fathoms, and attempted to prove, from the softness of the specimen, that the reef was liassic throughout. The very straight inner margin of the reef, which extends twenty miles and upwards in one straight line, was another reason for such argument; and, by comparing the fossils contained in the specimen exhibited with some from the boulders of the Holderness coast, he thought that there was a probability that those fossils had originally been derived from this submerged area.

On the Occurrence of Upper Lias Ammonites in the (so-called) Basement Beds of the Inferior Oolite. By THOMAS WRIGHT, *M.D., F.R.S.E.*

The brown sands which lie at the base of the Inferior Oolite are capped in some localities, as at Beacon Hill, Frocester Hill, and Wotton-under-Edge in Gloucestershire, and in several places in Somersetshire and Dorsetshire, by a remarkable bed containing a great number of Ammonites, Belemnites and Nautili, and which the author designates "the Cephalopoda bed;" by far the greater number of the ammonites contained in these deposits, have not been figured in the 'Mineral Conchology of Great Britain,' and are for the most part new as English fossils. Many of the same species of Ammonites as those exhibited are found in France and Germany, in strata which are regarded by the palæontologists of those countries as the uppermost zone of the Upper Lias, and are only found in that particular horizon; whereas the equivalent strata in England have been described as the basement beds of the Inferior Oolite.

In the localities already enumerated the brown sands are overlaid by a bed of coarse brown marly limestone, full of small, dark, ferruginous grains of the hydrate of iron, which impart an iron-shot aspect to the rock: fossils are very abundant in this bed, which attains only a few feet in thickness; the true position of the Cephalopoda bed is shown in the sections of Frocester Hill and Wotton-under-Edge, now exhibited. Beneath this fossiliferous band or Ammonite bed are the so-called sands of the Inferior Oolite, consisting of fine brown and yellow calcareous sands, often micaceous, and attaining a thickness of from 2 to 150 feet. The sands contain in their upper part inconstant layers of siliceo-calcareous sandstone, and sometimes in their lower part inconstant concretionary masses of coarse sandstone, the lowest beds becoming blue and marly, and passing insensibly into the clays of the Upper Lias. The sands themselves are not fossiliferous, but sometimes nodules lying near their base are found to contain organic remains.

When unquestionable sections such as those at Beacon Hill, Frocester Hill, and Wotton-under-Edge exist, it becomes a matter of great interest to study the boundary between two such formations as the Lias and Inferior Oolite, as the general principles developed in the investigation of this question apply equally to other frontier stratigraphical lines. The lithological characters, and other physical evidence, assist the investigation, but do not enable the geologist to assign exact limits to such contiguous formations. It is here that the value of palæontological evidence becomes so important; for without its aid it would be impossible to say where one rock group terminates and another begins: this testimony of the rocks proves, that it is by the zones of life alone that the line of separation between the Lias and the Inferior Oolite can be drawn, and that if we accept this view of the subject, we are bound to admit that a considerable deposit, which has hitherto been grouped with the Inferior Oolite, must be transferred to the Upper Lias, of which it forms its highest stage.

The following list contains all the species which have been collected from the sands and Cephalopoda-bed of Beacon Hill, Nailsworth, Frocester Hill, and Wotton-under-Edge:—

Reptilia.

Ichthyosaurus, sp., vertebræ of. F.

Pisces.

Hybodus, portion of a dorsal ray. F.

Cephalopoda.

Ammonites opalinus, *Reinecke*. B. F.
bifrons, *Brug*. F.
insignis, *Schübl*. F. W.
hircinus, *Schloth*. F.
Jurensis, *Zieten*. F. N.
striatulus, *Sow*. F.
Thouarsensis, *d'Orbig*. F.
radians, *d'Orbig*. F. B.
„ Dewalquianus. F.
Mooreii, *Lycett*, n. sp. F.
discoides, *Zieten*. F.
Ammonites Raquinianus, *d'Orbig*. F. N. W.
Levesquei, *d'Orbig*. F.
concavus, *Sow*.
Leckenbyi, *Lyc*., n. sp. F.
variabilis, *d'Orbig*. F. N. W.
Nautilus inornatus, *d'Orbig*. F.
Belemnites compressus, *Voltz*. F. N. W.
tripartitus, *Schloht*. F. N. W.
irregularis, *Schloht*. F. N. W.
Nodotianus, *d'Orbig*. F.

Gasteropoda.

Pleurotomaria nearly allied to Amalthei, *Quenstedt*.
Chemnitzia lineata?, *Sow*. N.
*Turbo capitaneus, *Münst*. F. N.
Trochus allied to duplicatus, *Sow*. N.

Conchifera.

*Lima bellula, *Lyc*. F. N.
*Pholadomya fidicula, *Sow*. F. N. B.
*Gervillia Hartmanni, *Münst*. F. N.
*Trigonia striata, *Sow*. F. N.
*Perna rugosa, *Goldf*. N.
*Hinnites abjectus, *Phil*. F. N.
*Pecten articulatus, *Goldf*. F.
*Gresslya abducta, *Phil*. F. N. B.
* conformis?, *Agass*. F. N.
*Pleuromya tenuistria, *Agass*. F. N.
*Goniomya angulifera, *Sow*. F.
*Astarte excavata, *Sow*. F. N.
*Myoconcha crassa, *Sow*. N.
*Astarte modiolaris, *Lamk*. N.
*Cypricardia cordiformis, *Desh*. F.
Pecten comatus?, *Goldf*. N.
Opis carinata, *Wright*. F.
Cypricardia brevis, *Wright*. F. N.
Cardium Hullianum, *Wright*. F. N.
Opellii, *Wright*. N.
Cucullæa allied to inæquivalvis, *Goldf*. N.
Lima electra, *d'Orbig*. F. N.
Unicardium, nov. sp. N.
Tancredia, nov. sp.
Trigonia Ramsayii, *Wright*. F.
Pecten textorius?, *Goldf*. F.
Pholadomya allied to media, *Agass*. F.
Astarte complanata?, *Römer*. N.
lurida, *Sow*. N.
Lima ornata, *Lyc*., n. sp. N.
Gervillia fornicata, *Lyc*., n. sp. N.
Arca allied to olivæformis, *Lyc*. N.
Nucula ovalis?, *Ziet*. N.
Pholadomya ovulum, *Agass*.

Brachiopoda.

Terebratula subpunctata, *David*. F. N. B.
Rhynchonella cynocephala, *Rich*. F. B.†

† B. F. N. W. indicate that the species is found at Beacon, Frocester, Nailsworth, and Wotton-under-Edge.

All the Cephalopoda of the above list are found only in the uppermost zone of the Upper Lias of France and Germany, with the exception of *Amm. bifrons*, which occupies always a lower zone, and at Frocester is contained in the nodules towards the base of the sands; one gasteropod and seventeen species of Conchifera, found in the Ammonite bed, extend upwards into the Inferior Oolite; the species marked with an asterisk (*) form the series which are common to the Cephalopoda bed, and to the limestones of the Inferior Oolite. All the others are either Upper Lias forms or are special to this bed.

One of the Brachiopods, *Rhynchonella cynocephala*, is found only in the Cephalopoda bed, whilst *Terebratula subpunctata* descends into the marlstone.

The author contended that all classes of the Mollusca are not of the same value to the palæontologist in stratigraphical geology, as some have a much wider range than others; for example, certain species of *Conchifera* extend through the Lower and Middle Lias, others pass from the Inferior Oolite into the Cornbrash, and even into the Coral rag, whilst the different zones of the Lias, and the several stages of the oolitic rocks, are all characterized by distinct species of Ammonites, which are limited to these different horizons of life; for this reason *Cephalopoda* are regarded as better indicators of geological time than *Conchifera*; as none of the twenty-one species of Ammonites, Belemnites and Nautili passed from the Cephalopoda bed into the Inferior Oolite, and were all identical with Upper Lias forms, it was inferred that the Cephalopoda bed represented the Jurensis-marl of German authors, or the uppermost zone of the Upper Lias.

The author further showed that the Inferior Oolite contains fourteen species of *Ammonites*, two *Nautili*, one *Belemnite*, ten species of *Gasteropoda*, forty species of *Conchifera*, ten species of *Brachiopoda*, eight species of *Annelida*, twenty-two species of *Echinodermata*, and fourteen species of *Anthozoa*, not one of which was found in the Cephalopoda bed on which the Inferior Oolite immediately rests.

The Dorsetshire sections confirm the same conclusions, but the lists of fossils from these rocks are not so complete as those furnished by the Gloucestershire sections; the author had not collected many of his Dorsetshire fossils himself, and was unable to decide on the stratigraphical position of many of his specimens. *Ammonites Dorsetensis*, Wright, has not yet been found in the Cotteswold hills, although it is most abundant in several localities in Dorsetshire.

The Cephalopoda bed is regarded as the English equivalent of the "*Grès supraliassique ou marly sandstone*" of M. Terquem, as developed in the department of the Moselle.

"*Schiste et Marne de Grand Cour*" of MM. Chapuis and Dewalque, as it occurs in the Province of Luxembourg.

"*Graue Kalkstein-Bank mit Ammonites Jurensis*" of Quenstedt, forming the bed ζ, the uppermost of his *Schwarzer Jura* (Lias).

The *Jurensis-marl* of Dr. Fraas, in his table of the Jura formation of Suabia.

The positive palæontological evidence leads the author to group his Cephalopoda bed with the uppermost zone of the Lias, specifically characterized by *Ammonites Jurensis* and *variabilis*, and *Rhynchonella cynocephala*, and the other *forty-four species* special to this bed; and negatively separated from the Inferior Oolite which rests upon it, by the *one hundred and twenty species* which appear for the first time in that stage.

Besides the *forty-seven* species which have hitherto been found only in the Cephalopoda bed, there are *eighteen species* which are common to this bed and the Inferior Oolite; but these are chiefly *Conchifera*, which have a wide vertical range, whilst the *Cephalopoda*, which are special to it, have a very limited distribution in time; both positive and negative evidence therefore support the conclusion that the Cephalopoda bed and sands belong to the uppermost part of the Upper Lias, and not to the Inferior Oolite with which they have hitherto been classed.

BOTANY AND ZOOLOGY, INCLUDING PHYSIOLOGY.

BOTANY.

On a supposed Fossil Fucus found at Aust Cliff, Gloucestershire. By C. C. BABINGTON, *M.A., F.R.S.*

ABOVE the well-known bed containing fossils occupying the higher part of Aust Cliff, there is a bed of laminated rock nearly, or quite, devoid of fossil remains. Lately a fall of the cliff brought down a part of this upper stratum, when Mr. Brodie, the author of a well-known work on fossil insects, found between some of the thin plates of stone a substance closely resembling a Fucus. There being no apparent mode of accounting for its presence in that position, and no reason except its very modern appearance for doubting its fossil character, Mr. Brodie and other geologists and naturalists inclined to think it of ancient origin, and for that reason presented it to the notice of the Section. Several naturalists examined the specimen, and thought it possible that it might be a recent product, a Rhizomorpha, which had intruded itself between the plates of stone. A careful microscopic examination alone can determine if it is of fungoid or algal structure, of recent or fossil date.

Notes on Experiments in the Botanical Garden of the Royal Agricultural College. By Professor BUCKMAN, *F.G.S., of the Agricultural College, Cirencester.*

In this paper the author first described the soil and situation of the *locale* occupied as his garden, which, from being situate on Forest Marble Clay, is of a somewhat sterile character. The experimental portion is divided into 200 plots, most of which are 2½ yards square, some double that size, and a few still larger, now engaged for experiments with various manures. The plots are employed at the present time with crops mostly experimental, in the following classes:—grasses, 82; papilionaceous feeding-plants, 25; crops for green food, 12; wheat, 6; garden vegetables, 5; turnips, experiments with manures, 14; economic plants, 13; flowering and ornamental plants, 40: total, 197. For the grasses many observations were given tending to show that several so-called species prove in cultivation to be varieties,—instances of which were given in the following genera:—*Bromus, Festuca,* and *Agrostis.* One case in particular of the three following forms of *Festuca, F. loliacea, F. pratensis,* and *F. elatior,* were shown to have been produced from the same seed by the gradual change of the first two into the latter. In the Papilionaceæ the author pointed out the production of the spring and winter varieties of Vetch from the *V. angustifolia.* In the genus *Trifolium* he made the following remarks on *T. pratense* and *T. medium.* The *T. pratense* occurs wild in all good and rich meadows and pastures; its place, however, in poor sandy soils is supplied by the *T. medium,* on which account the latter plant was some few years since introduced into agriculture to ensure a crop when the former usually failed. The seedsmen used to supply it under its botanical name of *T. medium*; but it is a curious circumstance that all the samples of this seed now in the market show it to be but a variety of *T. pratense,* and hence, at present, the best informed seedsmen no longer send it out under the original botanical designation of *T. medium,* but under that of *T. pratense perenne,*—the fact being well established that we have two varieties of broad clover in cultivation, whilst the true *T. medium* has been entirely lost to agriculture; and the whole evidence with respect to this subject showed that it has not been lost from neglect, but that it has merged into *T. pratense*; and if so, it remains as a most interesting matter for experiment, especially when it is considered that no doubt has been entertained by botanists of their distinction as species. Many experiments of a like kind were described, and their practical utility clearly pointed out.

On New Forms of Diatomaceæ from the Firth of Clyde. By Professor GREGORY, *Edinburgh.*

The author, after referring to two papers by himself on the Diatoms of the Glenshira Sand, the marine forms in which must have come from the Firth of Clyde, proceeded to describe the material now under investigation. It is remarkable that of all the many undescribed marine forms found in the Glenshira Sand, not one has yet been recorded as occurring in the Firth of Clyde. The new material was nothing more than dirt washed from some nests of *Lima hians*, dredged by Prof. Allman off Arsan, in four fathoms water, on the 19th of July. After washing with acids, &c., a residue, rich in Diatoms, was left. In this the author found—1. Many common species, both freshwater and marine; 2. Many known but rare or curious marine forms, such as *Navicula Hennedyi*, Sm.; *Lyra*, Ehr.; *granulata*, Bréb.; *Pleurosigma transversale*, Sm.; *obscurum*, Sm.; *rigidum*, Sm.; *delicatulum*, Sm.; *Stauroneis pulchella β*, Sm.=*Stauroptera aspera*, Ehr.; *Eupodiscus Ralfsii*, Sm.; *crassus*, Sm.; *Coscinodiscus concinnus*, Sm.; *Eupodiscus sculptus*; *Podosira Montaguei*, Sm.; *Campylodiscus Horologium*, Sm.; *Surirella fastuosa*, Sm.—3. Many of the new forms figured by the author in his two papers on the Glenshira Sand, the third part of which will not be published till October. Those here found are *Navicula rhombica*, W. G.; *maxima*, W. G.; *maxima, var. β*, W. G.; *quadrata*, W. G. (*humerosa*, Bréb.); *latissima*, W. G.; *angulosa*, W. G.; *angulosa, var. β*, W. G. *formosa*, W. G.; *Pandura*, Bréb.; *Crabro*, Ehr.; *incurvata*, W. G.; *splendida*, W. G.; *didyma γ*, *costata*, W. G.; *didyma*, W. G.; *clavata*, W. G.; *Amphora Arcus*, W. G.; *Amphiprora vitrea β*, W. G.; *Tryblionella constricta*, W. G.; *Synedra undulata*, W. G. (=*Toxarium undulatum*, Bailey). The above are all correctly figured in the two plates of Glenshira forms already published. The following are figured in the plate to be published in October:—*Cocconeis distans*, W. G.; *costata*, W. G.; *Amphora crassa*, W. G.; *elegans*, W. G.; *Grevilliana*, W. G.; *Amphiprora minor*, W. G.; *Nitzschia insignis*, W. G.; *socialis*, W. G.; *distans*, W. G.; *Eupodiscus sparsus*, W. G.; *Campylodiscus simulans*, W. G.; and another disc not yet named. It thus appears that about thirty of the new marine forms of the Glenshira Sand occur in this material, as might be anticipated from the connexion between Glenshira and Loch Fyne which is an arm of the Firth of Clyde.—4. Many forms which appear to be entirely new. These consist of—*a*. Naviculæ and Pinnulariæ, of which there are several, chiefly small; but there is one very fine large Navicula, of very peculiar aspect, which proves to be *N. prætexta*, Ehr. It has a marginal and two medial striated bands, and the space between these is irregularly powdered with round granules, the same as those of which the striæ are made up. One of the smaller forms exhibits, at one focal distance, a striated marginal band, at another the whole valve is seen to be striated. There are several others, which the author has not had time as yet to study. *b*. Filamentous forms, of which there are several. One is apparently a Denticula, a fine large form, which, as no marine species of the genus are known in Britain, the author names, provisionally, *Denticula marina*. Four appear to be species of Zygoceros, two of which are rather large, and two smaller. One frequent form is that named by Smith, from the front view alone, *Himantidium Williamsoni*. The side view proves it to be not a Himantidium; and it is probably a Diadesmis. A predominant form in the material is a small disc, possibly = *Coscinodiscus minor*, Sm. But it is here seen to be an Orthocira. *c*. Cocconeides. There appear to be three or four species of Cocconeis, which are only mentioned, not having been fully studied. Two of these are allied to *C. distans*, which also occurs as above stated, and is both frequent and fine, and, notwithstanding the opinion of Prof. Smith, is held by the author to be entirely distinct from *C. Scutellum*. *d*. Discs. These are some apparently new discs, one of which is a large Campylodiscus, allied to *C. Ralfsii*, which the author has also found in the Glenshira Sand, but has not yet described. *e*. Amphoræ. Of this genus, of which the Glenshira Sand has yielded so many and such remarkable new species, this material, besides several of the Glenshira forms, including two of the finest, *A. crassa* and *A. Grevilliana*, has yielded a large number of new, and in most cases very remarkable species. One of these is nearly square, one is linear with an expansion in the middle, and one is linear with two such expansions. There are probably about ten new species of Amphora, but it has been impossible in so short a time to determine them properly. Almost all the forms which have been named above, whether known or undescribed, occur finely developed, and there are also very fine specimens of many forms which have not been named. On the whole, the author trusts that this preliminary notice will show how much remains to be done among marine Diatoms, and how desirable it is that marine deposits on mud should be carefully and minutely searched.

On the Development of the Embryo of Flowering Plants. *By* ARTHUR HENFREY, *F.R.S., Professor of Botany in King's College, London.*

All those who have devoted attention to the study of vegetable physiology, are aware that a controversy has been carried on pretty actively of late years, regarding the real mode of origin of the primary cell, from which the embryo becomes developed in the seeds of the higher plants. On one hand, Prof. Schleiden has asserted that the "germ-cell" is produced in the end of the pollen-tube, after this organ has penetrated to the nucleus of the ovule. Until very lately, Schleiden has firmly adhered to this opinion, and it has been most actively defended by Dr. Schacht in various memoirs, receiving additional support also in a few other less important quarters. On the other hand, Prof. Amici, about ten years ago, announced his conviction that Schleiden and the pollinists were mistaken, and, moreover, showed that in certain species of *Orchis* and other plants the germ-cell originates quite independently in the embryo-sac, and is merely *fertilized* by the contents of the pollen-tube. Amici's views have been confirmed, and the illustrations of the doctrine extended, by Von Mohl, Hofmeister, and others, among whom the author of this paper may be counted. M. Tulasne also may be ranked, for his later researches, in the same company, although he differs in his conclusions in a subordinate point, he having been unable to detect the germ-cells in the embryo-sac prior to fertilization, although he finds them originating quite independently of the pollen-tube after this has exerted its influence. This discrepancy is perhaps explicable, by the perishable condition in which the germinal body has now been ascertained to exist, previously to its impregnation by the pollen-tube.

In the course of the last twelve months the aspect of the present question has undergone a most striking change, depending not only on the total surrender of one of the conflicting parties, but on the recognition of a totally new point, throwing very considerable light on the true nature of the analogies existing between the processes of reproduction in vegetables generally. The author is induced to lay the particulars of the recent occurrences before the British Association, not only on account of the importance of certain of the facts, but by the circumstance that his long-continued researches on this subject have been rewarded by his being the first to recognize what he believes to be the essential point in the process of fecundation.

In the first place, to dismiss certain matters which now belong only to the history of this question, it may be stated that Schleiden, the originator of the pollinic hypothesis, has become convinced that it is erroneous. One of his pupils, Dr. Radlkofer of Munich, published in the early part of this year, some researches carried on under the auspices of Prof. Schleiden; and in the relation of his results, he makes the statement, that he is authorized by Schleiden to publish that author's admission that the preparations figured in the memoir demonstrate the existence of the germinal vesicles as independent bodies before the pollen-tube reaches the embryo-sac. So far, therefore, as that point was concerned, Amici's doctrine might be considered substantiated, although it still remained to obtain the acknowledgment of error on the part of Dr. Schacht. That physiologist was in Madeira at the time Dr. Radlkofer's pamphlet appeared, pursuing his physiological researches; and we have just received a report of a communication sent by him to Berlin, containing not only the required admission, but a remarkable confirmation of a new and most important point, which had been brought forward in the mean time by the author of this notice.

From the time when I carefully repeated Amici's observations on *Orchis* years ago, I have been convinced that he was right in regard to the independence and pre-existence of the germinal bodies in the embryo-sac. Every summer I have prosecuted researches on this subject, with a view to overcome the obstinate resistance of the pollinists. During last year, I was led to observe certain minute characteristics of the germinal vesicles, and to apply reagents to them, in order to ascertain more accurately their conditions in various stages. In the article "Ovule" of the 'Micrographic Dictionary,' published last autumn, I stated that I had good reason for believing that the germinal bodies did not possess a cellulose coat until after impregnation. I had not leisure until the completion of that work to bring my

Fig. 1.

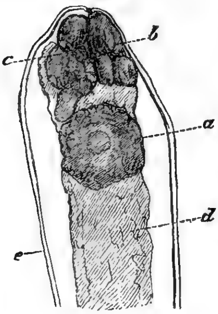


Fig. 2.

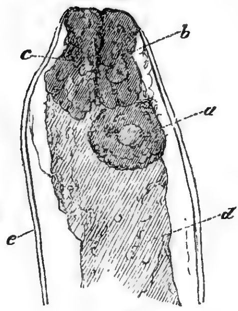


Fig. 3.

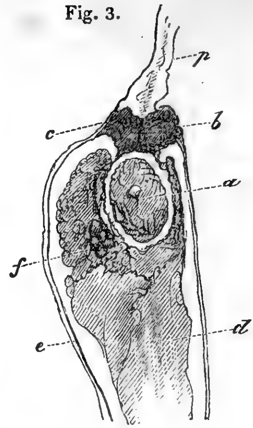


Fig. 4.

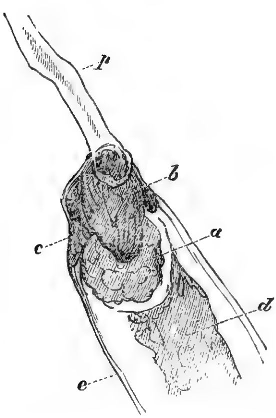
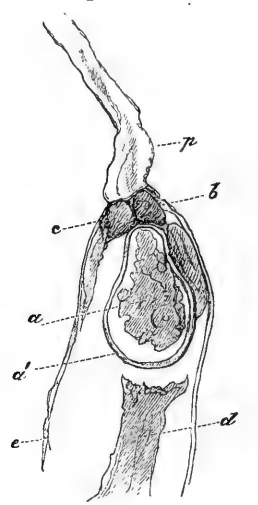


Fig. 5.



Embryogeny of *Santalum album*. (All magnified 400 diameters.)

All the figures represent the upper end of the embryo-sac (after soaking in spirit, by which the protoplasmic contents are coagulated): figs. 1 and 2, just before the pollen-tube comes into contact; figs. 3—5, after it has descended and become adherent to the embryo-sac. The letters have the same significance in all the figures. *a*. The protoplasmic germinal corpuscle which becomes the embryonal cell. *b* and *c*. Two protoplasmic corpuscles, which always occupy the apex of the sac (*coagula*). *d*. Protoplasmic substance in "primordial utricle" of the embryo-sac coagulated and contracted. *e*. Membrane of the embryo-sac. *f*. Starch-granules. *p*. Pollen-tube. *a'*. The cellulose membrane of the fertilized germinal corpuscle, now become a perfect embryonal cell.

notes into a fit state for publication, but in February I forwarded a paper to the Linnean Society of London, which was read on the 4th of March, in which the new discovery was fully illustrated and explained, as observed in the ovules of *Santalum album.* That memoir contained many details respecting the development of the ovule in all its stages; but the point of greatest physiological importance, and of absolute novelty, was the demonstration, that previously to the period when the pollen-tube reaches the embryo-sac, the germinal vesicles, or rather "corpuscles," are not perfect cells in the old and ordinary acceptation of the term in vegetable anatomy, but are merely definitely-bounded, spherical or ellipsoidal masses of granular *protoplasm*; being, in fact, in the same condition as the zoospores of the Confervoid Algæ, before they are discharged from the parent-cell in swarming. The pollen-tube reaches the summit of the embryo-sac, and adheres very firmly to it. It was not decided whether the membranes gave way, so as to allow the contents of the pollen-tube to be discharged into the embryo-sac, but this appeared probable. The result of the application of the pollen-tube to the end of the embryo-sac above the germinal corpuscles, was very quickly evident in the appearance of a solid cellulose membrane as a new coat to that germinal corpuscle which was to give origin to the embryo, converting it into a perfect cell. This cell then became divided into two by a transverse septum, the upper half forming the "suspensor"-cell, while the lower increased in size, and by cell-division became a cellular mass, ultimately taking the proper form of the embryo.

Botanists who are acquainted with the recent discoveries of Thuret, Pringsheim, Cohn and others in the reproduction of the Algæ, will see the interesting connexion which exists between the process above described, and the phænomena of fecundation of the species of the lower plants. I have dwelt upon this in the memoir presented to the Linnean Society, and stated my opinion, since confirmed by further observation, that the germinal corpuscle of the archegonium of the Ferns is likewise destitute of a cellulose coat until it is fertilized by the contact of the spermatozoids.

I send with this notice some drawings illustrating the phænomena presented in the fertilization of the ovule of *Santalum*.

Having arrived at the above views, it was with great pleasure I last week received the report of the May sitting of the Berlin Academy, containing a paper by Dr. Schacht, transmitted from Madeira, with the date of April, on the same subject, and confirming my account in all essential respects. His observations on the ovule of *Gladiolus segetum* have induced him not only to admit the error in his long and warm advocacy of the pollinic hypothesis, but to assert that the germinal corpuscles are, as stated by me, pre-existent as protoplasmic masses destitute of a membrane, and that their conversion into true cells, with a cellulose wall, is the result, and the first evidence of the process of fertilization by the arteries of the pollen-tube. This corroboration of my statements by an independent observer, is very satisfactory, seeing the delicacy of the observations on which they rest; but it may be observed, that the new views form a natural development of those previously entertained by Amici's school, resulting from a more minute attention to the nature of "cell-contents" than was formerly paid. It is probable that part of the error of the pollinists, together with Tulasne's inability to find the germinal corpuscles before impregnation, may have arisen from the great liability to destruction of the corpuscles by external agents, and alteration by endosmose. We have observed them best either by moistening the fresh preparations with solution of sugar instead of pure water, or by soaking the ovules in spirit before dissection.—August 2, 1856.

On the Triticoidal Forms of Ægilops *and on the Specific Identity of* Centaurea nigra *and* C. nigrescens. *By the* Rev. Professor HENSLOW, *M.A., F.R.S.*

In this paper the Professor recorded the result of his own experiments, in which he had so far succeeded in changing the character of *Ægilops squarrosa* as to lead him to conclude that M. Fabre's original statement, that *Æ. ovata* was the origin of the domestic wheat, *Triticum sativum,* was not altogether without foundation. He exhibited specimens in which the form of *Ægilops squarrosa* had undergone considerable change; but he had not succeeded in obtaining the characters of *Triti-*

cum sativum. Prof. Henslow then exhibited *Centaurea nigrescens*, in which it was seen that cultivated specimens of seedling plants had completely passed into the form of *C. nigra*. He then referred to instances of species of *Rosa*, *Primula*, and *Anagallis*, passing one into the other.

On the Movements of Oscillatoriæ. By Professor G. B. KNOWLES, *F.L.S., Queen's College, Birmingham.*

The Oscillatoriæ belong to a group of plants which seem to stand immediately between the animal and vegetable kingdoms. After very careful and repeated examinations, the author has fully satisfied himself that the motions of this family of freshwater Algæ are entirely independent of any electrical influence; of any current in the fluid in which they are placed; or of any effort to recover their straight position. The motions, in fact, have very much the appearance of being spontaneous; an opinion in which Prof. Knowles is pleased to find that Captain Carmichael, who devoted his attention for many years to the investigation of marine and freshwater algæ, fully concurs.

Many of the larger Oscillatoriæ, if carefully watched, may be seen to move in various directions, sometimes to the right, sometimes to the left; sometimes slowly, sometimes briskly. The author, however, never perceived in them anything like an effort to recover the straight position which is considered to be natural to them. On the contrary, they may often be observed to *bend* gradually, so as to form a very considerable curve; to return again to the straight position, and then to *bend* in an opposite direction. They have also a progressive motion; and two filaments lying side by side, may frequently be seen advancing in opposite directions on the field of the microscope. This progressive motion, in all probability, is effected by means of cilia, although they have not hitherto been detected. Of the correctness of these facts any one may readily convince himself, by examining with a little attention fresh specimens of any of the larger Oscillatoriæ.

On the genus Abrothallus, *De Nrs. By* W. LAUDER LINDSAY, *M.D., Perth.*

The genus *Abrothallus* has long been misunderstood and little known by botanists. Its species have generally been regarded either as the abortive, monstrous or accessory apothecia of various common lichens:—as parasitic species of Endocarpon or Lecidea; or as parasitic Fungi. They are athalline: hence the apothecia, which are very minute, almost microscopic, may be said to constitute the plants. They are parasitic on the thallus of various common foliaceous lichens belonging to the genera *Parmelia*, *Cetraria* and *Sticta*; and are especially abundant on furfuraceous states of *Parmelia saxatilis*. Though comparatively unknown to British botanists, Dr. L. has met with them plentifully on old road-side walls, and more sparingly on boulders, rocks, and trees, both in the Highlands and Lowlands of Scotland; and more particularly in the neighbourhood of Perth, Dunkeld, Braemar, Glen Shee, Lochaber, Skye, and Dumfries. The genus is specially interesting, from possessing, in addition to the ordinary reproductive organs,—the spores and spermatia,—of other lichens, accessory, reproductive bodies, *stylospores*, contained in minute microscopic conceptacles, termed by Tulasne *Pycnides*. The presence of stylospores and the absence of a thallus, tend to assimilate this genus closely to the Fungi, between which and the lichens the marks of differentiation are daily becoming less and less distinct.

The first approach to a satisfactory examination and description of the genus was made by De Notaris, who, however, was led into various errors regarding its structure. He described it as possessing a small, delicate thallus; hence the name which he bestowed on the genus. This thallus is now ascertained to belong to, or to be a modified portion or anamorphosis of, the thallus of *Parmelia saxatilis*, or other lichen, on which the *Abrothallus* is parasitic. His errors were corrected by Tulasne, in a monograph on the genus *Abrothallus*, and certain allied parasitic genera, included in his elaborate and valuable memoir on the minute anatomy of the lichens, published in the 'Annales des Sciences Naturelles' for 1852. The results of Dr. Lindsay's examination of a large number of Scotch specimens, have led him, however, to take a somewhat different view of the numbers and characters of the species; and have enabled him to supply certain important omissions, and to correct various minor errors of previous observers. He has been the first, it is believed, to observe and describe the spermogones and spermatia of the genus; and thus to give a complete account of its minute anatomy. The structure of the apothecia appears to entitle this genus to be classed in the natural family of the Lecideacea. Tulasne describes the five following species:—

1. *Abrothallus Smithii.*
2. " *Welwitzschii.*
3. " *microspermus.*
4. " *oxysporus.*
5. " *inquinans.*

Dr. L. includes the three first species of Tulasne under his *A. Smithii*, retaining Tulasne's specific characters as distinctive of varieties, which he denominates respectively *α.* var. *ater*; *β.* var. *pulverulentus*; and *δ.* var. *microspermus*. The fifth species, which Tulasne himself designates a "species recedens," he discards as not properly pertaining to the genus *Abrothallus* at all. The fourth he accepts as a good and well-marked species. The species described by Tulasne and Dr. Lindsay contrasted are therefore as follows:—

1. *A. Smithii*, Tul. 2. *A. Welwitzschii*, Tul. 3. *A. microspermus*, Tul.	=	1. *A. Smithii*, Linds. *α. ater.* *β. pulverulentus.* *γ. microspermus.*
4. *A. oxysporus*, Tul.	=	2. *A. oxysporus*, Linds.
5. *A. inquinans*, Tul. omitted.		

The following are the full characters of the genus and its two species, as emended by Dr. L.

Genus. *Abrothallus*, De Nrs. emend. Athalline: parasitic on the thallus of various foliaceous lichens. *Apothecia* developed in medullary tissue of matrix: burst through, sometimes fissuring in a radiate manner, the cortical layer, which may form a raised border: finally seated on, or partially immersed in, the alien thallus: at first flattened or discoid, sometimes becoming pulviniform or globose: immarginate: circumference agglutinated to matrix or free: smooth or pulverulent: mostly black. *Thecæ* 8-spored: clavate, becoming obovate: amyloid reaction with iodine often inconspicuous or absent. *Paraphyses* closely aggregated: thickened, deeply coloured and cohering at their apices. *Spores* ovate-oblong and obtuse at ends, or ellipsoid and acute: 2-locular, the loculi being unequal in size and the larger one always looking towards the apex of the theca, or simple: of an olive-green or brownish colour, or pale: frequently containing two or more globular nuclei. *Spermogones* immersed, spherical, simple, opening by a point-like or stellate-fissured ostiole: envelope of a deep brown tint. *Sterigmata* simple, slender, irregular, generating from their apices linear, straight, slender *spermatia*. *Pycnides* also immersed, spherical, 1-locular, opening by a simple or stellate ostiole: generally larger and more conspicuous than the spermogones. *Sterigmata* short, simple, sometimes inconspicuous or absent: monospored: generating from their apices the stylospores, which are pyriform or obovate, simple, pale, obtuse at ends, and contain an oily protoplasm or distinct oil-globules.

Species I. *Abrothallus Smithii*, Tul. emend. [including the *A. Smithii*, *A. Welwitzschii*, and *A. microspermus* of Tulasne; and the *A. Bertianus* and *A. Buellianus* of De Notaris and Massalongo.] Apothecia epithalline: scattered, rarely confluent: prominent: pulviniform or globose: normally smooth and black, sometimes green-pulverulent: circumference agglutinated or free: ultimately falling out and leaving distinct, cyphelloid, variously coloured foveolæ, which have sometimes raised and dark margins. *Theca*: amyloid reaction with iodine feeble or none. *Spores* ovate-oblong: 2-locular, upper segment broader and shorter than lower: olive-green or brownish: vary in size: loculi frequently containing one or two globular nuclei.

α. var. *ater*. Apothecia black and smooth.

[*A. Smithii*, Tul. in part.]

β. var. *pulverulentus*. Apothecia sparingly or copiously green-pulverulent. [*A. Smithii*, Tul. in part, and *A. Welwitzschii*, Tul.]

δ. var. *microspermus*. Spores small and pale. [*A. microspermus*, Tul.]

Habitats. I. Parasitic on furfuraceous states of *Parmelia saxatilis*, chiefly on old roadside walls, less frequently on boulders, rocks, and trees. Craigie Hill and Moncrieff Hill, Perth: Craig-y-Barus, Birnam Hill, and Amulrec Road, Dunkeld: Caerlaveroch Road, Dumfries: Ben Lawers: Glen Shee and Glen Clunie: Braemar: Fort-William and Ben Nevis: banks of Crinan Canal: Glen Sligachan, Portree, Broadford and Uig, Skye: Wrekin Hill, Shropshire: var. *a*. [Leighton's Lich. Brit. exsicc. No. 46. Fasc. 2. 7: Barmouth, North Wales, Rev. W. A. Leighton.]

II. On *Sticta fuliginosa*: rocks, New Cut, Meadfoot, Torquay, Devonshire [Leight. Lich. Brit. exsicc. No. 191. Fasc. 6.], var. β.

Species II. *A. oxysporus* Tul. emend. Apothecia not prominent: chiefly immersed: flattened or discoid: blackish-brown: generally crowded. *Thecæ*: amyloid reaction with iodine distinct. *Paraphyses*: tips light brown. *Spores* ellipsoid, acute at ends, colourless or pale yellow, normally containing two yellowish globular nuclei, placed at opposite ends of the spore.

Habitats. I. Parasitic on furfuraceous states of *Parmelia saxatilis*, generally associated with the preceding species in most of the stations already mentioned.

II. On *Parmelia conspersa*, Barmouth, North Wales, Leighton.

III. On *Cetraria glauca*, Barmouth, Leighton.

Mr. M. Masters exhibited a specimen of an abnormal growth in a rosewood-tree. The specimen consisted of two root-like organs which had been found in the hollow of a trunk of the rosewood-tree; the root-like branches having descended from the upper part of the cavity in the trunk, and descended and penetrated into the bottom of it.

On the Flora of the Crimea. By Dr. Michelsen.

On the Geography of Breadstuffs. By Dr. Michelsen.

Notice of the Natural Printing of Sea-Weeds on the Rocks in the vicinity of Stromness, Orkney. By Charles W. Peach.

The author found, on the rocks near Stromness, by the sea-side, distinct impressions of living Algæ, *Desmarestia ligulata, Halidrys siliquosa, Fucus nodosus*, and several others. It appeared that in some cases the stone (micaceous Old Red Sandstone) had been covered by a *Leathsia*?, that this was corroded by the larger seaweeds, so that their forms appeared slightly impressed, and of a yellow colour. In other cases no preparatory growth of *Leathsia* was observed, but the stone was slightly excavated, and darkened in colour. The author showed the bearing of this observation in cases of plant-like forms in the Lower Palæozoic strata of Cornwall, where no trace of carbonaceous matter appeared.

Zoology.

A Notice of some New Genera and Species of British Zoophytes. By Joshua Alder.

The paper contained descriptions of thirteen new species, found by the author on the coasts of Northumberland and Durham. They include two new genera, and another genus not before recorded as European. They are as follows:—*Vorticlava*, a new genus allied to *Clava*, but differing in having the tentacles in two regular circles round the head, and dissimilar. The species *V. humilis* has five tentacles in the upper row, and ten in the lower.—*Eudendrium confectum*, a small species encrusting old univalve shells, and having much the habit of a Hydractinia.—*E. capillare*, a minute slender-branched species, having the polypes and reproductive capsules on different branches.—*Sertularia tricuspidata*, somewhat resembling *S. polyzonias*, but more nearly allied to a New Zealand species (*S. Johnstoni*, Gray). It has three-toothed apertures to the cells.—*Sertularia tenella*, a species supposed by Dr. Johnston to be a variety of *S. rugosa* with the habit of *S. polyzonias*, but it differs from both in some of its characters.—*Campanularia volubilis*, *C. Johnstoni*, and *C. Hincksii*. The Linnean species is re-described for the purpose of distinguishing it from the other two, which have been confounded with it. According to the opinion of the author, the *C. volubilis* of Johnston differs from that of Ellis. The latter is considered to be the Linnean type, and the second species is named *C. Johnstoni*. They differ in the form of their ovicapsules, as well as in other particulars. A third species, with the margin of the cell sculptured in a castellated form, had been previously observed by the Rev. T. Hincks, and is here called *C. Hincksii*.—*C. gracillima*, a species allied to *C. dumosa*.—*Grammaria*, a genus lately described by Mr. Stimpson in 'A Synopsis of the Marine Invertebrata of Grand Manan,' published by the Smithsonian Institution of Washington. The British species, now first noticed, comes very near to the *G. robusta* of Stimpson, but differs in being much branched. It is called *G. ramosa*.—*Buskia*, a new genus of Polyzoa, belonging to the family Vesiculariadæ. It is parasitical, and consists of small cells, closely adhering to other substances, with marginal spines also adhering. They are united by a creeping fibre. The species *B. nitens* is minute, shining, and horn-coloured.—*Farrella pedicellata*. Found on old shells from deep water. It differs from the *Laguncula* (*Farrella*) *elongata* of Van Beneden in the great length and slenderness of the pedicle, and in some other respects.—*Alcyonidium mammillatum*, an encrusting species, found on old shells, distinguished by the size of the papillæ.—*A. albidum*, enveloping the stem of *Plumularia falcata* with prominent whitish polypides.

A skull of a Manatee, obtained by Dr. Baikie in Africa, was exhibited to the Section.

Dr. Ball, of Dublin, exhibited a Dredge which he had found of the greatest use in making dredging excursions.

Notice of a new Crustacean, Monimia Whiteana. *By* Spence Bate, *Plymouth.*

Observations on the Acalephæ, with respect to Organs of Circulation and Respiration. By Professor J. H. Corbett, *M.D., Queen's College, Cork.*

In this communication the author claimed for the Acalephæ a degree of organization higher than that usually conceded to them, and which might be supposed consistent with so soft and perishable a structure. He described two different sets of vessels—a centrifugal and centripetal; the former divide, subdivide, and anastomose, as they proceed towards the circumference of the disc; the latter larger, but less in number, commence towards the circumference and pass in straight lines towards the centre, where they become connected with the plaited red bands which are disposed around the gastric cavity. It seems evident that the tubes which circulate the nutritive fluid are not simply gastro vascular canals as generally described, but really vessels which assist in maintaining a complete circulation. The four bands situated around the gastric cavity are considered by recent authors as exclusively the organs of reproduction, consisting of vesicles which contain sperm-cells in the male and ova in the female. The contributor of this paper believes these to be compound parts, and states that the vascular plaited bands are organized in an appropriate manner for carrying on the respiratory action, while the contained vesicles are the agents of the reproductive function. According to some writers, respiration is accomplished by the agency of the cilia, which are attached along the margin of the disc; but as ciliary appendages are frequently absent amongst the Medusæ, such a view cannot be considered as satisfactory.

The following considerations seem to indicate that the membranous constituents of these bands are branchial or respiratory organs:—1st, by their position around the gastric cavity and their continuity with the membrane which lines it; 2ndly, by their connexion with the vessels; 3rdly, that a rhythmical action of the entire disc and of these bands takes place both by day and during night, as carefully observed by the author; 4thly, by an alteration in their colour when respiration is retarded; 5thly, by the diminution which occurs in one of these bands, if an injury happen to be inflicted, on the corresponding portion of the disc, while the others preserve their condition unchanged.

On the Pearls of the Conway River, North Wales, with some Observations on the Natural Productions of the Neighbouring Coast. By Robert Garner.

Though the *Unio margaritiferus*, or true British Pearl-mussel, is sufficiently well known to naturalists, yet some obscurity has been thrown on the subject, and the reputation of its beautiful pearls also suffered, from the circumstance that another very sordid sort of pearl is procured from the salt-water mussel found at the mouth of the Conway, the inquirer commonly resting satisfied with such as are here procured and offered him. With respect to these inferior pearls, undue mystery has been attached to them and their use. It is true that several families exist by gathering the mussels at low water, but it is not for the sake of the contained pearls, but as food for swine, some being also used as baits, the pearls, which indeed are sold as curiosities, being a secondary object. We doubt whether any method is known of making them ornamental. The true pearl mussel must be searched for a good many miles up the river, and the writer found it plentiful about a mile above the ancient bridge of Llanrwst, near the domain of Gwydir, where the water is beautifully clear, rapid, and deep, and it may be had hence up to Bettws-y-Coed. It was probably from the first spot that Sir Richard Wynne obtained the pearl which he presented to the queen of Charles the Second. The writer procured a couple of pearls from one mussel, one of which he considers by no means despicable, though inferior to another which he saw in the possession of one of the village maidens. By means of the coracles still used on this part of the river, the naturalists might procure plenty of these handsome shells, and it may be, be fortunate enough to meet with a pearl.

The banks of the Conway near its *embouchure* are singularly rich in maritime and other plants, very interesting to a naturalist from an inland district of England. On the rocks of the Great Ormshead, immediately over Llandudno, we picked *Cotoneaster chrysocoma, Veronica spicata, Hypochæris maculata*, an *Orobanche* (probably *minor*), apparently springing from the ivy, and, in the neighbourhood, about a score more plants nearly as rare. The madwort (*Asperugo*) is not to be had without endangering the neck, but it grows at Llech, the extreme and exposed point of the Great Ormshead peninsula. The *Scrophularia verna* is considered by some a doubtful native; we gathered it near Gloddaeth, where it is plentiful on one spot, and have it also from Diganeury; it can hardly have been introduced. Along the rather dangerous path which goes along the face of the Great Ormshead from the west, a variety of plants may be got, as the Samphire (*Crithmum*), generally rare in Wales. We here found the *Cyclostoma elegans, Bulimus obscurus* and *acutus, Zua lubrica, Helix virgata* and *pulchella*, with five or six other common species of *Helix*, and three or four common Pupæ and Clausiliæ.

On several places on the Llandudno mountain are large accumulations of shells, specimens of which a geologist gave to the writer as crag fossils, and proofs of an elevation of the rock in comparatively recent times. They entirely consist of the limpet, mussel, and periwinkle, and are mixed with bones of the sheep or goat. No doubt they are the *débris* of ancient inhabitants, who probably worked at the mines. We obtained a rude stone hammer which was found in the mines, similar to some found by Mr. Bateman in British barrows; and on Pen Ddinas, hard by, we noticed rows of the foundations of circular British dwellings. An intrepid female oologist, living by the mines, furnishes eggs of the Guillemot, Puffin, Divers, and two or three species of Gull.

In the drift at the entrance of the Conway, many minute shells abound, four or five species of *Rissoa*, and some of *Odostomia, Mangelia, Lacuna*, and *Chemnitzia*: *Chiton cinereus* is here abundant under the stones, the *C. fascicularis* more common on the Anglesea side of the Menai. The writer picked up also dead shells of *Emarginula reticulata,* and obtained a specimen of a rare fish, *Echiodon.* By means of the dredge, he got from Llandudno Bay *Tubularia indivisa, Bullea aperta, Ophiura rosula, Beroë pileus, Medusa aurita,* and a few other species of animals. The deep cavernous inlets at the foot of the Ormshead, appear to abound in other Medusidæ, which however we cannot attempt to enumerate. In a little pool in the Bay we captured two specimens of the beautiful little fish, the Argentine. The large yellowish Doris was common in the crevices of the rocks, and we found it also at Beaumaris. It appears to take the place of *D. verrucosa,* which we have commonly found on the Sussex coast. We picked living specimens of *Sphenia Binghami,* and, amongst Radiata, *Cribella oculata,* of a very rich orange colour, *Uraster violacea,* and *Asterias papposa*; also *Actinia mesembryanthemum* of distinct varieties or species, the beautiful *A. dianthus* (finer, however, at Penmon), and *Anthea cereus. Saxicava rugosa* seems to take the place of the Pholades as a borer in the limestone, though valves of *P. candida* and *crispata* are to be found. The Cephalopoda generally seem rare on the coast of North Wales; *Sepia, Loligo vulgaris* and *media,* all of which we have found plentiful on the Sussex coast, are uncommon, particularly the first; *Sepiola* and *Octopus* are, we have heard, occasionally found; of the ova of Cephalopoda we found none. *Trochus magus, crassus,* and *zizyphinus* are very fine on the Caernarvonshire coast; the largest of the first species are carried up by sea-birds to the summit of the rocks, the second is the most common species of the shores. *Patella pellucida* in all its forms is found on the *Laminaria.* We got two fresh shells of *Tornatella* from the Menai, and one of *Rostellaria pes-carbonis. Fusus antiquus* and *islandicus, Bulla lignaria* and the large *Turritella* are not rare as mere shells. The *Natica moniliformis,* as it is now termed, abounds alive in Cardigan Bay, but smaller than on our southern coast. *Pecten maximus* and *Donax trunculus* or *anatinus* are also often small. The different species of *Venus* seem to abound in this sea, particularly if we extend our search to the Isle of Man, where we found *V. striatula* and *casina, Tapes aurea* and *fasciata, Artemis lincta, borealis* and *exoleta,* and *Venerupis pullastra, decussata* and *virginea,* often containing the animals. *Solen ensis, Reliqua marginatus* and *legumen* are also common and fine on this coast; and other not rare bivalves are *Lutraria elliptica, Scrobicularia piperita, Mya truncata, Psammobia Ferroensis, Mactra solida, truncata, subtruncata,* and *stultorum,* the latter, however, often as *cinerea*; also *Pectunculus glycimeris* in its two principal varieties.

Crustacea appear to abound; we found species of the hermit crab in shells of *Trochus, Natica, Turbo,* and *Buccinum.* The latter on the Sussex coast, at the back part of the spire, in company with the crustacean, often contains great specimens of the *Nereis bilineata*; we have not been able to find it in Wales. The *Phyllodice viridis,* a pretty green worm, is seen crawling on the wet rocks of the Ormshead; also a species of *Aphrodite* or *Halithea,* about an inch and a half long, with blackish dorsal laminæ, four tentacles, muscular retractile proboscis, two sets of bright setæ on each side of every joint, the latter being between thirty and forty in number, also a small soft process above and below the setæ. The *Aphrodite aculeata* I could not meet with.

A specimen of Sponge (*S. pulchella*) accompanied the communication, which is abundantly thrown up on the Caernarvonshire coast; also some specimens of pearls, and a small shell of the *Unio* which produces the fine variety.

On the Morphological Constitution of Limbs.
By Professor Goodsir, *F.R.S.L. & E.*

On the Morphological Constitution of the Skeleton of the Vertebrate Head.
By Professor Goodsir, *F.R.S.L. & E.*

On the Morphological Relations of the Nervous System in the Annulose and Vertebrate Types of Organization. By Professor Goodsir, *F.R.S.L. & E.*

Remarks on the Anatomy of the Brachiopoda. By ALBANY HANCOCK.

Having been engaged for some time past in investigating the structure of the Brachiopods, I propose laying before this meeting of the British Association the results attained up to the present moment, especially on two or three points, to which my attention has been more particularly directed, and on which there exists some diversity of opinion among anatomists.

So far back as 1852 I had dissected *Waldheimia Australis* and *Terebratulina caput-serpentis*, and was struck by the peculiar appearance of the organs commonly denominated hearts, which seemed very unlike any molluscan heart that I had ever seen. On attentive examination, it became evident that they gave off *no* arteries as they had been described to do; and, moreover, that their apices, from which the arteries were stated to pass, appeared to open externally. I was therefore, and for other reasons, inclined to consider the so-called hearts oviducts.

At the same time I examined, with considerable care, the alimentary tube, my attention having been particularly drawn to this part by Mr. Woodward; and failed to demonstrate an anal outlet, though I was disposed to believe in the existence of a minute anal puncture; and thought that the refuse of digestion might make its escape by the foramen of the pedicle. Howsoever this might be, it was quite obvious that *no* anal aperture was situated in the pallial chamber as described by Professor Owen. I also examined the muscular apparatus, and likewise the nervous system; and the complicated structure of the mantle, I found, invited further investigation.

Other and more urgent matters, however, at that time claimed my attention, and all further inquiry into the structure of the Brachiopods was necessarily postponed. The results at which I had arrived were, nevertheless, partially made known, and have, to a considerable extent, been substantiated by the more recent investigations of Mr. Huxley, who in 1854 published a very interesting paper on the anatomy of the Brachiopoda in the 'Proceedings of the Royal Society.' In this paper the author arrives at the conclusion, that in *Waldheimia* and *Rhynchonella* there is no anus at all, but that the intestine terminates in a blind sac; that the so-called hearts give off *no* arteries, and that they possibly open externally. Mr. Huxley also describes, for the first time, a system of ramified peripheral vessels, and two or three pyriform vesicles, one of which is attached to the stomach, and is in connexion with a series of "ridges" and "bands." Some of the "ridges" are stated to pass from the so-called hearts to the genitalia; and the whole apparatus is supposed to be a portion of the circulatory organs.

It is then mainly in relation to these points, respecting the vascular and alimentary systems, raised by Mr. Huxley and myself, that there is a difference of opinion, Professor Owen maintaining the existence of an anal aperture situated in the pallial chamber, and that the so-called hearts are true vascular centres propelling the blood through arteries to the various organs. The opinion of this distinguished anatomist demands the utmost deference; and it is on no slight grounds that I have ventured to dissent from it in this instance, doing so only after the most diligent examination that it was possible to give to the subject, and when to doubt longer would have been to disregard the evidence of my senses. The greatest caution was forced upon me, not only by the respect due to authority, but likewise because analogy strongly favoured the views of the learned Professor respecting an anal aperture. And here it must be stated that I should never have been able to enter upon this subject with any chance of success, had I not had at my command an ample supply of specimens. I have therefore to express my obligations to Dr. Gray, Mr. Huxley, Mr. Woodward, Mr. Davidson, Mr. M'Andrew and Mr. Alder; as it is to the liberality of these gentlemen that I am indebted for the specimens used upon the present occasion.

First, with regard to the so-called hearts: these are two in number in the *Terebratulidæ*; they are composed of two portions, which have been denominated respectively auricle and ventricle. The former portion is suspended by a membrane in the visceral chamber, and resembles the mouth of a trumpet with the inner surface laminated in a radiating manner. The other portion is tubular, arched and tapering, and is imbedded in the thickness of the anterior wall of the visceral chamber, passing diagonally through it. On reaching the surface, the apical extremity *opens into the pallial chamber.* The whole organ may be looked upon as a tube, constricted a little near the centre, with one extremity expanded and opening into the visceral chamber, the other tapering and opening externally. These organs are placed one on each side of the intestine, and the apertures by which they communicate with the pallial chamber are situated near the junction of the two pallial lobes, one on either side of the mouth.

In *Rhynchonella* there are four of these organs, as first pointed out by Mr. Huxley, all of which open externally. Two correspond in situation with those of the *Terebratulidæ*, the other two being placed at the sides of the liver a little above the former. *Lingula* is supplied with a pair of these so-called hearts, which do not differ materially from those already described.

The external apertures of these organs I have seen in every instance, and though I have searched with the greatest care, have entirely failed to detect any arteries or vessels, or anything that could be taken for such, passing from their apices to the ovaries, or to any other part. When I first detected the external apertures I thought they might possibly be ruptures of the tissue; but further experience prohibits any such notion. They are always placed symmetrically, and are of equal size, resembling each other in form, and in every respect are similar, which would not be the case were they formed accidentally.

It is quite evident that these organs are not muscular centres; some other function than that of propelling blood must be assigned to them. I was originally disposed to look upon them as oviducts, and such I still believe them to be. It has, however, been suggested to me by Mr. Huxley that they are possibly renal organs, and that they may perhaps serve also as oviducts. This appears plausible enough, and may probably turn out to be correct. Professor Owen supposes that the eggs escape by dehiscence of the pallial membrane. Such a theory might seem feasible in respect to those Brachiopods which have the ovaries situated between the layers of that organ; but in *Lingula* they are developed in the visceral chamber attached to membranes to which the pseudo-hearts are appended. Here then the ovaries and these peculiar organs are brought into intimate relationship with each other; and it would appear more likely that the eggs should escape by this conduit than that they should have to find their way into the pallial sinuses and then escape by the rupture of the membranes. The walls of the conduit are of a glandular nature, and the lips of the internal aperture are spread out like the mouth of a funnel, as if for the very purpose of receiving the ova on their escape from the ovaries.

The alimentary tube in the *Terebratulidæ* and *Rhynchonellidæ* is remarkable for the firmness of its walls, which never collapse, though the œsophagus is generally a little compressed. It is bent into the form of a siphon, the arch being turned towards the dorsal or imperforate valve: the œsophagus represents the short, the stomach and intestine the long arm. The gastric organ, though small, is distinctly marked; it is irregularly oval, and suddenly contracting posteriorly gives origin to the intestine, which is short, and is suspended by a membrane in the midst of the visceral chamber. This portion of the alimentary tube passes downwards and terminates behind the adductor muscle, having a cardinal muscle on each side. In the *Terebratulidæ* it gradually tapers towards its extremity, which is *rounded and imperforate*. In *Waldheimia Australis* it abuts against the membrane circumscribing the visceral chamber, to which it is firmly attached. But in *Waldheimia cranium* and *Terebratulina caput-serpentis* there is no such attachment, the *rounded cæcal extremity* terminating at some little distance from the neutral wall of the chamber. The intestine of *Rhynchonella* on reaching this point doubles upon itself, and then advancing a little ends in an *enlarged rounded extremity*, which inclines to the right, and *projects freely into the centre of the visceral chamber*. In this, as in the *Terebratulidæ*, there is no anal outlet, the termination of the intestinal tube being cæcal. This is perfectly obvious in *Rhynchonella psittacea*. I have nevertheless made every endeavour to find an anal perforation; I have made numerous dissections under a powerful doublet,—have removed the part and examined it with the microscope; I have filled the tube with fluid as the finger of a glove with air, and by pressure have attempted to force a passage; I have tried injections; but have equally, on all occasions, failed to discover an outlet; and have only succeeded in demonstrating more and more clearly the cæcal nature of the terminal extremity of the alimentary tube. Therefore, however it may be opposed to analogy, the fact must be recorded,—*there is no anal orifice in* Waldheimia, Terebratulina and Rhynchonella.

The next point that claims attention, is that relating to the pyriform vesicles described by Mr. Huxley, of which there are five in *Waldheimia Australis*. In the other species that I have examined they do not appear to be so numerous; one, however, is always present. This is attached to the dorsal surface of the stomach on the median line; and I have satisfactorily ascertained that the "ridges" on the alimentary tube mentioned by Mr. Huxley as connected with it are really vessels; likewise that these vessels pass along the gastro-parietal and ilia-parietal bands of that gentleman, and thus reaching the ovarian sinuses run along their inner wall and become attached to the border of the membranous ridge which suspends the ovaries. They then course along the entire length of these organs, however ramified, forming the axis around which the ova are developed. Two other vessels are in connexion with this system; one, passing backwards from the tube that runs along the ilia-parietal bands, goes apparently to the pedicle; the other, which is larger than the rest, extends along the middle line of the stomach at the base of the membrane which divides the liver, and which has been denominated mesentery, and enters the vesicle in front. The other four vesicles are considerably smaller than that attached to the stomach, the walls of which are muscular, and are appended to the ovarian vessels as they enter these organs.

From the above facts it may be safely concluded that in this apparatus we see the true vascular system of these animals; and yet it must be allowed to be rather of a peculiar character. The vesicle suspended from the stomach is undoubtedly the heart, and the vessels passing from it backwards are as assuredly arteries. The vessel which passes along the stomach and approaches the vesicle in front, is apparently the channel by which the blood is returned from the aërating surface; but I have hitherto failed to ascertain by what path the blood reaches this channel. It would not, however, be difficult to conjecture, were it not better to wait the result of further investigation. The central organ of propulsion is here of a very simple form,—a mere vesicle scarcely higher in organic mechanism than the pulsating vessel of the Ascidian; there is no auricle, no pericardium. Its powers must necessarily be feeble; hence probably the additional vesicles appended to the ovarian arteries, which are apparently accessory pulsating organs.

With respect to the muscular system, I now find that the accessory cardinals are not always distinct from the cardinal muscles; but that the two occasionally coalesce, forming only one muscle. This is the case in *Waldheimia cranium*. It is also worthy of remark, that the dorsal pedicle muscles are not invariably attached to the hinge plate. In *W. cranium* and *Terebratulina caput-serpentis* they have their origin in the valve itself between the adductors, extending nearly as far forward as they do.

I have nothing very positive to communicate on the reproductive system; it does not, however, appear conclusive that the Brachiopods are diœcious; but, on the contrary, I find that the so-called ovaries or testes in *Waldheimia Australis* are really composed of two parts,—one yellow and minutely granular, the other red and formed of large vesicles. In some specimens the former portion was developed into eggs; but I have not yet observed spermatozoa in the red part, which is probably the male secreting organ. This would appear to be likely from what I have observed in *Lingula*. In this genus the ovary is developed within the visceral chamber, of a yellow colour; and on the inner surface of the dorsal and ventral walls of this chamber there ramifies a red dentritic organ which is made up for the most part of large vesicles like those of the red portion of the genitalia of *Waldheimia*; and in this organ I have found what I believe to be spermatophora filled with spermatozoa. Thus it would appear that *Lingula* is androgynous; and if so, it is probable that the other Brachiopods may likewise have the sexes combined in the same individual.

I shall refrain on the present occasion from entering upon the nervous system, which is beautifully developed, only remarking that it requires further elucidation; and in conclusion may express a hope that I shall be able, before terminating the investigation on which I am now engaged, to clear up what still remains obscure in the anatomy and physiology of these interesting animals, and that at no distant period I shall be in a position to publish a detailed and illustrated account of these matters. With a view to this I have already made numerous drawings.

Suggestions for ascertaining the Causes of Death in Birds and Animals. By W. E. C. Nourse, *F.R.Med. & Chirur.S.*

The Medical Indications of Poisoning. By William E. C. Nourse, *Surgeon to the East and West Cowes Dispensary, and Fellow of the Royal Medical and Chirurgical Society*

The medical proofs of poisoning are to be sought for,—1. in the *recognition of the physiological or vital effects of the poison*; and 2. in the *detection of the poison by tests*:—by *chemical* tests, used in the test-tube, the subliming tube, or the blowpipe; by *mechanical* tests, powerful microscopes being used for the identification of crystals; and by *vital* tests, portions of the suspected matter being given to animals, applied to living tissues, or tasted with the tongue.

The *testing* of a poison thus seems in a fair way of being thoroughly understood; but the methods of its recognition by its physiological or vital effects demand a few further remarks.

1. The author insists in an especial manner on the importance of recognizing the *earliest symptoms of the administration of a poison.*

2. The recognition of the *severer and fully developed symptoms of poisoning* requires no new comment; yet we have seen that life has actually been allowed to pass away without such recognition being made.

3. In cases of recovery, it is important to note the *manner in which the symptoms ass off*, and to observe the *sequelæ of them*, if any.

4. The *mode of dying*, when death takes place, is very indicative. There may be death from coma, death from suffocation, or death from exhaustion, either of vital power or of the vital fluid, or both. It is necessary to remember which sort of death each poison produces, both to aid in identifying the poison, and for purposes of treatment.

5. The first thing sought for *in examination after death* should invariably be, *physiological evidence as to the mode of dying.* The contents of the cavities of the heart ought therefore to be examined before any other part is touched. It seems surprising, that in the very able and careful post-mortem examinations now made, this needful attention to the order of proceedings should be overlooked; yet we every day read accounts of such investigations in cases of the highest importance, in which no notice is taken of the contents of the heart, or if they are examined, it is after other parts have been looked into, and when the empty or full condition of these cavities can no longer be ascertained, owing to the vessels having been cut across.

A proper examination of the contents of the heart, which can only be done rightly if done first, would show the immediate physiological state which caused death, and which points directly, through a more or less rapid series of effects of which it forms the closing one, to the poison which originated them.

Nor is it in cases of poisoning alone that this point should be attended to. It should be done in *all* cases; and should invariably form the first step in any post-mortem examination. The uses and advantages of this proceeding will be obvious to every medical man; and for the sake of the student, who is generally called on to assist or to be present, it ought to be especially insisted on.

6. The *other effects of poisons discovered in examinations post-mortem*, are well known, and have always received due attention.

In fact, these, with the chemical detection of the poison, and the severer and fully developed symptoms during life, are and have been generally relied on as the great medical proofs of poisoning. They must continue to be so; but it is also necessary that the other points alluded to should not be overlooked, especially the earlier and premonitory symptoms which indicate poisoning, and the information to be gathered from inspection of the contents of the heart.

Note on an instance of Instinct in a Caterpillar. By Sir Thomas Phillipps, *Bart., M.A., F.R.S.*

Recent Researches on the Cause of the Fluidity of the Blood.
By B. W. RICHARDSON, *M.D.*

The point of Dr. Richardson's researches consisted in the discovery of the volatile alkali, ammonia, as a constituent of the living blood, and its escape from blood abstracted from the body. The author related a long series of demonstrative experiments, all proving not only that ammonia was present in the blood, but that upon its presence the solubility of the fibrine, and therefore the fluidity of blood, depended. The peculiarity of this demonstration of the cause of the fluidity of the blood is, that it explains the different hypotheses which have previously been offered on this question, and shows how far these hypotheses have approached or fallen short of the truth. In concluding his paper, Dr. Richardson pointed out that ammonia, in combination with carbonic acid gas, is a constaat constituent of the air expired in the breath. The presence of ammonia in the animal economy, and its evolution in respiration, was of interest, in that it connected more closely the link that exists between the animal and vegetable worlds. But the subject was of the greatest importance in relation to the causes, the nature and the treatment of various diseases, especially those of the fever class.

Experiments and Observations on the Development of Infusorial Animalcules. By J. SAMUELSON, *Honorary Secretary to the Royal Institution (Literary Society), Hull.*

The author mentioned that, in March last, he had traced in rain-water the growth of an infusorial animalcule, called *Glaucoma scintillans,* from one of the so-called Monads of Ehrenberg, and, aided by a diagram, pointed out its gradual development; explaining, at the same time, the action of the internal organs, such as those of digestion, &c., and the differentiation in structure which takes place as the animalcule grows older. He stated that he had fed these invisible forms with vegetable cake in the first instance, and under the microscope with indigo, so that the process of digestion was rendered visible (the latter is a mode which has for some time been adopted by microscopists). Another phase in the existence of the animalcule was then described by the author, namely, the encysting process; also, the subsequent appearance of numerous examples of Kerona,—a form of a higher character than *Glaucoma,* which the author believed to be the result of the process just named. Having obtained this glance at the life of *Glaucoma,* Mr. Samuelson then tried (at the suggestion, he said, of Mr. Robert Hunt) what effect the rays of the sun would have when filtered through variously-coloured glasses in accelerating or retarding animalcular life. For this purpose, he fitted up a box containing three compartments, covered by a pane of *blue, red,* and *yellow* glass respectively; and he found that whilst under the *blue* and *red* glass infusorial forms were rapidly developed, under the *yellow* hardly any signs of life were visible. He then transferred a portion of the infusion from the yellow to the blue compartment, when the infusorial forms very shortly made their appearance. After this he varied the experiment, employing distilled water and finely-cut hay, when the same results were even more strikingly exhibited. The temperature, he said, under the three compartments varied on the average about three degrees, though frequently the variation was greater, the blue always being the lowest. After mentioning one or two other circumstances connected with the experiment, Mr. Samuelson concluded with a review of the results, and observed that if they should be confirmed, that is, if the differently-coloured rays could be proved to operate variously upon animal and vegetable life (to which he also adverted in the course of his paper), much new light would be thrown on the debateable ground between the two kingdoms.

Description of the Ajuh, a kind of Whale, found by Dr Vogel *in the River Benué (Central Africa) in September* 1855. *Translated and communicated by* Dr. SHAW.

The Ajuh is a species of whale found in the River Benué, or Upper Chádda, by Dr. Vogel, and is thus described by him :—It is black, horizontal, shovel-shaped, with two fins, situate close behind the head, each with three three-jointed bones, each ending in a short nail. The head is pointed; upper lip cleft; mouth extraordinarily small (in one individual, of 5 feet in length, the head was 18 inches long, 15 inches high, and the orifice of the mouth only 3 inches); nostrils directed forward and close over the upper lip—they are crescentic; eyes upward directed, close behind the nostrils, and (in the above mentioned case only $3\frac{1}{2}$ inches from the end of the muzzle or snout) very small (3 lines in diameter), black; no spouting-holes; gullet hard; tongue immoveable (grown fast) on each side, above and below; five grinders (with six points and three roots each), extending only a few lines above the gum; front teeth wanting, instead of which the jaw is bordered with hard, short bristles; colour, dark grey; belly, whitish; the back covered with isolated, rough, red hairs. The Ajuh becomes 10 feet long, and lives in the marshes inundated by the river. With the subsidence of the waters, the animal retires down the river to the ocean; but reappears in the commencement of the rainy season with the rising waters, bringing with it one or two young, at that period from 3 feet to 4 feet in length. Its food consists chiefly of grass; and in the dung, which in colour and form resembles that of the horse, no trace of fish was ever found. The Ajuh is exceedingly fat; the flesh and fat, similar to that of the hog, is very well-tasting. The bones are as hard as ivory, and rings are fabricated from them, and whips are made from the skin. The Ajuh appears to be rare; and I do not believe that during the three months it remains in the Benué more than twenty to thirty are taken.

On this paper, Prof. Owen read the following Note on the Ajuh of Dr. Vogel.—The translation of Dr. Vogel's account of the animal which that enterprising traveller had seen in the river Benué or Chádda, in Central Africa, permits of no doubt being entertained as to the class, and even genus, of animal to which that brief and somewhat vague account refers. The combination of two crescentic nostrils, with a pair of fins attached "close behind the head," shows that it is a cetaceous animal; whilst its food, "chiefly of grass," proves it to belong to the herbivorous section of the order Cetacea of the Cuvierian system, answering to the order Sirenia of Illiger. That order now includes three genera, *Manatus, Halicore,* and *Rytina*; the first of which is the only one in which the teeth are multicuspid and with two or more roots. It is therefore a species of Manatee that Dr. Vogel makes known to us under the name of Ajuh. One species of *Manatus* has long been known as inhabiting certain rivers of Africa, especially those terminating on the west coast. This species is the *Manatus Senegalensis* of Cuvier and other zoologists. A stuffed specimen from that coast is in the British Museum; it was presented by Messrs. Vorster and Co., African merchants. The back and sides of the body are of a very dark gray, approaching to black; the belly is a light gray. The head is small in proportion to the body, and tapers to an obtuse muzzle; the upper lip is cleft, and the mouth small. The nostrils, a pair of crescentic clefts, with the convexity upward and backward, are situated as described in the Ajuh: the eyes are, however, not situated *close* behind the nostrils, and they are distant $7\frac{1}{2}$ inches from the end of the muzzle. This admeasurement is from an individual about 3 feet longer than the one of which the dimensions are given by Dr. Vogel; but the difference of relative position seems still too great to be accidental or probable in animals of the same species. The hard short bristles which fringe the mouth, the scattered hairs along the back, the nails terminating each of the three-jointed digits of the pectoral fin, the want of front or incisive teeth, the hard ivory-like texture of the bones, the fatness and vapid nature of the flesh, are all characters common to the Manatees. The number of nails appears to vary in individuals of the same species, as might be expected in parts almost rudimental in their development, and of no very great utility to the animal. Thus Cuvier notices in one individual of the American Manatee (*Manatus Americanus*, Desm., *M. Australis*, Tilesius) four flat rounded nails on the edge of the fin; the fourth being very small. In a fœtus of this species there were but three nails on one fin, and four on the other. In a young Manatee, Cuvier noticed only two nails on each fin*. The three nails observed by Dr. Vogel on the fin of the Ajuh, cannot, therefore, be depended on as a constant or specific character. The teeth of the known species of Manatee have the crown divided into two transverse ridges,—each ridge, in the upper molars, being at first tri-tuberculate; but the intervals of the tubercles are so shallow that they are soon worn down, and a transverse ridge of dentine,

* Ossemens Fossiles, ed. 1836, 8vo, tom. viii. p. 18.

bordered by enamel, is exposed. There is also an anterior and posterior low barrel ridge; the posterior one being most developed in the lower molars. The upper molars have each three diverging roots, one on the inner and two on the outer side. The lower molars have two fangs. Dr. Vogel's description of the grinders, as "having six points and three roots each," would apply to the upper molars of the *M. Senegalensis* before they had been much worn*. As to the number "five," that doubtless refers to the number forming the series of teeth on each side of the jaw. I have not had the opportunity of examining the dentition of the known African Manatee. In the figure of the skull of the *M. Senegalensis* given by Cuvier†, six molars are shown on the right side of both upper and lower jaws, and the coronoid process of the mandible may hide a greater number. In the American Manatee I have ascertained that at least nine molars are developed on each side of both jaws ‡, but they are never simultaneously in place or use. The greatest number which I have found in that condition is seven, the socket of a shed anterior molar being at one end of the series, and that containing an incomplete ninth molar at the opposite end. Prof. Stannius has observed a small simple conical molar anterior to the normal two-ridged molars, and divided by a narrow interval from them, in a new-born American Manatee. The individual Ajuh, 5 feet in length, which appears to have been more especially the subject of Dr. Vogel's account, was a half-grown animal, and the number of grinders (five), as well as their six-pointed crowns, doubtless relate to that circumstance. Fifteen feet is said to be the length to which adults of the *M. Senegalensis* attain: the Ajuh becomes 10 feet long. It may be a distinct and somewhat smaller species. The chief indication, however, of such specific distinction is the closer approximation of the eyes to the nostrils and to the end of the snout, as shown by the admeasurement given by Dr. Vogel. The easiest procurable and transportable evidence of the Ajuh, and the best calculated to determine this point would be the skull; but every part would be most acceptable; and, in the meanwhile, the species may be indicated and kept before the notice of the naturalists by entering the Ajuh in the Zoological Catalogue as the *Manatus Vogelii*, or Vogel's Manatee.

Experimental Researches on the Eye, and Observations on the Circulation of the Blood in the Vessels of the Conjunctiva, of the Iris, of the Ciliary Ligament, and of the Choroid Membrane, during life, as seen under the Compound Microscope. By Augustus Waller, *M.D., F.R.S.*

Dr. A. Waller states, that his observations are founded in great measure on the fact observed by him some months since, that the eye may be obtained sufficiently protruded from the cavity of the orbit to render its deep-seated parts accessible to direct observation.

Artificial exophthalmosis of this nature, he finds from experiment, may be easily produced in various animals, sufficiently to expose the anterior two-thirds of the eyeball and to observe the circulation over the greatest portion of the vessels of the choroid.

While in this state the iris may be made to contract by light, and there is reason to suppose that the organ of the animal still possesses the powers of vision.

The eye is obtained in this state by opening widely the eyelids, and by exercising a slight lateral pressure on the eye, which causes the eyeball to escape through the opening of the eyelids; returning to its original situation as soon as the pressure is removed.

For his experiments, Dr. Waller employs the rabbit, the guinea-pig, and the *Mus decumanus* or rat, all of them of the albinos variety, and more especially the albinos rat.

In these animals, by means of the light passing through the pupil and through the sclerotica, the organ may be sufficiently illuminated by transmitted light to enable us to observe, under the compound microscope, the different parts of the eye as a transparent object.

The body and the eye of the animal are fixed by using a roll of linen like a swaddling band, and then tied to a piece of flat cork, the eye at the same time being pro-

* Cuvier figures a similar molar of the *M. Americanus* in pl. 220. fig. 11.

† *Loc. cit.*, fig. 4.

‡ Odontography, vol. i. p. 371. pl. 96. fig. 2.

truded from the orbit by a few turns of thread passed alternately behind and in front of the eyeball in close contact with it.

The result is, that the animal's eye is kept nearly immoveable, and that by directing the microscope to any point of the exposed surface, the circulation of the vessels may be easily examined under a magnifying power of 200 diameters and upwards.

Dr. Waller then proceeds to describe minutely the different parts of the eye, and the distribution of the vessels over the cornea, the sclerotica, the iris, and other deep-seated parts of the eye.

On the Mechanism of Respiration in the Family of Echinidæ. By Thomas Williams, *M.D.*

The author stated, that, after a very careful research upon the subject, he had arrived at the conclusion that the mechanism of the breathing process in the Echinidæ differed in a radical manner from that which obtained in the Asteridæ. In the latter, the entire integumentary skeleton was perforated by minute orifices, through which digital, membranous, cæcal processes protruded, and in and by which the cavitary fluid was brought into contact with the exterior aërating element. In the Echinidæ, on the contrary, the integumentary skeleton was perforated *only* by the "ambulacral feet." The branchiæ in this family were restricted to the membranous area which surrounded the mouth, around the circumference of which they are disposed in a row. They differed in number and structure in different orders, but in all they conformed to one type. They were hollow-branched membranous processes, considerably larger in size than the corresponding processes rising from the ligamentary surface of *Asterias*; and communicated directly with the general cavity of the body. They bore an intimate resemblance to the branchiæ of the *Sipunculidæ*. The Echinidæ differed from the *Sipunculidæ* in being totally destitute of every provision along the general surface of the body which could aid in the office of respiration. The relation which was thus established between the branchiæ and the cavitary fluid in the Echinidæ, was a strong presumptive ground for the belief that a blood-vascular system did not exist at all in this family of Echinoderms.

On the Fluid System of the Nematoid Entozoa. By Thomas Williams, *M.D.*

In this communication the author mentioned the leading facts:—1. That especially in the genus *Ascaris* the peritoneal cavity was occupied by a peculiar vesicular tissue, opening on the integumentary exterior, which appeared to be adapted to absorb fluid from without. 2. That in some species it almost entirely filled up that space which in the Annelids was *free*, and occupied by an oscillatory fluid; and, 3. That in the Nematoid Entozoa there did not exist any trace whatever either of a blood-vascular or a water-vascular system.

Miscellaneous.

On the Variation of Species. By the Rev. L. Jenyns, *M.A., F.L.S.*

The object of this paper was to draw the attention of the Natural History Section of the British Association to the importance of collecting all the facts already known, or which might be obtained by further researches, connected with the variation of species. The subject was stated to be one, which, more than almost any other, deserved the consideration of naturalists at the present day. Reference was made to the many complaints which may be found in the works of different authors, as to the difficulty of determining what is and what is not a species, as also to the excessive multiplication of species by some naturalists, and their too ready disposition to overrate the value of those slight differences, by which many of these so-called species are distinguished. It was thought that a very large number would probably prove to be merely local races, originally derived from one stock, their differential characters being due to climatal or other external causes exercising a permanent influence through a succession of generations. Hence it was recommended, in the case of such species as have others closely allied to them but supposed to be probably distinct, to endeavour to trace the effect of such causes. Many facts bearing on this question were thought to be already on record, only scattered over various works and periodicals, which required to be collected under one head; while a far larger number were wanted in order to arrive at any certain conclusions admitting of such generalization. These last must principally be sought for at the hands of travellers or naturalists stationed in different parts of the world, whose comparative observations on the same species, as found in different regions and latitudes, would prove of great value.

In this communication the author restricted his remarks for the most part to the species adopted in zoology. It was urged especially that we should endeavour to work out the history of those exotic animals which either appear identical with, or which closely approximate to, European forms, and observe whether, between two nearly allied species inhabiting remote countries, there cannot be discovered intermediate forms, or as they have been termed *transition species*, serving to show the passage from one species to another, and so proving all to be the same. Or, if such cannot be detected in any of the intervening parts of the globe, inquiry should be made whether the exotic form is never found in any transition state in the particular country it inhabits. It was remarked that it does not follow, because the European race never acquires the distinguishing character of the exotic form, that the latter may never so vary as to become identical with the former.

But it was added, that before we can hope to clear up the doubts which hang over a large number of exotic species, we must be better acquainted with the European species themselves to serve as a standard of comparison with all others. Even in the case of some of our most common birds, and the same is true in every other class of animals, there are several different races, or sub-species as some call them, or real species as accounted by others, inhabiting either the same or different countries on the continent, each showing some slight though constant peculiarity of character, but on the whole so generally similar, that we are at a loss, in the present state of our knowledge, whether to refer them to one or more than one original stock. It was thought that the endeavour to remove some of the difficulties which attend this question would prove more serviceable to zoology than adding to our already overloaded lists of names, one-half of which would probably in the end sink to mere synomyms, increasing the confusion. We alone advance the philosophy of the science, when we are not content with registering a new species, or subdividing an old one; but when we seek to ascertain the origin and nature of species themselves, their geographical range, the influence they receive from the particular circumstances under which they live, the limits within which they may vary, without having their essential differences destroyed,—and the degree of permanence stamped upon some of these variations, through the slow operation of local and climatal causes over a long period of time.

The author, in allusion to the doubts entertained by some with respect to species in general, stated his opinion that there was nothing to contradict the belief that they had a real existence in nature, and that all the individuals belonging to the same species had emanated from a single stock, or in other words, that there had been for each species but one centre of creation. He considered that the case of hybrids, so far from proving anything to the contrary, only demonstrated the reality of species the more plainly; for he believed that strictly hybrid plants had never been known to reproduce themselves beyond two or three generations at most, while there were not more than one or two well-authenticated instances of hybrid animals producing offspring at all, excepting with one of the parent species, to which in this way, the hybrid, making continually a nearer approach, was gradually brought back. He regarded this as a clear indication on the part of nature that there *is* a barrier separating certain forms, or collections of forms, from certain others, which shall not be ordinarily passed, and never passed, without those who pass it, being, so to speak, sent back in the end. Unless we ground our notions of the species on this law, we in vain attempt a definition of it at all. If we once hold that species can intermix through an unlimited succession of generations, since no species under such circumstances could preserve its distinguishing characters for any length of time, it is equivalent to saying that species have no existence at all.

He thought it probable that a great deal of the obscurity in which this subject is involved arose from our inadequate ideas with respect to the degree to which certain species may vary, without losing their identity, and the unwillingness of some naturalists who have been long accustomed to other ways of thinking, to receive the facts as conclusive, which have been adduced in support of this opinion. He then adverted to certain facts and observations which had been brought forward of late years by different naturalists to show the variation to which many species are liable in the classes of Insects, Birds, and Shells. Several conclusions arrived at by Mr. Wollaston*, in reference more especially to the coleopterous insects of the island of Madeira, were much dwelt upon. Variations of structure, size and colouring had been found by that gentleman to be often connected with the insular or continental stations in which these insects lived, the temperature of the climate, the altitudes at which they were found, and their greater or less proximity to the sea.

In the class of Birds, a few cases were alluded to in which the adult males of certain species in certain countries appeared never to arrive at the same state of plumage which characterized the very old male in others: also the instance of the common Ruff (*Machetes pugnax*), which, according to Mr. Blythe†, is never met with in the neighbourhood of Calcutta in the breeding plumage, by which it is so remarkably distinguished in Europe. Mention was then made of several common European birds, of which two or more races existed in different parts of the continent, each characterized by certain constant peculiarities of plumage, and which it was very desirable should be studied more closely, especially in respect of habits and manner of life, by those who had the opportunity, in order to ascertain whether they have any real claim to be elevated to the rank of species, the light in which they have been considered by some naturalists:—such, for example, as the *Sylvia suecica* of Latham, of which one race exists in the north of Europe having the pectoral spot *rufous*, and another in the central and south parts having the same spot *white*; the *Saxicola aurita*, and the *S. stapazina*, found, at least in the greatest plenty, in the north and south parts of Italy respectively, and only to be distinguished by the colour of the throat; the *Common, Cisalpine*, and *Spanish Sparrows*, the differences between which, and those very slight, were almost confined to the adult males; the many so-called species of *White* and *Yellow Wagtails*, mostly inhabiting different parts of Europe, though occurring, some of them, together in some places. It was observed, in reference to these and similar cases, that if two closely-allied species are found living together *always*, without any individuals occurring of an intermediate kind, it is a strong argument for their being really distinct. But if they are mostly found in two different countries or districts, the same inference cannot be drawn from the circumstance of their being *occasionally* met with together in the localities lying between those two countries, or bordering on them when contiguous.

In the above-mentioned instances, the differences between the supposed species rest principally in the plumage; but the author went on to speak of others, in which these are combined with slight differences of form or size of parts, but on which it was shown, from many recorded observations, no greater reliance could be placed, as a ground at least in all cases, of specific distinctness. The differences between the *White-winged Cross-bills* of America and Europe, as indicated by De Selys-Longchamps‡, were adduced as a probable example of this kind of variation. That naturalist observes that these two Cross-bills (which have been considered by some naturalists as two species to which the names of *Loxia leucoptera* and *L. bifasciata* have been respectively given) differ *slightly*, but *constantly*, in size, form of the bill, depth of the red tint of the plumage, and proportions of the wings and tail. He thinks, nevertheless, that these are only the distinguishing marks of two races, sprung originally from the same stock,—one race having fixed itself in the North of America, the other in the North of Asia. He suggests, in explanation of the modified form of the bill in the two kinds, that, in birds which use the bill as pinchers for detaching the seeds of fir-cones, and tearing them violently away, the shape of this organ may to a certain extent be affected by the different forms of fructification in the different

* In a little work 'On the Variation of Species,' 1855.

† Ann. and Mag. of Nat. Hist. vol. xii. p. 170.

‡ "Notice sur les Bécroisés Leucoptère et Bifascié," Bull. de l'Acad. Roy. de Belg., tom. xiii.

species of conifers. And he is strengthened in this opinion by the circumstance that the second American species of Cross-bill (*Loxia Americana*, Wils.) resembles on the whole the *L. curvirostra* of the Old World, but differs from it, exactly in the same way as the *L. leucoptera* differs from *L. bifasciata*, that is to say, by its smaller size, and weaker bill with the points finer and more elongated.

Reference was also made to a remark by Mr. Gould respecting the swallows and sylvan birds in the island of Malta, which, "though unquestionably of the same species as those of Great Britain, exhibit small local characteristics by which they may be immediately distinguished, such as the length of the wings, size of the bills, and tints of the plumage*." Mr. Gould was inclined to think that the shortening of the wings in these Maltese individuals was connected with the circumstance of their having a shorter distance to traverse in their migrations to and from Africa, where they winter.

These and several other observations, all tending to show the occasional variation of the characters of birds,—more especially some by the same gentleman last alluded to respecting the greater brilliancy of the plumage, according as individuals of a given species were found in the interior of continents, or in insular or maritime countries†,—led the author to ask, whether there is not enough on record to make us at least hesitate respecting the stability, not of species in general, but of many of the so-called species of Birds. When we couple the facts above referred to, with the known influences of season and temperature in causing *periodic* changes in the plumage of some species;—when we find these changes hastened or retarded according as the seasons are more or less forward, prevented, it is probable, from taking place at all some years, or in some localities, in which the summers are colder or the winters milder than in others;—when we further take into consideration the known effect which particular kinds of food have in altering the plumage of birds in captivity, the colours becoming deeper or more dull, sometimes changing to a complete black‡;—when we bear all this in mind, and recollect too how generally the offspring is marked with the peculiarities of the parents,—might we not almost *à priori* be led to expect, that if a species had originally extended itself ages back, or been accidentally introduced into other countries than that in which it had been first created, these countries having a different climate, or the bird finding there a particular food, calculated to exercise a *permanent* influence of a like kind to that which is only *seasonal* or *occasional* elsewhere,—it would become, in the course of generations, stamped by some permanent variation of plumage, just as we have the different races of men, each bearing so remarkably its own distinctive characters, yet surely all of one species, as the best ethnographers and physiologists of the day seem disposed to admit?

An opinion was expressed, that where two species are really distinct, there will generally be some difference of song, nidification, or other habits, accompanying any slight differences of plumage, as in the instance of *Sylvia trochilus* and *S. rufa*, which no one would mistake when heard in the woods, though difficult to distinguish in hand. And though we must for a long time be necessarily ignorant of the habits of a large number of foreign birds, the author thought it far better, in the case of any supposed new species, especially where only one or two specimens have been obtained, to abstain from naming it for the present, unless characterized by well-marked and unmistakeable peculiarities of form or plumage, rather than incur the risk of increasing the synonyms of some previously known species, from which it may not prove to be distinct. Until further information respecting it were obtained, it would be preferable to regard it as a mere local race, to which race, however, there would be no objection to append the name of the particular country or district in which it was found.

Before concluding, the author made some remarks on the variation of shells, noticing chiefly some valuable communications to science by Dr. Gray§ and Mr. M'Andrew‖, who have shown that the characters of many species of shells greatly alter, according to the depth of sea they inhabit, or the more or less exposed situations in which they are found. He then expressed a hope that these variations, along with

* Mentioned by Mr. Wollaston in his work 'On the Variation of Species.'

† Ann. and Mag. of Nat. Hist. vol. xvii. p. 510.

‡ See Bennett's edition of 'White's Selborne,' p. 165, note.

§ Phil. Trans. 1833.

‖ Edinb. New Phil. Journ. vol. xlvi. p. 355, &c.

the others he had spoken of in the species of different classes of animals, would receive more attention from naturalists in future, as tending to throw light upon a question which is every day assuming more importance, and on the solution of which all correct notions of classification must be based.

Dr. LANKESTER laid upon the table several Tables of Forms issued by the Committee for obtaining Reports on Periodic Phænomena that had been filled up by various observers. It was stated that new forms could be had by application to Dr. Lankester or Professor Phillips.

Photographs of Objects of Natural History were exhibited by WM. THOMPSON.

GEOGRAPHY AND ETHNOLOGY.

Report of an Expedition to explore the Interior of Western Australia. By ROBERT AUSTIN.

On recent Discovery in Central Africa, and the reasons which exist for continued and renewed Research. By Dr. W. B. BAIKIE.

Let a map constructed about the commencement of the present century be examined, and attention will be at once arrested by the immense tracts of country marked unexplored; and even in other directions names are but sparingly given, and the positions of cities and the courses of rivers marked only by guess. The famous city of Timbúktu was known merely by name—the marshy Lake Tsád was then a myth—the mighty Niger, or Kwóra, historical ever since the days of Herodotus, was inserted without beginning and without termination, save when some bold theoretical chartographer connected it with Gambia, or led it to the Nile or the Congo. Even the numerous streams which enter the Bights of Benin and Biafra were unknown except as breaks in the coast line, which were never visited but by slaves or pirates. The tide of more modern discovery may be held to have commenced with the travels of Bruce in Abyssinia, when he discovered the sources of the Blue Nile, and in more central Africa, with the first expedition of the celebrated Mungo Park, when he determined the easterly course of the Niger. Many other adventurers, as Houghton, Hornemann, Nicholls, &c., followed, and added little by little to our previous scanty knowledge. But by far the most important facts were collected by Denham and Clapperton, who re-discovered Bornú, identified Lake Tsád, visited Bagírmi, Mándara, and other unknown districts, and brought circumstantial accounts of a wonderful, dominant race, the Púlo or Fuláta tribes. About the same time Timbúktu had been reached, first by the unfortunate Major Laing, and shortly afterwards by M. de Caillie, whose narrative was the first authentic one relating to that wondrous city. The next important journey was that of the brothers Richard and John Lander, who, having penetrated from Badágry, on the coast, to the town of Yäúri, descended the river in a canoe, and at the expense of great hardship and danger, discovered its embouchure, and so settled a controversy which had commenced long before the Christian era. This exploit of the Landers caused the beginning of a new series of efforts, and thenceforth attention was especially directed to a water communication with Sudán. The first of these was by Mr. Macgregor Laird, Capt. Allen, and Mr. Oldfield; the second by the late Mr. Consul Beecroft; and, finally, one undertaken by the Government, and which left this country in 1841. All of these showed clearly that the Niger was easily navigable, the only difficulty being from the effects of the climate, which proved so fatal to European life, that Mr. Laird lost 44 out of 49, and the Government Expedition in less than two months experienced a mortality of 49 out of 145 whites,—a result which shook the confidence and deadened the energy of the most ardent philanthropists. In 1845 and 1846 Mr. J. Richardson travelled from Tripoli to the northern parts of the Great Desert, visiting Ghadámes, Tuát, and Murzúk, during which time he collected much information, both geographical and commercial, which may be found in his interesting volumes entitled 'Travels in the Great Desert of Sahára.' On this gentleman's return to England he made proposals to Government for an expedition on a more extended scale, for the purpose of establishing commercial relations with the tribes across the Desert, and, by the introduction of legitimate trade, of striking a blow at slavery. Accordingly, he again set forth accompanied by Drs. Barth and Overweg, who started from Tripoli for Sudán on the 30th of March, 1849. Mr. Richardson's strength was not equal to the great fatigue and labour he had to undergo, and he died at Ungurutúa, in Bornú, on the 4th of March, 1851. His journal up to that date, full of instructive materials, has since been published under the care of Mr. Bayle St. John. His companion, Dr. Overweg, also unable to withstand the baneful effects of climate, expired in Bornú on the 27th of September, 1852; but Dr. Barth, composed probably of tougher materials, undismayed by the death of his associates, boldly continued his solitary wanderings, and after a sojourn in Central Africa of upwards of five years, happily returned in safety to England. He is now preparing for the press an account of his most interesting journeys and discoveries; and from some conversations and correspondence I have had with him, I am looking forward with impatience for the appearance of his work, as with such a fund of information and of novelties as he possesses, he must be able to give the fullest and most accurate, as well as the latest, account of Central Africa, from Timbúktu to Adamáwa. The most recent traveller in Nigritia is Dr. Vogel, who, by the last letters received from him, was endeavouring to penetrate towards the kingdom of Wádai, and from whom numerous important astronomical and other observations have been already transmitted.

In 1852, Dr. Barth, whilst on the route to Yóla, the capital of Adamáwa, crossed a large river called the Bínue, just at its junction with a considerable affluent, the Fáro. This river he conjectured, from the information he received, to be the upper portion of that hitherto known near its termination, to Europeans, as the Tsádda or Tshádda,—a name which seems to have been given to it by Lander, in consequence of a report he heard from a travelling Mallam, that it flowed from lake Tsád,—a view now proved to be erroneous. Dr. Barth described this as a large river, and as containing during the rainy season a large body of water,—fitted, therefore, for the purposes of navigation. On hearing these accounts from Dr. Barth, Government resolved to fit out a small expedition, to endeavour to ascend the so-called Tsádda, and to ascertain its identity with the Bínue. For this purpose a small iron screw schooner was built by Mr. John Laird at Birkenhead, and fitted out and manned by Mr. Macgregor Laird; and as it had been agreed to combine the commercial element with exploration, a suitable cargo was also provided. Government appointed certain officers to proceed in this vessel for geographical, scientific, and other general purposes. Careful and copious instructions were drawn out under the direction of Sir Francis Beaufort, aided more especially by the scientific knowledge of Sir Roderick Murchison, who took an especial interest in the progress of the expedition, was one of its chief promoters, and who himself personally prepared a set of hints on geology and mineralogy for the guidance of the officers. This expedition entered the mouth of the Kwóra or Niger on the 12th of July, 1854; and after remaining in the river 120 days, again left without the loss of a single life, and without having encountered any troublesome sickness. This almost unlooked-for exemption is to be ascribed, first, to the employment of as few Europeans as possible; secondly, to ascending the river during the rainy season, and avoiding any delay in the Delta; and, thirdly, to the free use of quinine as a prophylactic or preventive. Nearly 700 miles of river were explored and surveyed, a chart was compiled, the capabilities of the surrounding countries examined, and friendly relations were established with the various tribes.

The trade with Western Africa is much greater than is generally supposed, and has for some years past been steadily on the increase. From 1846 to 1850, the annual value of exports from Britain to the West Coast averaged £554,000, and in 1854 amounted to upwards of £958,000. The African races are, almost without exception, born traders, buying and selling being with them the chief end of their lives. Only give them the chance, and they will eagerly grasp at it; and being also naturally friendly and well-disposed, they only require kind treatment to render them confiding and quiet. The only well-marked exceptions are among the natives living along the coasts, who have contracted from Europeans all possible vices, which have been unfortunately encouraged for selfish ends by white men, until now; the present generation, at least, is almost beyond the reach of reform. In the interior the population is much better conducted, and it is with these people that I now propose to open trade directly, by means of the rivers, instead of through the medium of the many savage races with whom we now deal. This would, moreover, open to us vastly increased supplies, which could also be purchased at more moderate rates. By opening new markets also with these people, they would have other things to occupy them instead of intestine wars, and above all it would tend directly to supplant by means of legitimate commerce that still existing unnatural and horrid traffic in human flesh, which, first established and since fostered by men styling themselves Christians, has been the bane and the curse of Africa, but which I feel assured, from what I have observed, as well as from the experience of other recent travellers, would be greatly lessened, and in time altogether stopped, by the means I now recommend.

The population of Sierra Leone is composed, to a very great extent, of recaptured and freed slaves and their families, and among them are to be found representatives of almost every tribe in Central Africa. These people have become civilized, are Christians, speak the English language, have acquired English manners, and learnt our methods of trading; they are usually most industrious, and many have acquired wealth. Still, among them an intense love of country exists, and the all but universal desire is to revisit their native land. One very extensive race, the Yóruba or Akú tribe, have already returned to their original seats in great numbers, their country having a sea-coast, and access being easily attained by Lágos and Badágry. But others are not so fortunate, and have not the opportunities of gratifying their *amor patriæ*. But in these persons we have at hand all that we desire, ready instruments to be employed alike in establishing commerce, and in civilizing, by their own efforts, their less favoured brethren. By opening to these the navigation of the Niger, and aiding them to settle along its banks, we do good alike to them, to the country, and to ourselves; and I have satisfied myself, by actual inquiry, both that these people would eagerly embrace any opening for return, and likewise that they would be received with open arms. Such are the commercial and philanthropical grounds for advocating further progress; but there are equally strong scientific reasons for prosecuting the inquiry. Numerous tribes are yet unknown, many countries unexplored, cities and towns unvisited, lakes and rivers unsurveyed, and mountains unmeasured. The zoological and botanical novelties are unaccountable, the geologic condition and mineral treasures have yet to be examined, and the economical products carefully inquired into. The climate is not so deadly as has been supposed, and the hitherto dreaded diseases are more thoroughly understood. The expense, too, of exploration, especially if combined with commercial enterprise, would be very trifling,—not one-twentieth part of what was lavished on the unfortunate attempt in 1841. If the expedition is to be renewed, no time should be lost; as if not at once undertaken, all that has been effected in 1854 will be thrown away, and efforts would have to be commenced *de novo*. During my ascent of the river, I was often asked why white men had been so long in revisiting the place, and why they had not sooner kept the promises they made in 1841. My ingenuity was often taxed to afford explanations and excuses, and the chiefs said that when they saw us returning regularly they would then believe white men, but not before. Two years have already elapsed since my visit; and it would be of the utmost consequence that preparations should be now made for the season 1857, for which purpose Government should be urged to come to a decision, so as to enable the requisite arrangements to be at once entered upon, as those engaged should leave England early in the spring.

Notes on some Antiques found at Cirencester as Evidence of the Domestic Manners of the Romans. *By* Professor Buckman.

In this communication the evidence derived from the position of most of the Roman stations went to show that this people was guided by a careful survey of the district, as they fixed some important stations, and Corinium amongst others, at a distance from the direct road, making an abrupt turn in accordance with the geological facts which presented themselves; and as for some miles round the country does not offer water supply for a large community, but this is ensured at Cirencester by a curious concatenation of geological conditions. The esteem in which this people held a good water supply, is attested by the remains of most carefully executed wells still remaining, and indeed some of those now in use, all lined with fine ashlared stone, the rubbish which has been cleared from the bottom of some of them presenting traces of the well-moulded coping stones by which they were surmounted.

In metallurgy it was pointed out that they greatly excelled; and two most interesting crucibles were exhibited, in order to show that the chemical apparatus so named is of very ancient date.

In metallic work some beautiful bronze personal ornaments were exhibited, especially some armillæ or bracelets, six of which were stated as having been taken from a single arm; and as these possessed rivets, it was suggested that they were never removed from the person; if, therefore, these were lovers' gifts, it showed either that the lover was very lavish or that a gift was not returnable.

An oyster-knife was shown, as also some fictilia for domestic use, as a funnel, colander, infants' feeding-bottle, their form and application so much like our own as to lead to the inference that comfort and convenience were sought in furniture which we have very exactly copied. Amongst other articles, bone-spoons, like those used in country places, were shown to be so perfect, as to lead to the inference that they could scarcely be antique; however, on comparing them with our present forms, it was observed that the handles were pointed, a custom with all spoons of Roman work, whether in bone or metal; it is stated that this was for the piercing of egg-shells, so that they should not swim, the legend that uncanny visitors may swim in egg-shells, being, like many articles of modern use, not a modern invention.

In concluding his remarks upon the various relics which he had collected at Cirencester, the Professor remarked that these were not sought often by the antiquary merely as curious property, but because their study was so well calculated to fill up those blanks in history which acquaint us with the inner life of the people, instead of confining it to a mere account of the battles, murders and sudden death of potentates and rulers.

On the Site of Ecbatana. *By the* Archdeacon of Cardigan.

On a more positive Knowledge of the Changes, both Physical and Mental, in Man, with a view to ascertain their Causes. *By* R. Cull, *F.S.A.*

On the Varanger Fiord. *By* Dr. L. K. Daa.

On the Torenic System of the Ugrians (Finns), Albanians, and other Populations. *By* Dr. L. K. Daa.

On the Relation of the Siberian and Armenian Languages. *By* Dr. L. K. Daa.

On the Forms of the Crania of the Anglo-Saxons. *By* J. Barnard Davis, *F.S.A.*, *F.E.S.*

The *typical form* of the Anglo-Saxon skull is distinguished for its great size, the horizontal development of the brain-case being somewhat expanded in all directions at its periphery, without being deficient in height; by which means is produced a well-marked *platy-cephalic* skull. The calvarium, when viewed vertically, does not impress the eye with its unusual length or shortness, although it is not at all deficient in length; but it appears somewhat broader than common. The frontal region is frequently upright, so as to afford a good Camperian angle, broad and expanded at the sides, in this respect greatly resembling what we regard as the typical Roman form. The lateral regions are full, and sometimes project over the base of the skull. The posterior region is usually capacious and elevated. The outer surface of the vault of the calvarium, which is full, equable, and expanded, gives the impression of great capacity, and of constituting the receptacle of a massive powerful brain. The face is upright, and only occasionally presents any marked prominence in the region of the frontal sinuses. The nasal bones differ a good deal in form, are seldom large, and only very rarely aquiline. The face is somewhat broad; but from the angles of the lower jaw not being so much expressed, does not present the quadrate form of the ancient Roman.

Table of Measurements derived from the Crania exhibited, and others to show the considerable size of the Anglo-Saxon skull.

	Internal capacity.
Largest skull in Mortonian College at Philadelphia, of a Dutchman of noble family, 114 cub. in. (of sand)	94 oz.
Largest skull author has gauged, of an Irishman, found 10 feet deep in Dublin.	102¼ oz.
Anglo-Saxon skull from Harnham near Salisbury.	75 oz.
,, ,, ,, ,, another example.	76½ oz.
Anglo-Saxon skull from Linton Heath, Cambridgeshire.	79 oz.
,, ,, ,, ,, another example.	90¾ oz.
Skull of Merovingian Frank from cemetery at Envermeu, Normandy.	80 oz.
Large modern Saxon skull from Leipsic	90 oz.
Mean internal capacity of these six crania, 99 cubic inches, or.	81¾ oz.

In Morton's great table the mean of eighteen German skulls was 90 cub. in., that of five English ones 96 cub. in., and that of seven Anglo-Americans 90 cub. in. The mean of these three classes, 92 cub. in., is 7 cub. in. less than the mean of the six crania enumerated; and these three classes stand at the head of Morton's table. Without claiming for the Anglo-Saxon skull such a large average capacity as that deduced from the examples, we are still justified in assuming that it was not at all deficient in capacity, and in believing that the people of Germanic race equal, if they do not exceed, all others in the size of their heads.

Besides the typical form, there is a large proportion of skulls found in Anglo-Saxon cemeteries, which present much of the *oval form* that may be regarded as distinctive of modern English crania.

Of the accounts of the ancient German tribes, that of Tacitus is most ethnological. He says, "I have already acceded to the opinion of those who think that the Germans have hitherto subsisted without intermarrying with other nations, a pure, unmixed, and independent race, unlike any other people, all bearing the marks of a distinct national character. Hence, what is very remarkable in such prodigious numbers, a family likeness throughout the nation; the same form and features, stern blue eyes, ruddy hair, their bodies large and robust, but powerful only in sudden efforts." It should be recollected these accounts are derived from Italian writers, accustomed to a people of somewhat smaller stature, and to dark hair and eyes, and for these reasons likely to exaggerate the more marked differences which arrested their attention in the ancient Germans.

That the Anglo-Saxons were a large people we have the indisputable evidence of their skeletons. Of three thigh-bones, one is 17·6 in. long, another 19·5, and the third 20·5. Of thirty-six thigh-bones of different ancient Britons, the range is from 17 to 19·5 in. The longest therefore is an inch less than the longest of these Anglo-Saxon femora. Faussett, in the 'Inventorium Sepulcrale,' remarks of a skeleton found at Crundale, "I think this person must needs have been about 6½ feet high." The brothers Lindenschmit found the skeletons in the Frankish cemetery at Selzen to range from 5¾ to 7 feet Rhenish, including those of women, or from 4 ft. 8 in. to 6½ feet English. One woman actually measured this extreme length. Douglas met with Anglo-Saxon hair in Greenwich Park of an auburn colour; and Mr. Bateman, near Taddington, Derbyshire, of a decidedly light colour.

Dr. Prichard thought the Germans had *lost* the peculiar features attributed to them by classical writers, from a change of climate, both which positions are most questionable, and, indeed, are disproved by the evidence of facts. The present German natives are a tall stout people with large heads, fair complexions, and generally light or *blond* hair and eyes, probably all that was intended by the Italian writers. This view is quite borne out by Dr. Beddoes's careful examination of people of different districts of our own country. In the Lothians and borders which were subdued by the Angles and Saxons in the sixth century, he says, "the people seem generally tall, large, and muscular; their outlines of face and figure are rounded, particularly in the forehead and the chin; the nose varies in form, but as a rule is short and straightish. The heavy overhanging brow and deep sunk eye, which, with the high cheek-bones, are generally sufficient to mark out a Scotchman from among a group of Saxon Englishmen, are in this district comparatively rare. The prevailing complexion is fairer than in any other district [of Scotland] I have visited. The eyes are in a great majority of cases blue or light grey, but hazel is not an uncommon colour. The hair varies from light yellowish-red and flaxen yellow, through divers shades of brown."

The great mental power of the Germanic races, with its special manifestations in different tribes; and the probability that the ancient Germans, and perhaps the Anglo-Saxons, distorted the skull artificially, were briefly alluded to, previous to the closing remarks on the striking ethnological position of *the lasting permanency of ethnical characters* confirmed by all the evidence adduced.

On some Volcanic Islets to the South-East of Japan, including the Bonin Islands. By A. G. Findlay, *F.R.G.S.*

The recent importance of our commercial relations with Japan, consequent upon the opening of the ports of Nagasaki and Hakodadi to our shipping, and the increasing commerce now developing itself between Eastern Asia and North-West America, has rendered the great ocean-highway between Nippon and the Bonin Islands of great interest. The dangers of this region to the seaman is much increased by the rapid Japanese current, first shown by the author in 1850 to run from east to west across the North Pacific Ocean, in an analogous course to the Atlantic Gulf-stream. This mighty stream, running to the E.N.E., through the space under consideration, has given rise to the very complicated nature of the so-believed new discoveries; above thirty of these announcements being, by investigation, reduced to five or six rocky islets of very singular character. The islands nearest to Japan, the Broken Ids, Fatsisyo, the Japanese penal colony, and South Island, were shown to be in some cases defectively represented. The Redfield Rocks are those discovered by Broughton, and corrected by Capt. Donnel in 1850, and therefore not a discovery by the United States Japan Expedition in 1854. The islands south of this are, perhaps, Tibbit Island of 1844, then an island or reef of pointed rocks, discovered by Coffin in 1825, afterwards announced as new by Capt. Jurien-Lagravière in May 1850; again announced as new by Capt. Rogers in 1851; again in 1852 by Capt. Drescher of the 'Walter,' and again in 1856 by Capt. Grove, each person believing that he had discovered a new island. Others similar were also cited. The next group, perhaps, is about eight miles to the south of the last, or lat. 31° 53′ N., long. 139° 59′ E., was discovered in the Dutch corvette, the 'Koerier,' August 24th, 1849, and is of a very dangerous character. Jeannette Island, twenty-three miles further south, is doubtful. Smith Island, in lat 31° 12′ N., long. 139° 55′ E., discovered by Capt. Smith of the 'Heber,' March 1846, is a most singular needle-rock, springing from unfathomable depths to a height of 300 feet, and not more than 250 feet diameter at the base. It has been seen by others. Ponafidin Island of the Russians lies next, to the south. St. Peter's or Black Rock, first seen in 1821, and again in 1853, is a wonderful column of basalt 200 feet high, parallel and quite perpendicular sides, not more than 150 feet in diameter, and like a bottle in appearance. It is in lat. 29°42′ N., long. 140° 15′ E. The volcanic nature of these remarkable rocks, lying near the meridian of 140° E., indicates a continuation of those immense volcanic ranges which pass along the Kurile Islands, throughout Nippon, the great Japanese island, and thence to the well-known range of spiracles in the Ladrone Islands. At the northern end of this range is the well-known Mount Fusi, 10,000 or 12,000 feet in height, now quiescent. To the south of this volcano is Simoda,—a port between the two capitals of Japan, Jedo and Miako, which has been thrown open to the ships of the United States in 1854. The dreadful earthquake of 1854 at this place was alluded to. It totally changed the character of the harbour of Simoda, destroyed the fine city of Osaca, and injured Jedo. The wave which was caused by this upheaval of the land traversed the entire breadth of the North Pacific in twelve hours and some few minutes, a distance of between 4000 and 5000 miles, demonstrating the depth of that ocean to be between two and three miles. The diagram illustrating the paper showed the singular confusion before mentioned in the hydrography of these small but important positions. The Bonin Islands lie to the southward. They have recently been made the subject of some uncourteous disputation by the Americans as to the right of discovery and ownership. There can be no doubt of their Japanese discovery, and are the Arzbispo Islands of the early Spaniards. Next follows Captain Coffin in 1824–25, who was believed to be an Englishman, but which is controverted by Commodore Perry of the United States Navy. The particulars of the discovery were related. Next, Captain (now Admiral) Beechey saw them in 1827, and took possession of them before the discovery of Coffin was published. They were colonized under the direction of Her British Majesty's Consul at Oahu in 1830, the survivors of those settlers still living there. These islands have been lately explored by the United States Japan Expedition, and their volcanic origin established. It was hoped that some authority to repel aggression would be established there, as the islands have now become important, as they are adapted for a coaling and refitting station for steam-vessels. The Volcano Isles which follow are tolerably well known, and from these the volcanic submarine ridges diverge to S.S.E. and S.W., several isolated shoals and volcanic rocks having been discovered in these directions. The paper concluded with a hope that our naval officers would endeavour to clear up the embarrassing confusion which had arisen from the imperfect accounts given of this now important region.

Vesuvius and its Eruptions; illustrated by a Collection of Drawings by W. Baylis. *By* F. D. Hartland.

On the most Ancient Map of the World, from the Propaganda, Rome. By F. D. Hartland.

Vesuvius and its Eruptions. By Frederick D. Hartland, *F.S.A., F.R.G.S.*

The first part of this paper (which was illustrated by a series of views) was devoted to a geographical and geological description of the mountain; it then touched on the legends of the Phœnicians, of its previous volcanic character, and finally gave an outline of the principal of its fifty-four historically recorded eruptions, selecting from each the peculiarities that render it most interesting. The 34th, which took place on the 8th of August, 1779, and terminated in three days, was thus described:—"A dense smoke first issued from the cone, followed by a shower of scoriæ and large stones; an explosion, of such force as to shake Portici, Torre del Greco, and Torre dell' Annunziata, followed, and then in an instant a fountain of liquid transparent fire began to rise, and gradually increasing, arrived at so amazing a height as to strike every beholder with the most awful astonishment. The height of this stupendous column of fire could not be less than three times that of Vesuvius itself, which rises perpendicularly near 3700 feet above the level of the sea. Puffs of smoke, as black as can be possibly imagined, succeeded each other hastily, and accompanied the red-hot transparent and liquid lava, interrupting its splendid brightness here and there by patches of the darkest hue. Within these puffs of smoke, at the very moment of their emission from the crater, could be perceived a bright but pale electrical light, briskly playing about in zigzag lines." This graphic description is from the pen of Sir

William Hamilton; but Mr. Morris also states the light was so strong at Sorrento, nearly fourteen miles off, that he could read large print by it. The column fell partly perpendicularly, filling up the valley of the Atrio del Cavallo, and partly around Ottajano. After its fall, the black cloud advanced towards Naples, putting the citizens in great fear, but it did not fall on it. Next day another vast column arose, but there being no wind, it fell back into the crater. On the 11th some lava was discharged, and Vesuvius was covered with a mass of white cotton-like clouds, piled one over another in a colossal mass, scarcely possible to describe.

The last eruption from its proximity was the most interesting.

The fifty-fourth and last eruption of Vesuvius took place on the 1st of May, 1855. The warning of its approach was given early in January, by the opening of a new crater at the summit of the cone, between the old one and the city of Naples, and directly across the route of ascent. This crater differed from the others, insomuch as it was neither sulphurous in its character, nor was it of the usual chimney form. It was from sixty to eighty yards wide, and a slight smoke issued from its blackened sides. After its appearance, the report of an immediate eruption was spread, and was kept up without intermission for many months; but on Monday, the 30th of April, the symptoms were so apparent, that the guides declared to a party then making the ascent the number of hours it would be before it occurred. On Tuesday, the 1st of May, Vesuvius was invisible at Naples, and it was not till the afternoon that the fact became known that the eruption had commenced. A rush was then made for Santa Lucia, the spot of Naples from which the mountain can best be seen, and here the truth became apparent, as the mountain was blazing from several points. Upon accomplishing the ascent, and after passing the Hermitage, the intense heat betrayed the approach of the burning element; and after leaving various cascades of fire, down which half-melting blocks of lava were dashing at a pace to overcome all resistance, the current of the eruption was reached, and resembled a liquid fiery river rushing from the side of the cone, and apparently fed from an orifice about half-way up it, which, amidst flames of fire, was throwing out stones to an immense height, accompanied by volumes of dark smoke; whilst all below was clear, and the lava at times even assumed a bright phosphoric blue. This was the most magnificent part of the scene, as the ascent of the cone did not repay the risk and trouble. During this scene daylight dawned, and so earnest had been the attention given to it by the thousands assembled on the mountain, that although a perfectly visible eclipse of the moon occurred during the time, it passed, with few exceptions, unobserved. The eruption continued till the end of the month (27th), and before its close eleven cones were in active operation, the discharge from which was so great, that at one time a total falling in of the mountain was dreaded. This discharge, almost unaccompanied by the ejection of stones or ashes, was the peculiarity of the last eruption.

On the Homolographical Maps of M. Babinet. *By* Prof. Hennessy.

Prof. Hennessy explained the nature of the new system of maps, invented by M. Babinet, Member of the Institute of France, and referred to a letter which that gentleman had written on the subject to General Sabine. In the new projection all the meridians are ellipses, and the parallels straight lines; whence it follows that the areas included between any two pairs of equidistant meridians are always equal. It follows that all areas lying between the same parallels and having equal bases on these parallels will be also equal. This property is not possessed by any of the ordinary modes of projection, all of which, more or less, distort the actual configuration of the surface of the globe. This new projection, designated by its author the Homolographical Projection, alone possesses the property of making the areas of the different parts of a map comparable among each other, like corresponding areas on the surface of a globe. Its value in geography is thus obvious, especially in such cases as those where relations of surface are important, such as the distribution of vegetable and animal life, of population, of races, and, generally, in all questions of physical and statistical geography.

On the Arctic Current around Greenland. By Capt. Irminger, *R.D.N.*

Report on his Expedition up Smith's Sound in Search of Sir John Franklin. *By* Dr. E. K. Kane.

An original Letter from General Mouravieff. *By* Col. A. Lake.

Return Journey across Southern Africa. By the Rev. Dr. D. Livingston.

Sir R. I. Murchison communicated to the Section an outline of the accounts of the last journey of the Rev. Dr. D. Livingston, from the western to the eastern coast of South Africa, as contained in three long and highly interesting letters addressed to him by that eminent explorer and successful missionary. The first of these was written at Linyanti, on the river Chobe, from whence he had been accompanied across the continent, to St. Paul di Laonda, on the west coast in 10° S. Lat., by the natives, whose fidelity to him during his perilous adventures had been rewarded by being instructed and reconducted to their native place, and is dated the 16th of October, 1855; the second from the Hill Chanyuné, on the banks of the Zambesi, the 25th of January, 1856; the third from Teté, or Nyungwe, lower down the same river.

The map about to be constructed by Dr. Livingston, of the vast unexplored region, has been for some time in preparation by Mr. Arrowsmith for publication in the volumes of the Royal Geographical Society; and some of the information contained in the letters recently received will occasion improvements in that map,—the chief points of which have, for the first time, been fixed by astronomical observations, which the undaunted traveller was enabled to accomplish even under all the privations and dangers of his two remarkable journeys. These observations have been calculated by Mr. M'Clear, the astronomer at the Cape of Good Hope.

Not endeavouring to detail the names of all the African chiefs and places alluded to, but pointing out generally the line of route pursued, Sir Roderick read those passages of the first letter which confirmed, by actual observation, a theory he had himself formed in the year 1852*, of the probable physical condition of the interior of Africa in modern as well as in ancient times, from the examination of a geological map of the Cape Colony by Mr. Bain, and from the earlier discoveries of the Lake Njami by Dr. Livingston and his former associates, Oswell and Vardon; viz. that crests of hard rocks constitute both the eastern and western flanks of the continent, through which the rivers, escaping by deep fissures, have proceeded from a broad central watery region of no great altitude. Of this interior basin, intersected by a network of rivers, Dr. Livingston gives a clear account,—some of the waters even flowing northwards into the Zaire or Congo, and others south-eastwards into the Zambesi.

The chief geological and mineralogical characteristics of the eastern and western flanking crest-lands are described, including coal-fields, iron and other ores, and hot springs issuing from igneous and metamorphic rocks. The internal or watery basin, on the contrary, is everywhere occupied by calcareous tufa, often of considerable thickness, in which are enclosed the remains of existing shells and animals of the land and water of the present day. A collection of fossil bones found to the south of the last explorations, and consigned to Dr. Buckland, has been unfortunately lost; with measurements of chief altitudes as determined by the ebullition of water. The return journey from St. Paul di Loanda to Linyanti was facilitated for a time by the possession of two asses, given to the author by friends in the Portuguese settlement of Loanda; these animals being insensible to the sting of the Tsetse, which destroys oxen and other animals.

In the second letter, Dr. Livingston, then within a few days' march of the Portuguese eastern station of Tete, gives a lively and graphic sketch of the remainder of the route he pursued in proceeding across the eastern hilly region; and his description of the scenery (as read to the Section), where the broad river Zambesi, after forming great rapids, is compressed into a narrow gorge and cascades over a lofty precipice, amidst the most luxuriant and extraordinary vegetation, afforded the liveliest gratification. This rocky region is very salubrious, and in passing through

* Journal of the Royal Geographical Society.

it the traveller is no longer molested by the Tsetse, or destructive insect. The author speculates, indeed, on the probability of such hilly *sanitaria* being extended vastly further to the north, and adds, "At present there is the prospect of water-carriage right up to the bottom of the eastern ridge; and if a quick passage can be effected thither during a healthy part of the season, there is, I presume, a prospect of residence in localities very superior to those on the coast." The deltas between such hilly districts and the shores of the eastern as well as of the western oceans, are, on the contrary, described as the most unhealthy of all the tracts examined.

The third letter, much of which was read to the Meeting, gives a general view of the ethnological distinctions and habits of the various tribes among whom he has lived and with whose languages he is so well acquainted, assigning a manifest superiority in bravery and conduct to the hill people, and particularly to the Caffre-Zuluh race. He also explains that the Bible has been nearly all translated into Sechuana, or the dialect of the Bechuanas, the most regularly developed of all the African languages. "Of its capabilities (he adds) you may judge, when I mention that the Pentateuch is fully expressed in considerably fewer words than in the Greek Septuagint, and in a very greatly less number than our verbose English."

After a sketch of the zoology and natural history of the region, and a record of the prevalent diseases of the people, showing that certain maladies which civilized man cannot eradicate, are often worn out and disappear naturally in South Africa, Dr. Livingston, adverting to previous explorers, and returning his warmest thanks to the Portuguese authorities of Laonda and Tete, modestly expresses his belief that he is the first European who has travelled across Southern Africa in those latitudes,—and having acomplished thus much, he speaks of a visit to his native land, but only with the intention of returning to exercise his sacred calling. He concludes in these words:—"I feel thankful to God who has preserved my life while so many who would have done more good have been cut off. But I am not so much elated as might have been expected, for the end of the geographical feat is but the beginning of the missionary enterprise. Geographers labouring to make men better acquainted with each other, soldiers fighting against oppression, and sailors rescuing captives in deadly climes, are all, as well as missionaries, aiding in hastening on a glorious consummation to all God's dealings to man. In the hope that I may yet be permitted to do some good to this poor, long trodden-down Africa, the gentlemen over whom you have the honour to preside, will, I doubt not, all cordially join."

In conclusion, Sir Roderick called attention to the great merits of Dr. Livingston, who had justly been honoured with the adjudication of a Gold Medal of the Royal Geographical Society, and having also adverted to the extraordinary and extensive travels of Barth in Central Africa, who had received a similar honour, and to the prospect of fresh explorations both up the Niger and from Zanzibar on the east coast, to the mountains from whence the Nile is supposed to flow, he congratulated the assembly on the hope we might now rationally entertain of spreading civilization and Christianity throughout these benighted lands.

In the absence of detailed maps, and in the expectation of seeing Dr. Livingston soon in England, Sir Roderick forbore to enter into any specific account of the courses of the interior rivers, or to dwell upon data which would in due time be brought before the Geographical Society.

A New Route to India—the Syro-Arabian Railway. By JOHN LOCKE.

This paper suggested a railway from Acre to Busrah, passing the Jordan between the 32nd and 33rd degrees of latitude. The gain in space of this line over the projected Euphratean route was stated to be 400 miles, and in time (making due allowance for greater velocity of locomotive than steamer) two days and a half; and over the present overland route of 1000 miles, or six days, which might be increased one day and a half by accelerating the speed in the long level reaches of the Desert, where the traveller can observe at the distance of several miles any object of a size likely to impede or endanger a train. Mr. Locke's paper went to demonstrate the shortness, security and economy (both in time and in cost of construction) of this route. He also pointed out the facilities likely to be afforded by the Ottoman government and the Imaum of Muskat, and especially dwelt on the collateral advantages of developing new markets and commercial relations, not only in the Persian Gulf, but also with the eleven millions of the Arabian peninsula, hitherto almost isolated from the conditions of modern civilization.

Researches in the Crimean Bosphorus, and on the site of the Ancient Greek City of Panticapæum (Kertch). *By* Dr. D. Macpherson, *F.R.G.S.*

The present town of Kertch is built close to the site where 500 years B.C. the Milesians founded a colony. About fifty years before Christ, this colony became subject to Rome, or rather a Satrap of the Roman Empire, from the circumstance of the Bosphorean kings, who were also rulers of Pontus, having been subdued by this people in Asia. In the year 375 of our era, the colony was utterly annihilated by the Huns. Barbarous hordes succeeded one upon another thereafter until A.D. 1280, when the Genoese became possessors of the soil, and held it until expelled by the Turks in 1473; they being in their turn expelled in 1771 by the Russians. The characteristic features around Kertch are the immense tumuli, or artificial mounds, that abound in this locality, more especially within the second vallum. These sepulchres of the ancient world are found in many places. We have them in the form of barrows in England, and cairns in Scotland. Calculated as they are for almost endless duration, they present the simplest and sublimest monument that could have been raised over the dead. The size and grandeur of the tumuli found in this locality excite astonishing ideas of the wealth and power of the people by whom they were erected, for the labour must have been prodigious and the expenditure enormous. The highest specimens of Hellenic art have been discovered in these tumuli—such as sculpture, metal, alabaster and Etruscan vases, glass vessels, remarkable for their lightness, carved ivory, coins, peculiarly pleasing on account of their sharpness and finish, and trinkets, executed with a skill that would vie with that of our best workmen. All originals were forwarded to the Hermitage, at St. Petersburg, duplicates being preserved in the Museum at Kertch, and these might have been with ease secured to England on the investment of the place by the Allies; but with the exception of some bas-reliefs, which, in connexion with other two officers, I transmitted to the British Museum, the whole of these rare treasures were barbarously made away with. The local tradition is, that these tumuli were raised over the remains, and to perpetuate the memory, of the kings or rulers who held sway over the colonists, and that the earth was heaped upon them annually on the anniversary of the decease of the prince, and for a period of years corresponding to the rank or respect in which its tenant was held or had reigned; and to this day successive layers of earth, which were laid on in each succeeding year, can be traced, a thin coating of sea-shell or charcoal having been first put down. I have counted as many as thirty layers in a scarp made in one of those mounds, about two-thirds from its base. They are to be seen of all sizes, varying from 10 to 300 feet in circumference, and in height from 5 to 150 feet, and are usually composed of surface soil and rubble masonry. Herodotus's reference to these sepulchres is the earliest account which history has recorded of this mode of burial; and I would particularly draw attention to his description of the mode adopted by the Scythians to perpetuate the memory of their deceased princes, for it will be hereafter seen that one of my excavations corresponds exactly with the description given by him. "The tombs of the Scythian kings," he states, "are seen in the land Gberri, at the extreme point to which the Borysthenes is navigable. Here, in the event of a king's decease, after embalming the body, they convey it to some neighbouring Scythian nation. The people receive the royal corpse, and convey it to another province of his dominions; and when they have paraded it through all the provinces, they dig a deep square fosse, and place the body in the grave on a bed of grass. In the vacant space around the body in the fosse they now lay one of the king's concubines, whom they strangle for the purpose, his cup-bearer, his cook, his groom, his page, his messenger, fifty of his slaves, some horses, and samples of all his things. Having so done, all fall to work, throwing up an immense mound, striving and vieing with one another who shall do the most." The Greeks, who always respected the religion of the countries they had subjugated, and who, in process of time, imbibed, to a certain extent, their customs and observances, appear to have adopted this Scythian mode of burial, Instead, however, of placing their magistrates or rulers in a "deep square fosse" dug in the earth, they built tombs, and over these raised the conical hill. I examined several without meeting with any success. All, or nearly all, of these tumuli have been already explored. Not far from Mons Mithridatis I came upon a portion of an aqueduct which probably conveyed water to the Acropolis. It was formed of concave tiles; one of these, with a Greek name thereon, I have brought with me. On one occasion I arrived at a place where five stone tombs were found adjoining, neither of which contained any relic; but in a spot contiguous a large ornamented earthenware jug and five glass cups, one within the other, were discovered. It was not unusual thus to find the remains in one spot and the ornaments in another. On removing the earth off the sides of a rock, the apex of which was only perceptible on the summit, I struck upon a recess, three sides of a square chiseled out of the rock 16 feet in length and 8 in depth. Following this, I reached a stone seat; hewn out on each side of this seat small recesses had been made, apparently for the purpose of receiving lamps. After descending 12 feet I came to human remains, and for five days the workmen turned nothing out of this pit but human bones. How far these would have descended I know not, for I ceased my explorations here, feeling satisfied, from the appearance of the bones, that they must have been placed there at the same period—the result, most probably, of some great engagement, for many of the skulls and long bones presented fractures and injuries. The marks on the rock would indicate that sacrificial meetings, possibly commemorative of the event, was held here. Replacing these remains, I proceeded to a point indicated as the tombs of the diminutive or pigmy race, but discovered nothing that would indicate a peculiar class of people. Beneath an extensive sloping artificial tumulus, running at right angles with the ridge extending northwards from Mons Mithridatis, I came upon a mass of rubble masonry, beyond which was a door leading to an arched chamber, built under the side of the mound. This led me to a larger chamber, which was also arched. The walls of the larger chamber were marked off in squares, with here and there flowers, birds, and grotesque figures. Over the entrance into this chamber were painted two figures of griffins rampant, two horsemen, a person in authority and his attendant—the latter carrying in his hand a long spear—being rudely sketched on one of the inner walls. There were no remains of any sort in this tomb or temple. A recess in the walls on two sides resembled doors blocked up. On removing the masonry to the right, the skeleton of a horse was found. To the left a human skeleton lay across the door. Tunnelling on each side, the work was carried on beneath the descents of former explorations from above. On the right-hand side the tunnel extended seven yards, but nothing of interest was met with. On the left, descending as the tunnel was formed, arriving occasionally at objects possessing much interest, I came upon a layer of natural slate rock, the sides and roof of the tunnel being composed of artificial soil, charcoal, animal remains, and, as usual, heaps of broken pottery. Thirty feet from the entrance, the rock suddenly disappeared to the front and left, the mark of the chisel being perceptible on the divided portion. Tunnelling on, the rock was again reached 12 feet from the spot where it had disappeared, loose sand occupying the intervening space, into which the exploring rod, 6 feet long, dropped without any effort. I worked down into this shaft 12 feet. But the left side of the shaft, which was composed of the same loose sand as far as the steel rod could reach, was continually falling in. Moreover, the labour caried on by candlelight of raising the earth in baskets, and conveying it in wheelbarrows to the outside through the building was becoming very arduous, and I was compelled to abandon the work. At this period no relics or remains of any sort were discovered, and the steel rod sunk into the loose sand as if it had been so much flour. I felt satisfied that this shaft led to rich treasures below, but regard for the safety of my workmen prevented my proceeding deeper. I now sought out other ground, and selected a place removed about 100 yards from that I had just left. Descending some 10 feet, I struck upon a tomb cut out of the solid rock. Not far from this my attention was attracted to an excavation in the rock, somewhat similar to, but on a much smaller scale, than that large descent which I had just abandoned. Clearing the surface, I found that the rock was hewn out 3 feet in width and 12 in length, the intervening space being filled with sand, similar in all respects to the other into which the steel rod sunk with ease. Fifteen feet of this sand being removed, I came upon the skeleton of a horse. A few feet further on, an upright flag, 4 feet high, and the breadth of the shaft, was placed over the entrance of a tomb cut out of the calcareous clay. The opening faced the east by an arched door, 24 inches wide and 32 high. The tomb was of a semicircular form, arched, 10 feet by 12 in diameter, and 8 feet high in the centre. Above the doorway, a lintel stone was placed on which the slab which closed it rested. The cavity was cut out of the natural calcareous clay, which was firm and consistent, the form and shape of the instrument by which it had been removed being very distinct. The candle burnt brightly on entering. The floor was covered with beautiful pebbles and shells, such as are now found on the shores of the Sea of Azov. A niche was cut out of the walls on three sides, in which lay the dust of what once was human. It was a sight replete with interest to survey this chamber—to examine each article as it had been originally placed more than 2000 years ago—to contemplate its use, and to behold the effect of twenty centuries upon us proud mortals. There lay the dust of the human frame, possessing still the form of man. The bones had also crumbled into dust; the space once occupied by the head did not exceed the size of the palm of the hand, but on the undisturbed dust, the position of the features could still be traced. The mode in which the garments enveloped the body, and the knots and fastenings by which these were bound, were also distinct. On each niche a body had been placed, and the coffins, crumbled into powder, had fallen in. At the head were glass bottles—one of these contained a little wine. A cup and a lacrymatory of the same material and a lamp were placed in a small niche above. A coin and a few enamelled beads were in the left hand, and in the right a number of walnuts—the wine and nuts being doubtless placed there to cheer and support the soul in its passage to Paradise. Some fibulæ and common ornaments, valuable on account of their antiquity, were also found. Continuing my researches in the same locality, I came upon other similar shafts, at the end of which were the bones of a horse, and then the large flagstone closed the mouth of tombs similar to the last. I now resolved to make another attempt to explore the great shaft; the only mode of effecting this being to remove entirely that portion of the hill above it, I brought all my labourers to the spot, although the few days that remained of our sojourn in Kertch would hardly enable me, I feared, to complete the work. Placing my men in two gangs, each were made to work half an hour without ceasing. On the third day we struck on two large amphoræ, containing each the skeleton of a child. Adjoining these were the tombs of two adults, and then came the skeleton of a horse. There was now every indication that a great feast or sacrifice had been held, for a few feet further on we came upon immense heaps of broken amphoræ, fragments of wine jars, the inside of which were still encrusted with wine lees, broken drinking cups, flat tiles which may have served the purpose of plates, beef and mutton bones, fragments of cooking pots still black from the smoke, and quantities of charcoal. Descending still further, we came upon what appeared to have been a workshop—portions of crucibles in which copper had been smelted, corroded iron, lumps of vitreous glass, broken glass vessels, moulds, and other things being found. Five feet deeper we exposed the excavation in the rock, and a shaft exactly similar to, but on a much larger scale than the descent into the arched tombs. As the hill was removed, platforms were scarped on the sides, on which the earth was thrown up, a man being placed on each platform; and as I descended into the shaft, similar platforms of wood were slung from above. On the twelfth day we reached a depth of 16 feet in the shaft, the portion of the hill removed being 38 feet in length, 20 in depth, and 12 in breadth. The mouth of the shaft hewn out of the rock, 3 feet in thickness, was 18 feet long by 12 broad. It then took on a bell shape, the diameter of which was 22 feet, cut out in dark consistent clay, a depth of nearly 7 feet. Beyond this the size of the shaft became a square of 7 feet, cut out of successive layers of sandstone and calcareous clay. When we had attained a depth of 30 feet in the shaft, the labour of raising the earth became very great; but by means of a block and shears, which Capt. Commerell, of Her Majesty's ship 'Snake,' very kindly fixed over the descent, the work was much facilitated, the earth being slung up in baskets, and the men ascending and descending in the same manner. A few feet beyond the bones of the horse, and exactly in the centre of the shaft, the skeleton of an adult female appeared enveloped in sea-weed. Under the neck was a lacrymatory, and on the middle finger of the right hand a key-ring. Three feet further we met a layer of human skeletons, laid head to feet, the bones being here in excellent preservation,—as, indeed we found them to be in all places where the calcareous clay came into immediate contact with them. There were ten adult male skeletons on this spot, and separated by a foot of clay between each, five layers were found, being fifty in all. I may state that toads in large numbers were found alive in this part of the pit. We had now reached a depth of 42 feet in the shaft, the bones of another horse were turned out, and then we came on loose sand to a depth of 5 feet. Six more skeletons were here again exposed. The sides of the shaft were regular and smooth, the mark of the chisel on the rock being as fresh as when first formed. Six feet more of the loose sand being now taken away, hard bottom could be felt by the steel rod, and there lay two skeletons, male and female, enveloped in sea-weed; and in a large amphora at the corner, which was unfortunately found crushed, were the bones of a child. Some beautiful specimens of pottery, lacrymatories, beads, and a few coins, were all that I got to repay my labours on this spot. I examined well on every side, and in the rock below, for a trap-door or concealed passage, and an abrupt perpendicular division in the natural strata or layers of calcareous clay appeared to indicate the existence of such, but I found none. Everything during the descent had promised so very favourably, that I fully expected to have found a large chamber leading on from the termination of the shaft; but if such does exist, the discovery of the passage to it utterly baffled all my researches. The deep fosse, the mode in which the skeletons were found at the bottom, the six discovered immediately above these, the fifty about the centre, and the bones of the horses, are exactly in harmony with the description of Herodotus of the mode in which the Scythian kings were buried. The substance which I have called sea-weed, from its bearing a stronger resemblance to that production than anything else I can compare it with, may possibly be the "grass" described by Herodotus as used to envelope the body. If such be the case, the description is in all respects exact.

This wonderful place of sepulture must therefore be Scythian, and date with the very earliest colonization of the Greeks; full 500 years B.C. That able osteologist and comparative anatomist, Professor Owen, confirms this by pronouncing the crania brought with me from the bottom of the shaft, as certainly not of Grecian, but rather of Indo-European characters, and of the dolichocephalic variety.

On the Plastic Origin of the Cuneiform Characters, and its Relation to our own Alphabet. By JAMES NASMYTH.

Since Mr. Nasmyth first brought this subject forward in a lecture which he gave at the Royal Institution in 1838, so much additional interest has been excited in relation to the cuneiform character in consequence of the admirable discoveries and researches of Layard, Rawlinson and others, that Mr. Nasmyth availed himself of the opportunity afforded by the meeting of the British Association at Cheltenham to recall attention to the subject.

With this view he gave a complete practical illustration of the mode in which he conceives the cuneiform character had originated; secondly, how it was written; and thirdly, how far he conceives it to have been the parent of certain portions of our own alphabetic characters.

In respect to the first part of the subject, namely the *plastic* origin of the cuneiform characters, Mr. Nasmyth stated that he considered it was due to the simple circumstance of clay or plastic mud, in the form of bricks and tiles, having been employed as the chief building material by the primitive founders of the cities on the banks of the Euphrates and Tigris, that the cuneiform character owes its origin and adoption. Mr. Nasmyth showed, by a practical demonstration of the most convincing kind, that the peculiar triangular impression or indentation which is the distinguishing feature or characteristic element and basis of all cuneiform inscriptions, is the direct and inevitable result of the contact of the angle or corner of a hard or dried brick with the side of a soft one.

That the most perfect cuneiform characters can thus be inscribed on soft clay, Mr. Nasmyth proved to the meeting by rapidly inscribing a vast variety of cuneiform characters on plastic clay by the means referred to. He then proceeded to state, that although he considered it highly probable that the first idea of the cuneiform had thus suggested itself, yet as a brick would be found to be rather an awkward stylus to manipulate with, and as it was only the corner of the brick that was acting as the stylus, the cumbrous brick would soon be substituted by a triangular stylus as the most convenient agent to be employed in inscribing the cuneiform on plastic clay. In proof of this Mr. Nasmyth exhibited to the meeting an impression from a Babylonian brick which he had access to in the British Museum, in which the absolute size as well as the form of the stylus employed in impressing it was given. This specimen appeared to set at rest all doubt as to the nature of the instrument employed, as well as to illustrate the mode of using it. Mr. Nasmyth gave a practical illustration of the capability of such a stylus in enabling the inscriber to produce cuneiform characters of a vast variety of size as well as form, simply by varying the depth to which it was impressed into the clay.

In conclusion, Mr. Nasmyth stated his views as to the probable connexion that appeared to him to exist between certain parts of our own alphabetic characters and that of the cuneiform, referring in this respect to those portions of our alphabetic characters termed "Serifs," namely, the cross strokes which terminate the limbs of most of our capital letters. In illustration of this part of the subject he referred to several ancient Greek inscriptions, in which he showed that the characters of which they were formed were decomposable into absolute cuneiform elements; in many cases the bottom strokes terminating the limbs of the letters were so identical with the cuneiform element, that they were at right angles to the axis of the limb of the letter, and not parallel to the line of inscription.

Remarks on the Esquimaux. By JOHN RAE, *M.D., F.R.G.S.*

The Route between Kustenjeh and the Danube. By Capt. SPRATT, *C.B.*

On recent Discoveries in Australia. By Capt. CHARLES STURT, *F.R.G.S.*

On the earliest traces of Human Remains in Kent's Cavern. By E. VIVIAN, *M.A., Torquay.*

The cavern is situated between Torquay and Babbicombe, beneath a conical hill of the Devonian limestone, extending to a circuit of about 600 feet. It appears to have been first occupied by the bear and hyena, the remains of which, with the bones of elephants, rhinoceros, deer, &c., upon which they preyed, were strewn upon the rocky floor. By some violent and transitory convulsion, a vast amount of the soil of the surrounding country was injected into the cavern, carrying with it the bones, and burying them in the inmost recesses. Immediately upon its subsidence the cavern appears to have been occupied by human inhabitants, whose rude flint-knives and arrowheads are found upon the mud beneath the stalagmite. A period then succeeded, during which the cavern was not inhabited until about half of the floor was formed, when a streak containing burnt wood and the bones of the wild boar and badger was deposited, and again the cave was unoccupied, either by men or animals, the remaining portion of the stalagmite being, above as below, pure and unstained by soil or any foreign matter. Above the floor have been found remains of Celtic, early British and Roman remains, together with those of more modern date. Among the inscriptions is one of interest as connected with the landing of William III. on the opposite side of the bay, "W. Hodges, of Ireland, 1688."

The position of the flint instruments beneath the stalagmite, although contrary to the generally received opinion of geologists, and carrying back the first occupation of Devon to very high antiquity, was shown to be not necessarily at variance with Scriptural chronology, the deposit of stalagmite having apparently been much more rapid at those periods when the cavern was not inhabited, in consequence of a greater discharge of carbonic acid gas. Without attempting to affix with any certainty more than a relative date, Mr. Vivian suggested that there was reason for believing that the introduction of the mud was occasioned, not by the comparatively tranquil Mosaic Deluge, which spared the olive and allowed the ark to float without miraculous interposition, as was once assumed by Dr. Buckland, but by the greater convulsion, alluded to in the first chapter of Genesis, which destroyed the pre-existing races of animals—most of those in this cavern being of extinct species,—and prepared the earth for man and his contemporaries.

The original formation of the cavern was attributed principally to the action of trap and the volcanic action which had disturbed the strata in many parts of this district, causing deep fissures, as at Daddy's Hole and Ansty's Cove.

The sources from which the statements in the paper were obtained were principally the original manuscript memoir of the late Rev. J. MacEnery, F.G.S., which is deplored by Professor Owen, in his *Fossil Mammalia*, and by other writers, as lost to science, but which had been recovered by Mr. Vivian and was produced before the Section; also the report of the sub-committee of the Torquay Natural History Society, and his own researches. Photographic representations were exhibited of the fossils, showing the connexion between the teeth of elephants, horns of deer, &c., found in the cavern, and in the submerged forest in Torbay.

The following was read amongst other extracts from Mr. MacEnery's manuscript:—

"The floor we found at our first visit covered, through its whole extent, with a darkish mould, varying in depth from a few inches to a foot. It only dates since the cavern became a popular place of resort, and the further progress of the stalagmite in open situations was interrupted by the trampling of visitors. In the vestibule were found, deep imbedded in it, those curiously shaped pieces of oak to which the appellation of Druids-sandal was given, as has been remarked,—together with a quantity of decomposed animal and vegetable matter, the remains of fires and feasts, mingled with rabbit bones.

"In the crevices of the rock, and in the cavities occasioned by the overlapping of fallen masses, were concealed the skeletons of such animals as strayed or retired hither to die, such as dog, hare, rabbit, sheep; and the remains of the bat, with its delicate framework spread out on the black mould, were particularly noticed.

"But, for greater precision and perspicuity, I shall take the chambers in the order they are visited in. To commence with the common entrance.—Here, once for all, I must solicit indulgence for entering into details apparently unimportant. In this cavern are found grouped together, phænomena which have only been observed separately in others, dispersed over divers countries. By closely examining the disclosures of this, a clue may be obtained to all. At the hazard of unnecessarily charging the thread of my narrative with seemingly frivolous particulars, I proceed to note down the characters presented by its general aspect, no less than its contents, before it was altered by those operations which have since left no part of it in its original state. It is only on a just appreciation of all their circumstances that a true estimate can be founded of those facts which should serve as the basis of all reasoning on its nature and history.

"The floor of the entrance, except that it had the appearance of being broken up, offered nothing remarkable to detain us;—we shall have occasion to return to it presently. Not so the lateral branch by which it communicates with the body of the cavern on the left; at this point so great was the obstruction, from the accumulation of mould and a fallen ledge of rock lying across the way, that those who then visited it will not have forgotten their accomplishing the passage on all fours. These impediments have been partly removed. Under a similar ledge on the left, still standing, was found the usual sprinkling of modern bones; and, in the mould beneath, which had acquired the consistence of hard clay, were found fragments of pottery, calcined bones, charcoal, and ashes,—in the midst of all were dispersed arrow-heads of flint and schist; the ashes furnished a large proportion of the mould. In the same heap were discovered round slabs of roofing-slate of a plate-like form, some crushed, others entire. The pottery is of the rudest description, made of coarse gritty earth, not turned on a lathe, and sun-baked; on its external margin it bears zigzag indentations, not unlike those represented on the urns found by Sir Richard Hoare in the barrows of Wiltshire. These fragments, there seems no reason for doubting, are the remains of cinerary urns which once contained the substances scattered around, and to which the slates served as covers. At a short distance nearer the entrance were found, in a continuation of the same mould, articles of bone, of three sorts,—some of an inch long and pointed at one end, or arrow-heads,—others about three inches long, rounded, slender, and likewise pointed.

Conjecture was long busy as to their destination; they were thought by some to be bodkins; by others, for confining the hair, like those ornaments used by the women in Italy; lastly, they were supposed, with more probability, to be a species of pin for fastening the skin in front which served savages for garments.

The shaggy wolfish skin he wore,
Pinn'd by a polish'd bone before.

"The third article does not seem quite so easy to explain: it is of a different shape, quite flat, broad at one end, pointed at the other; the broad part retains the truncated form of a comb, the teeth of which were broken off near their root,—whether it was used as a comb or for making nets for fishing, is not clear. There was only this solitary one found, and two of the former, but several of the first, with a quantity of bone chips. All three bore marks of polish. Nearer the mouth are collected a good number of shells of the mussel, limpet, and oyster, with a palate of the Scarus. This, as well as the nacker of oysters, which was thickly disseminated through the mould, served, as they do at the present day among savages, most probably for ornament. The shell-fish may have furnished bait for fishing. The presence of these rude articles render it probable that they were collected here by the ancient aborigines, who divided their time between the chase and fishing in the adjacent sea.

"Close to the opposite wall, in the same passage, buried in black mould, I found a stone hatchet, or celt, of syenite, the only one found in the cavern. Another of the same material, but of a different shape, I found shortly after, not far from the cavern near Anstis Cove, which the labourers engaged in making the new cut had just thrown up with the mould. As we advanced towards the second mouth, on the same level, were found, though sparingly, pieces of pottery. The most remarkable product of this gallery were round pieces of blue slate, about an inch and a half in diameter and a quarter thick. It may have served, like the Kimmeridge coal, for money. In the same quarter were likewise found several round pieces of sandstone grit, about the form and size of a dollar, but thicker, and rounded at the edge, and in the centre pierced with a hole, by means of which they seem to have been strung together like beads. Clusters of small pipes or icicles of spar, such as depended from the roof at our first visit, we saw collected here in heaps buried in the mud. Similar collections we had occasion to observe accompanied by charcoal, throughout the entire range of the cavern, sometimes in pits excavated in the stalagmite. Copper ore with these various articles in the same stuff was picked up; a lump much oxidized, which the late Mr. Phillips analysed, was found to be pure virgin ore. Though this branch of the cavern is more spacious and the mouth more ample, it by no means furnished an equal proportion of antiquities as the other. Several of these articles were slightly encrusted with a pellicle of stalagmite, according as they happened to lie within the reach of the drop when exposed on the surface. Having taken a general survey of the surface of the floor, we returned to the point from which we set out, viz. the common passage, for the purpose of piercing into the materials below the mould. Here, in sinking a foot into the soil (for of stalagmite there remained only the broken edges adhering to the sides of the passage, and which appeared to be repeated at intervals), we came upon flints in all forms,—confusedly disseminated through the earth, and intermixed with fossil and human bones, the whole slightly agglutinated together by calcareous matter derived from the roof. My collection possesses an example of this aggregation in a mass consisting of pebbles, clay, and bone, in the midst of which is imbedded a fine blade of flint, all united together by a sparry cement. The flints were in all conditions, from the rounded pebble, as it came out of the chalk, to the instruments fabricated from them, as arrow- and spear-heads, and hatchets. Some of the flint-blocks were chipped only on one side, such as had probably furnished the axes, others had been on several faces, presenting planes corresponding exactly to the long blades found by their side, and from which they had been evidently sliced off; other pebbles were still more angularly chipped at all points, which were no doubt those which yielded the small arrow-heads, which abounded in by far the greatest number. Small irregular splinters, not referable to any of the above divisions, and which seem to have been struck off in the operation of detaching the latter, not unlike the small chips in a sculptor's shop, were thickly scattered through the stuff, indicating that this spot was the workshop where the savage prepared his weapons of the chase, taking advantage of its cover and the light. I have discovered in this passage precisely similar arrow-heads to those which I detected in an urn from a barrow presented to me by the Rev. Mr. Welland. With the exception of the boar-spear and a blade of the same metal found not far from it very much rusted, all the articles in the mould, or in the disturbed soil, consisted of flint, chert, syenite, and bone,—such primitive substances as have been in all countries, and down to the present, used by the savage for the fabrication of his weapons, whether for the chase or battle. At a still greater depth, near the common entrance, in the passage, lay extended, lengthwise, in the ordinary position of burial, the remains of a human skeleton, much decayed;—two portions only of the jaw and some single teeth, with the mouldering vertebræ and ribs, were all that remained. As in the case of the flint-knife mass, already described, there adhered to the jaw portions of the soil on which it lay, and of the stalagmite which partly covered it. The teeth were so worn down that the flat crowns of the incisors might be mistaken for molars,—indicating the advanced age of the individual. M. Cuvier, to whom I submitted the fragments, in 1831, was struck with the form of the jaw. He pronounced it to belong to the Caucasian race: he promised to bestow particular notice on it, but death, unhappily for science, put a stop to his glorious labours. All the specimens, together with a collection of fossil bones,—the third I had presented to the museum of the Jardin des Plantes,—I transmitted to him before I quitted the Continent, and may be found among his effects. The skeleton lay about a foot and a half below the surface; from the tumbled state of the earth, the admixture of flags of stalagmite, added to the presence of flint articles and pieces of slate, it was manifest that the floor had been dug up for the reception of the body, and that it was again covered over with the materials thrown up from the excavation. The earthy covering consisted of the red soil, containing fossil bones mixed up with recent mould; the mound of earth outside the mouth, at the right hand, was thrown up from the passage to render it more accessible. It was precisely that which covered the human skeleton and contained the admixture of human and fossil relics. Previous to the disturbance of the floor for the admission of the body, it would appear, from the presence of flags of stalagmite in the rubble, that it was covered by a continuous crust,—the edges indeed of which still adhere to the sides. It further appears from the repetition of similar crusts, as indicated by the broken edges at the sides, that there were periods of repose which allowed new floors to form, marking clearly their repeated destruction and renovation at intervals of time. With the exception of single teeth and an occasional rib or vertebra in charcoal, which may have possibly belonged to the same subject, there were no other traces of human remains."

Further extracts from this manuscript will be found in the Geological Section, p. 78.

STATISTICS.

Opening Address by LORD STANLEY, *M.P., President of the Section.*

I BELIEVE it will be my duty to open the proceedings of this Section by a few words relative to the purpose of our meeting; and I must begin by observing, that the remarks which follow were prepared before the passing of that resolution of yesterday, which has enlarged the scope of our duties so as to include, in addition to Statistics, properly so called, Economic Science in general.

It is needless in this presence to define, at any length, the nature or the object of statistical science. The axiom on which that science is based may be stated thus: that the laws by which nature is governed, and more especially those laws which operate on the moral and physical condition of the human race, are constant, and are, in all cases, best discoverable—in some cases only discoverable—by the investigation and comparison of phænomena extending over a very large number of individual instances. In dealing with the individual human being every thing is uncertainty: in dealing with man in the aggregate, results may be calculated with the precision and accuracy of a mathematical problem. To take a familiar instance,—the length of a single life can never be known beforehand; but by the accurate keeping of returns the aggregate length of ten thousand or a hundred thousand lives is easily ascertained. This aggregate length, the conditions of life being generally the same, approximates to a constant quantity, however often the experiment be repeated; and from that quantity, thus obtained, we deduce an average, which, as the experience of every insurance office shows, is near enough to the truth for ordinary purposes of calculation. Accidental diversities, whether of internal constitution or of external circumstances, tend to neutralize one another. Their influence diminishes as the area of investigation increases, until, if that area be sufficiently extended, we are justified in disregarding them altogether, and in admitting as approximately, if not as absolutely true, the general inference to which our successive trials point. I will not lead you into those strange and startling conclusions to which Quetelet has come, when comparing some of the averages obtained with one another, and representing them in mathematical form; he finds in the laws thus discovered a close resemblance to, perhaps an actual identity with, those which operate in physics; as, for instance, when he lays it down that the obstacles which oppose the increase of population act in a manner exactly the same as does the resistance of the medium in which a body moves to the motion of that body. Wide as is the field of thought which such a suggestion opens, it must probably be, for many years, premature to enter it: the laws as yet made known to us by statistical research are too few to allow of generalization relative to their mutual inter-connexion. Enough to cite the dictum of Quetelet, confirmatory of what was said above, "All observation tends to confirm the truth of this proposition, that that which concerns the human race, considered collectively, is of the order of physical facts: the greater the number of individuals, the more completely does the will of individuals disappear, and allow the series of general facts, which depend upon the causes by which society exists and is preserved, to predominate. . . . . We must admit, that on submitting to careful experiment unorganized bodies, and the social system, we are unable to say on which side causes act in their effects with the greatest regularity."

This, then, is the first characteristic of statistics as a science: that it proceeds wholly by the accumulation and comparison of registered facts;—that from these facts alone, properly classified, it seeks to deduce general principles; and that it rejects all *à priori* reasoning, employing hypothesis, if at all, only in a tentative manner, and subject to future verification. It starts from the assumption, verified by many trials, that human action, fluctuating as regards the human unit, is approximately invariable as regards the masses which make up society. But there is another aspect in which it may be considered. As a rule, the degree of certainty which attends any science is exactly proportioned to the extent to which such science admits of the application of numbers. We know what has been done for chemistry by the discovery of a single numerical law—the theory of definite proportions—turning, by one stroke, into a science, what was before little more than a collection of important, but detached observations. And what we aim at in statistics is, to substitute for vague phrases, intended to express certain qualities, arithmetical formulæ, by which the same idea may be conveyed with a precision to which language alone cannot attain. For instance, the uneducated man, speaking of a climate or season of the year, will say only that it is warm, hot, or very hot; the statistician registers the temperature of each day, strikes an average, and gives his result, in numerical form, extending, it may be, over a period of several years, and calculated, accordingly, with the most absolute accuracy of which human investigation is capable. Again, the traveller, in describing a nation which he has visited, writes that offences of violence are exceedingly common, probably more so than in any other country; the statistician obtains returns of convictions, distinguishes the different classes of crime, ascertains the per-centage of murder, or assaults per head, on the total population, allows for the probable amount of undetected criminality, and finally compares these results with others similarly obtained in other parts of the world.

When, therefore, in discussing social questions, we apply the statistical test, we are really doing nothing more than appealing from imagination to fact,—from conjecture to certainty—from an imperfect to a perfect method of observation. In the principle, srrictly speaking, there is no novelty: every sensible and observing man who has lived in a civilized state of society, has been to some extent a statistician; the novelty, consists, first, in the greater accuracy with which, and the enlarged scale on which, facts can be collected in modern Europe; and, secondly, in the practical application of that theory, which to philosophers must, from the analogy of inanimate nature, have always appeared probable—the theory, namely, that organized beings, taken in the aggregate, are governed in their acts by determinate and discoverable laws.

It is obvious that in a science of this kind, unlike many which have occupied the attention of mankind, little room is left for imagination, and as little for error. On the first ground, the study is unattractive even to many who appreciate its value; on the second, it is eminently and necessarily progressive. "Hypotheses non fingo,"—those memorable words of Newton's—should be written over the door of every Statistical Society in Europe. Nor is there any branch of mental exertion so calculated to promote a cosmopolitan habit of thought and feeling. Man is the object studied; and man, so studied, is seen to vary in different countries only in consequence of discoverable influencing causes, such as race, climate, food, laws, modes of life, &c. However great, therefore, the external differences between branches of the human family, the tendency of sociology is to eliminate these differences one by one, to refer each of them to its several specific orgin, and thus, finally, to bring to light the essential unity of type which underlies them all.

I would also observe, that as an experimental science, the progress of statistics is not liable to those delays which impede the advance of many other branches of knowledge. Where, as in mathematics, the work to be done is transacted necessarily and exclusively within the mind of the discoverer,—where not the quantity, but the quality of intellect brought to bear is all-important,—great advances are rare, for the plain reason that they can only be made by men of extraordinary capacities. No number of ordinary proficients in mathematics, working jointly, can make up for the absence, or supply the place, of one Newton. But though not one man in ten thousand can be distinguished as an analyst or a geometer, the number is far larger of those who possess the mental requisites for statistical investigation, at least in its simpler forms: and without disparaging the remarkable talent for arrangement and generalization evinced by such men as Quetelet, and by some of our own countrymen whom I will not here mention, it may be safely affirmed that the extension of statistical inquiry depends less on the appearance among us of any one mind of more than common power, than on the sustained and cooperative industry, encouraged by the State, of many minds trained to this pursuit, and each taking a separate and distinct department in which to labour.

It is almost superfluous to point out the sources of those errors which most beset statisticians. They may I think be reduced under two heads: (1) Calculation of mean results from an insufficient number of data; a fault, from the effects of which, in finances, many provident societies are suffering grievously: (2) Calculation of mean results without sufficient care being taken to eliminate disturbing causes: whether this omission arises from the classing together of phænomena essentially distinct, and referable to separate laws, or from omitting to make allowance for imperfections in the data supplied, *e.g.* as though one engaged on criminal statistics were to assume that all offences committed were actually brought to light, overlooking those in which no detection follows, and, consequently, in which no trial takes place. Neither of the sources of error which I have mentioned are difficult to avoid. The one danger against which they warn us is that of premature conclusions. In all physical science, but in no science more than this of which we treat, is supension of judgement necessary. I mean by the phrase, that temper of mind which says, "I neither believe nor disbelieve; evidence is wanting to do either. I only wait and hold myself free from bias until further facts are adduced." How easy this is in theory,—how hard and painful in practice, need not be told to any one who has given time, and thought, and toil to the proof or disproof of a scientific hypothesis.

Time would not allow me to attempt even the most rapid and hasty survey of what has been done, and of what yet needs doing, in the way of statistical research. Generally,—I think we may say this of the progress of the science in England,—that what defects remain arise principally from causes beyond the control of individuals. Statistics are the function of the State in a sense in which no other science is so. The details of population, of employment, of instruction, of religious worship, of commerce, and of health, are already recorded in official publications; those of agricultural production we may hope will shortly follow. The branch which I principally note as deficient is that which relates to civil and criminal judicature. Lord Brougham has brought this subject before the House of Lords, and even embodied in a Bill the data on which information is needed. We require a regular and uniform record to be kept of every fact connected with the administration of the law. We require to know, in civil proceedings especially, the number and nature of suits that go to each court, the length of time occupied in their decision, the nature of that decision, and the cost to the parties. Our criminal returns might be fuller than they are: they give us at present absolutely no information respecting that vast class of offences (of late much increased) which are dealt with under summary jurisdiction. It is not wise in any country to copy servilely the practice of another: local differences may create and necessitate diversity of procedure. But I may refer to the annual reports (two yearly volumes) of the Minister of Justice in France as examples of an almost perfect arrangement of complicated statistical details. One result of that publication is to show a vast local difference between department and department in the nature and amount of crime. It is obvious, that when such a difference is shown, by the lapse of a sufficient period, to be chronic and not merely casual, the Government, whose attention is thus invited, must feel itself bound to investigate the source of the evil, and, if possible, to provide a cure. In fact, an executive regularly supplied with such knowledge, may be said to have its finger on the pulse of every province, ready, at the first symptom of disease, to intervene with the requisite remedy.

There is another suggestion which I may make, and which indeed connects itself with this last. I allude to the advantage, I might almost say the necessity, of establishing a Statistical Department of Government, charged with the annual publication of such facts relative to the management of national affairs, as are reducible to numerical expression. We have statistics enough presented to Parliament every session, but they are, in the great majority of cases, called for by individuals. They are drawn out to suit the particular purpose of those who move for them: they are, accordingly, deficient in unity, and often of no use beyond the moment. Now I speak from some personal observation when I say, that at a cost hardly greater than that of these desultory, fragmentary, isolated returns, (which have in addition the inconvenience, coming as they do, at unexpected times, and without any regularity, of throwing a sudden increase of work on particular offices,) it would be possible to present to the nation such a yearly *résumé* of administrative statistics, as should, to a very great degree, supersede the present system (if system it can be called) of moving for returns as, and when, they are wanted.

I have said that I think a Statistical Department desirable, instead of a Statistical Branch in every Department; because the former method gives better security for unity of plan, and because the work will be best done by those whose sole and undivided business it is.

I have not referred to the meetings of the International Congress of Brussels and Paris, because on such a subject I could offer no remark that would not naturally occur to those whom I address. Such meetings have a twofold value. First, they extend the field of statistical research: and we have seen that accuracy of result varies directly as the magnitude of the area of investigation. Secondly, they form a new link between nation and nation; because, though speech differs, arithmetical notation is the same everywhere. In proportion, therefore, as numerical is substituted for descriptive statement, we approach nearer to that otherwise impracticable dream of philosophers—a universal language.

There is, I believe I may state, a probability of the Congress of 1857 being held in London; an expectation which seems both natural and reasonable, inasmuch as it has been averred in public, and not denied, that the first design of holding such international meetings was suggested by the analogy of the Hyde Park Exhibition of 1851.

Should the event I allude to take place, it will become the duty of all concerned in statistical science to see that such an opportunity does not pass unimproved; so that 1858 may find us with a thoroughly organized system for the annual collection and publication of national facts, assimilated, if possible, to the systems of France and Belgium. For it must be borne in mind, that the objects to be aimed at are two: one, the adoption of a method as perfect in itself as possible; the other, the assimilation of that method to those which prevail elsewhere, so that nations may mutually profit by each other's experience.

As a proof how much such comparing of notes is required, I may remind you that the census of Ireland and Scotland was taken in a manner different from that of England, while no attempt has ever been made to bring the entire British empire, including India and the colonies, under a single statistical organization.

The constitution of such a statistical department as we require is matter of fair discussion at the approaching Congress. Probably the most effective combination of working talent would be that obtained by the appointment of a Commission or Board, to preside over the issuing of official publications, partly composed of scientific men, partly of members of the permanent or parliamentary administration (the former preferably, as having more leisure), who would bring in the necessary element of a knowledge of official customs. This is, I believe, the system actually existing in Belgium. In Prussia there is a Minister at the head of the Statistical Department. Those who wish to see the question more fully discussed, will find information in a valuable Report by Dr. Farr to the Registrar-General, dated October, 1855, p. 108 *et seq.*, of the Registrar-General's Sixteenth Annual Report. It was also gone into at the Paris Congress of 1855, and a debate upon it will be found in the volume of Proceedings, s. 360 *et seq.*

I wish also to point out to the Association the advantage of such a communication between the Home Government and the leading British colonies, in reference to the approaching Congress, as may enable such of them as desire it to represent themselves by means of delegates.

Before I conclude, let me read two letters from the Secretary to the London Statistical Society, giving an account of an important work in which its members are engaged, the only work of the kind which the Society has just now on hand.

"Statistical Society, 12 St. James's Square,
London, 5th August, 1856.

"My Lord,—A Committee was appointed by this Society on the 25th January of this year to collect information relating to the Beneficent Institutions of the Metropolis. The class of institutions to which their attention was first directed was the Medical Charities. They have received reports from 49 hospitals, of which the total annual income is £352,370, and from 58 dispensaries, with a total annual income of £28,192; besides this, the Samaritan and other small funds connected with hospitals have an income of £1656; the Poor-Law-Board's expenses for medical officers are £28,000, and for vaccination £4000, so that the total sum expended in medical relief in the Metropolis is £414,218 per annum. The Committee will shortly be able to publish a detailed account of the items of which this income consists, deduced from the reports of the institutions themselves.

"I am, my Lord, your Lordship's obedient Servant,

"Edward Tudor Scargill."

"Lord Stanley, M.P."

"Statistical Society, 12 St. James's Square,
London, August 6th, 1856.

"Sir,—I have received from Mr. Lumley, this morning, the Returns relative to the expenses of the Poor-Law-Board in the Metropolis.

"Hence I have deduced the following statement, which I believe to be as correct as it is possible to make it from the information in my hands.

	£
Annual income of 49 Hospitals	352,370
,, 58 Dispensaries	28,192
,, 11 Samaritan and other Funds (dependent on Hospitals and Dispensaries)	1,656
Annual cost of Medical Relief under Poor-Law	28,776
,, Vaccination ,,	4,393
Total amount of Medical Expenses	415,387
,, Poor-Law Relief, *not medical*	736,809
	£1,152,196

"I am, Sir, your obedient Servant,

"Dr. Farr, F.R.S. "EDWARD TUDOR SCARGILL.

"P.S.—I have reduced the francs to £ sterling, and am able to give you, as the nearest comparison that can be made, the following:—

Hospitals and Dispensaries.

London: £256,558 | Paris: £215,664

Lunatic Asylums and Medical Poor-Law Expenses.

In London, contrasted with Hospices in Paris*.

£158,829 | £184,304

"The sum expended in non-medical relief under the Poor-Law (£736,809) would have also to be taken into consideration, as well as the very considerable sums expended in the support of aged and infirm persons in alms-houses. Against this, in the case of Paris, will have to be set £160,882, which with the two sums already quoted, appears to be the sum devoted to the relief of poor, aged, infirm, sick, and lunatic persons in Paris; giving, as a grand total, supposing that I have rightly understood Mr. Legoyt's letter,

For London: £1,152, 196 | For Paris: £560,853

"The returns of the 49 hospitals include a sum of £72,402, paid from parish rates to lunatic hospitals.

"In Paris, in 1853—

	Francs.
Expenses of the *Hôpitaux*, including *Maisons de Santé* and *Maisons de Convalescence*	5,391,614
,, *Hospices*	3,948,323
,, General Management	631,168
,, General Establishments for the use of both *Hospitals* and *Hospices*	28,161
	9,999,266

"The receipts of the Central Board (*l'administration générale de l'assistance publique*) are of various sorts, and are not all applicable to medical charities.

	Francs.
In 1853 their amount was	9,583,148
,, Annual Municipal Grant	4,438,181
	14,021,329

"Assuming that the population of Paris is one-half that of London, the sum expended, at the Paris rate, for a population equal to that of London, would be £1,121,706; the total expenditure for London being, as just stated, £1,152,196."—E. T. S.

I have now only to announce to you the papers about to be read, and to request attention to the following rules, laid down for the sake of brevity and clearness in our proceedings:—

"To avoid reading long consecutive lists of figures, and, as far as possible, to give only results.

* Including central expenses.

"Where money is in question, to avoid shillings and pence, stating only the number of pounds.

"Where large sums are concerned, to give round numbers, avoiding units."

Of course there is a medium in observing these directions; and if the choice lies between the two, better be obscure than inaccurate. All I mean to convey, is that over-minuteness in these matters is apt to defeat its own ends.

Statistics and Suggestions connected with the Reformation of Juvenile Offenders. *By* T. Barwick Lloyd Baker.

The author commenced by saying that it was not necessary at the present time to go into the general question—whether Reformatories were good or bad. The voice of the country had decided that point, and probably by Michaelmas there would be only two counties which would not be provided for. But there were three points which he thought had hardly received the attention they deserved: and he would confine himself to these.

The first and principal point was the necessity of paying attention, not merely to the individual boys who chanced to be committed to the school, and endeavouring to reform them, but the paying attention also to the statistics of juvenile crime in the district, with the view of finding out all those who are extending the evil by corrupting and teaching others. The apprehension of one or two leaders of a gang will frequently restore the others to at least comparative habits of honesty: but what is far more important, the apprehension of one or two instructors in crime will prevent the temptation and fall of perhaps eight or ten others whom they would have corrupted. He produced some local statistics of juvenile crime, showing that the number of boys under 16 years, convicted in the Cheltenham district of any offence since the 1st of January, 1852, was 149. Of this number, 54 may be termed regular thieves; 39 have been, or are at Hardwicke, of whom two had not been convicted; 9, convicted once; 16, twice; 6, three times; 4, four times; and 2, five times. Of these youthful prisoners nearly all had had a fair education*, and could read and write well; and the statistical result, in that point of view, did not show that mere instruction prevented the necessity of reformatory schools. Mr. Baker explained that the object of the reformatory school was to clear out of the district all who might be termed regular thieves, and gradually to reduce to the lowest the amount of criminality which might be considered to confer the title of regular thief. This, he said, must vary in different towns. In Liverpool, from which place he had lately had several boys, there were many who lived entirely by plunder for years together; and a boy who usually works, and only occasionally steals, even though he might be three or four times convicted, was comparatively a trifling case. In Cheltenham he did not believe that for the last three years there had been a single boy belonging to the place who had gained one-half of his keep dishonestly for a month together. The term, therefore, "regular thief" is applied to all who had been convicted a second time, even though many of the cases were extremely slight.

Extracting from the total number of convicted boys returned by the Cheltenham police during the 4½ years all those who either were convicted a second time, or whose first offence was considered sufficiently serious to send them to a reformatory school, it gave a total of 54 regular thieves, *i. e.* either twice convicted, or such as were thought worthy of being sent to the Hardwicke Reformatory on a first conviction. Of these, 39 had been, or still were, at Hardwicke, 8 were long past age, and 7 are still in the town. Of these seven, two have not been convicted since May 1854; and the other five†, though repeatedly convicted, were merely very slight cases of vagrancy. Considering that in January 1852 there were 20 boys who had been twice, thrice, or four times convicted, this result he (Mr. Baker) considered not unsatisfactory. With regard to the 39 boys who had been or were at Hardwicke, he by no means pretended that all were "reformed," past the possibility of again falling into crime.

* Of 39 who have been sent to Hardwicke, 15 could read and write well, and were well up in the four first rules of arithmetic; 17 could read and write sufficiently to understand and be understood, though with incorrect spelling, and were fairly up in addition and subtraction; and 7 only were below this point.

† Of these 5, 3 have been since committed to Hardwicke.

He could not predicate more of them than he could of himself. But all had at least been kept long enough away from Cheltenham to break the course of education which had been handed down from boy to boy. Of fifteen who had left the school, six were doing well, one had fallen, but was still hopeful, three unsatisfactory, but never convicted, four had been convicted, and one had not been heard of lately. The other twenty-four were still either in his (the Hardwicke) school or in others, where situations would probably be found for them that would keep most of them away from Cheltenham. He was by no means one of those who abused the prison system. In many points it was admirable; but it certainly had the grand failing, that after a boy or man had undergone his punishment he was returned to the world with very little capability of earning an honest livelihood, or doing anything but steal again. Now, he thought they might say,—1st, that they had been able at Hardwicke to receive for two years all regular thieves, and to break off the connexion between them and the innocent; 2ndly, that they had wiped off from themselves the reproach of committing boys to prison, and then turning them out without enabling them, if they pleased, to live honestly; 3rdly, that they had reduced the degree of evil necessary to confer the title of regular thief as low as they could well hope, there being now no such thing as a gang, or connexion between the dishonest boys, but all being merely boys yielding to a sudden temptation,—not premeditately planning a theft.

The two other points he would touch upon very briefly. When a boy was once committed to the school for two years, he believed it was by no means intended by the Legislature that he should necessarily remain the whole of those two years at the school. It was extremely undesirable that he should do so, because it would then be difficult to find a place for him exactly at the moment that his sentence chanced to expire. Power had been given to the Secretary of State to release a boy at any time upon good grounds shown for it; he always appeared willing to exercise this power. But if he could go further, and, without granting a pardon, he could *allow a boy leave to go on trial for a time*, it would enable the managers, if the boy behaved ill or did not suit his place, to receive him back again, and at any rate to keep a more thorough surveillance over him for the first part of his new service.

The third point was the allowing a parent or guardian, where good proof of respectability could be shown, and in such cases as in the opinion of the committing magistrates and manager of the school should be desirable, to bail a boy out from the school, on finding security for his good behaviour for a time *longer* than the expiration of the sentence. Mr. Baker then concluded by recapitulating the three points:—First, the giving attention to *clearing a district* *; second, the *giving leave on trial*; third, the *permitting bail.*

Statistics of Cheltenham. By Richard Beamish, *F.R.S.*

This paper gives a short account of the early history of Cheltenham, its connexion with the Crown, and grant to the celebrated Bohun, Earl of Hereford, its present government under commissioners, and its rapid increase in population from 3076 in 1801 to 35,051 in 1851, being greater than that of any town in England, with the exception of Lemington Priors, which in 1801 numbered but 315 inhabitants, and in 1851 15,724; Cheltenham having increased 1039·5 per cent. in 50 years, while Lemington in the same time increased 4891·74 per cent.

The paper further shows the salubrity of the climate of Cheltenham in the longevity of its inhabitants, and its immunity from epidemic diseases, cholera never having visited the town, which is attributed to the high range and great equality of tempera-

* The Gloucestershire Quarter Sessions at Midsummer ventured on what will probably be a most important step in recommending to the magistrates of the county, as a general rule, (*not* without exception nor interfering with the due discretion of the magistrates) to send all boys on a first conviction to gaol for *one week* (thus securing the lowest diet, and not giving them time to overcome their dislike to a prison). If they are convicted a second time, to send them to the Reformatory. If they relapse after this, they fairly merit penal servitude.

If this be feasible, as it probably now is in Gloucestershire and will be in all counties when they have had sufficient time, three important points will be gained. 1st. There will rarely be any boys in our gaols. 2nd. No boys can become habituated to gaol. 3rd. Unless the police are very careless, no boys can obtain sufficient practice in crime to enable them to teach others.

ture, combined with the excellent sanitary regulations of the place. The discovery and application of the mineral waters are stated; their popularity as curative agents, and their subsequent decline. A considerable portion of the paper is allocated to the statistics of secular and religious education, from whence it would appear that Cheltenham has attained a pre-eminence above all the towns in the kingdom, and that while secular education has been extended from 1 in 17¼ of the population in 1818, to 1 in 8¼ in 1851 throughout the kingdom, Cheltenham reckons 1 in 6, whilst the accommodation afforded for religious worship in its churches and chapels amounts to no less than 60 per cent.

Interesting details are given of the rise and progress of the various schools and proprietary colleges, and more particularly of the resuscitation of the Cheltenham Grammar School, the amount of money expended by these establishments in the town, that of the Cheltenham Proprietary College being upwards of £16,000 per annum; the Grammar School and Training College upwards of £5000 each. The author dwells strongly upon the importance of schools for the adult poor. "Father and son," he observes, "are thus found learning the same lesson; both drinking at the same purifying fountain; both being made to feel that there are higher pleasures than those of the senses, and that being without well-being may be a curse rather than a blessing." He considers that it is beginning at the right end, and "that however children may be instructed in their schools, their moral development must still depend upon their homes." He adds, "that it is scarcely possible to conceive any antagonism greater than the influence sought to be exercised upon the minds of children in a well-organized school, and those to which they are subjected in a rude semi-barbarous home; but bring the parent into sympathy with the intellectual and moral progress of the child, and the whole atmosphere is changed. Education then really commences, and every subsequent step in the path of knowledge adds another element to the lofty reciprocities of domestic and social life, and affords another defence against immorality and crime."

Pauperism and crime is brought into juxtaposition, and some illustrative evidence given of the evils resulting from eleemosynary institutions, in which Cheltenham, like Salisbury and Newbury, abounds, and which are found to exercise a baneful influence upon the moral condition of the people, and to weaken the efforts of the local authorities. In Cheltenham, the result seems to have been to increase largely the amount of larceny and of pauperism, although vagrancy has been repressed to the extent of 70½ per cent. since 1849.

The paper closes with an account of the Reformatory at Hardwicke Court, and the benefit which it has conferred on the county generally, and on Cheltenham in particular; and the author infers that one-half at least of those whom a prison would have consigned to a life of infamy, may be rendered valuable, if not worthy members of the community.

His conclusions are,—1st, that opportunity is afforded him whose moral tendencies are favourable, to break his connexion with the really vicious.

2ndly. That the instructed thief is deprived of his opportunity of daily exercise in his art, whereby his chance of future success is reduced to a minimum, and he is made to feel that life has charms, and labour has sweets which no amount of dishonest skill can obtain.

3rdly. That the heavy reproach against society is (so far as boys are concerned, and why not girls?) thus removed; that it punishes crime without providing any means by which to change the character of the criminal.

Suggestions on the People's Education. By the Rev. C. H. Bromby, *M.A.*

The principles laid down in this paper were as follow:—

1. That a rate shall not take the place but come in aid of voluntary benevolence.

2. That existing schools as well as future schools, originating in denominational zeal, and claiming the *rate in aid,* shall contribute threepence from subscriptions, collections, endowment, and children's payments, in order to secure for themselves denominational management.

3. That a local School Committee shall be empowered to establish new schools, which children in the receipt of outdoor parochial relief shall be *compelled* to attend, and

for whom the Guardians of the Poor shall pay the school premium; and the capitation fee now made by the Committee of Council shall take the place of subscriptions and donations.

4. That such a school shall be regarded in the light of a *preventive* school, and shall be industrial in its character.

5. That in all *ragged* or *preventive* schools, in regard of moral and religious instruction, the British and Foreign School might be taken as a type.

After briefly reviewing the system of public education in present operation, and which was originated in 1846 by Sir J. K. Shuttleworth, the paper proceeded to point out the more prominent defects of the system.

The pupil-teacher is apprenticed at an age too early to know his natural fitness for the office. He is often coaxed into it at 13, and at 16 he finds he has no heart for the work, becomes desultory in character, and loses rapidly in moral tone. 2. There is a want of unity of action in everything that relates to school-keeping. Each of Her Majesty's Inspectors has his peculiar views of school-fittings, school-method, and school-organization. A master is written down by one, and held up another year as a model. This is a growing evil, and the more so as new regulations place the master more and more absolutely in the hands of the Inspector. The third great defect is—the present system fails to carry help where help is most imperatively wanted. The problem which proposes to supply this defect has not been solved. No measure can succeed which does not distinctly show that the working of the present system will not be arrested. And yet almost every plan hitherto proposed has failed in this particular.

A Scheme proposed.—In order to excite and not to nip nor finally destroy subscriptions, let the amount of support borne by the rate hold a fixed proportion to the amount of voluntary subscriptions. It is found that in towns the average cost of each child is at the rate of 17*s.* a-year, or of fivepence a-week for 45 weeks in the year. Let grants be made to existing schools from the rates of twopence per child to meet threepence raised by local subscriptions and children's pence conjointly. The proportion in which the latter sum shall be divided may perhaps be left to be determined by the circumstances of the locality, but a minimum proportion of local subscriptions should be defined. Such a plan would have the effect of encouraging private benevolence up to the extent required, and at the same time it would leave disengaged any excess now found in the more favoured districts of a borough, for the benefit of those neighbouring localities which are now neglected. A subscriber who now pays £1 for the school of his own district, finding 10*s.* sufficient under the operation of the rate-system, would be likely to divide his original donation with another school, in order to enable it to claim the benefit of the rates, and remain under Denominational control. A great advantage would thus accrue from such diffusion. This plan would have the direct effect of encouraging combined Denominational action. Local School Associations would take the place of isolated Church or Chapel School Committees, and the poorer schools belonging to the same religious society would have an equal claim with the richer upon the central fund.

Compulsory Attendance.—There is great reason to fear that free schools in destitute localities would be comparatively empty without some inducement or compulsion. Poverty, intemperance, and improvidence, are not likely to beget any high estimation of school work. In Manchester and Salford, from inquiries of 17,426 families visited, the following results have been published:—

1. Children between 3 and 15 neither at school nor work, 17,177.

	Once attended.		Never attended.		Total.
Sickness..................	669	+	238	=	905
Domestic Causes	757	+	139	=	896
Poverty and Indifference....	6040	+	9336	=	15,376
Total	7466	+	9711	=	17,177

2. In spite of *improved* instruction and *increased* number of schools, the census returns show a *diminished* attendance.

Year.	Attendance.	Population.	Proportion.
1854–5	24,365	250,323	10–27
1851	29,145	387,816	13–30

These statistics go to show that no system, however perfect, will satisfactorily meet the educational wants of the land, so long as the improvident parent is under no obligation to send his children to the school. Even the Denominational Schools already supply more room than is filled, and if this be the case in the localities where the presence of the higher orders of society must exercise a favourable influence, it is more than possible, nay, it is sure that the free and rate-supported schools in wholly destitute neighbourhoods, will miss their aim for want of children. From the census return we find 17,002 children attending school in, Manchester and Salford, while private inquiry in connexion with Mr. Entwhistle's local scheme, gives the number 21,925. Taking the larger figure, and comparing it with the school accommodation which is given on the same authority, as 74,887 children, we find that two-thirds of the school accommodation is entirely wasted. How much lost energy therefore may be expected in those rate-supported schools erected and set to work in the still poorer and neglected localities, without some species of compulsion? But for what species of compulsion are we prepared? Mr. Horner remarks, "Popular education must be in some form obligatory, and *the successful working of the Factory Act in this respect is a very satisfactory beginning.*" Let the inhibitory clauses of the Factory Act be at once applied to at least similar fields of child employment; and in all other desultory and less organized spheres of labour, let it be illegal to employ a boy under 14 who cannot produce the school certificate that he has attended for three years, 172 days at least during each year. Above all we repeat, make it *compulsory* upon a child who receives out-door parochial relief, that he attend a day-school at the expense of the parish, and ultimately make a certificate of school attendance a condition of the elective franchise. Beyond this it is better to foster than to force. It is a favourable sign that the Government have adopted the employment of educational tests as passports to clerkships in public offices. The example of Government has been happily followed by the Society of Arts, who have established a system of examination with granting certificates of merit. A large number of capitalists, both individual and corporate, have signed a declaration that they will give preference to candidates for their more lucrative offices who hold these certificates. A great necessity presses upon the Government for establishing institutions of secondary education. In France we find *écoles de dessein* and schools of trade; but in England, the workshop of the world, where there is no law to compel attendance in the primary school, there is no opportunity of learning the principles of trade in the secondary school. The time has gone by when England can safely trust to her coal and iron, when steam can cheaply convey the raw material to countries who are educating their skilled operatives.

Another instrument of secondary education is the establishment of Free Libraries. Wherever the measure has been tried the most satisfactory results have followed. In the Parliamentary Return asked for by Mr. Ewart, we find very interesting details.

At Liverpool, "the number of volumes issued in the first year was 35,928, in the second 99,021, and the circulation is now 5000 per week."

At Oxford, "during the two years since its establishment 236,000 persons have visited the Free Library. Here the working-man finds rest after a day of labour, which he was wont to spend in a far less creditable manner."

At Salford we find the issue steadily increasing at the rate of 10,000 a year, while a corresponding improvement in taste is observable in the following comparison of the character of the books selected. The comparison is limited to 3000 consecutive issues of books:—

	All Classes except fiction.	Works of fiction.	Total.
1850	1069	1931	3000
1851	1316	1684	3000
1852	1816	1184	3000
1853	1915	1085	3000
1854	2199	801	3000
1855	2280	720	3000

Résumé.—In the advocacy of a supplementary measure, let it be distinctly seen that present schools will not be thinned by proximate free schools, and that they will not slip under the control of the local board. Let it be felt that such supplementary measure looks simply at present to the lowest and outcasts of our children. In this way the religious jealousy of denominations will be avoided, for they never quarrel about *ragged* children. According to the census of 1851, there were 132 Ragged Schools, with 23,643 scholars. Only nine of these schools were connected with particular denominations. The politician and philanthropist need not fear religious scruples here. Those who, as a rule, object to all religious teaching except what is formal and technical, are found to merge their scruples in the paramount necessity for converting the dangerous classes into new constituents of social strength. Here, at least, is a work in which the attractive element of philanthropy and pity is stronger than the repelling element of sectarianism. Nor will the advocates of national economy object either. They know that a million spent upon moral and industrial training will save ten millions in county rates. The simple state of the case is that two millions are neither at work nor school. The question is, how shall we obtain hold of them? We answer, refuse to feed by out-door relief those who attend no school. This would reduce the two millions by one-half. A fourth below those who receive out-door relief might still remain untouched, and another fourth above. But the lower fourth might be thinned by the provisions of Reformatories, and the fourth above them, who are the children of parents able but unwilling to educate them, would be stimulated by the improvement of those who are below them, and who are threatening to supplant them in the walks of life and industry. In Cheltenham there is a population of 35,000, of which number there are 867 children under 16 years of age receiving out-door relief. The parents are either hopelessly poor, or culpably unthrifty, and the majority of the children, as might be expected, are left to chance and ignorance. This is the point on which to put the screw. More compulsory measures may indeed be needed, but is the country prepared to adopt them?

On the Advantages to Statistical Science of a Uniform Decimal System of Measures, Weights, and Coins throughout the World. By SAMUEL BROWN, *F.S.S., and Vice-President of the Institute of Actuaries.*

There are few facts relating to material objects in which weight and measure do not form principal points in the comparison; and if the comparison be made for commercial purposes, value also becomes a prominent consideration.

Whoever has undertaken for statistical purposes to reduce a collection of facts to one measure for comparison, will recall the immense labour which the system of measures, weights, and coins prevalent even in this country has caused him. If, in addition to this, it be desired to make the comparison of the results with similar tables of other countries, how much additional labour is thrown upon him!

This difficulty has of late been felt so strongly since the frequent assemblages of men interested in science or commerce, that scarcely any meeting of consequence has been held without an expression of opinion on the incongruities of existing systems, and the importance of preparing the way for a change. At the Statistical Congress at Brussels in 1853, a resolution was carried, recommending that in the Statistical Tables of counties not possessing the metrical system, a column should be added indicating the metrical reductions of weights and measures. Previous to this, however, the great difficulty of comparing the measure, weight and value of articles from so many different countries as were represented in the Great Exhibition of 1851, had forced the subject on the attention of the Jurors. In every year since then an addition has been made to the number and influential position of those who advocate some uniform system. The resolution above quoted only partially removes the difficulty. It merely suggests the advantages of reducing all measures and weights to the metrical system, which is already extensively recognized; but it does not provide the means of dispensing altogether with the great labour required in the reduction.

The declaration signed by the Members of the International Jury of the Great Exhibition in Paris, or Commissioners sent by their respective Governments to the Exhibition, takes a more comprehensive view, and, without pledging themselves to the support of any particular system, they urge "upon the consideration of their respective Governments, and of enlightened individuals, friends of civilization, and advocates for peace and harmony throughout the world, the adoption of a uniform system of weights and measures computed decimally, both in regard to its multiples and divisions, and also in regard to the elements of all the different units."

At the Statistical Congress held in Paris last year, after a discussion originated by Mr. Peut, a resolution was passed still further extending the objects to be aimed at, and applying it expressly to the purposes of the Meeting:—"The Congress, considering how much the adoption by different nations of a uniform system of measures, weights, and coins would facilitate the comparative study of the statistics of different countries, resolves that it is desirable to put such a uniform system into energetic practice."

Of the extraordinary labour which attends the comparison of the statistics of different countries at the present time, no better idea could be given than by a little work containing only a few pages, which was prepared and published by Mr. Woolhouse in 1836, and which is still used by architects and contractors whose operations are carried on in foreign countries. It is entitled "Tables of continental lineal and square measures." Table I. contains a list of the principal lineal measures of the various countries, states, and cities throughout Europe, arranged in alphabetical order. The columns exhibit to 4 places of decimals the value of a unit of each respective measure, when estimated in English feet, Florence bracchi, French metres, Neapolitan palmi, Rhineland feet, Roman palmi, Venice feet, and Vienna feet. Under each column the number of different places in which the unit of measure is compared under Table I. amounts to 143, nearly all forming different proportions of the English foot. In the second table is shown the comparison of square and superficial measures for the same number of places.

In the discussion which took place at the Institution of Civil Engineers in February 1854, Professor Airy stated that for every different class of objects a different unit was adopted; that the multipliers of that unit were counted by the decimal scale of common arithmetic, and the subdivisions of that unit by the binary scale. Thus he enumerates—

The Acre (for land measure).
The Mile (for itinerary measure).
The Yard (for measure of drapery).
The Coomb (for capacity of corn, &c.).
The Gallon (for capacity of liquids).
The Pound (for grocer's ware).
The Stone of 8 pound (for butcher's meat).
The Stone of 14 pounds (for flour, oatmeal, &c.).

And the learned Professor did not consider that the Government ought to enforce a decimal scale except in coinage.

Now it is evident that if so many units are to be maintained, having no connexion with or relation to each other, and if they are not even to be divided decimally, and if foreign nations may each have as many units equally unrelated to each other, no great advantage would be gained by any change at all. If the inconvenience of an alteration of system must be encountered, the one adopted should at least be of such a kind, that no further change should be necessary, that the system should be decimal for the convenience of calculation, that it should be distinguished by the utmost simplicity, and that both measures and weights should be in harmony with each other.

The author states that at the present time no system so completely fulfils these conditions as the metrical system, which, beginning in France, has been since established in so many countries, and from which, whatever prejudices it may have to overcome, there seems no desire in any country where it has been introduced, to withdraw or to substitute any old system for it. Both in weights and measures the difference is so slight between some denominations of the metrical system and some used in this country, that very little inconvenience would be felt in the change. Thus the ton=1015·65 kilogrammes might easily be altered to 1000 kilogrammes.

1 pole or perch (5½ yards)	=	5·029 metres	to 5 metres.
1 furlong (220 yards)	=	201·164 ,,	to 200 metres.
5 furlongs	=	10053·22 ,,	to 1 kilometre.
1 foot	=	3·048 decimetres	to 3 decimetres.

On the Position of Reformatory Schools in reference to the State, and the General Principles of their Management, especially as regards Female Reformatories. By MARY CARPENTER *(of Bristol).*

Reformatory schools have only been brought prominently before the public during the last five years, and great ignorance still prevails respecting their real object and working.

The old Saxon law distinctly provided that all persons who are by the "act of God" irresponsible, should not be punished; and that a child "pardonatur, quia infans."

Yet, although in the United States for thirty years, and in France and Germany for a long period, the school had been considered a fitter place than the gaol for juvenile delinquents, our own country had forgotten that a child was a child, and till August 1854 had compelled magistrates and judges to punish them as adults. The act 17 and 18 Vict., chap. 86, allows magistrates to sentence young persons under sixteen to a reformatory school under legal detention; the schools being private, but under government certificate and inspection, and the superintendents receiving from Government five shillings per week for each child so sent. Further aid, in the establishment and working of schools, is provided by recent minutes of the Committee of Council on Education; and acts have been passed during the present and the last sessions, to facilitate the practical workings of the original measure. This indeed must simply be regarded as tentative, the establishment of Reformatory Institutions being left to the accidents of private benevolence, and the *old laws still remaining in force.* Hence it happens that *in some large cities and towns not a child has been sent to any such institution,* though schools exist in the immediate neighbourhood, and young delinquents swarm in their streets who are receiving a gaol education in short and repeated imprisonments. This painful fact shows the necessity of a law making it compulsory on magistrates to send to a Reformatory all children on a second conviction; and on a first, all children whose circumstances prove that they cannot escape from crime if left to themselves.

It is also found that great differences exist in the length of imprisonment to which a child is subjected before transmission to a Reformatory School,—the time being often proportioned to the magnitude of the same crime in the adult, and not to the circumstances of the child, who often, if of tender years, suffers not a little from the rigours of the system. The experience of four years in the management of Reformatory Schools, and a close observation of the effects of different modes of treatment on both boys and girls, leads the writer to the conviction, that while a lengthened imprisonment is most injurious to the physical and mental health of the child, and while his conduct in prison is in no way a criterion of his penitence or future course, yet the influence of a short seclusion in a separate cell, under the good influence now happily administered to such prisoners, prepares the child to receive in a grateful and submissive spirit the advantages held out in the school, and makes him understand the consequences which his past conduct would entail on him in future life.

Government has power to compel parents to pay a larger or smaller proportion of the weekly cost of the child's maintenance; a power already enforced in Bristol and other towns. Thus all cause of fear lest the advantages of the school should be a premium on vice or a relief to the natural guardians, is removed.

Reasons were given for the well-ascertained fact that girls of the criminal class are far worse than boys, and more difficult to manage. The object is to restore the young girl to the natural condition of childhood, and fit her for the social duties of life. The writer's experience as manager of the Red Lodge Girls' Reformatory School, Bristol, leads her to give the following recommendations.

1. A *healthy physical state* to be attained, with a view to moral reformation. Ventilation, cleanliness, temperature. Out-door play and walks in the country, to supply the want of boys' agricultural labour. Food sufficient, and of a more nourishing description than is allowed in most pauper schools, the girls having been previously accustomed to a stimulating diet.

2. The child must be brought under *steady regular restraint,* administered with a firm, equal, but loving hand.

3. They must be trained to feel themselves *a part of society*; not to have the dress of a caste; and to have intercourse, as far as possible, with persons of virtuous character and loving spirit.

4. The *healthy affections* must be cultivated; the natural ties cherished; and the school made a home, and a happy one.

5. The *activity and love of amusement* natural to childhood should be cultivated in a healthy and innocent manner. Many useful lessons respecting social rights may be built upon it.

6. Rewards and punishments should be made the *natural consequences of* actions. Bribery to do right as well as angry infliction of pain should be avoided. The child should be taught to surpass not others, but herself.

7. Children should be gradually brought into situations of trust. *It is only in pro-*

portion as liberty is rightly used, that security can be felt that the child is really reformed.

8. Wholesome direction should be given to the mental energies by *no inconsiderable amount of intellectual training.*

9. Every effort must be made to bring the *tone of the school* and the common feeling of its inmates to the side of virtue, and into harmony with the instructors. The religious element must be the prevailing one in the minds of the teachers; and must infuse itself into all their intercourse with the children. This will have a greater direct influence than any formal lesson.

10. The *will* of the child must be enlisted in her own reformation. She must be led to feel that obedience to the Divine Will is the highest good; and to *desire* to obey that Will.

On the Tendency of European Races to become extinct in the United States. By EDWARD CLIBBORN, *Corr. Mem. Nat. Inst. Washington.*

The object of this paper was to exhibit the probability of the extinction on the continent of North America, not only of the Celtic, or Irish race, but of all other European races, provided intercourse with Europe was entirely interrupted.

The argument was based on a fact admitted everywhere in the United States, that the town populations there are more healthy and productive than those of the country districts; and that as the law of extinction of town populations exists in the United States, as well as in Ireland and other parts of Europe, and as the annual loss of population cannot be supplied by the country districts, which are, on the contrary, in a measure replenished by the towns in the United States, it follows, that in the course of a few generations, both the towns, as well as the country districts, would be left without inhabitants,—provided the annual deficiencies in both were not supplied by the emigrants from Europe.

It was admitted there were some favoured localities in the United States where the population of European extraction increases by reproduction, and which in some degree helps to replace the loss of population in other districts, which are, however, by far the more numerous. It was however argued, from the general unfitness of the climate to the European constitutions, coupled with the occasional pestilential visitations which occur in the healthier localities, that on the whole, or on an average of three or four generations, extinction of the European races in North America would be almost certain, if the communications with Europe were entirely cut off. And thus the facts indicated by the extinction of the colony from Iceland, in Naraganut Bay,—the extinction of French and German settlements in the West,—of Spanish settlements in the South,—the non-increase of the numbers of people representing the old settlers in New York, Maryland, and especially the families who with Penn colonized Pennsylvania,—all told the same sad story, and led to the inference, that the continent of North America had not been, and was not likely to become, a homestead to the European races, and which would, from the force of circumstances not likely to change, die out if the intercourse with Europe were prevented.

It was also explained, that the probability of the United States being long a temporary homestead to the European peoples was greatly endangered, if not prospectively barred, by the Chinese emigration, entirely antagonistic in its sympathies, which had begun to flow in, and which, at no very distant period, promises to overrun the whole country with an increasing population, whose constitution was perfectly adapted to the climate, it might be said, in the inverse ratio of its unwholesomeness to the European constitution; thus giving the Chinese rice cultivators and others extraordinary opportunities of plantation not offered to any Europeans, except in a very few limited localities, the population of which, in the course of time, could not stand their ground against overwhelming and surrounding populations perpetually at war with them; so that it was clear from causes now in operation, that no matter how favourable the circumstances of the European peoples in the United States were, their extinction at no distant period was certain, provided the connexion of America with Europe ceased.

On the Diversity of Measures in the Corn-Markets of the United Kingdom. By J. Towne Danson, *F.S.S.*

Taking the current circulars of upwards of twenty firms engaged as corn-factors in as many of the principal corn-markets of the kingdom, Mr. Danson enumerated the various measures upon which the prices were quoted, some having reference to capacity only, some to weight only, and some to both; and the weights used varying with nearly every change of locality. In London the bushel of wheat and all other grain is determined by the imperial measure. In Liverpool a bushel of wheat means 70 lbs.; in Birmingham, 62 lbs.; in Gloucester, 60 lbs.; and in Newcastle-on-Tyne, 63 lbs. Again, in Birmingham, a bushel of barley means 49 lbs.; in Gloucester, 50 lbs.; in Leeds, 52½ lbs.; and in Newcastle, 56 lbs.; and to extend the field of comparison only extends the variety of measures to be dealt with. The following evils were specified, as resulting from this want of uniformity in these markets, where, since the promulgation of the Imperial Measures Act, it is vulgarly supposed that tolerable uniformity has existed:—"1. That in almost all cases in which a seller or buyer of agricultural produce has occasion to resort to more than one market, he is compelled to deal with more than one mode of ascertaining the quantity sold; and that, while such differences answer no good purpose whatever, they check the freedom of commercial intercourse, afford facilities for the commission of fraud, often cause mistakes and disputes, and always involve trouble and loss of time. 2. That the quotations by which producers, dealers, and the public seek to inform themselves of the variations of the price of the same commodity at the same time in different parts of the kingdom (in order to their equalization by the legitimate action of trade), are deprived of a great part of their proper utility, in consequence of the weights or measures quoted for each locality being very commonly unintelligible in most others. 3. That the inconveniences thus arising are increased precisely in proportion as the commercial intercourse of each locality with every other in the kingdom is promoted, by the improvement of road and postal communication; and, hence, are now much greater than they were when reported on by the Parliamentary Committee of 1833; and are growing greater year by year."

On the Connexion between Slavery in the United States of America and the Cotton Manufacture in the United Kingdom. By J. Towne Danson, *F.S.S.*

Mr. Danson argued in favour of five propositions, which may be thus expressed:—1. That cotton, from the conditions of climate necessary to its culture, cannot be grown in Europe; but that, with the single and not important exception of the factories in the New England States of America, it is, and must long continue to be, manufactured almost exclusively in Europe. 2. That the present supply is chiefly raised, and for the present must continue to be raised, by slave-labour—seeing that while for fifty years we have sought over the whole earth for cotton, we have during that time continued to obtain from the slave States of the American Union a continually increasing proportion of our entire supply. 3. That two-thirds in number at least of the slave population of the United States have been called into existence, and are now directly or indirectly maintained, for the supply of cotton for exportation. 4. That of the cotton thus exported, three-fourths at least in value are raised for, and sent to, this country alone. And 5. That of the entire quantity we import, four-fifths at least in value are thus derived from the United States. Each proposition was supported by tabular accounts extracted from the public records of this country and the United States, and the conclusion was expressed thus:—"That hence, in the present state of the commercial relations of the two countries, the cotton-planters of the United States are interested, to the extent of two-thirds at least of their entire exportable produce, in the maintenance of the cotton manufacture of the United Kingdom; and that, reciprocally, the cotton manufacturers of the United Kingdom, and through them the entire population of the kingdom, are interested, to the extent of more than four-fifths of the raw material of that manufacture, in the existing arrangements for maintaining the cotton culture of the United States."

A Table of the Lapps and Finns in Norway, according to the Census

Parishes and Towns.	In 1845.				In the year				
	Lapps.				Lapps.				
	In fixed habitations.	Nomadic.	Total.	Finns.	In fixed habitations.	Nomadic.	Total.	Finns.	Landed proprietors.
Röros	—	31	31	—	—	45	45	—	
Trondhyem Town	—	—	—	—	—	—	31	—	....
Sælbo	—	44	44	—	—	—	—	—	....
Stördal	—	10	10	—	16	—	16	—	—
Skogn	—	—	—	—	10	—	10	—	....
Værdal	—	7	7	—	—	—	—	—	—
Ytterö	—	—	—	—	12	—	12	—	—
Inderö	2	—	2	—	—	—	—	—	—
Sparbo	8	—	8	—	14	....	14	—	—
Stod	12	—	12	—	17	—	17	—	—
Snasen	—	41	41	—	....	....	....	....	....
Beitstaden	9	—	9	—	5	—	5	—	—
Overhalden	—	—	—	—	—	—	2	—	—
Grong	8	89	97	—	—	97	97	—	—
Fosnæs	—	—	—	—	—	14	14	—	—
Brönö	6	—	6	—	1	—	1	—	—
Bindalen	—	—	—	—	—	39	39	—	—
Alstadhoug	28	—	28	—	—	....	36	—	—
Vefsen	253	—	253	—	....	....	....	....	....
Nesne	—	—	—	—	2	—	2	—	—
Kemnes	47	36	83	—	38	27	65	—	—
Rödö	25	—	25	—	29	—	29	—	—
Mo	59	—	59	—	26	77	103	—	—
Gildeskaal	4	—	4	—	—	—	21	—	1
Skydrstad	240	—	240	—	230	—	230	—	—
Saltdalen	119	—	119	—	94	—	94	—	2
Bodö	53	—	53	—	49	—	49	—	—
Folden	60	—	60	—	69	—	69	—	1
Stegen	9	—	9	—	1	—	1	—	—
Hamerö	54	—	54	—	52	—	52	—	—
Lödingen	140	9	149	—	—	—	163	—	7
Ofoten	522	—	522	—	570	7	577	8	—
Hadsel	80	—	80	—	84	—	84	—	—
Bö	28	—	28	—	34	—	34	—	—
Oxnes	—	—	—	—	—	—	98	—	—
Dverberg	—	5	5	—	—	3	3		
Vaagen	—	14	14	—	—	14	14	—	—
Borge	—	—	—	—	—	—	3	—	—
Trondenes	202	—	202	—	231	—	231	1	1
Krædfyord	112	—	112	—	118	—	118	—	14
Ibestad	653	—	653	—	734	—	734	25	L. 41 F. 1
Tranö	207	—	207	—	235	—	235	7	—
Lenvik Maalselven	329	—	329	—	380 109	— —	380 109	10 80	L. 16, F. 1 L. 11, F. 6
Tromsö Parish	600	10	610	22	—	—	720	91	—
Tromsö Town	3	—	3	82	—	—	—	38	—
Karlsö	844	—	844	29	708	—	908	45	—
Lyngen	1460	—	1460	436	1601	—	1601	721	L. 23 F. 19

Returns of 1845 *and* 1855. *By* Louis Kr. Daa, *of Christiania.*

of the Census 1855.									
Social Condition. Heads of Families.						Besides of mixed origin, and included in the Norwegian population.			Notes.
Farmers.	Cotters with land.	Cotters without land.	New Settlers in waste lands.	Mechanics	Captains of vessels.	Norwego-Lapps.	Norwego-Finns.	Lappo-Finns.	
....	....	....	....	....	....	....	....	....	Convicts in prison.
....	....	....	....	....	....	....	....	....	Return yet wanting.
—	—	2	—	—	—				
—	—	—	—	—	—				
—	—	—	—	—	—				
1	—	—	—	—	—				
—	—	—	—	—	—				
—	—	4	—	—	—				
—	—	2	—	—	—				
....	....	....	....	....	....	....	....	....	Return yet wanting.
—	—	1	—	—	—				
—	—	1	—	—	—				
20	—	—	—	—	—				
—	—	—	—	—	—				
—	—	—	—	—	—				
—	—	—	—	—	—				
—	—	1	—	2	—	10			
....	....	....	....	....	....	....	....	....	Return yet wanting.
—	—	—	—	—	—	—			
—	3	4	—	—	—	—			
—	—	—	—	—	—	27			
19	—	1	—	—	—	7			
—	1	1	—	—	—	13			
—	—	—	—	—	—	43			
4	3	13	—	—	—	31			
—	—	—	—	—	—	10			
6	1	2	—	—	—	87	....	....	Not stated whether they are included among the Norwegians.
—	—	—	—	—	—	8			
—	—	—	—	—	—	3			
6	8	8	—	—	—	—			
—	—	—	—	—	—	—			
8	13	—	—	—	—	19			
3	2	—	—	—	—				
16	1	4	—	—	—	....	....	....	Among the Lapps some are stated to be mixed.
—	—	4	—	—	—				
—	—	—	—	—	—				
—	29	4	9	—	—	62			
4	1	7	3	—	—	32			
27	28	32	12	—	—				
1	1	1	....	—	—				
—	—	—	—	—	—	19	11	4	
25	6	26	5	—	—	78	43	—	
—	—	—	....	—	—				
4	....	6	2	—	—	14	21	5	
1	2	8	1	—	—				
—	—	—	—	—	—	—	—		
—	—	—	—	—	—	—	—		
—	—	—	—	—	—	8	8	3	
127	43	129	3	—	—				
42	22	66	2	—	—				

Table

Parishes and Towns.	In 1845.				In the year				
	Lapps.			Finns.	Lapps.			Finns.	Landed proprietors.
	Infixed habitations.	Nomadic.	Total.		Infixed habitations.	Nomadic.	Total.		
Skyærvö	1447	—	1447	426	1620	—	1620	858	—
Alten	1069	—	1069	863	1019	—	1019	1107	L. 162 F. 84
Loppen	550	—	550	50	569	—	569	26	L. 60 F. 1
Hammerfest Parish	1011	—	1011	118	1166	—	1166	160	—
Hammerfest Town	—	—	—	154	—	—	—	195	—
Kistrand } Koutokeino }	664	1026	1690	205	763	405	1168	253	L. 154 F. 51
					122	705	827	23	—
Lebesby } Næsseby }	919	116	1035	31	233	20	253	40	L. 8 F.—
					1303	85	1388	83	L. 236 F. 14
Vardö Parish	—	—	—	—	—	—	65	14	—
Vardö Town	4	—	4	8	5	—	5	14	—
Vadsö Parish	1093	93	1186	129	564	110	674	259	L.— F. 10
Vadsö Town	—	—	—	134	3	—	3	353	....

Remarks.

1. In comparing the printed account of the Census of 1845 with this paper, it will be seen that I have omitted altogether that cluster of Finns who are living in Christiania Stift, in the Glommen valley (Solör). The reason of this is, that their denationalization and amalgamation with the Norwegians has made such progress, that it has become utterly impossible to distinguish them ethnologically by that administrative machinery employed in taking a general census; except a few old men and women, they all understand and speak Norse, and the young people do not even use the language of their ancestors among themselves. What has been enumerated by the parish officers, is then rather the population of that peculiar district (Finskogen), originally inhabited by Finns, than a body of true and unmixed Finns. This colony, that is about 250 years old, may now be considered practically extinct as a peculiar nationality, by a transformation into a population that could not be distinguished from the Norwegian but by investigations into the pedigree and the language of each single inhabitant.

2. The separate and recognized Tshudic population of Norway, then, now commences to the north of the Dovre range of mountains at Böros, and is noted down from south to north.

3. In these districts of Trondhyem, Nordland, and Finmark, will be observed several discrepancies between the enumerations of 1845 and 1855. These differences are explainable by the greater accuracy of the last census; the roaming and wandering habits of the Lapps, and the continual immigration of Finns from the Russian territory into Norway, that are going on to the north of Tromsö.

The census gives no means of distinguishing between the increase of this Finnic population, that is owing to the new settlers, and to an increase of births.

The Lapps do not change their domicile in this way, but many of them live periodically on both sides of the Kiölen range in Sweden and Norway. This circumstance is stated as the cause of the census not being completed in due time in the parishes of Selbo, Snasen, and Vefsen.

continued.

of the Census 1855.

Social Condition. Heads of Families.						Besides of mixed origin, and included in the Norwegian population.			Notes.
Farmers.	Cotters with land.	Cotters without land.	New Settlers in waste lands.	Mechanics	Captains of vessels.	Norwego-Lapps.	Norwego-Finns.	Lappo-Finns.	
—	—	—	—	—	—	116	107	167	Whether the mixed races are included among the Norwegians is not stated.
16	—	7	7	—	—				
2	2	2	16	—	—	28	283	63	
—	2	30	6	—	—	19	34	9	
—	....	3	3	—	—				
—	—	—	—	—	—	50	29	2	
—	—	—	—	3	6	2	1		
—	—	2	1	—	—	12	3	34	
—	....	2	1	—	—				
—	—	—	—	—	—	—	—	8	
—	26	11	—	—	—	8	6		
—	1	—	4	—	—				
—	—	4	....	—	—				
—	—	2	19	—	—				
—	—	—	—	—	—	11	5		
—	—	—	—	—	—	—	3		
—	—	—	113	....	....	12	12		
—	—	—	31						
....	....	....	....	....	....	....	27		

4. The distinction of Lapps living in fixed habitations and nomadic, is not strictly but merely approximately correct. The account for the parish of Grogn shows that some of those Lapps, who are considered as undoubtedly nomadic, because they wander with their flocks of reindeer, yet rent lands and habitations. This tendency to prefer fixed abodes will of course be increasing. The classification given of the social condition of the Lapps with fixed habitations, shows that their ways of living are like those of the Norwegian peasantry; that interesting portion of them who are put down as settlers in waste lands, are proprietors of their cleared and claimed lands.

5. Between the census of 1845 and 1855, the parish of Maulselven has been established. Finmark proper was divided in three parishes, Kistrand, Lebesby, and Vadso. It now forms eight subdivisions. To judge of the fluctuation of its population, these last eight districts of the Table must then be joined together, and will give,—

	1845.	1855.
Lapps in fixed habitations	2683	2985
Nomadic	1235	1325
Total	3918	4383
Finns	743	1272

6. In the census of 1845 no account was taken of the mixed races. They were most probably by the enumerating officers included among the Norwegians. In the census of 1855, only those are noted down as mixed whose father or mother was a pure Lapp or Finn, the further offspring being considered as Norwegian.

When it is observed that the Lapps and Finns keep up their numbers, or even increase considerably, in spite of this loss by absorption, it will be perceived that their population is a great deal progressing.

It will be observed that this intermixture is next to nothing in the southern districts, where the Lapps are few, and of course looked upon with an idea of strangeness, if not contempt; but that it is considerable where they constitute a number in the parish, almost equalling that of the Norwegians. The intermixture is stated to be chiefly owing to legitimate marriages.

Table showing the Population of Ireland at different intervals, from 1603 to 1856, with Causes for Periodical Increase or Decrease.
By VINCENT SCULLY, *M.P.*

A.D.	Authorities.	Population.	INCREASE.	DECREASE.	Operative causes for Increase or Decrease.
1603.	Fynes Morrison (Secretary to Lord Deputy Montjoy)	700,000	....	....	Famine, Pestilence, and "Fifteen Years' War," up to 1601.
1641.	Sir W. Petty's "Political Anatomy"	1,466,000	766,000	....	Forty years' peace.
1652.	Ditto ditto	850,000	....	616,000	The Cromwellian civil wars.
1672.	Ditto ditto	1,100,000	250,000	....	Twenty years' peace.
1695.	Captain South (Commissioner of Revenue)	1,034,000	....	66,000	The Williamite civil war, and emigration, up to 1691.
1731.	Established Clergy and Magistracy Returns, by order of Irish House of Lords	2,011,000	977,000	....	Forty years' peace.
1754.	Hearth Money Collectors	2,372,000	361,000	....	Continued peace.
1760.	De Burgho's "Hibernia Dominicana"	2,317,000	....	55,000	Emigrations, consequent on converting tillage into pasture. (See Encyclop. Brit., Article "Ireland," vol. ix. p. 336. Dublin, Ed. 1792.)
1767.	Hearth Money Collectors	2,544,000	227,000	....	Any temporary checks on the increase of population, during each of the periods between 1760 and 1845, were far more than countervailed by reproductive influences; through which the population became nearly trebled within the sixty years preceding the Census of 1821, and probably almost quadrupled before the famine of 1845–46.
1777.	Ditto ditto	2,690,000	146,000	....	
1788.	G. P. Bushe (Commissioner of Revenue)	4,040,000	1,350,000	....	
1791.	Hearth Money Collectors (Inspector Wray's return)	4,206,000	166,000	....	
1805.	Newenham's Population of Ireland	5,937,000	1,731,000	....	
1811. 1812. 1813.	Incomplete returns under Act of Parliament (revised by Mr. Lynch)	5,977,000	40,000	....	
1821.	Government Census, under Act of 1815	6,801,827	824,827	....	
1831.	Ditto ditto	7,767,400	965,573	....	
1834.	Commissioners of Public Instruction (revised Census of 1831)	7,943,940	176,540	....	
1841. June.	Government Census	8,175,124	232,184	....	
1845. Oct.	Probable estimate, say	8,500,000	324,876	....	
1851. Mar.	Government Census	6,515,794	....	1,984,206	Five years' famine and emigrations.
1856. Aug.	Probable estimate, say	6,500,000	....	15,794	It is not improbable that continued emigrations and the œconomic influence of poor laws, have slightly reduced the population of Ireland since the last census in March, 1851. An increase, however, is no doubt now (August 1851) taking place.

On the Wirral Peninsula, and the Growth of its Population during the last fifty years in connexion with Liverpool and the Manchester District. By J. Towne Danson, *F.S.S.*

The Wirral Peninsula is that tract of land, part of Cheshire, lying between the Mersey and the Dee, and about 60,000 acres in extent, on the eastern border of which has recently sprung up the town of Birkenhead. The following Table exhibits the growth of the population, on the assumption that Birkenhead is, in fact, an offshoot of the town of Liverpool:—

Liverpool. Town and Suburbs. Population.				Wirral alone.	
Years.	In Lancashire.	In Wirral.	Total.	Total population.	Decimal increase, per cent.
1801.	81,910	...	81,910	9,410	
1811.	104,740	120	104,860	10,013	6·3
1821.	141,340	720	142,660	12,191	21·7
1831.	198,660	4,540	203,200	17,340	42·5
1841.	232,770	16,060	248,830	31,784	83·5
1851.	299,450	40,230	339,680	57,157	80·0

The assumption that Liverpool and Birkenhead are substantially but one town, was supported by a return of the number of passengers across the Mersey by the two ferries between Liverpool and Birkenhead, showing an increase from 3,800,000 in 1850, to upwards of 5,000,000 in 1854; the passengers by the ferry attached to, and principally serving, the Birkenhead and Chester Railway, forming but a small portion of the total number. The comparative distribution of the entire population of Wirral at the beginning and end of the fifty years—the additional population being almost entirely concentrated within about 12,000 acres of the peninsula, along the bank of the Mersey,—confirmed the general inference, that to the growth of Birkenhead, or rather to the expansion of Liverpool across the river, the whole or nearly the whole of the change was due. The return of the birth-places of the population of 1851, showed that of the immigrants of twenty years of age and upwards, about equal proportions had come in from the other parts of Cheshire, from Lancashire, and from Ireland. Scotland had contributed nearly as many as Wales, and York and Cumberland stood together next on the list. The avowed purpose of the paper being simply to place distinctly upon record a statistical outline of the leading facts touching the growth of Birkenhead, the writer abstained from inferences, and left the materials to be added at a future period.

The Family Principle in London Banking. By James William Gilbart, *F.R.S.*

The author states, that the object of his paper is to inquire to what extent the private banks of London are composed of members of the same family. Where we find two or more partners in any bank bear the same name, it is reasonable to suppose that they are members of the same family. The annual returns published in the London Gazette give the name of each firm, and the individual name of each member of the firm. From these returns the author has constructed a table of all the London Banks classified according to the number of families they respectively represent.

The following is a summary of this Table:—

				Partners.		Names.
20	Banks are composed of	1	family having together	52	bearing	20
25	,, ,, ,,	2	families ,, ,,	78	,,	50
8	,, ,, ,,	3	,, ,, ,,	33	,,	24
6	,, ,, ,,	4	,, ,, ,,	28	,,	24
1	,, ,, ,,	5	,, ,, ,,	6	,,	5
1	,, ,, ,,	6	,, ,, ,,	6	,,	6
Total 61				203		129

The author observes in conclusion, that from the official returns he can trace only those family connexions that are denoted by a similarity of name. The relation of fathers-in-law and sons-in-law, of brothers-in-law, of uncles and nephews, and of cousins, may exist in cases where the parties have different names. He professes only to give an analysis of the facts stated in the returns, and he abstains from stating any opinion as to whether family relationships are beneficial or otherwise as an element in the composition of our Banking Institutions.

The Definition of Income in Economic Science compared with the existing Taxes on Income. By W. Neilson Hancock, *LL.D.*

On the Mortality among Officers of the British Army in the East. By R. Thompson Jopling, *F.S.S.*

The battle of the Alma was fought on the 20th of September, 1854, and Sebastopol was taken on the 9th of September, 1855,—a period of little less than a year. During this interval three, or including the battle of Sebastopol, four, distinct battles were fought, besides several minor ones, such as the attack on the Quarries on the 7th of June; the attack on the Redan on the 18th of June; and others.

It appears that the total number of officers killed in action was 162, and of those dying subsequently from wounds 62; making together 224. Of these, 4 were Major-Generals, 5 Colonels, 21 Lieutenant-Colonels, 16 Majors, 77 Captains, 88 Lieutenants, 11 Ensigns and Cornets, 1 Quartermaster, and 1 Surgeon. Among the Captains, 62 were killed in action, and 15 died subsequently from wounds; while among the Lieutenants, 60 were killed in action, and 28 died from wounds, proving how much more Captains are exposed to sudden death (*i. e.* to be killed in action in proportion to dying subsequently from wounds) than Lieutenants, and, indeed, looking generally at Table I., than any class of officers.

The following Table shows the number exposed to risk, the number killed or dead from wounds, with the rate of mortality, for each of the four battles before alluded to. Under the column of Sebastopol, the deaths therein stated occurred from the two attacks on Sebastopol on the 18th of June and the 8th and 9th of September, 1855, as well as the Quarries on the 8th of June, and also include officers killed in the trenches by chance shots, &c.

Battles.	Number exposed to risk.	Number killed.	Being one in	Number killed and died subsequently of wounds.	Being one in
Alma	1065	23	46·3	29	36·7
Balaklava......	1146	11	104·4	13	88·2
Inkerman ...	1115	43	25·9	54	20·7
Sebastopol ...	3250	85	38·8	128	25·2
Crimea.........	3250	162	20·1	224	14·5

The number of officers exposed to risk, as shown in this Table, represent the actual number present on the field. On this subject the author states, that although it may be argued that these numbers will not represent the numbers actually under fire in each battle, yet upon consideration it will be seen, that for the purpose of showing the proportion killed by the casualties of each battle, the total number in the field should be taken; and that because only a small portion may happen to be actually under fire, arising from the fact that the battle did not last long enough to require all the troops to be called into action.

By the above Table it appears that the estimated number of officers of Her Majesty's Army, exclusive of those attached to Foreign Legions, the Artillery, Engineers, and Land Transport Corps sent to the Crimea since the commencement of the war, amounts to 3250. Of these, 5 per cent., or 1 in 20, were killed in action or in the trenches, and nearly 2 per cent. (1·9) died subsequently from wounds, making together 7 per cent. (6·9), or 1 in 14 (14·5).

Of the Indian wars, the statistics of which the author elaborates in his paper, the greatest mortality occurred at the battle of Ferozeshah, where it was 1 in 12 (12·4), and the lowest at Alliwal, at which only 4 officers were killed, the mortality being 1 in 58 (58·2). Of the Peninsula wars, Waterloo shows a mortality of 1 in 12 (12·3), at which 186 officers were killed; while at Vittoria, where the number of officers killed amounted to 44, the mortality was only 1 in 58 (58·5).

The number of officers who died of disease in the Crimea amounted to 148, being a per-centage on the total number sent out of 4½ (4·5), or 1 in 22. This number of 148 consisted of 28 field officers, 30 Captains, and 90 Subalterns. If we add the numbers of those who were killed in action, and died subsequently from wounds, we shall have 74 field officers, 107 Captains, and 191 Subalterns, making together a total of 372.

The following abstract shows the general result of mortality from all causes:—

Killed in action	5 per cent.
Died of wounds	2 per cent.
Died of disease	4½ per cent.
Deaths from all causes	11½ per cent.

Hence the total number of deaths from all causes, during the whole of the Crimean campaign, which extended over rather more than twelve months, were 372, beng 11½ (11·5) per cent., or about 1 in 9 (8·7) of the number sent out.

The author concluded by stating, that at a subsequent period he purposes laying before the public a complete statistical review of the whole question, including every branch of Her Majesty's service, and enlarging more particularly on the general sickness of the army, and on the mortality from disease. On these latter points the peculiarities of each disease will be carefully considered, with the causes producing them, the influence of seasons, temperature, humidity, the prevailing winds, and other incidental conditions.

Distribution of the Albanians, politically. *By* R. G. Latham, *M.D., F.R.S.*

In the Ottoman Empire.—Albania Proper			1,600,000. (Albania Proper, Turkish Servia, Bosnia)
Turkish Servia			
Bosnia			
Bulgaria, Asia Minor, &c.			
In Greece.—Attica (minus Athens), Megara, Salamis, the Piræus	30,000		
Bœotia	25,000		
Phokis	5,000 (?)		
Valley of Sperchius	10,000 (?)		
Eubœa (South)	25,000		
Andros (North)	6,000		
Argos	25,000		
Korinth and Achaia	15,000		
Arcadia	10,000		
Hydra	12,000		
Spezzia	10,000		
		173,000	
In Austria.—Clementines of Ninketze and Herkovtze in Syrmia	(?)		
—— Erizzo, a suburb of Zara in Dalmatia	880		
—— Pervi, near Pola in Istria	210		
		1090	
In Russia.—(Bessarabia)		1328	
In Italy.—Calabria Ulteriore	4,407		
Calabria Citeriore	30,812		
Basilicata	10,090		
Capitanata	13,465		
Terra d'Otranto	6,844		
Abruzzo Ulteriore	220		
Sicily	19,713		
		85,551	

To which add a few families in Venice, chiefly, or exclusively, in the parish of S. Cassiano. Add too, as areas more or less Albanian, some villages of the Monte Gargano in Italy, and those of Bronte, Biancavilla, S. Michele, and S. Angelo in Sicily. Here, however, fusion has taken place, and the general character is Italian or Sicilian.

Religion.—Albanians of Ottoman Empire.

A. Mahometan		(?)
B. Christian		(?)
——	Greek Church	(?)
——	Romanists	96,000 (?)

Some of the professors of Mahometanism really Christians (*Crypti Catholici*).

I. Greece.—A. Mahometans, few.
B. Christians.
—— Greek Church all, or nearly all.
—— Romanists, few or none.

II. Austria.—Christians and Roman.

III. Russia.—Mahometan? Greek Church.

IV. Italy.—Christian, two-thirds Roman, one-third Greek.

On the Former and Present Plans of disposing of the Waste Lands in the Australian Colonies. By William Newmarch, *F.S.S.*

On the Credit Mobilier and other recent Credit Institutions in France. By William Newmarch, *F.S.S.*

Plan for Simplifying and Improving the Measures, Weights, and Money of this Country, without materially altering the present Standards. By Lieut.-General Sir C. W. Pasley, *K.C.B., R.E., D.C.L., F.R.S. &c.*

I. General Table of New Lineal Measure proposed.

10 tenth parts	1 imperial inch.
10 imperial inches or 100 parts	1 foot.
3 feet	1 yard.
6 feet	1 fathom.
1000 fathoms	1 mile.
60 miles	1 degree of the terrestrial meridian.

For Architectural and Mechanical purposes.

10 tenth parts	1 imperial inch.
10 imperial inches or 100 parts	1 foot.

For Itinerary Measure.

10 links	1 fathom.
100 links	1 chain of 10 fathoms.
100 chains or 1000 fathoms	1 mile.

For Cloth Measure.

2 half-tenths	1 tenth of a yard.
$2\frac{1}{2}$ tenths	1 quarter.
5 tenths	1 half.
$7\frac{1}{2}$ tenths	3 quarters.
10 tenths	1 yard.

The new standard of lineal measure to be the fathom of 6 feet, marked on a rod of brass or other metal, and made equal to 6 feet 0·91548 inch of our present measure, at the temperature of 62°·6 of Fahrenheit, or 17° of Celsius's thermometer, when the barometer stands at 29 inches and 4 tenths of an inch of the new measure. This proportion will make the proposed mile equal to 1012·715 fathoms of our present measure, being the mean length of the minute of a degree of the terrestrial meridian, according to Mr. Airy's treatise on the Figure of the Earth in the 'Encyclopædia Metropolitana.' Should more extensive surveys of meridional arcs, since made or in progress, lead to a more accurate value of the said minute, it is proposed that the necessary correction shall be effected, not by changing the standard rod, but by altering the legal temperature to a higher or lower temperature than the above.

In measuring works of architecture and engineering, the foot and its decimal subdivisions will be the unit without reference to the fathom; and all workmanship measured by lineal measure must be priced by the foot, the 10 feet, or the 100 feet, not by the yard or rod.

For Itinerary Measure or Land Surveying the fathom will be the unit without reference to the foot. The mile will be the nautical or geographical miles, the only universal measure recognized by all civilized nations. The proposed new fathom and foot will differ so little from our present standards—only by one-eightieth part of the latter in excess— that, supposing the two fathoms to be set up at some little distance apart, no person standing between them, and who consequently could not see both at the same time, would be able, after having looked first at one and then at the other, to say which of the two was the shorter.

II. New Square or Superficial Measure proposed.

For Architectural and Mechanical purposes.

100 square inches . . . . 1 square foot

All work now measured by the superficial foot to be priced in future by the square foot, by the 10 square feet, or by the 100 square feet, and not by the square yard or rod.

For Cloth Measure.

Cloth to be priced by the new or imperial yard, in the same manner as is now done by the present standard yard.

For Land Measure.

100 square links . . . . 1 square fathom.
1000 square fathoms . . . . 1 imperial acre.
1000 imperial acres . . . . 1 square mile.

III. New Measures of Solidity and Capacity proposed.

Of Solidity for Architectural and Mechanical purposes.

1000 cubic inches . . . . 1 cubic foot.

Of Capacity for Dry Goods.

100 cubic inches . . . . 1 can.
10 cans or 1000 cubic inches. . . . 1 cubic foot.
10 cubic feet. . . . . 1 quarter of corn.

In measuring corn for wholesale dealings, as well as sand, lime, &c., wooden boxes of 1 cubic foot and of 5 cubic feet respectively, open at the top and bottom, and laid upon a level floor, to be used; two of the latter to be put together, one over the other, to measure a quarter of corn.

Liquid Measure for Wholesale Dealings.

100 cubic inches . . . . 1 can.
1000 cubic inches . . . . 1 cubic foot.

Liquid Measure for Retail Dealings exclusively.

2 gills or 10 cubic inches . . . . . . 1 half-pint or chopin.
2 chopins. . . . . 1 pint.
2 pints . . . . 1 quart.
$2\frac{1}{2}$ quarts or 5 pints . . . . 1 can.

Beer, wine, and other liquors, sold wholesale, to be gauged and priced, and the duties collected by the cubic foot and can.

In retail dealings, the cubic foot, divided as above into 10 cans, 25 quarts, 50 pints, 100 chopins and 200 gills, if sold in bottles, should be priced by the 10 bottles instead of the dozen, and each bottle should contain a quart or pint of the new standard. When not bottled, to be sold in pewter pots or other measures, being respectively the same aliquot parts of the new cubic foot that have been specified.

New Apothecaries' Liquid Measure proposed.

50 minims . . . . 1 tenth of an imperial cubic inch.
500 minims or 10 tenths . . . 1 cubic inch.
10 cubic inches . . . . . . 1 half-pint or chopin.

This will differ so very little from the present apothecaries' liquid measure, that no medical practitioner can hesitate in adopting it.

IV. New Measures of Weight proposed.

10 tenth parts	1 imperial ounce.
10 ounces.	1 imperial pound.
100 pounds	1 hundred weight.
1000 pounds	1 thousand weight.
2000 pounds	1 imperial ton.

For Retail Dealings exclusively.

$2\frac{1}{2}$ tenths	1 quarter	of an imperial ounce.
5 tenths.	1 half	
$7\frac{1}{2}$ tenths	3 quarters	

The standard one-pound weight to be exactly one-sixtieth part of the weight of the new cubic foot for distilled water as ascertained by brass weights, at the temperature and state of air before mentioned. By this arrangement 100 lbs. of the new will be equal to about 108 lbs. of the present avoirdupois weight.

All goods now sold by avoirdupois weight to be priced in future by the imperial pound, and its decimal multiples the 10 lbs., the 100 lbs., and the 1000 lbs., to the exclusion of stones, quarters, hundred weights and tons of our present avoirdupois weight. For retail purposes the new ounce and its tenth parts to be used.

For Coins, Bullion, &c., and for Apothecaries' Weight.

10 hundredth parts of a grain	1 tenth part.
10 tenth parts	1 grain.
1000 grains.	1 imperial inch.

The grain, being subdivided into tenths and hundredths for very delicate purposes, and its decimal multiples the 10 grains, the 100 grains, and the 1000 grains or imperial ounce, will be used exclusively for weighing and pricing all valuable articles to which troy weight is now applied, to the entire exclusion also of pearl weight, diamond weight, and all the carat weights.

For apothecaries' weight, to which troy weight is also applied in preparing medical prescriptions, and which requires the use of the grain as well as of the ounce, the difference between the present and the proposed new grain and imperial ounce are not worth noticing.

Barrels and casks of various denominations, as well as sieves, baskets, sacks, boxes, and other packages, now designating special quantities or weights of beer, wine, fruit, corn, and other goods, together with the various customary loads, lasts and weys, all differing from each other, not to be used as measures or weights without specifying the contents or the amounts of each in cubic feet or pounds weight, as may be.

Measures of Temperature and Air.

For determining the new standard measures of length and of weight proposed, 62°·6 of Fahrenheit's thermometer, or its equivalent 17° of Celsius's, were recommended, with the barometer standing at 29·4 inches of the new measure. The author suggests, that the last mentioned thermometer, which is established in France, and which has its zero at the freezing-point, the only invariable point of temperature in nature, shall be adopted in preference to Fahrenheit's*.

If the foregoing suggestions, or any system on the same principle, for simplifying our national measures and weights, should be adopted, the fine idea, generally supposed to have been intended in Magna Charta, and most clearly and unequivocally expressed, in one of our ancient laws of a subsequent date, but which has never yet been realized in this country, will be literally accomplished, namely, that THERE SHALL BE ONLY ONE MEASURE AND ONE WEIGHT THROUGHOUT ALL THE LAND†.

* He is also of opinion, that it would be desirable to ascertain the length of the seconds' pendulum by experiments in air, on the first floor of the new Houses of Parliament, in reference to the mean level of the tides in the Thames, without attempting to reduce it to the level of the sea in a vacuum, by theoretical corrections, of which subsequent experience has rendered the accuracy doubtful. The new experiments now suggested might be carried on in September, during the recess of Parliament, when the above-mentioned temperature might easily be obtained, and the state of air corrected, by ascending or descending from the given spot to a different level.

† See the tenth chapter of an Act of the 27th of Edward III., Statute 2nd, entitled *Ordinacio Stapularum*, in the Statutes of the Realm, vol. i. p. 337.

V. New Monetary System proposed.

10 farthings	. . . .	1 cent.
10 cents or 100 farthings	. . . .	1 florin.
10 florins, 100 cents, or 1000 farthings	. . .	1 pound sterling.

Setting aside all the new coins, proposed by him in his first publication of 1834, except the tenth of the pound (since called the florin) and the silver cent, and setting aside also his attempt to simplify the monetary system therein proposed, in the paper read to the British Association at Oxford in 1847, which he admits was by no means an improvement, the author now thinks, that the only new coin that ought to be issued, is the silver cent, and that no silver coin greater than the florin should be coined in future, gradually withdrawing all the crowns and half-crowns still in circulation, as soon as florins to an equal amount can be issued from the Mint to replace them.

When any sum of money of the new coinage is written in sterling money, the last figure or unit of the pound should always have a point after it, the three next figures to which will designate florins, cents, and farthings, whether having these denominations written over them or not; but more than three such figures must never be used.

He is also of the opinion, now adopted by the Council of the Decimal Association, of which he is a member, that instead of coining new copper mils, or tithings as he called them at first, it will be much better to declare by royal proclamation, that the farthing shall be the tenth part of the cent, and the thousandth part of a pound, or to make it so by Act of Parliament; but it does not appear to him to be necessary to withdraw any of the smaller silver coins, such as the threepenny and fourpenny silver pieces, which, though not known when he first published, have been a very great convenience to the public, and which none of the working classes ever mistake for one another, even in the dark, nor will they confound any of them with the new silver cent proposed.

The silver cent should be stamped with the words, ONE CENT OR TEN FARTHINGS; the present sixpenny pieces need not be called in; but when more are required, let them be stamped with the words ONE HALF SHILLING. In like manner, when more fourpenny pieces are required, let them be stamped $\frac{1}{3}$ OF A SHILLING, and when more threepenny pieces are required, let them be stamped $\frac{1}{4}$ OF A SHILLING. To add anything more would be superfluous.

The author then treats of the "difficulties urged as objections to the decimal coinage proposed," points out the advantages of the new system proposed, and urges objections to the French metrical system.

Aphoristic Notes on Sanitary Statistics of Workhouses and Charitable Institutions. By M. Roth, *M.D.*

1. A number of *adult* disabled persons are kept year after year in workhouses or charitable institutions, and very little or nothing is done to improve or cure their *chronic ailments*.

2. A number of constitutionally weak infants and children are in the workhouse who could be cured or considerably improved.

3. The expenses of the parish and charitable institutions would be, in the course of years, considerably diminished by a better state of health amongst the poorer classes.

4. It is necessary to have detailed statistics of the sanitary condition of the workhouses and charitable institutions, and, if possible, of those who receive permanent or periodical outdoor relief; and, as such returns do not exist,

5. I have proposed the following as a specimen of a sanitary statistic table, which, by the kindness of a poor-law guardian, was returned with the numbers showing the actual sanitary state of one of the metropolitan suburban workhouses.

I have proposed the classification of ages in a different way; but as all the inmates of workhouses are divided according to the scale shown in the Table, the actual workhouse classification has been retained.

Age.	Total Number of					1. Scrofula.				2. Rickets.			
	Adults.		Children.										
Years.	Men.	Women.	Boys.	Girls.	Infants.	Men.	Women.	Boys.	Girls.	Men.	Women.	Boys.	Girls.
Over 60	154	133	...	...	...	...	...	...	...	...	...	...	...
Under 60	201	243	...	...	...	5	7	...	...	...	...	...	...
„ 15	...	...	69	71	...	...	...	5	3	...	...	1	1
„ 9	...	...	70	73	...	...	...	1	2	...	...	3	2
„ 2	...	...	...	...	75	...	...	...	1	...	...	1	2
	355	376	139	144	75	5	7	6	6	...	...	5	5
	731		358			12		12		...		10	
	1089					24				10			

Age.	3. Consumption.				4. Spinal deformities.				5. Limb deformities.				6. Ruptures.			
Years.	Men.	Women.	Boys.	Girls.	Men.	Women.	Boys.	Girls.	Men.	Women.	Boys.	Girls.	Men.	Women.	Boys.	Girls.
Over 60	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Under 60	21	25	...	...	3	4	...	...	1	1	...	...	25	10	...	...
„ 15	...	...	4	3	...	...	2	2	...	...	1	...	...	...	1	...
„ 9	...	...	1	1	...	...	1	3	...	...	1	1	...	...	1	...
„ 2	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...
	21	25	5	4	3	4	4	5	1	1	2	1	25	10	2	...
	46		9		7		9		2		3		35		2	
	55				16				5				37			

Age.	7. Paralysis.				8. Diseases Chronic.				9. Blind.				10. Deaf and Dumb.				11. Idiots.			
Years.	Men.	Women.	Boys.	Girls.	Men.	Women.	Boys.	Girls.	Men.	Women.	Boys.	Girls.	Men.	Women.	Boys.	Girls.	Men.	Women.	Boys.	Girls.
Over 60	4	2	...	...	60	69	...	...	1	1	...	...	...	...	...	...	...	2	...	...
Under 60	20	10	...	...	68	32	...	...	1	3	...	...	1	...	...	...	6	8	...	...
„ 15	...	...	...	...	...	...	11	7	...	...	...	...	...	...	...	...	...	...	...	2
„ 9	...	...	...	...	...	...	9	8	...	...	...	...	...	...	...	...	...	...	...	...
„ 2	...	...	...	1	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...
	24	12	...	1	128	101	20	16	2	4	...	...	1	...	...	...	6	10	...	2
	36		1		229		36		6		...		1		...		16		2	
	37				265				6				1				18			

Thus of 1089 inmates, 474 are affected by chronic diseases, or 43·5 per cent. The following Table shows the per-centage of chronic diseases in the five classes:—

Age.	Number of Inmates.	Patients.	Per-centage.
Under...... 2	75	7	9·3
„ 9	143	34	23·7
„ 15	140	43	30·7
„ 60	444	251	56·5
Over 60	287	139	48·7

Table showing the per-centage of the most frequent chronic affections, as mentioned in Table 1.

Age.	Scrofula.	Rickets.	Consumption.	Deformities of the Spine.	Deformities of the Limbs.	Ruptures.	Paralysis.	Other Chronic Diseases.
Under 2	1·33	4·00	...	1·33	...	...	1·33	1·33
„ 9	2·09	3·49	1·3	2·79	1·39	0·69	...	11·88
„ 15	5·7	1·42	5·0	2·87	0·71	0·71	...	12·85
„ 60	2·7	...	31·2	1·57	0·45	7·88	6·75	22·50
Over 60	...	...	...	...	...	...	2·09	44·94

Such a sanitary state, as exhibited by the preceding Tables, cannot exist without great loss of life and without considerable expense to the community at large, and the following are a few suggestions to remedy this bad state of health amongst the poorer classes.

6. All constitutionally weak children of several parishes should be brought into a *union sanatorium,* where all the available hygienic and medical means, according to the present state of science, should be used, and the education of the children continued, as far as their weakly state permits; when healthy, these children might be sent to the union or charity school.

7. The curable adult disabled paupers suffering from chronic affections should be also visited, for the sake of cure or improvement.

8. The expenses for the cure of such paupers would not be much more than the expenses of the workhouse, where such paupers are frequently kept for years in consequence of their having been neglected at a time when their health could have been restored.

9. In order to prevent the increase of the number of disabled paupers, it is most important that the health of the healthy inmates should be kept up to the highest standard, for which purpose the masters and matrons of workhouses, as well as all schoolmasters and schoolmistresses, should have an elementary, popular, and practical knowledge of the injurious and beneficial influences affecting health. This sanitary knowledge should be imparted to the children, whose bodily faculties should be developed simultaneously with their mental faculties.

10. This sanitary knowledge should form a part of the instruction in the training schools of schoolmasters and schoolmistresses, of whom we cannot expect that they should bestow more care on the preservation of the health of their pupils so long as they are entirely ignorant on the subject; the preservation of individual health depends upon the parents and schoolmasters, but not on the medical man, who enters on his duties, in the great majority of cases, only after those of the educator have been neglected.

11. The importance of a large garden or play-ground, as an indispensable part of a workhouse, has been sufficiently advocated and proved by the condition of those schools and workhouses which are not sufficiently provided in this respect.

12. The kitchen fire in workhouses and charitable institutions can, by the aid of hot water or steam, provide the necessary warmth in the various apartments, and sufficient warm water or steam for baths, which are most important in preserving health, in cutting short many diseases at the beginning, or in curing them when developed.

Conclusion.—It is most important not only to diminish the amount of ill-health at present existing among our poor population, but we must prevent, as far as it depends upon ourselves, all the causes artificially producing disease and deteriorating the general health: the number of inmates of our workhouses would thus considerably decrease, and a diminution of poor's-rate would go hand-in-hand with the improved health of the paupers.

On the Territorial Distribution of the Population, for purposes of Sanitary Inquiry and Social Economy. By H. W. Rumsey, *F.R.C.S.*

1. If opportunities are now rarely afforded to States to group their populations on scientific principles, to determine the most salutary and beneficial sites for human habitation, and to combine the sites so occupied in well-contrived districts for statistical inquiry and local management,—it cannot be denied that the past neglect of governments, and the mistakes of private or associated enterprise, in the selection of places for migration and colonization, have led to most fatal results,—to enormous sacrifice of life, to immense national and personal loss, and to sad degradation of race.

2. Correct principles of localization are not easily applied to old communities, yet the difficulties in the way of a re-adjustment of territorial divisions, even in this country, are not insuperable. The mobility of the population of England has undergone some striking variations since the Conquest. Many causes and great facilities existed for change of abode until the sixteenth century. Legislation and other circumstances tended to fix the population in the sixteenth, seventeenth, and eighteenth centuries. But most of those impediments to locomotion have been removed in the present age;

great changes are now in rapid progress; and the obstacles to an amended distribution of the inhabitants are fast disappearing.

3. During the first half of this century, a much larger proportion of the population aggregated in towns; but now a reflux of population from crowded centres is again taking place. Suburban inhabited *areas* are accordingly increasing in a greater ratio than the numbers of town residents.

4. Past legislation has limited political privileges to crowded populations within narrow boundaries, and has thus fostered the injurious condensation of the masses. It is important to reverse this policy, and to treat the whole population on equal terms.

5. The old divisions of the country, various and conflicting, are inapplicable to the progressive extension of inhabited areas. Changes have accordingly been found necessary in parochial and municipal boundaries, which cannot therefore be considered of a settled or permanent nature.

6. The recent division of the country into poor-law Unions was based on the parochial system, and like it, is irreconcileable with municipal boundaries. Unions were not formed scientifically; and they often manifest, in their form and contents, singular inattention to physical geography and sanitary considerations.

7. The registration districts, and (now) the census arrangements, are based on the poor-law division, and the returns of population, births, deaths, and marriages, have made the defects of that division more obvious, while an erroneous distribution of the people has, in turn, affected the compilation of vital and sanitary statistics, so that these returns do not afford, to the extent which they might, the means for correct inferences respecting the physical condition and social progress of distinct communities, in special circumstances, natural or artificial.

For this, among other valid reasons, it is unsafe to adopt the rate of mortality in any union or registration district, as a test of the actual salubrity, either of its principal town or of its more scattered population.

8. Until our national records of vital statistics are more complete (including facts now omitted) and compiled from a more scientific classification of the people, we can arrive at no satisfactory conclusions respecting the life, the health, the social state, the education, the morals and the habits of those who inhabit different places; we are unable to demonstrate the causes of social evils, and therefore we cannot fairly call upon the legislature to inaugurate the required reforms.

9. Another obstacle to a correct territorial division for statistical objects, is the coexistence of several kinds of local administrative bodies, exercising conflicting functions, within different areas of jurisdiction. Various administrative duties, of a sanitary or reformatory nature, are performed in most towns by two rival bodies (a Board of Guardians and a Town Council or Local Board of Health) managing districts which differ widely in extent; the vital statistics being collected under the authority of that local board which has been the most distrusted as regards sanitary management.

10. The practical evils of limited and isolated jurisdictions, in the execution of measures of public health, are many and serious,—evils to the inhabitants included, and evils to those excluded.

11. It is of paramount importance to extend sanitary inspection and regulation to suburban and rural districts. The outskirts of towns are more and more peopled by the humbler classes of society; and it is therefore increasingly necessary to promote a better description of dwellings for working people *out* of towns, either near railway stations, or within accessible distance of their places of labour.

12. Measures of public health should be extended to the whole population of the kingdom, without reference to any district-rate of mortality. It is absurd to defer the application of preventive measures, until the fatal result of neglect, namely, a high proportion of deaths,—the precise ratio of which different parties cannot agree upon, —be detected in any place.

13. No system of territorial division, for statistical purposes and for local self-government, deserves consideration, which would not secure for every portion of the country, whether town or rural parish, the superintendence of a uniform administrative machinery, competent to collect all returns relating to the numbers, the vital force (ages of the living), the mortality, the diseases, and the reproduction oft he population,—as well as to carry into effect all sanitary precautions.

14. A public registration of diseases should have special regard to their causation,

and to their relations with residence and occupation; while observations of meteorology, and of the varying conditions of the animal and vegetable kingdoms (agricultural statistics) should be concurrently made in each superior registration district. And these combined observations and records in each locality should be published periodically for the instruction of its inhabitants.

15. Again, the law should no longer confer badly-defined powers upon two or more rival boards in the same place. If each of the existing local boards and councils were fairly represented in a superior court, with a larger jurisdiction than now belongs to any of those bodies,—as the district boards of London are in its metropolitan board,—all reasonable objections to a transfer of local functions might be avoided.

16. As to the extent and form of the proposed larger districts for collecting and registering vital and social statistics and for local management (the jurisdiction of the Metropolitan Board of Works being wholly excluded from present considerations), each might contain, on the average, two or more parochial unions.

Wherever a correction of existing boundaries might be deemed necessary, the natural features of the locality should be carefully borne in mind; each parish or cluster of population being included in that district, the principal town of which would be most easy of access; and special regard being had to density of population.

17. Every sanitary jurisdiction should be provided with a superintending officer of health, debarred from private professional engagements, and performing a variety of most important public functions*.

And such sanitary jurisdictions should be an exact aggregate of a sufficient number of smaller districts for medical visitation, which should be either identical with the registration sub-districts or subdivisions of them.

18. Recapitulation of practical suggestions.

(*a.*) The physical geography of the district, and the general character of its population, should be the main facts upon which any revision of existing territorial divisions should be founded.

(*b.*) Areas for statistical returns should invariably be co-extensive with those for sanitary management.

(*c.*) The extent of these areas should be large enough to provide satisfactorily for the amalgamation of existing smaller jurisdictions.

(*d.*) They should also be large enough to secure, with economy, the appointment of a superior class of superintending Registrars, as officers of health.

All these changes might be effected without any offensive sacrifice of existing interests, or violation of justly established rights.

On the Progress, Extent, and Value of the Porcelain, Earthenware, and Glass Manufacture of Glasgow. By JOHN STRANG, *LL.D., F.S.S.*

At the last meeting of the British Association I had the honour of bringing before this Section a paper on the progress, extent, and value of the coal and iron trade of the west of Scotland, of which Glasgow is the central mart; and I now have the pleasure of presenting you with the past and present position of certain other modern branches of industry, which, although not so great as the former, have tended to give an onward impulse to that progressive city: I allude to the manufacture of porcelain, earthenware, glass, and tobacco-pipes. Although the making of delft or stoneware in its rudest style and forms, and the manufacture of porcelain in somewhat better taste, were there early introduced—the one in 1748 and the other in 1766—the whole actual value of both these articles made during the year 1777 amounted only to £5000; and although the manufacture of black bottles and flint-glass was begun—the one in 1730 and the other in 1777—the export of the former from the Clyde during the year 1777 merely reached 4760 cwts., and of the latter to little more than 14 cwts. The fact is, till within these thirty years, there was only one pottery, one flint-glass, and one bottle-work in the city of Glasgow. The trade in all these articles may therefore be said to be but of yesterday, when it is stated that there are now eight large potteries engaged in the manufacture of all kinds of china, porcelain, parian, and other ware, four flint-glass manufactories, and twelve bottle-houses, with a considerable number of manu-

* See also 'Essays on State Medicine,' pp. 50, 302, &c.

factories of ornamental vases, chimney-tops, gas retorts, drain- and water-pipes, fire-bricks, figures and fountains from fire-clay, and several very extensive works, wholly engaged in the production of coarse earthenware, sugar moulds, and drips and chimney caps from the red clay of the district. For the purpose of exhibiting more palpably and clearly the present extent and importance of this almost new branch of manufacture in Glasgow, the following statistical facts have been obtained, which cannot fail to prove the rapid rise of this important department. During the year 1854 the eight manufactories of porcelain and earthenware imported and used 7805 tons of clays from Dorset, Devon, and Cornwall, 1240 tons of Cornish stone, and 2850 tons of flints, employing in all 11,895 tons of shipping, while in these works were consumed about 50,000 tons of coals. The number of persons employed during the same period, consisting of men, boys, and girls, were 2000, who, on an average, gained 12*s.* per week of wages; making an aggregate of £62,400 paid to workpeople in the Glasgow potteries during the twelvemonth. The total value of this branch may be fairly estimated at £120,000, while the quantity exported in 1854 from the Clyde amounted to 4,931,166 pieces. At first sight it might be supposed that a manufacture which requires to draw such heavy products as clays, flints, and Cornish stone from so great a distance would be disadvantageously placed as to profit. But as respects this, Glasgow is not less favourably situated than the great seat of the porcelain manufacture in England,—Staffordshire; while in regard to the price of fuel, and the ready means of conveyance to all parts of the world, it is even more advantageously placed. In the manufacture of porcelain, however, there are a vast variety of articles required, in addition to clays and flints. As a somewhat curious picture of the variety of articles which enter into the manufacture of porcelain, we find the following rather long list used in a Glasgow pottery employing 315 persons:—

Blue clay	600 tons.	Tar used with colour	30 galls.
China clay	500 ,,	Flannel used for transferring prints, &c.	320 yards.
Cornish stone	300 ,,	Gold used for gilding	30 ozs., [pure.
Flints	700 ,,	Straw used for packing	17,000 stones.
Fire-clay used	500 ,,	Crates used during year	3,000
Borax used for glaze	15 ,,	Cordage used	14 cwt.
Lead ,, ,,	16 ,,	Fire-bricks used for keeping up kilns and slip pans	40,000
Calcined bone	25 ,,	Covers	600
Gypsum used for moulds	40 ,,	Granite stone used for grinding purposes	70 tons.
Paris whiting	12 ,,	Enginepower for grinding materials	60 horse [steam-engine.
Chromate of iron	1 ,,	Coals consumed	5,000 tons.
Oxide of zinc	15 cwt.		
Pink, green, black, brown, and colours	1200 lbs.		
Oxide of cobalt	600 ,,		
Paper used for printing	550 reams.		
Cost of engraving and copper	£200		
Linseed oil used	100 galls.		

In the flint-glass manufactories of Glasgow there was produced during the year 1854 about 1,640,000 lbs. of finished goods, which employed 323 persons; and there were used in these glass-houses 330 tons of white sand, 220 tons of red lead, and 115 tons of saltpetre and pearl-ashes; the wages paid out of the manufactories being £16,000, and the whole value of the branch being about £40,000, while the quantity exported from the Clyde amounted to 2262 cwt. From the twelve bottle-houses which, during 1851, employed 400 workers, there were produced bottles to the extent of 208,000 cwt., or 14,992,667 bottles—the value of the branch in 1854 being about £104,000. The amount of wages paid was £31,200; and the export from the Clyde 90,430 cwt.

In the manufacture of tobacco-pipes, there has of late years been perhaps a greater proportional advance than in that of porcelain or glass. This is a handicraft which may be said to belong peculiarly to Glasgow, being carried on to a far greater extent there than in any other part of the country. Within little more than twenty years, there were not above fifty persons employed in this manufacture in that city, and at this moment there are no fewer than 600 persons, who work up 2740 tons of clay, and who manufacture, finish, and pack about 2700 gross of pipes per day, and whose wages amount for each person employed to about 20*s.* yer week. The whole value of this manufacture may amount to £44,000.

Assuming, then, all these statements to be as correct as they probably can be made, let us see what the gross value of these branches are in twelve months:—

Value of porcelain	£120,000
Value of flint-glass	40,000
Value of bottles	104,000
Value of tobacco-pipes	44,000

We find, also, from the foregoing statements, that the number of persons employed in these branches, and the wages paid, during one year, were as follows:—

Employed in porcelain and earthenware manufactories, 2000, at 12*s.* per week	£62,400
Employed in flint-glass works, 323	16,000
Employed in bottle works, 400, at 30*s.* per week	31,200
Employed in tobacco-pipe manufactories, 600, at 20*s.*	31,200

In short, the foregoing Tables show that the porcelain, glass, bottle, and tobacco-pipe manufactories in Glasgow, produce at present an annual value of £288,000, and give employment to 3323 persons, who receive for their labour wages to the amount of £140,800.

The rapid progress which these several manufactures have made in Glasgow may be chiefly attributed to the demand which the foreign trade of the Clyde has created for bulky freight, and which the following Table, showing the number and tonnage of the vessels employed in the foreign trade at the harbour of Glasgow alone, will best illustrate:—

	Number of Vessels.	Tonnage.
1851	716	176,441
1852	700	195,062
1853	760	221,139
1854	878	245,062
1855	756	212,913

It is well known that Liverpool has long enjoyed, through the manufacturers of Staffordshire, the desideratum of bulky freight; and no sooner had Glasgow become, as it has only done within twenty years, an increasing harbour for vessels trading to every quarter of the globe, than it was found, that while she could furnish abundance of heavy freight in the shape of pig, malleable iron, and coal, she was deficient in such bulky articles as coarse earthenware, common porcelain, flint, and bottle glass and china to fill up the space unoccupied by finer goods. It is probable, therefore, that the manufactures whose progress we have been attempting to illustrate will go on increasing with the increase of foreign commerce, and that the increase of these will in future be chiefly excited and marked by the increasing tonnage employed in the foreign trade from the harbour of Glasgow and the other lower ports of the Clyde.

On the Money-rate of Wages of Labour in Glasgow and the West of Scotland. By JOHN STRANG, *LL.D., F.S.S.*

A correct chronicle of wages, as applied to different kinds of manufactures and handcrafts, combined with the changing cost of the necessaries and even the common luxuries of life, would form one of the most valuable contributions to economic science. While the rate of these would at once mark the advance or fall on the value of labour at particular epochs, it would, at the same time, note the changes which have taken place in the value of labour as applied to particular distinct handicrafts; and if the money-rate were further measured by the cost of the great necessaries of existence, would give a pretty clear insight into the social condition of the labourer at any period of the country's history. As a humble contribution to this chronicle of labour, I have now to present you with a comparative statement of the rate of wages in one of the most important of the labour marts of Great Britain, I mean the City of Glasgow and its neighbourhood; and for this purpose I shall select, from the long list of mechanics, handicraftsmen, and labourers, a few of those who are engaged on the production of the great staples that belong to that district, premising that the following facts in general are based on returns made to me by some of the leading manufacturers, engineers, ironmasters, and builders of the city and surrounding district, and that they are not general estimates, but are founded on the actual wages-books of the several concerns to which they apply. Let us commence with the cotton-spinners and power-loom weavers, of whom in the West of Scotland, Glasgow is the central mart, and whose numbers amount at present to about 30,000. It appears the average wages of those persons were as follows at the three different periods of 1841, 1851, and 1856:—

	1841.	1851.	1856.
Power-loom weavers—average per week........	7*s.*	7*s.* 3*d.*	8*s.* 3*d.*
Cotton-spinners—average per week............	21*s.*	21*s.* 0*d.*	20*s.* to 35*s.*

From these figures, it appears that the wages in this department of manufactures have been gradually rising since 1841. While this has been generally the case, it may however be remarked that not more but even less has been paid for weaving for each piece of cloth, and for spinning each hank of yarn. In the case of cotton-spinners in particular, matters have so changed, and mills and machines have been so altered in productive power, that it is almost impossible to arrive at a correct average of wages at present paid: for while in the older factories a spinner cannot gain more than 20*s.* a week, in the new mills, possessing all the advantages of improved machinery, his wages may even reach 35*s.* In the one a man manages 500 spindles, whereas in another he can superintend 1500 or 2000. In proof of this I may mention that five and thirty years ago the spinner of the finest or highest numbers of yarn had only about 150 spindles to each jenny to attend to, whereas now in the factories where the finest numbers of yarns are spun, one individual can easily manage 880 spindles, and these two are annually on the increase. In short, in cotton-spinning and power-loom weaving the advance of wages has arisen principally from increased production in consequence of improvements in machinery. It must also be kept in mind that weavers and spinners worked 69 hours in 1841 and only 60 in 1851, and hence received more money for less labour.

Let us next advert to the wages of two of the most important manufactures of the West of Scotland, I mean the rates obtained by the workmen employed in mines and iron-works, whose numbers in the year 1854–55 amounted to 33,900, and whose united wages during these twelve months reached the large sum of £1,976,000. Average rate of mining labour for the last five years:—

							Per day.
From	January,	1852,	till October,	1852,	inclusive	......	2*s.* 6*d.*
,,	November,	1852,	,, January,	1853,	,,	......	3*s.* 0*d.*
,,	February,	1853,	,, August,	1853,	,,	......	3*s.* 6*d.*
,,	September,	1853,	,, October,	1853,	,,	......	4*s.* 0*d.*
,,	November,	1853,	,, December	1853,	,,	......	4*s.* 6*d.*
,,	January,	1854,	,, January,	1855,	,,	......	5*s.* 0*d.*
,,	February,	1855,	,, September	1855,	,,	......	4*s.* 0*d.*
,,	October,	1855,	,, March,	1856,	,,	......	5*s.* 0*d.*
,,	April,	1856,	,, August,	1856,	,,	......	4*s.* 0*d.*

Average rate of wages paid to workmen connected with the manufacture of pig and malleable iron:—

	1852.	1853.	1854.	1855.	1856.
Blast furnace-keepers, per day ..	5*s.* 0*d.*	6*s.* 3*d.*	6*s.* 8*d.*	6*s.* 8*d.*	7*s.* 9*d.*
Do. assistants, per day	3*s.* 2*d.*	3*s.* 7*d.*	4*s.* 2*d.*	4*s.* 2*d.*	4*s.* 9*d.*
Do. fillers ,, ...	2*s.* 3*d.*	3*s.* 4*d.*	3*s.* 10*d.*	3*s.* 9*d.*	4*s.* 2*d.*
Puddlers, inclding under hands ..	7*s.* 6*d.*	10*s.* 3*d.*	10*s.* 6*d.*	10*s.* 0*d.*	10*s.* 0*d.*
Rollers (chief rollers)	10*s.* 0*d.*	14*s.* 0*d.*	14*s.* 6*d.*	13*s.* 6*d.*	13*s.* 6*d.*
Labourers	1*s.* 6*d.*	1*s.* 10*d.*	2*s.* 1*d.*	2*s.* 0*d.*	2*s.* 0*d.*

From the foregoing statements, it appears that there has been a gradual but important rise in the wages of those employed in the coal and ironstone mines, as well as of those employed in the manufacture of pig and malleable iron; in the former, from 2*s.* 6*d.* a day, in October, 1852, to 5*s.* in March last; and in the latter of from 25 to 50 per cent. on the wages paid to the labourers connected with the working of the blast furnaces and the rolling and puddling of iron since 1852: and when the number of men connected with these several departments is remembered, being nearly 34,000, such a rise cannot fail to involve most important consequences. The third point to which we would call attention, is the wages of engineers and mechanics—a very large class of workers in Glasgow and its neighbourhood. The following is the average rate of engineers' wages per day (of ten hours) during the last six years:—

	Shillings.
1851	3·43
1852	3·52
1853	3·82
1854	3·97
1855	3·99
1856	4

From the foregoing Table it is quite plain that the wages paid to engineers and mechanics during these last six years have been progressively advancing, and shows since 1851 to the present time a rise of about 14 per cent.

The fourth subject to which we would allude is that of building, or house construction. In so growing a city as Glasgow, which, with its suburbs, has a population at present of not less than 400,000, and whose rate of increase from births over deaths and immigration amounts annually to about $3\frac{3}{8}$ per cent., it is easy to conceive how very large the employment must be of those engaged in this business. Of the many handicraftsmen engaged in constructing houses, warehouses, and other buildings, we shall, however, limit ourselves to stone quarriers, masons, carpenters, and labourers.

The following is the rate of wages paid to quarriers from 1851 to 1856:—

1851	16*s.*	per week	of 60 hours.
1852	16*s.*	,,	,,
1853	17*s.*	,,	,,
1854	19*s.*	,,	,,
1855	20*s.*	,,	,,
1856	22*s.*	,,	,,

Or a rise of 6*s.* per week, or about 37 per cent., since 1851.

The following is the average rate paid to masons:—

			Per week.	
During	summer of 1850 and	1851	21*s.*	
,,	winter of 1850 and	1851	18*s.*	
,,	summer of	1852	21*s.* and 18*s.*	
,,	,,	1853	23*s.* 9*d.*, $\frac{1}{7}$th less in winter.	
,,	,,	1854	25*s.*	,,
,,	,,	1855	25*s.*	,,
,,	,,	1856	25*s.*	,,

For the last three years masons have restricted themselves to 57 hours' work per week; previous to this, they worked 60 hours; and there is a prevalent feeling among this class of craftsmen still further to reduce the hours of labour.

The following is the rate of the wages paid to carpenters and joiners, from 1850 to 1855 inclusive:—

1850	(average during year)	21*s.* 6*d.*	per week of 60 hours.
1851	,,	21*s.* 0*d.*	,,
1852	,,	22*s.* 0*d.*	,,
1853	,,	23*s.* 0*d.*	,,
1854	,,	24*s.* 0*d.*	57 hours.
1855	,,	24*s.* 0*d.*	,,

or an advance of 2*s.* 6*d.* per week, with a reduction during the last two years of the series of three hours on the week's work. At the present moment the rate of wages paid to carpenters and joiners is 5*d.* per hour for whatever time they are working, without reference to weeks; but the stated time is 57 hours per week, or 23*s.* 9*d.* per week; or, should they work the day of 10 hours, 4*s.* 2*d.* per day. This shows the advance on the wages of this handicraft to have been 4*s.* 6*d.* per week.

The following is the rate of wages paid to common labourers, connected with all matters of house construction:—

1850, 1851, and 1852	12*s*. per week.
1853	14*s*. ,,
1854	17*s*. ,,
1855	17*s*. ,,
1856	17*s*. ,,

Thus the rise has been greater on unskilled than even skilled labour, being 5*s*., or upwards of 40 per cent. These labourers are almost exclusively Irish; and, strange to say, that while in the north of Ireland, within 30 miles of Belfast, labourers can be got from 1*s*. to 1*s*. 6*d*. per day, or 6*s*. to 9*s*. per week, with the cost of transit per steam to Glasgow of from 2*s*. 6*d*. to 4*s*., the flow of Irish immigration to Glasgow has greatly diminished.

It would be easy for me to multiply examples of the advance which has taken place in the rate of wages from almost every class of workmen during the last five years, an advance which has now reached the long sinking employment of the hand-loom weaver. For a long period the position of those connected with this last employment had been gradually lowering, till at length it became pitiful indeed. The facility with which the art can be learned, the numbers which unfortunately rushed to this work, frequently creating an equal competition between the man and the child, coupled with the competition of power-loom labour, are assuredly some of the causes which have produced the great fall during these thirty years past in this species of handicraft. But whatever the causes may have been for sinking the value of hand-loom labour, it can scarcely be denied that the average rate of weekly wages, as furnished me by two or three of the leading manufacturing houses in Glasgow, being at present from 6*s*. to 7*s*. 1*d*. per week, is indeed a miserable pittance even when measured by the reduced prices which have taken place in every article of consumption and clothing since 1825, when the wages was 13*s*. 6*d*. per week. The following is a progressive statement of the average wages earned by the hand-loom weavers from 1825, marking the periods when the reductions took place:—

1825	13*s*. 6*d*.	1848	6*s*. 0*d*.
1827	9*s*. 0*d*.	1851	5*s*. 8*d*.
1829	7*s*. 6*d*.	1852	6*s*. 9*d*.
1831	6*s*. 6*d*.	1853	7*s*. 0*d*.
1834	8*s*. 0*d*.	1856	7*s*. 0*d*.
1837	7*s*. 0*d*.		

It will be observed from the foregoing statement, that the late advance in wages has even reached those miserably paid workmen, the wages in 1851 being 5*s*. 8*d*. per week, whereas, in 1856, the average is 7*s*. 1*d*. It is gratifying to state that the hand-loom weavers are fast diminishing in Glasgow, although in the villages and towns around they still maintain their numbers. That they should do so, is at first sight surprising, when other branches of manufacture offer such high wages for labour. There is, however, some compensation to the hand-loom weaver which the factory workman and the artisan do not enjoy—I allude to the feeling that they are their own masters, can work short or long, late or early, in the garden or in the shop, and that without any detriment to their web—that they can employ their wives and children either as adjuncts or assistants in their own labour, and can thus eke out a tolerable subsistence without the restraints imposed on many of their more money-gaining brethren.

The deduction which may be gathered from the foregoing statements and figures is simply this:—That during the last five or six years a gradual and permanent rise seems to have been established in all wages connected with the leading manufactures of Glasgow, and we may almost add, throughout Great Britain and Ireland; and that, too, even in the face of the reduction which has been made in the hours of labour. And were we to carry the inquiry further, and place in a comparative table the price of the chief articles of consumption which enter into the domestic economy of the artisan and labourer, since the period when the policy of this country was directed, to relieve not only all the great necessaries of life from fiscal burdens, but to reduce, as far as possible, the duties exigible on those articles of luxury, such as tea, sugar, coffee, &c., which more particularly enter into the consumption of the labouring classes;—it may be fairly affirmed that this most important body of the community is at the present moment placed in a more enviable position in the social scale than they were ever formerly in this country, or are perhaps to be found in any quarter of the globe. From the foregoing facts, and from the results of the policy pursued by the Government, it is quite certain that the industrious man never knew a period in which, if he could only be temperate and frugal, he might more easily save money; and could he only be induced to eschew the whisky shop, and turn his footsteps to the Savings' Bank, he would speedily find himself more comfortable, independent, and happy, than the mass of his fellow-labourers, whose increased means are but too frequently devoted to the gratification of the grosser passions of humanity.

On some Statistics bearing upon the Relations existing between Poverty and Crime. By W. M. Tartt, *M.S.A.*

After alluding to the crimes committed by those who were in the enjoyment not merely of competence but of luxury, Mr. Tartt contended, that, although poverty might be a predisposing state, it was rarely an immediate cause of crime till it became allied with drunkenness and ignorance. It was proved by prison returns from the manufacturing districts of Lancashire, that crime had increased during periods of prosperity, and diminished (sometimes to the extent of 40 per cent.) in immediately succeeding periods of adversity; plenty leading to vicious indulgence, while poverty was the severe teacher of economy and restraint. In addition to the more minute details furnished by the chaplain of the County-House of Correction at Preston (the Rev. W. Clay), and quoted in the paper now read, it was shown by the reports of the chief constable for Manchester, that the committals and summary convictions in that borough for the prosperous years 1844-45 were 10,436, and that for the two years of distress which followed, they were only 7635. It seemed admitted by all who came in contact with the administration of criminal law, that the two great causes of crime amongst the lower classes are drunkenness and ignorance; and it was shown by the returns which were now before them, that the greater proportion of the crimes committed were directly or indirectly to be traced to drunkenness. At the assizes for Lancashire in the year ending March 1854, out of 380 of the worst cases, 250 (including 9 murders) were traceable to this vice. Much of it is the result of ignorance, and of the consequent inaptitude to find amusement in better things. To show the extent to which it prevails, it was stated that of the male prisoners who came under the notice of Mr. Clay in 1853 and 1854, 1088 (or 41 per cent. of the whole) were incapable of reading at all; 938 (or 36 per cent.) were unable to repeat the Lord's prayer with any approach to accuracy in the words or proper comprehension of their meaning; and 1836 (or 72 per cent.) were unable to understand the import of the plainest language necessary to convey instruction in moral and religious truth. The Liverpool police returns showed a similar result; and they pretty nearly confirmed the calculations of Mr. Porter for an average of thirteen years from 1836–1848. They cannot be taken as evidence on the general question of education: they merely refer to the connexion between ignorance and crime. The remedy was our great difficulty. One of the judges (Mr. Justice Wightman) had more than once declared his belief, "that drunkenness would ultimately be eradicated by moral and religious instruction. He did not depend so much upon the *knowledge* acquired, as upon the habit of discipline and self-restraint consequent upon better education; and the creation of a tone of self-respect which might operate as a check upon disgraceful or degrading conduct." Something might also be effected by example. The lower classes were, at times, encouraged in their vices by the conduct of those above them; and as temperance has now been substituted for debasing excesses in the one, the same change may, before long, be witnessed in the other. But, above all, we should endeavour to get rid of the monstrous anomaly of raising revenue from the vices of the people; for whatever may be shown by *tabulated returns*, we cannot but believe that the establishment of beer-houses has been the greatest incentive to crime that was ever sanctioned by legislative enactment.

It is, under every aspect, one of the most important questions to which our attention can be directed.

A Deduction from the Statistics of Crime for the last Ten Years. By Professor R. H. Walsh, *LL.D.*

A theory has lately grown up, that when the people suffer privation they refrain from crime, but fall into excesses when prosperity returns. This notion, opposed to the *malesuada fames* of the poet, is based on some criminal statistics, principally composed of the records of summary convictions in a few localities. But it is not fair to estimate the morality of a nation by the number of petty offences committed in one or two districts, or even throughout the entire country. The returns of the summary convictions before magistrates do not afford a correct test either of the number of prohibited acts committed, or of the guilt of the perpetrators. Most of the offences which swell these returns are of a most trivial character; and at one time the acts which constitute such offences are committed with impunity, while at another the excessive vigilance of the police and over-energy of the public in the assertion of their rights, let nothing escape. But even if these alternate fits of remissness and zeal (the necessary consequences of the petty nature and trivial character of the offences in question) did not occur, and the summary convictions afforded a true representation of the *quantum* of prohibited acts committed, the test they furnish must be objected to. The accurate measure of crime is to be found in the returns of offences sent for trial to assizes and quarter sessions. These are usually of a serious and well-defined character; and for that very reason, the acts which constitute them are rarely committed without being made the subject of legal investigation. These are the returns to be employed in measuring the morality of a nation, and they should not be mixed up with the summary convictions. To do so is to be guilty of the absurdity of confounding together, as if they were on a footing of equality, the most serious offences and trifling misdemeanors, and placing in the same category with the robber and the murderer the man who slights the dignity of a policeman, heedlessly offends an irascible wayfarer, or happens to drive on the wrong side of the road. The returns of the committals for trial at assizes and quarter sessions in England and Wales from 1844 to 1854 (the last year for which they have been published), show clearly that crime increases when the physical condition of the people deteriorates, and *vice versâ*. In 1844 the number of committals was 26,542; in 1845, 24,303; 1846, 25,107; 1847, 28,833; 1848, 30,349; 1849, 27,816; 1850, 26,813; 1851, 27,960; 1852, 27,510; 1853, 27,057; and in 1854, 29,359. The first year in which the committals increased is 1847, a year of distress; the rise then being nearly 4000. This rise was maintained with an addition of nearly 1500 in 1848, likewise a year of distress, partly owing to the same causes as in 1847, and partly on account of political disturbances and apprehensions. In 1849, the causes which before had depressed the condition of the labourer died away. Food was cheap and employment abundant. Emigration had removed many of the working classes, and those who remained at home found the demand for their services increased; and in that year we find the committals decline by nearly 2500. The succeeding years were likewise seasons of prosperity, and during these the criminal returns exhibit no marked fluctuation. In the last year of the series, the number of committals rose by a little over 2000, but at the same time the condition of the people was impaired owing to the enhanced price of food and other necessaries of life, and also to the waste of the national resources and partial derangement of trade occasioned by the war. It may be observed in conclusion, that, if the number of committals in 1844 was but 26,542 and in 1854 29,359, the population had increased in the interval in a greater proportion. The criminal returns for Ireland tell a similar tale, when we take into account the changes experienced in the physical condition of the people. Indeed, the lesson is the more instructive from the fact of the changes in the condition of the people having been greater than those experienced in England, so that the corresponding fluctuations in crime exhibit more strongly the marked connexion between the two. During the years of distress the committals rose to over 40,000, and when prosperity visited the land they fell to less than a fourth of that number. The returns of the summary convictions (as might be expected) do not exhibit in their fluctuations any constant relation to the changes in the physical condition of the people; but, as far as they go, they more frequently follow the same than an opposite course to that of the other criminal returns. So much for the results of the statistics of summary convictions, the class of offences from which it had been inferred that poverty and privation are conducive to popular morality. But, taking the statistics of real and formidable offences, we arrive at the more agreeable conclusion, that, when the people are comfortable, they are well-conducted; while it is only when they suffer privation, that a general increase of crime takes place.

On the Present Export of Silver to the East. By Prof. R. H. Walsh, *LL.D.*

So far back as the time when Pliny termed it the sink of the precious metals, silver was a favourite article of export to the East. It has continued so since; but the trade of late has assumed an extraordinary magnitude. In the five years prior to the present over £22,000,000 worth of silver have been exported to the East through England alone, and from other countries a similar movement has been in operation. The export in 1855 was £6,400,000; and this year it is proceeding at the rate of over £9,000,000 per annum, judging from the returns that have been published for the first four months. Unlike the old movement, the present cannot be permanent. The former was seldom more than might be accounted for as the distribution of silver to some of its chief consumers—the nations of the East—according as new supplies were raised elsewhere. It was, in fact, the ordinary movement from the producer to the consumer. But now silver goes faster to the East than it is produced throughout the world. Hence the process cannot be permanent, but must come to an end as soon as the re-distribution of the old stock has been effected; for the annual production of silver is only about £8,000,000, and since the export to the East through England alone is at the rate of over £9,000,000, it follows that it cannot be the new supplies of silver which meet that demand and all others for the same metal, but there must be some auxiliary fund to be drawn upon. Such a fund is furnished by a cessation in the demand for silver in several countries which before employed it most largely, but now use gold instead. In a paper brought before this Association at Glasgow last September, I had occasion to notice that silver, which used to be coined in France and the United States at an average rate of £4,000,000 per annum, is now little employed, while much of the old coin of that metal is melted down and exported. In France, it is said, that in one year, 1853, so much as £12,000,000 was disposed of in this manner, and that the operation has since been proceeding at a still greater rate. All this acts in the same way as if a silver California had been discovered. No one thinks it extraordinary that gold is exported on a large scale from the auriferous regions to the various nations which use that metal; but it is quite as natural to suppose that when large supplies of silver are thrown upon the market (it matters not whether newly extracted from the earth, or just taken from the melting-pot), they would find their way to those places where silver is generally employed. India, China, and other Eastern nations come under this description, and hence the late extraordinary exportation. As this cause is a novel one, there is an inclination on the part of some who call themselves practical men to adopt any other rather than it. Experience gives no instance of any such, and hence those who look to their personal experience alone are completely at fault when discussing this question. Some talk of the balance of trade; others of an increased importation of tea and silk from China; and a third set of investigators enunciate details of the machinery of the foreign exchanges by which the transmission is effected. But such persons forget that the export of silver is just as likely in the abstract to be the cause as the effect of the "balance," or "increased importation," in which they dogmatically assume it originated; and that, as for the details of the foreign exchanges, they merely tell us how and not why the export takes place. Yet all this is said while the question presents no difficulty whatsoever, when two facts are noticed in juxtaposition,—one, the great cessation in the demand for silver in countries which employ a double standard; the other, the circumstance that the Eastern nations habitually use silver on a large scale, especially in their currency. After that there is nothing to be said to complete the explanation, except to call to mind that when the supply of any article is unusually great compared with the number of consumers, it must find its way to these latter in quantities proportionally augmented; and that such is the case at present with the article silver, the principal consumers of which are the nations of the East.

Concluding Address. By R. Monckton Milnes, *M.P.*

In the absence of Lord Stanley, Mr. Monckton Milnes, a Vice-President of the Section, gave a summary of the proceedings of the Section. He remarked on the small proportion of papers that had been read bearing on political economy when compared with the papers on other subjects. They were, no doubt, aware that there were French and

American economists who disputed the very fundamental principles of political economy as laid down by Adam Smith and Ricardo, and he should be glad if the members of the British Association would make this subject their study. In reviewing the papers, he particularly alluded to the paper on the 'Crédit Mobilier' of France, and expressed his fear that it would lead to the wildest speculations, such as could not occur in any country without creating the greatest social disorganization. The Crédit Mobilier had this peculiarity, that it was not like the great commercial crises which had fallen in our own time, which had arisen from over-employment of capital in public works by the authors and promoters of these works; the speculators were ruined, but the works remained. This was not the case with the Crédit Mobilier, which encouraged speculations for the advantage of a mere body of capitalists, who, by their very system, liberate themselves from all personal responsibility and all interest in the works undertaken, and thus give encouragement to every extravagance, without even the pretence of any permanent public utility. He believed the greatest political danger was likely to result from evils of this kind, and hoped that British capitalists would take no part in so unsound a system. He also commented on the papers on social subjects which had been read, especially on those connected with the reformation of young offenders, for which object he had brought a Bill into Parliament ten years ago, and which was now bringing forth abundant fruit. Crime might, under certain circumstances, as had been shown, be increased by national prosperity, but it might be diminished by moral training and true education.

MECHANICAL SCIENCE.

On the Manufacture of Iron and Steel without Fuel. By H. Bessemer.

On the Manufacture of the large-wrought Iron Gun, and other Masses of Iron made at the Mersey Iron Works, Liverpool. By W. Clay.

On the Application of Corrugated Metal to Ships, Boats, and other Floating Bodies. By Major V. Eyre.

On a Method of uniting Iron with Iron or other Metals without welding, invented by M. Sisco *of Paris. By* Dr. Greene.

On a New Railway Break, invented by M. Sisco *of Paris. By* Dr. Greene.

On the Inundation of Rivers. By Professor Hennessy.

Explorations through the Valley of the Atrato to the Pacific in search of a Route for a Ship-canal. By F. M. Kelley, *of New York.*

Several surveying expeditions have been sent by Mr. Kelley into this region, and much valuable information has resulted. But the chief result is a conviction of the feasibility of a ship-canal through the isthmus. The most recent of Mr. Kelley's explorers, Mr. Kennish, proposes to enter the Atrato by the Caño Coquíto. The greatest depth on the bar is about 4 ft. at low water; the soundings gradually deepen, and become 30 ft. within 2 miles, when the depth increases to 47 ft., and is nowhere less up to the Truando. The width varies from a quarter of a mile to 2 miles, and the removal of the bar would allow of the transit of the largest steamers. The confluence of the Truando is about 63 miles from the Gulf, and that river forms the channel of the proposed line for 36 miles. The line then follows the valley of the Nerqua through rock-cutting, and passes the summit by a tunnel of 3¼ miles. It reaches the Pacific through the valley of a small stream, and debouches at Kelley's Inlet. In the valley of the Atrato, 300 miles long and 75 broad, and lying between the Antiochian mountains on the east and the Cordillera of the Andes on the west, rain falls almost daily, which accounts for the immense supply of water in that region. On the Pacific side of the Cordillera there is scarcely any rain for eight months of the year. The greater portion of the rain falling in the Atrato valley is caught above the confluence of the Truando. Fifteen large tributaries and numerous smaller streams fall into the Atrato and contribute to the immense lagoons, which form natural reservoirs and a superabundant store of water throughout the year. There are various cogent reasons for selecting the confluence of the Truando as the best point from whence the passage from the Atrato to the Pacific may be effected. In the first place, there is no point of junction with the Atrato by western tributaries so near the level of high water on the Pacific as that of the Truando. It happens to be 9 ft. above the Pacific at high water, and it is therefore of sufficient elevation to prevent the Pacific at high water from flowing through the proposed cut into the Atrato; while it is not so high as to cause the current from the Atrato to the Pacific at *low* water to pass through the cut too rapidly. In fact, the elevation of the Truando confluence just preserves a preponderating balance on the side of the Atrato. The Atrato, at the junction of the Salaqui, is only 1 ft. above the level of the Pacific at high water; but the dividing ridge is 1063 ft. high and 30 miles wide, according to a survey of that route by Mr. Kennish and Mr. Nelson. Should any of the rivers at the mouth of the Atrato be selected without reference to the height and width of the dividing ridge, it may be observed that the maximum tidal wave in the Pacific being 25 ft. and that on the Atlantic only 2 ft., the Pacific at high tide would flow into the Atlantic with a current equal to a head of 11½ft; and at low water in the Pacific the Atlantic would flow into it with a similar current. In the inlet of the Gulf of Micuel recently called Darien Harbour, the action of the tide is so strong, that Her British Majesty's steamship 'Virago,' commanded by Capt. Prevost, dragged both anchors ahead, and was only brought up by paying out nearly all her cable. The heights of the tides and the levels of the two oceans have been well established by the recent observations of Col. Tolten in Navy Bay on the Atlantic, and in a deep bend of the Bay of Panama on the Pacific. On the Atlantic a consecutive series of thirty-two observations were taken in the months of August and September during the season of calms. On the Pacific two sets of observations were made: the first during May and June, when fifty-four consecutive tides were observed in a season of calms; and the second in November and December, when fifty-two consecutive tides were observed in a season of light winds. The results do not exactly correspond, and are given in the following Table:—

	Pacific.		Atlantic.
	May and June	Nov. and Dec.	Aug. and Sept.
Greatest rise of tide	17·72	21·30	1·60
Least	7·94	9·70	0·63
Average	12·08	14·10	1·16
Mean tide of Pacific above mean tide of Atlantic	0·759	0·140	
High spring-tide of Pacific above high spring-tide of Atlantic	9·40	10·12	
Low spring-tide of Pacific *below* low spring-tide of Atlantic	6·55	9·40	
Mean high-tide of Pacific above mean high-tide of Atlantic	6·25	6·73	
Mean low-tide of Pacific *below* mean low-tide of Atlantic	4·73	5·26	
Average rise of spring-tides	14·08	17·30	
Average rise of neap-tides	9·60	12·40	

These observations make the mean level of the Pacific from 0·14 to 0·75 higher than the mean level of the Atlantic; but this is probably owing only to local circumstances, and it may be assumed that there is no difference in the mean levels of the two oceans. The conclusions arrived at by the successive independent surveys carried out at the expense of Mr. Kelley may be summed up as follows:—first, that the oceans can be united through the Atrato and Truando by a canal without a lock or any other impediment; second, that while the distance between the oceans by this route is only 131 miles, half that distance is provided by nature with a passage for the largest ships; third, the remaining distance requires the removal of bars, excavations, and cuttings presenting no unusual difficulties; fourth, harbours requiring but little improvement to render them excellent exist at the termini.

On the Patent Laws. *By* W. A. Mackfie.

On the Management of Mercantile Vessels. *By* R. Methuen, *F.R.G.S.*

On a New Plan for a Ship Communicator. *By* Dr. Sibbald, *Liverpool.*

Nothing is more common than for a ship in some position of difficulty to require to communicate readily with adjoining land, especially with a lee shore when she is in danger. Or it may be that two vessels require to communicate when they cannot approach each other; and various other sets of circumstances may arise to render such communication desirable or absolutely necessary.

The following apparatus has been patented for the purpose; and numerous experiments have shown that it may be employed with great success.

A series of four parallel hoops of wood, about two feet and a half in diameter, are covered with patent oiled cloth so as to be impervious to water. When not in use, the machine lies flat, about four inches in thickness, and is less than six pounds in weight. When required, the hoops are separated, and the machine becomes inflated on the system of a pair of bellows. It forms two cylinders with a small neck between, the cylinders serving to produce buoyancy and to be acted upon by the wind; and the intermediate neck having coiled round it a cord of two miles, or of any required length. In the centre of the lowest circle or bottom is an orifice of brass, into which a spindle of light cane is inserted; and this is fastened at the top by a screw so as to keep the machine inflated during pleasure.

It is now dropped into the water; and a weight attached to the bottom keeps it in a uniform position. Standing at least two feet out of the water, the wind catches it, and drives it on. It revolves on a vertical axis, and "pays off" the cord with which it is surrounded. When the line has reached the shore, a communication can easily be effected with the other ship, or the wreck, as the case may be, in either direction. It is obvious that additional line can be attached, should the original quantity be found insufficient.

To this general outline, various modifications have been added. For example, a brass hoop, the plane of which is vertical, is screwed to the centre of the top, and inside this are suspended a lamp and bell. These keep their position in all circumstances, and address themselves to two senses, the eye and the ear. Also, in a pocket on the top, suitably protected from the water, letters may be inserted; so that the instrument acts as an inanimate postman, returning with replies, or conveying the most explicit directions. Lastly, to the top are attached ropes by which one individual, or even more, can in special circumstances make it serve the purpose of a life-buoy; but this use might interfere with its primary one, which is simply that of a communicator. Experiments have shown that it requires about a ton to effect its immersion; and it is hardly possible under any circumstances that such an amount of force could be employed.

There are many circumstances which might arise in which this instrument could not be employed; but the occasions are so numerous in which it could be put to its legitimate use, that it is surely most desirable that it should be known and possessed. Its perfect portability is a great recommendation; and its inflation and immersion occupy only one minute.

On Improved Mechanical Means for the Extraction of Oil, and the Economical Manufacture of Manures from Fish and Fishy Matter. *By* W. Smith.

On the Quantity of Heat developed by Water when violently agitated. *By* GEORGE RENNIE, *F.R.S. &c.*

Our knowledge of the mechanical properties of heat was very limited until the year 1798, when Count Rumford published his valuable paper "On the Source of Heat excited by Friction." The investigations of Dr. Black, and subsequently of Watt, Southern, Creighton and Murdoch of Soho, and of Lavoisier, Mongolfier, Dulong, Seguin, Mayer, &c. on the Continent, have been engaged in similar researches; while the chemical or mechanical properties of heat have been largely augmented by Dalton, Leslie, Taylor, Davy, Faraday, Hesse, and Thomson. The question may be considered —

1st. As to the effects of electric action in separating or decomposing compound bodies.

2nd. The effects of the compression and extension of solids and fluids.

3rd. The effects of the chemical affinity of acids on metallic or saline bases, in which may be included the spontaneons combustion of metals, fossils, and fibrous substances.

4th. The condensation and expansion of fluids and gases.

All these have attracted the attention of modern philosophers, among whom may be cited the names of Andrews, Graham, Joule, Thomson, Rankine, and of M. Regnault, whose magnificent experiments, under the auspices of the French government, and published in the year 1847, and since continued in a second part, have developed, more fully than hitherto, new values of the calorific and specific heat of water under different states of density, and temperature, and of other elastic fluids. He found the calorific capacity of water to be double that of ice or steam, a quality which would tend to prove that liquid water has a different molecular arrangement from that of ice or steam.

But it is owing to the more recent experiments of Mr. Joule, communicated to the Philosophical Society of Manchester in 1843, to the British Association in 1847 and 1848, and afterwards to the Royal Society in 1849, that we became first acquainted with the numerical value of heat as a mechanical power. Mr. Joule's experiments* were made on three different fluids, water, oil, and mercury; and in all the three cases the remarkable result appeared, viz. that the mechanical power represented by the force necessary to raise 774·88 lbs. one foot high, produced a quantity of heat equal to the temperature of 1 lb. of water raised 1° Fahrenheit. This equivalent was afterwards altered by an improvement in the apparatus with which he experimented to 711 lbs.; thus confirming the experiments of Rumford and Davy on the friction of solids, and proving that the heat of elastic fluids consists simply in the vis viva of their particles. In the years 1845 and 1847, Mr. Joule employed an agitator to agitate water, oil, and mercury in a box, to produce fluid friction on the principle of common paddle-wheel, by which means he obtained equivalents of 781·5, 782·1, and 787·6 respectively.

These and other experiments left no doubt in his mind as to the existence of an equivalent relation between force and heat. The care bestowed upon these experiments in deducting the retarding influences entitle them to every credit. Upon examining the Table showing the results, it does not appear that the temperature of the water had been raised more than 0·563209°, say half a degree to 97470·2 grains, or as 1 to 7·84229 lbs. of water, and to a higher temperature, and for mercury, than 31·31. It is desirable, therefore, that these experiments be extended.

Having long entertained the idea that steam, as applied to the movement of engines, lost a large portion of its heat in the act of transmission, I watched carefully the attempts which had been hitherto made by inventors for improvements in the application of it through the medium of atmospherical air, such as by Neipce in France in 1806, by Sir George Cayley in 1807 and 1838, by Sterling in 1816, by Erichson in 1826 and 1830, by Brown with his hydrogen gas-engine in 1823, and by Du Trembley's combined steam and ether engine in 1846; and its subsequent realization on a great scale in 1849, and more recently by Siemens in his combined steam- and air-engine now in operation on the Continent, gave reason to expect that

* In 1843, Mr. Joule announced that he had found that heat was evolved by the passage of water through small tubes, and that each degree required for its evolution a mechanical force of 770 lbs.

the loss of heat occasioned by the use of steam, and which had been variously estimated from $\frac{1}{13}$ to $\frac{1}{14}$ of the heat transmitted, might be avoided, and that we should ultimately discover a more economical medium. All these attempts have as yet been arrested by practical difficulties which have been encountered, but which may yet be obviated.

The dynamical theory of heat has, however, been more recently developed by Mayer in 1842*, and Helmholtz in 1847, and greatly extended by Messrs. Rankine and Thomson about the same period. Mr. Siemens, in his paper "On the Conversion of Heat into Mechanical Effect," published in the second part of the twelfth volume of the 'Transactions of the Civil Engineers,' in citing proofs against the material theory of heat shown by the experiments of Davy and Dulong, says, that, "inasmuch as they show an intimate connexion between heat and the mechanical force by which it was produced, and according to which heat, mechanical force, electricity, chemical affinity, light and sound are but different manifestations of one great and infinite cause, *motion*†, — the specific heat and temperature of a body determine the vibrating velocity of the material particles, the square of which multiplied by the weights of the particles gives their inherent force or vis viva. In solids, the vis viva is least remarkable; in fluids it is greater. In gaseous fluids, it predominates so strangely over gravitation that the latter force becomes inapplicable."

Mr. Siemens gives the following as the results obtained in units of power or foot-pounds for one unit of heat by different authors: —

	Centigrade Thermometers.	Fahrenheit's Thermometers.
By Holtzman's formula..............	1227 foot lbs.	682 foot lbs.
By Joule's experiment	1386 ,,	770 ,,
By Rankine's formula	1252 ,,	695 ,,
By Thomson's ,, ...	1390 ,,	772 ,,
By the best Cornish engine, according to Bambur	148 ,,	82 ,,
By a perfect low pressure and condensing	90·8 ,,	50·4 ,,
By an actual Bolton and Watt's engine..	46 ,,	25·5 ,,

The above Table is further illustrated by a table showing the theoretical and an actual performance of steam- and air-engines by diagrams showing the curves which would be indicated theoretically by converting heat into dynamic effect.

In March, 1856, being at Southampton, it occurred to me to make an experiment on the difference of temperature between the water in the tidal basin of the docks there, and the water then running through the sluices of the iron gates of one of the dry docks which was then filling for the purpose of letting out a vessel into the tidal basin. The result was a difference of two degrees. In both cases the same thermometer was suspended ten minutes in the water of the tidal, and afterwards in the current of water running through the sluices into the dry dock. Observations on the temperature of the sea in stormy weather, and through water-wheel races, always indicated an increase.

Being desirous of corroborating these statements, a box or cistern made of deal, 24 by $22\frac{1}{4}$ inches square, and 20 inches deep, was prepared; a quantity of Thames water, about 20 inches in depth, was poured into it, equal to $437\frac{1}{2}$ lbs. Into the side of the box was fitted a bent iron tube of 2 in. diameter; and into the upper part, above the bend of the pipe, a glass tube was inserted; so that, by suspending a glass thermometer in the water contained in the tube, the temperature could be easily seen.

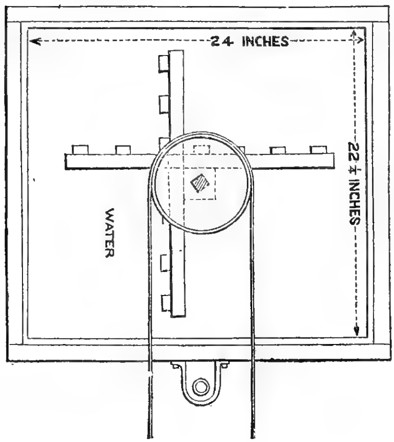
The box was then covered by a wooden lid, so closely fitted as to exclude the surrounding air, and to prevent the loss of water by agitation. A wooden spindle having four arms, and twelve vertical agitators, was previously fitted into the lid of the box, as shown by the accompanying woodcut; a pulley of wood was fitted to the top of the spindle; and the apparatus was rapidly revolved in the water by being connected with a steam-engine.

* Mayer was the first to observe an increase of temperature of from 12° Centigrade to 13° Centigrade by agitating water in the year 1842.

The remarkable experiments of Beaumont and Mayer in the boiling of 400 litres of water by the friction of a roller revolving in the interior of a tube, in the middle of a boiler surrounded by water, 1855, at the Paris Exhibition, show the effects of mechanical force.

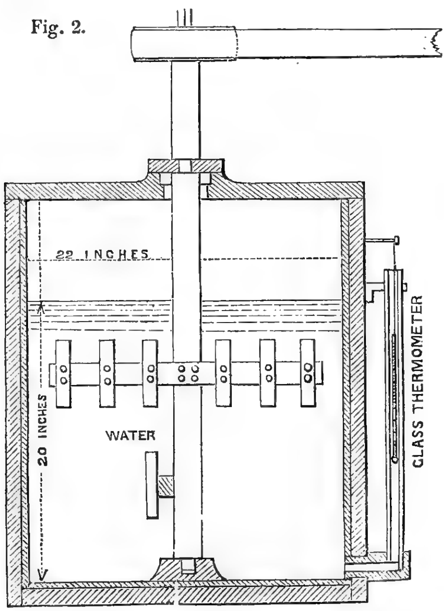
† Correlation of Forces, by Grove.

Fig. 1.



The annexed illustrations exhibit views of the apparatus, and the accompanying description will make the whole understood. (See woodcut.)

Fig. 2.



The experiment commenced on the 19th of June last.

The apparatus was then worked for an hour and a half, and the result was the raising of the temperature of the water by agitation from 58° to 64° Fahrenheit.

The apparatus, however, got deranged, and the experiments were postponed to the following day. The Thames water was then replaced by clear well-water. The apparatus was again adjusted. The quantity of water weighed in the box 437 lbs. The temperature of the air was 65° Fahrenheit when the experiment commenced, and of the water 64° Fahrenheit.

The apparatus made 270 revolutions per minute, and in 55 minutes raised the temperature of the water from 64° to 73¼°, or an increase of 9¼° Fahrenheit.

The experiments were continued on the third day with well-water at 59°, and the temperature of the air 60½°. The apparatus was worked from $10^h\ 5^m$ A.M. to $1^h\ 5^m$ P.M., when the temperature of the water was raised from 59° to 75¼°, or 16¼° increase in three hours.

On the third day the apparatus was defective from the slipping of the strap, and only made 140 revolutions instead of 270 revolutions per minute.

The apparatus having been repaired was again set to work on the 24th of June, being the fourth and last day of experimenting.

The following were the results: —

Number of revolutions of apparatus 240 per minute.

Temperature of well-water in the box 59½° Fahrenheit.

Began at 10 A.M.	Temperature of Water.
10·0	59½ deg. Fahr.
10·5	69½ ,,
11·0	74 ,,
11·30	74 ,,
11·34	75 ,,
12·0	79 ,,
12·8	80 ,,
1 P.M.	89 ,,

Stopped at 1 P.M. for one hour, and on starting again at 2 P.M., found that the temperature of the water had fallen to 76°, being a loss of 13° Fahrenheit.

This, however, was owing to the tube which contained the thermometer being exposed to the influence of the east wind: started the engine and apparatus at 2 P.M.

At P.M.	Temperature.
2·0	76 degrees.
2·5 (increase 10°)	86 ,,
2·15	88 ,,
3·0	92 ,,
3·30	95 ,,
4·0	97½ ,,
4·15	99 ,,
4·45	100 ,,
5·0	101½ ,,
5·15	102 ,,
5·30 stopped	103 ,,

The total increase of temperature having been 44½° in 6½ hours.

On examining the foregoing Tables, it will be seen that the increase of temperature seems to follow no regular laws; thus: —

From 10 A.M. to 11 A.M. the increase is	....	14½° Fahrenheit.	
,, 11 A.M. to 12 A.M. ,,	....	5° ,,	
,, 12 A.M. to 1 P.M. ,,	....	16° ,,	
,, 2 P.M. to 3 P.M. the temperature of the water rose from 76° to 92°, being an increase of		16° in 1 hour.	
,, 3 P.M. to 4 P.M. ,, 92° to 97½°	,,	5½°	only per hour.
,, 4 P.M. to 5 P.M. ,, 97° to 101½°	,,	4°	
,, 5 P.M. to 5½ P.M. ,, 101½ to 103½°	,,	2°	

So that, had the experiments continued longer, the rate of increase per hour might have been reduced to an equilibrium.

As a proof that the box radiated very little heat, on one occasion the apparatus (after the temperature of the water had been raised from 60° to 103° Fahrenheit) was left all night for 14 hours exposed to the external air. The temperature of the water in the box next morning was found to be 87° Fahrenheit, being a loss of 16°, or little more than one degree per hour.

The conclusions to be derived from the foregoing experiments are as yet uncertain. That the evolution of heat by fluid friction has been proved, cannot be doubtful, as has been shown by the refined experiment of Joule; but by what law remains to be determined by future experiments.

Experiments to determine the Resistance of a Screw when revolving in Water at different Depths and Velocities. By George Rennie, *F.R.S. &c.*

The experiments which have hitherto been made upon screw propellers, have had for their object, principally, to determine their forms and proportions, to enable them to act most effectively in propelling the vessels to which they were attached, and at the same time to impede by their form as little as possible the vessel's motion through the water when under steam or sail.

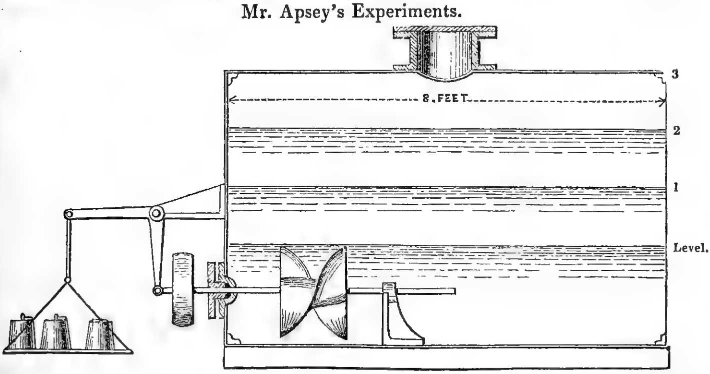
In every case it has been considered necessary to give as large a diameter to the screw as the draft of the vessel would admit, in order that the area of its whole disc should have as large a proportion to the midship section and resistance to the onward motion of the vessel as possible. So that the present state of our knowledge upon screw propulsion is confined to the best form and area of the propeller and of the vessel to which it is attached.

The experiments of Mr. Barlow on several of Her Majesty's paddle-wheel vessels, and of Mr. Lloyd on the propelling powers of Her Majesty's steam sloop 'Rattler,' and the recent investigations of Mr. Charles Atherton, had already established certain relations between these extremes. But no experiments have as yet been recorded on the action of screw propellers immersed at different depths and driven at high velocities.

Last year my attention was called by Mr. Joseph Apsey, an engineer of Broadwall, in the parish of Christ Church, Surrey, to some remarkable properties which he stated to have discovered in a double screw which he had invented, but which was similar in every respect to the screw used in the Archimedes steamer.

The screw which he experimented upon was of brass $13\frac{3}{8}$ diameter, 28 inches pitch, and 145 square inches, or about 1 foot area. The screw was fixed upon an iron spindle resting in bearings, one being a stuffing-box on the outside of a boiler in which the experiments were made, so as to prevent leakage, and the other end

Mr. Apsey's Experiments.



loose in the bearing fixed at the bottom of the boiler. A pulley of iron was fixed to the outer extremity of the spindle, so as to allow of its being driven by leather bands at any rate of speed. A bracket was bolted to the outside of the boiler for the purpose of serving as a fulcrum to a bent lever, the horizontal extremity of which supported a scale and weight, and the vertical extremity was pushed by the screw when revolved in the water in the boiler, so that the weights lifted by the bent lever indicated the thrust of the screw.

The length of the boiler was	....	8 feet
The breadth of do. was	....	4 feet
The height of do. was	....	4 feet

The depth of the water in the boiler was at first regulated so as to have its surface level with the surface of the screw. This depth was subsequently increased to

One foot above the level of the screw
Two feet do.
Three feet do.

The speed of the engine (which was 50 revolutions per minute) was multiplied by different-sized pulleys and bands, so as to cause the screw to make 920 revolutions per minute, and was reduced afterwards to 460 (one half) the revolutions per minute. The following were the results:—

	Revolutions 920 per min. Pressure. lbs.	Revolutions 460 per min. Pressure. lbs.
First experiment, water level with top of screw	67	63
Second do. water above top of screw 1 ft.	299	88
Third „ „ „ „ 2 „	350	112
Fourth „ „ „ „ 3 „	448	126

So that on reducing the results, they approximated to a parabolic curve with high velocities, and a sharper curve with lower velocities. The conclusions derived from these experiments at the meeting at Glasgow in 1855, were, that the water being confined in a boiler by its reaction damaged the results, and were not to be depended upon.

In order, however, to remove further doubts on the subject, I had an apparatus constructed somewhat similar, figure 3, as represented in the accompanying woodcut, with these differences, that the diameter of the screw was 1 ft. 9 in., and its disc area $346\frac{1}{3}$ square inches, or nearly $2\frac{1}{2}$ times larger than Mr. Apsey's screw. The screw worked on the outside of the cistern, and the lever and weights and pulley were inside the cistern, the water having been kept out by means of a stuffing-box let into one of the sides of the cistern, through which the spindle of the screw worked. The experiments were made in the river Thames; so that as the tide rose or fell, the screw could be driven at different depths outside the cast-iron cistern, while the observations were taken within the cistern.

The greatest speed at which the screw could be driven, was at the rate of 558 revolutions per minute, and the following were the results:—

Experiments made in June, 1856, *in the river Thames, for the purpose of determining the resistances experienced by an ordinary two-bladed screw propeller when driven at a high rate of speed and at different depths.*

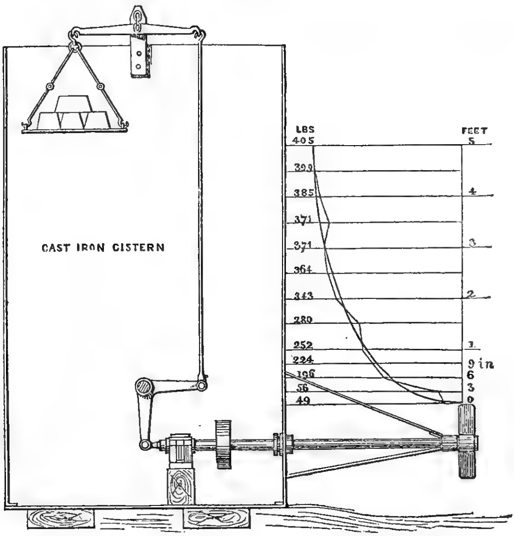
Number of Experiment.	Rate of speed in all cases, 558 revolutions per minute.		Weight lifted by screw.
1	Water level with top of screw	in.	49
2	Above top of screw	3	50
3	ditto	6	196
4	ditto	ft. in. 9	224
5	ditto	1 0 or 12	252
6	ditto	1 6 or 18	280
7	ditto	2 0 or 24	343
8	ditto	2 6 or 30	364
9	ditto	3 0 or 36	369
10	ditto	3 6 or 42	371
11	ditto	4 0 or 48	385
12	ditto	4 6 or 54	399
13	ditto	5 0 or 60	405

The ordinates of the above thrusts are represented by a parabola.

On comparing these experiments, it will be seen that, although the propeller is of larger dimensions than that of Mr. Apsey, the *thrusts* are not so great. In the first case, the velocity is nearly twice as great, while the area, taken as discs, are as 1 : 2·47 ; but taking the respective thrusts of the two propellers, Mr. Apsey's in the boiler, and mine in the open river Thames, the ratios of resistance or thrusts of the propellers at one, two, and three feet immersion respectively, are not very dissimilar.

In both cases the influence of velocity is much greater than depth, and is such as to approximate the action of a screw in a solid, like which the water becomes when rapidly acted upon ; but the joint influence of depth and velocity shows that the thrust or resistance of the screw is $6\frac{3}{4}$ times greater when immersed three feet

Fig. 3.



below the water level than when working at a level; consequently, a screw whose *disc area* is one-sixth, three-fourths of the area of the screw, when the level of the water is level with its circumference, is equally effective. If this be the fact, as the often-repeated experiments proved, it is reasonable to expect very important results hereafter in the use of the screw ; and further, if one small screw proportioned as above shown be as effective as one large screw working in the dead wood, how much smaller and more effective will be two screws, when applied to a vessel's quarters on either side of the dead wood and stern !

APPENDIX.

Containing Abstracts which were not received in time to be included in the Sections to which they belong.

Crystallogenesis, and the Equivalent in the Mineral Kingdom corresponding to Geographical Distribution in the Animal and Vegetable Kingdoms. By Samuel Highley, *F.G.S.—(Read in* 1854.)

The author pointed out, that in mineralogy no scientific value could be attached to Locality, equivalent to that which it possessed in botany or zoology; and although the Leonhards had published works on topographical mineralogy, no laws had been deduced analogous to those of the geographical distribution of plants and animals, though it was very evident local conditions determined the association of minerals, and the aspect, form or its modifications, isomorphic constitution, colour, &c. of the same species; and as we know from laboratory experience that temperature, light, electricity, magnetism, catalytic action, &c. are determining influences in crystallogenic force, we must learn in detail the physical as well as the chemical conditions of geological districts in various parts of the globe before we should have data for founding any general laws on the mineral-producing conditions of the earth. The following form was then proposed and described in detail for tabulating local mineralogical phænomena, which if distributed amongst naturalists, mine-masters, &c. at home and abroad and returns obtained, would furnish matter for deductions, not only of value in mineralogical, but also in physical, geological, zoological, ethnological, and agricultural science.

Geographical.			Geognostic.		Physical.			Physiognomical.	Chemical.				Physiographical.						Deductions.
Latitude.	Longitude.	Locality.	Enumerate rocks in their order of association—gases and waters affecting rocks — rough sectional sketch.	Enumerate species and varieties of minerals in their order of association and relation to rocks.	Dip of strata on particular rocks, and direction of mineral veins.	Temperature of mine.	Magnetic and electrical phænomena.	Physiognomy of the mineral formations at the surface described, and, if possible, illustrate by a sketch or photograph.	Analysis of the rocks.	? Analysis of the gases.	Analysis of the waters.	Analysis of the minerals.	Morphological characters.	Specific gravity.	Hardness.	Colour, lustre, &c.	Optical character.	Electric, magnetic, &c.	Chemical. Morphological. Physical, &c.
		*	*	*	*		*	*	*	*	*	*	*			*	*	*	*

* Space to be given to these columns according to the requirements of the observations to be made.

On some points connected with Agricultural Chemistry. By J. B. Lawes, *F.R.S., and* Dr. J. H. Gilbert, *F.C.S.—(Read in* 1854.)

The authors thus express the conclusions to which their inquiries, mentioned in this paper, which was read at Glasgow, conducted.

1. That the manure indicated by the resultant requirements of British agriculture, has no *direct connexion* with the composition of the mineral substances collectively found in the ashes of the produce grown on, or exported from the farm; and that the direct mineral manures which *are* required, are not advantageously applied for the direct reproduction of the exported corn, but should be used for the green or *fallow crops*, an office of which it is, to collect from the atmosphere, or to conserve on the farm, *available nitrogen* for the increased growth of the saleable cereal grains.

2. That the nitrogen required to be provided *within the soil* for this purpose, is far greater than that contained in the increase of produce obtained by it.

3. That the effects of *fallow* in increasing the growth of the saleable cereal grains

(so far as they are chemical), are not measurable by the amount of the additional mineral food of plants liberated thereby, these being under ordinary cultivation in excess of the assimilable nitrogen existing in, or condensed within the soil in the same period of time; the amount of which latter therefore—the *available nitrogen*—is the measure of the increased produce of grain which will be obtained.

4. That the beneficial effects of *rotation*, in increasing the production of saleable produce (so far as they are chemical), are *not* explained by the fact of one plant taking from the soil more of the different mineral constituents than another, but depend on the property of the so-called green or *fallow* crops bringing on, or conserving upon the farm, more of substance rich in nitrogen than is yielded to them in manure, whilst the crops to which they are subservient are both largely exported from the farm, and yield in their increase considerably less of nitrogen than is given to them in manure.

5. In a word, that in the existing condition of British agriculture, a full production of the *saleable cereal grains*, with at the same time other exportable produce, is only attained—whether by *manures, fallow, or rotation*—by an accumulation of available nitrogen (normally an *atmospheric* constituent), *within the soil itself*.

On the Composition of Wheat-Grain, and its Products.
By J. B. Lawes, *F.R.S., F.C.S., and* J. H. Gilbert, *Ph.D., F.C.S.*

The authors had for a series of years conducted experiments on the successive growth of wheat, on the same land, by different chemical manures. The general result of these experiments had been to show, that, although the amount of the produce had been much increased by the use of nitrogenous manures, the per-centage of nitrogen in the grain had been, comparatively speaking, but little affected thereby. Variation in season had had more influence on the composition of the crop in this respect. It had further appeared, that, within the limits of their own locality and climate, there was, on the average of the seasons, a lower per-centage both of nitrogen and of mineral matter in the grain, the more favourably the produce was developed and matured. The varying composition of the entire grain as affected by season and manuring, the authors hoped to treat of more fully elsewhere *; their object, in the present paper, being chiefly to call attention to some points in the character and composition of the different products obtained from wheat-grain by means of mechanical separation.

With a view to the prosecution of this part of the inquiry, in selected cases, quantities of the experimentally grown grains, namely, seven lots from the produce of 1846, nineteen from that of 1847, and two from that of 1848, had been carefully watched through the milling process. In some of the cases nine, and in others seven different products of the dressing apparatus, were separately taken. The proportion of each of the several products in the respective grains was ascertained and recorded, and the per-centages of dry substance and mineral matter were also in every case determined. The three first wires of the dressing machine gave on the average rather more than 70 per cent. of the grain as *fine* flour; but in practice about 10 per cent. more would be obtained from the next two products, yielding in all 80 per cent. or more of pretty good bread flour. The average amount of *dry substance* in the various mill products was about 85 per cent.; the external or more branny portions containing rather more, and the finer flours rather less. The per-centage of *mineral matter* varied very much in the different products, it being scarcely $\frac{3}{4}$ths of 1 per cent. in the fine flours, and ten times as much, or more than 7 per cent., in the coarsest bran. From the much larger proportion of flour than bran, however, it resulted that rather more than $\frac{1}{3}$rd of the total mineral matter of the grain would be accumulated in its currently edible portions.

In one series of these mill-products, from the finest flour at the head of the machine down to the coarsest bran, the *nitrogen* was determined, and also some of the constituents of the respective ashes. It appeared that the per-centage of nitrogen was about once and a half as great in the bran as in the finer flours. And even including all the currently edible portions, still the excluded branny parts contained

* See Quarterly Journal of the Chemical Society, April, 1857; where also is given, with additions, the tabular matter, &c. to which this abstract relates.

considerably higher per-centages of nitrogen. Turning to the ashes of the respective mill-products, there was a much larger proportion of matter insoluble in acid in those of the finer flours than in those of the coarser brans; of the *phosphoric acid*, on the other hand, there was considerably the higher per-centage in the ash of the brans. The magnesia also was the higher in the ash of the brans, and the potash and lime the higher in that of the flours. Looking to the *distribution* of the various constituents, according to the average proportion in the grain, of each of the several mill-products, it appeared that about $\frac{3}{4}$ths of the total *nitrogen*, and about $\frac{1}{3}$rd or $\frac{2}{5}$ths of the total *mineral matter*, were accumulated in the usually edible flours, and of the total phosphoric acid, there was only about $\frac{1}{3}$rd in the ashes of the latter. Notwithstanding the higher per-centage of nitrogen, and the large actual amounts of the mineral constituents of the grain contained in the branny portions, the authors were of opinion, that, besides the information at present at command as to the character and condition of the nitrogenous constituents of the bran, such were the effects of the branny particles themselves in increasing the peristaltic action, and thus clearing the alimentary canal more rapidly of its contents, that it was questionable whether frequently more nutriment would not be lost to the system by the admission into the food of the imperfectly divided branny particles, than would be gained by the introduction into the body coincidently with them of the larger amount of supposed nutritious matters. The action alluded to might indeed be conducive to health with those of a sluggish habit or who were overfed; but with those who were not so, the benefits derivable from an already perhaps scanty diet would be still further reduced.

Experiments were also described, in which several lots of the experimentally grown wheats were ground in a colonist's steel hand-mill. The results of the examination of the products thus obtained were in the main consistent with those from the products of the ordinary mill. They showed, however, more strikingly the effects of mechanical means in separating different chemical compounds within the limits of the floury parts of the grain.

Experiments were next adduced, in which the different edible products, from grains grown by different manures or in different seasons, were made into bread; the several products of the dressing machine being employed sometimes separately and sometimes collectively. The result obtained was, that comparing with each other the three separate products which together yielded a fine flour, that at the head of the machine, which was the least nitrogenous, yielded on the average the least weight of bread for a given amount of flour, that is to say, it retained the least amount of water. Again, when the three products were mixed together, the flours of the season of 1846, which were the less nitrogenous, gave the less weight of bread, that is, retained less water than those of 1847, which were rather the more nitrogenous. The effect of an increase of nitrogen in augmenting the weight of bread was, however, not observable when this increase was due to including more of the more branny portions of the grain. The average yield of bread in twenty-two experiments with the individual products was rather more than 135 for every 100 of flour,—equal to about 63 per cent. of dry substance and 37 of water in the bread. The average of nineteen experiments with fine flour, composed of the products of the first three wires mixed together, gave a produce of about $137\frac{1}{2}$ of bread for every 100 of flour, and about $61\frac{1}{2}$ of dry substance, and $38\frac{1}{2}$ of water in the bread. Bakers' loaves were next examined. Of these, four obtained from different bakers in the country gave an average of about 62 per cent. of dry substance and 38 of water in the bread; and three procured in London, rather more than 64 of dry matter and rather less than 36 of water. The authors concluded, that from 36 to 38 per cent. of water was perhaps the best average that could be assumed for bakers' bread within twelve hours of its being withdrawn from the oven. They showed, by reference to a Table of the results of other experimenters, that this agreed pretty well with the determinations of some of the most recent and trustworthy. Others, however, gave the water in bread as much higher; and all seem to agree that it was generally higher in country bread than in that of towns and cities.

The point next illustrated was the general influence of locality and varying climatic circumstance upon the per-centage of *gluten* in wheaten-flour. It appeared by the numerous results adduced, that, other things being equal, there was a tendency to an increase in the per-centage of gluten, proceeding from the north to the south—a point which was illustrated in specimens both from the European and American continents. A comparatively high ripening temperature was indeed, among other circumstances, favourable to a high per-centage of gluten. There were, however, interesting exceptions to this generalization; at any rate, so far as the per-centage of the *nitrogen*, if not of the gluten itself, was concerned.

The foreign wheats containing a high per-centage of gluten, which were generally ripened under a high temperature, had the undoubted character of yielding a flour of great '*strength*,' and retaining a considerable amount of water in the bread. Owing, however, to their frequent hardness, and the peculiarity of their structural character generally, which rendered them both refractory in the mill, and less fitted to make an easily workable dough, and a bread of the desired colour, texture, and lightness, they were less valued to use *alone* for bread-making purposes than many grains of less *per-centage* of gluten, provided only that they are in an equal condition as to maturation or elaboration of their constituents. Some of the most approved foreign bread-flour grains in the market had indeed a comparatively low per-centage of nitrogen; but apparently of very high *condition* of both their nitrogenous and non-nitrogenous compounds, as well as a very favourable relation to each other of these two classes of constituents. Within the limits of our own island, again, on the average of seasons, the better elaborated grain would probably be the less nitrogenous; though the nitrogenous matter it did contain would be in a high condition as to elaboration, and as to its mutual relations, structural and chemical, with the other constituents of the flour. Hence it came to pass, that as our home-grown flours go, those which were the best in the view of the baker would frequently be those having a comparatively low *per-centage* of nitrogenous compounds, a higher *condition* more than compensating for the higher per-centage of nitrogen, generally associated as it was in our climate with an inferior degree of development and maturation of the grain.

The authors further maintained, that the high per-centage of nitrogen or gluten in wheaten-flour was no more an unconditional measure of value to the *consumer*, than it was in the view of the baker.

In illustration of this latter point, a Table was exhibited showing the relation of nitrogen to carbon in a number of current articles of food. It was submitted, that the under-fed or chiefly bread-fed working man, would, as his means increased, generally first have recourse to the addition of bacon, or other highly fatty matters; which, though they might increase the actual amount of nitrogen consumed, would seldom increase, and frequently decrease, the *proportion* of the nitrogenous or flesh-forming to the more exclusively respiratory and fat-forming constituents. Indeed, so large was the amount of fat, and therefore of respirable hydrogen, as well as respirable carbon, even in fresh meat itself, that by its use the proportion of the nitrogenous to the other constituents would be much less augmented than might be generally supposed.

On the Correlation of the North American and British Palæozoic Strata. By Henry Darwin Rogers, *Corresp. Memb. of the British Association, Hon. F.R.S.E., F.G.S. &c.*

The palæozoic system of strata constituting the first term in the great succession of fossiliferous deposits of the globe, surpasses in geological interest all other groups of rocks. It is from it that we learn under what types animal and vegetable existence appeared in the morning of the great day of life, which is only now culminating towards its noon. The classification of the palæozoic deposits, only another expression for the determination of their true chronology, assumes in this light a high importance, since through it alone can we trace the physical history of our earth through the most interesting of all its phases, that of the infancy of its inhabitants; but a sound classification and correct chronology are not to be reached but through a comparison of the sediments and fossils of very wide areas, indeed, not until the contents of several great ancient contemporaneous basins have been faithfully coordinated. This consideration confers an especial interest at the present time, upon the study of the palæozoic fields of North America, which constitute, apparently, five-sixths of that wide continent, and possess, from their very breadth of distribution and amazing continuity of mineral and organic type, unusual value for such comparison. Their title to the attention of the philosophical geologist will be admitted when he reflects,—1st, on the remoteness and apparently partial original insulation of the North American palæozoic basin from the European one; 2ndly, on their amplitude and unbroken continuity, offering unusual facilities for the detection and tracing of their natural horizons; and 3rdly, on the fullness of the whole series of deposits as a record of the physical and vital conditions of the ages which beheld their accumulation. The American basin is not only more replete in specific forms than the palæozoic basin of Europe, but more abundant in well-defined palæontological horizons. Geographically more continuous, it appears to be stratigraphically more expanded. From the lowest platform of ancient life to the uppermost layers crowning the coal series, its latest formation, the aggregate thickness of the strata is between 35,000 and 40,000 feet.

To coordinate faithfully such distant affiliated systems of strata, each set of the rocks to be compared should be classified in accordance with their own phænomena, and not upon any preconceived notions of their equivalency to the deposits of independent districts assumed as standards; nor should the classification rest solely on the relations of their organic remains, but should recognize equally their physical peculiarities or composition, and the nature of the horizons dividing them. From a deferential feeling among American palæontologists towards their learned British brethren, there has been, the author conceives, a disposition to apply prematurely a favourite British nomenclature to the American strata, and this unphilosophical procedure has tended to check that spirit of free inquiry which is indispensable to the perception of the wider relationships and grander laws of creation. To apply to a large field of nature in North America an interpretation expressed in a classification and nomenclature drawn from a distant region across the Atlantic, is to make one country a standard for another; whereas by the sanctions of inductive philosophy, each great tract of creation must be its own exemplar, must itself furnish the measure of its own phænomena. In the universal federation of scientific intellect, no community or school of thinkers, however able or authoritative within their own domain, can become a supreme court of opinion in questions of a world-broad significance.

Hitherto little has been done by the American and European geologists who have attempted the arduous study of the American palæozoic basin, to measure the degrees of relationship subsisting between its constituent formations, while those affinities which have been examined have been almost exclusively palæontological. In this field all honour is due to the masterly labours of James Hall, and the investigations of M. De Verneuil, and of the lamented Daniel Sharpe. Other skilful naturalists have contributed much to the definition of the American species; Conrad of Philadelphia, and William Salter of the Geological Survey of Great Britain, have supplied many valuable determinations. Still there has been no systematic attempt to explore the physical phænomena, which are in beautiful coordination with these palæontological discoveries. While the fossils have been appealed to, as they should in every attempt at classification, the strata themselves have scarcely been interrogated.

In the present essay, the author's leading aim is to indicate the principal natural planes which intersect the North American palæozoic strata and insulate them more or less into formations, and to point out the relative magnitudes of the breaks of continuity, both as respects their geographical areas, and their greater or less distinctness in the vertical scale. But first it will be expedient to sketch the general limits of the palæozoic area of North America and of its chief subordinate basins.

Palæozoic Basins of North America.

We may estimate the surface originally covered by palæozoic sediments on this continent at about five-sixths of all the land between the North Atlantic, Pacific, and Arctic Oceans. These deposits are embraced in two great natural basins, bounded by zones of the older crystalline rocks. By far the largest is a great interior basin, spreading from the Appalachian chain to the Pacific mountains, and from the parallel of 32° or 33° to the Arctic Sea and the Laurentian water-shed. This continental palæozoic area includes three wide fields of these rocks, partially separated superficially by overlapping newer strata, but probably united underneath. These may be designated severally as the *Appalachian*, the *Saskatchewan*, and the *Chippewayan* basins. The *first* extends westward from the Appalachian mountains to the eastern edge of the sandy plains of Texas, Kansas, and Nebraska, and northward from the low cretaceous and tertiary plane fringing the Gulf of Mexico to the crystalline zone north of the St. Lawrence and its lakes. The Saskatchewan basin, strictly a prolongation of the Appalachian area, is a long palæozoic belt stretching north-westward from the sources of the Red River of Winnipeg to the Arctic Sea, between the crystalline lacustrine zone on its east, and the cretaceous and tertiary prairies on its west.

The *Chippewayan basin*, more vaguely known, may be defined, provisionally, as coextensive with the Rocky Mountains and Humboldt Mountains of the Utah Desert, and as including wide tracts surrounding the sources of the Rio-Colorado of California, palæozoic rocks being developed on a stupendous scale between the Rocky Mountains and the Salt Deserts of Utah and the Columbia River. It would seem from palæontologic evidence, that each chief division of palæozoic time, except the Permian, is represented within each of these vast tracts or basins; and there appear good reasons for inferring that many of the Appalachian formations, modified in composition and fossils, extend into both the other areas.

The Hudson Bay Palæozoic Basin, lying north of the crystalline plateau, skirting the valley of the St. Lawrence and its lakes, is of much more limited extent than the main continental area. The zone of metamorphic rocks separating the two, after running from Labrador to the head of Lake Superior, deflects to the north-west and ranges in that direction 1500 miles to the Arctic Sea. Hitherto no strata of Cambrian or Lower Silurian age have been detected within the basin thus enclosed.

Appalachian Formations.—The palæozoic strata of the Appalachian basin constitute fifteen series or natural groups, individualized by distinctive organic species and by their mineral composition. Some of these blend together both in their fossils and their materials more than others, and it becomes important to ascertain their relative degrees of affinity. Objecting to a geographical nomenclature as inapplicable to formations so very widely distributed, and on the same ground of their inconstancy, to the plan of naming them from prevailing local fossil or mineral features, titles have been applied to them based on the consideration of their relative age, using a series of terms significant of the different natural periods of the day as metaphorically expressing the relative ages of the formations. These Appalachian rocks of North America are therefore here named *Primal, Auroral, Matinal, Levant, Surgent, Scalent, Premeridian, Meridian, Pomeridian, Cadent, Vergent, Ponent, Vespertine, Umbral* and *Seral*; the deposits, that is to say, of the dawn, daybreak, morning, sunrise, mounting-day, climbing-day, forenoon, noon, afternoon, declining day, sinking day, sunset, evening, dusk and nightfall.

[The communication, of which this is an abstract, contains in this place a tabular view of these *fifteen series* of formations, with their synonyms and nearest equivalents among the European strata; also their lithological characters, their more characteristic organic remains, and the nature and relative magnitude of the physical and ontological breaks which separate them; but it is too voluminous to be inserted here.]

This vast succession of strata admits of a somewhat natural classification into four assemblages, partially representing the Cambrian, Silurian, Devonian, and Carboniferous series of European geologists, but the relative values of these groups are by no means the same as the European, and it is doubtful if some of them can be strictly coordinated. One main object of this essay is to indicate the proportionate value of the differential elements which divide the fifteen members of the system, and bring these into relationship with the palæontological breaks upon the recognition of which the palæozoic rocks of Europe have received their present classification. Attention will be first directed to the stratigraphical phænomena, and then to the palæontological; but some preliminary suggestions will be offered respecting the inferences to be deduced from the conditions of superposition of strata.

It must be conceded that every over-resting sheet or current of water has left some permanent monument of its presence, and therefore wherever between two strata or ancient surfaces known to have been produced in periods separated by some interval of time nothing sedimentary intervenes, we must assume the vacuous space to have been dry land. It is not supposable that water, endowed as it is with a power of suspending and transporting sedimentary matter into the very middle of the ocean, and there and everywhere teeming with animal and vegetable organisms, could have rested over any surface without leaving an indelible record behind it. Until it can be proved that some one formation has been thoroughly swept away from a wide area where it was deposited, we are not entitled by rules of sound reasoning to infer that such have existed.

Looking at the conditions under which strata repose upon each other, we may view their relations of superposition under the four following categories.

1st. Successive deposits may lie together in parallel arrangement, and so graduate into each other as to denote no pause in time or interruption in the formative process; and even a formation of one long period may thus graduate into another by their sediments and their fossils. Such a close following of strata, the author entitles a *conformable continuous sequence.*

2nd. One set of strata may rest immediately on another with perfect parallelism, and yet their plane of contact represent a long interval of time and a total change of sedimentary conditions and of the physical geography; for certain beds or even whole formations interposed between them in other districts, may be altogether absent. This relationship is entitled a *conformable interrupted sequence.*

It proves not merely a lift of the watery floor into dry land, and its subsequent re-immersion, but a movement unaccompanied by any tilting or undulation of the lower deposit.

3rd. An upper group of beds may repose on a lower with an angle between them such as to imply an uptilting from horizontality in the inferior, before the superior was deposited, while a close sequence of type in their organic remains shows them to be the products of immediately consecutive periods, or that no time elapsed for the production elsewhere of a middle formation. This relationship is entitled an *unconformable continuous sequence.*

4th. Two sets of strata resting in contact, may present not only an absence of parallellism, but an omission of one or more intermediate formations elsewhere existing. This state of things implies not only an inclining of the inferior beds, but a lifting of them into dry land, with a lapse of time before their immersion for the reception of the overlying deposits. Such a condition, familiar as the commonest species of unconformity, may fitly be entitled an *unconformable interrupted sequence.*

The fifteen principal divisions of the Appalachian palæozoic strata contain several important planes of discontinuity. These are of very unequal magnitude, both geographically and stratigraphically. Between them are other lesser horizons, but only the greater ones are discussed in this paper. The two most conspicuous of all, are that at the end of the Matinal or Hudson River period, and that at the beginning of the Vespertine or first Carboniferous age. Another, though materially less extensive one, divides the Premeridian or Lower Helderberg period from the Meridian or Oriskany sandstone age.

Evidences of an extensive Paroxysmal Revolution in the Physical Geography and Organic Inhabitants of the Appalachian Sea at the end of the Matinal Period.

The break or plane of discontinuity terminating the Matinal series or Hudson River group, exceeds all the others in the Appalachian basin for the abruptness of the transition which it implies in the organic remains, and in the magnitude of the crust-movement. From the Gulf of St. Lawrence to the Hudson River, nearly 800 miles, this break is marked by an unconformable interrupted sequence; the Matinal rocks highly inclined and folded, generally supporting less inclined strata of the Levant or some other middle palæozoic formation. The Scalent or Niagara group, next to the highest of the four true Silurian equivalents, reposes discordantly upon the Upper Cambrian or Matinal, not only in the Peninsula of Gaspé, but in the Eastern Townships and in Vermont. The evidence of a great crust-movement at this epoch of the close of the Matinal slates, was shown by the author as long ago as 1838, in an annual report on the geological survey of Pennsylvania, where he pointed out the unconformity in the vicinity of the Hudson River, and drew the inference of an upheaval of the bed of the ancient ocean. It would appear that throughout this north-eastern division of the Appalachian chain, the movement at the epoch separating the Cambrian and Silurian or older and newer Silurian periods, was so vehement, as to plicate and partially metamorphose the older strata. The condition of unconformity, with and without interruption of sequence in the strata, extends to the west side of the River Hudson, and there is good geological evidence that the displacement of level producing it reached westward as far as Oneida Lake. Undulated Matinal rocks support horizontal Niagara or Scalent strata, with a lapse of two intermediate formations for some distance from the Hudson, westward along the base of the Helderberg range. Ascending the Mohawk valley, the undulation in the Cambrian rocks disappears, and both series become approximately horizontal and parallel, but still with omission of formations.

South-westward from the Hudson, following the north-west margin of the great Appalachian valley, one may trace this plane of discontinuity as far as Eastern Tennessee, or even into Alabama; for throughout this whole distance of 800 or 900 miles, though there is no lapse of a formation at the plane of contact, or any physical unconformity, there is universally so abrupt and crisp an horizon dividing the strata, in respect to composition, conditions of bedding, and organic remains, and such plain evidence that the upper rock was formed from the wreck of the lower ones, that the conviction is inevitable, that a crust-movement revolutionizing the physical geography extended throughout this whole space. The Levant rocks, though next in succession to the Matinal, and reposing conformably upon them, give evidence of such a movement in every feature of their composition. The lower bed is usually a conglomerate composed of fragments of all the underlying formations of the earlier palæozoic or Cambrian series. Some of its pebbles belong to the Primal sandstone; some are of chert from the Auroral limestone, and much of the grey sandy matter has evidently come from the Matinal slate group.

Turning attention to the phænomena connected with this horizon in other parts of the broad Appalachian basin west of the mountains, it can be shown, that, over half the width of the continent, there exists, notwithstanding an almost absolute horizontality and parallelism of the two sets of strata, or the lower and middle palæozoic series, a true discontinuity in the sequence of the formations. In New York there is a conformable interrupted sequence from the Hudson to Oneida county; from Oneida to Lake Ontario the Levant conglomerate, or Lowest Silurian stratum, enters the gap and makes the sequence complete.

But this state of things nowhere again prevails from Lake Ontario westward to Illinois and the Missouri River, nor southward from the Laurentian Lakes to the southern outcrops of the two systems on the borders of Alabama, Arkansas, and Texas.

The Medina sandstone, a higher Levant stratum, partially fills the break across New York, and across Canada to the Manitoulin islands of Lake Huron, where, after constantly thinning, it dies out. Thence to the western boundary of Iowa the hiatus remains unsupplied by any equivalent throughout this whole distance. Tracing the Surgent or Clinton group, the second Silurian formation ascending along the same plane of discontinuity, it is found, after entering the brake or gap near Schoharie, to stretch westward to the Niagara River, and north-westward to the Manitoulins, and possibly thence to Green Bay. Beyond the Niagara River it is an extremely thin bed of limestone and calcareous shale. Thus from the peninsula of Michigan to the cretaceous plains of the Missouri, two entire formations are omitted above the top of the lower palæozoic or Cambrian formations. The Scalent or Niagara series, the third Silurian group, ranges through a wider zone. Thin and obscure in the eastern part of New York, and almost gone in the Appalachian chain from the Hudson southward, it is an important stratum from western New York westward to its disappearance beneath its cretaceous covering in the plains of Nebraska. It was the first middle palæozoic or Silurian deposit, formed upon the floor of the old Appalachian sea, upon its re-immersion after its upheaval at the close of the Matinal period.

Reviewing these statements, we arrive at this interesting general picture:—1st, a violent and universal agitation of the whole bed of the Appalachian palæozoic ocean at the close of the Matinal period, resulting in its upheaval and drainage, from the region of the Gulf of St. Lawrence to that of the centre of the continent, and in a general shoaling of every other portion. 2nd, a more local paroxysmal movement of depression accompanied by the formation of the Levant or Oneida conglomerate, followed by a gradual and successive subsidence, letting in the ocean over a wider space during the Levant and Surgent periods, until in the Scalent or Niagara period the whole area was reclaimed again by the ocean. In the first stage of the subsidence, the sea filled only a long, narrow trough, parallel with the present Appalachians; in the next or Median age, it had spread along its northern coast westward as far as Lake Huron, but was evidently very shallow; and in the following or Surgent period, steadily deepening and supporting more living inhabitants, it extended its bed as far as the western side of Lake Michigan; but not till the Scalent or Niagara age did this second-time created palæozoic ocean recover all its old domain.

Break between the Middle and Lower Palæozoic Formations in the Anticlinal Zones of Ohio, Kentucky, and Tennessee.

The lower palæozoics rise to the day upon this wide flat wave in two districts; one enclosing Cincinnati, the other occupying a central position in the plain of Middle Tennessee. Upon the Matinal strata, which are there very calcareous, there rests not a vestige of the Levant or Medina formation, and scarcely a trace of the Clinton or Surgent. The first Silurian deposit lapping upon the uppermost Cambrian, is the Scalent or Niagara limestone. Still more striking is the hiatus, where the contact of the lower with the middle palæozoic formations is exposed round the margin of the Tennessee anticlinal, for there we find on its eastern side, neither Levant, Surgent, Scalent, nor Premeridian rocks, that is to say, no proper Silurian formation whatsoever, and on its western only a thin layer of the Scalent or Niagara.

Break in Eastern Missouri.—From Lake Superior, by the valley of the Upper Mississippi, and by the Ozark and Washita Hills, to the igneous range of the Rio-Colorado of Texas, there is a chain of broad anticlinals, exposing ancient plutonic and gneissic rocks, but chiefly the older palæozoics near their axes. Around every one of these, either the middle, that is Silurian and Devonian, or upper, namely the Carboniferous deposits, rest in discordant superposition with or without parallelism upon the Primal, Auroral, or Matinal members of the older palæozoic division. This condition prevails in southern Wisconsin, but to a more marked degree around the anticlinal area traversed by the Missouri River eastward of the Osage*.

On the western and northern borders of the Matinal area, some one of the Carboniferous formations very generally reposes unconformably upon the strata of the older palæozoic or Cambrian age, all the middle formations, Silurian and Devonian, being absent. Here then we have the clearest demonstration, that the anticlinal zone of the Lower Missouri remained in the condition of dry land from the period of the general movement of the bed of the Appalachian Sea at the close of the Matinal period throughout all the long ages of the middle palæozoic formations. This district gives evidence of a similar, but less extensive paroxysmal movement, resulting in discordant stratification at the beginning of the Carboniferous period, but the discussion of this and other subsequent displacements of the crust can only be alluded to in this abstract. The physical break visible throughout this western chain of anticlinals implies a wider interval of time, or longer cessation of formative actions, than is discernible anywhere further east within the Appalachian area.

Reasoning from the data afforded by recent geological researches, especially those of Owen, Norwood and Swallow, the author infers that the Silurian waters, even as late as the Scalent or Niagara period, when they had attained their widest expansion, were by no means co-extensive with the wide bounds of that earlier Appalachian ocean which covered the Matinal and other primordial palæozoic sediments. In the middle latitudes of the United States, this Silurian sea had crept no further eastward than a line joining the Tennessee anticlinal and the Helderberg Hills of New York, prolonged thence into New England, Lower Canada, and New Brunswick. It occupied the area of the present Laurentian Lakes, but did not reach the limit of the ancient Matinal sea even in that direction, and towards the west and south-west it did not spread to the Lower Missouri. It was merely a wide Mediterranean, covering the area which is now the northern-middle and north-western Atlantic States. [Want of space compels the omission of that part of the memoir which relates to the Saskatchewan palæozoic basin, and to the Chippewayan region, or that west of the Rocky Mountains.]

Palæozoic Basin of Hudson Bay.—The north-eastern palæozoic basin of North America is encircled on three sides by a low, broad zone of gneissic and azoic strata, between 200 and 300 miles broad, and of a curved length of not less than 3000 miles, from Labrador to the Arctic Sea. This belt is not, in the proper sense, an axis of crust elevation, but more truly, the still uncovered remnant of the broad floor of metamorphic strata upon which the palæozoic deposits of the two great basins which

* See Owen's Geological Survey and Map, of Wisconsin, &c.

fringe it were accumulated. It seems not to have been sensibly upheaved since the date of their deposition.

Of the age of the palæozoic basin of Hudson Bay, recent research has furnished some very suggestive information. According to the statements of the geologists of the Canadian government, and others, it has hitherto disclosed not a single fossil indicative of the existence of either the Primal, Auroral, or Matinal formations of the older palæozoic series, but it abounds in deposits of middle palæozoic or Silurian age. Mr. Isbister, in an admirable summary of the results of research in this region, considers this important general fact to be well-established for all the widely scattered localities hitherto visited. It receives the strongest confirmation from the determinations of Mr. Salter, who has devoted a careful scrutiny to the extensive collection of fossils brought to England by the recent Arctic expeditions. According to Isbister, middle palæozoic or Silurian rocks extend uninterruptedly from Lake Temiscaming, a little above 47° latitude, to the shores of Wellington Channel beyond 77°, or through more than 30°. From all the geological evidence collected, it would appear that a large portion, if not the whole of this wide palæozoic area remained uncovered by the sea throughout the three earlier or Cambrian periods, and was not submersed until that stupendous disturbance of the crust took place which displaced so large a tract of the bed of the Appalachian ocean. This north-eastern area was therefore the nucleus of the continent, or, at least, one island centre, from the infancy of its growth down to the end of the Matinal ages. The stupendous movement which then depressed its central districts, converting it into a Silurian basin, also lifted off a large part of the waters to the south of the neutral axis of motion marked by the dividing zone of metamorphic strata. No sharp corrugations of the crust attended this enormous displacement of the levels, analogous to the crust-undulations of the same epoch between Gaspé and the Hudson. Still the subsidence of the Hudson Bay region must have been violent or paroxysmal, if we are to judge from the conglomerates which strew its immediate floor, their lowest bed, according to Sir William Logan, being composed of great boulders and blocks of sandstone, some of them 9 feet in diameter, so energetic was the disturbance which attended the letting on of the waters. It is not certain that this subsidence occurred at the beginning of the Levant or first Silurian period, for Mr. Salter has shown* that all the strata of the southern border of the Hudson Bay area yet examined, are of the age of the Scalent or Niagara limestone. It is probable that after the first tremendous and nearly universal disturbance of the levels at the close of the Matinal period, there occurred an interval of comparative repose, with a slow deposition of the Levant and Surgent formations in the central and southern tracts of the Appalachian Sea, and also in the central parts of the Hudson Bay basin; and that succeeding this there was a broad, nearly equalized subsidence of the whole northern basin, and the northern half of the southern one in the Scalent or Niagara period.

Reviewing all the facts, it would seem that the wide break in the sequence of the American palæozoic strata above the Matinal, or latest Cambrian formation, is as well indicated north of the Laurentian metamorphic zone as south of it, though not by a physical unconformity in the usual narrow sense, but by a prodigious hiatus in the series of deposits.

[The paper next contains "Evidences of a physical break or interruption in the depositions between the Premeridian or latest Silurian, and Pomeridian or Devonian formations," and also "Evidences of a similar physical break between the Pomeridian and Vespertine, or earliest Carboniferous formations." These instances of discordant sequence are shown to be of less magnitude than that already discussed between the Matinal and succeeding deposits; and as the physical breaks are, so are the palæontologic; the transition in the organic remains being far more complete and abrupt between the lower and middle palæozoics, than between the middle and upper or anywhere within the middle between its Silurian and Devonian equivalents.]

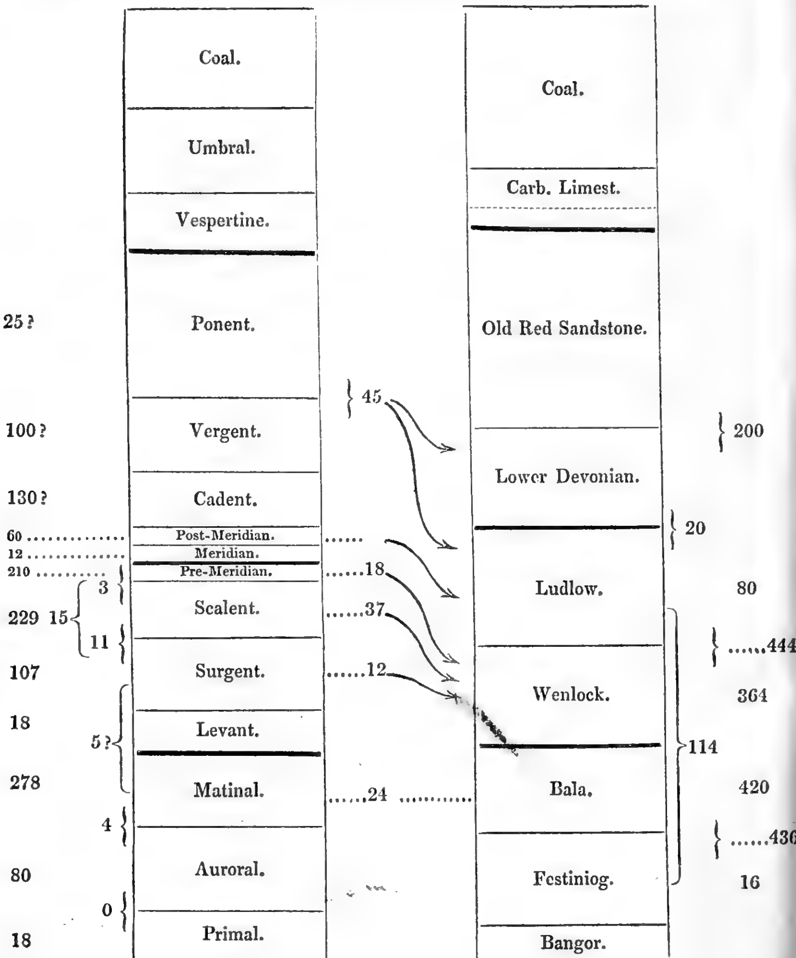
Palæontological Break, or Amount of Change in the Organic Remains between the Older and Middle Palæozoic Strata of the Appalachian Basin.

Great as the physical discordance is between the lower and middle palæozoic formations, the palæontological break or the transition in the fossils is even more re-

* Proceedings of British Association, 1851.

markable. All the American palæozoic formations appear to contain fewer species in common than do the European; and even strictly sequent formations divided by no crisp physical plane, display decidedly abrupt transitions in their organic types. No doubt every such sharp palæontological horizon coincides with a horizon of true physical discontinuity, or sudden change at least, somewhere within the same basin. Indeed, such palæontological planes may be accepted as evidence of important revolutions in the level of the ancient oceanic floor. This horizon of the upper limit of the Matinal rocks is incontestably the sharpest palæontologically within the whole palæozoic system of the Appalachian basin, whether we measure it by the smallness in the proportion of the species which bridge the gulf, or by the

Palæontological relations of the American and European Palæozoic Strata.



alteration in their types of structure. The following summary of the results of the researches of Professor James Hall, and other skilful palæontologists, will show the extent of this revolution in palæozoic life. Unluckily, neither Hall nor any other naturalist, has yet advanced to an exhaustive description and enumeration of the American species above the Scalent and Niagara series, though it is possible to glean valuable data from his essay on the Palæozoic Deposits of the United States and Europe, and from other sources whereby to make the comparison between the Cambrian-Silurian break and the other later horizons of life discontinuity.

The annexed Table presents in a summary form the palæontological relations of the American and European palæozoic strata, indicating the numbers of the species restricted to the several groups, and the numbers which are common to related ones.

It is a striking fact, bearing directly on the present inquiry, that the proportion of organic forms common to the lower and middle palæozoic divisions, scarcely exceeds zero. According to Professor Hall *, the number of species now examined from the lower palæozoics of the United States surpasses 400, and those from the Levant, Surgent, and Scalent series, or all but the uppermost Silurian formation, are about 344. He also states †, that already more than 200 species have been recognized in the Premeridian or Lower Helderberg limestone, from which it would appear that the Silurian or Upper Silurian of Great Britain have yielded about 550 forms. The two sets together have thus turned out about 950 species, or nearly the number catalogued by Professor Morris as found in the corresponding formations in the British Islands. Now it is a most instructive fact, that, out of these nearly 1000 lower and middle palæozoic fossils, only three or four, if as many, span the great break which divides the two groups of rocks. This complete extinction of the earlier or Cambrian races, is a circumstance so important in the comparative palæontology of the two continents, that it deserves to be dwelt on sufficiently to show the precise extent of the evidence. Professor Hall, speaking of the Medina, Clinton, and Niagara groups, states, "In these investigations, some new facts have been brought to light, which all the previous examinations have not shown, the discovery of several species of fossils heretofore known only in the lower rocks. In the western part of the State of New York, the lower beds of the Clinton group have furnished very dilapidated specimens of *Bellerophon trilobatus* with *Delthyrus Lynx,* and one or two imperfect specimens of a *Leptæna* undistinguishable from *L. alternata.* A few other fragments and imperfect specimens have also been found, which appear to be forms belonging to Lower Silurian strata. These facts are extremely important and interesting, and I take the present occasion of recording them, from the circumstance that all our investigations previously had only strengthened the opinion that no fossils of the lower rocks had passed the Oneida conglomerate."

When we compare this remarkable palæontological break, amounting to certainly 99 per cent. of all the discovered organisms from the two sets of strata, with the synchronous break, separating the Cambrian or older Silurian from the Silurian of Great Britain, we find a marked difference in the extent of the discontinuity in the vital stream. Sir Roderick Murchison has shown in an Appendix to his work 'Siluria,' in a Table of the vertical range of the older palæozoic fossils, compiled by Mr. Salter, that not less than 114 species are common to the lower and upper groups. This number, assuming 880 as the species accessible for comparison, is nearly 13 per cent. of the two entire faunas compared. It is obvious, therefore, that the life-break, like the mechanical, was even more complete in the Appalachian portion of the American palæozoic basin, than it was in the British part of the European. A little more than one half of the 880 species enumerated by Professor Morris, belong to the Upper Caradoc, Wenlock, and Ludlow formations, while, according to Mr. Salter's list, 114 species, that is to say, about 22 per cent., range from the Llandeilo into these upper rocks.

We reach a still clearer apprehension of the relative magnitudes of the American and the British palæontological breaks at the Matinal or Caradoc period, when we regard for a moment the additional evidence afforded by comparing the proportionate number of genera which pass the boundary in the two countries. According to Professor Phillips's condensed enumeration framed from Professor Morris's Cata-

* Palæontology of New York, vol. ii. p. 319.

† Foster and Whitney's 'Geology of Lake Superior.'

logue of British Fossils, there are restricted to the strata below the break 136 genera, and to those above it 149, while there are 74 genera common to the two sets. In other words, the proportion of common to restricted is nearly 26 per cent. Turning now to the American older and middle palæozoic faunas, I find, on carefully comparing Hall's catalogues of the fossils of the two corresponding sets of formations (deficient, unfortunately, in any enumeration of Premeridian or latest Silurian species), that there are restricted to

the Primal }
,, Auroral } 53 genera,
,, Matinal }

while there are restricted to

the Levant }
,, Surgent } 81 genera;
,, Scalent }

and that there are 37 genera common to the two series, the whole number of genera being 171. Here the proportion of common to restricted is about 25 per cent. The introduction of the Premeridian fossils, many of which are on the horizon of the Wenlock beds of Britain, would add materially to the proportion of genera not held in common, and would reduce the common to probably less than 20 per cent. Thus even on this broadest basis of comparison, there would seem to have been a much more complete extinction and replacement of organic types in North America, than occurred in Europe, or at least in Britain.

Parallelism of the North American and European Palæozoic Rocks.

Having examined the reciprocal relations of the Appalachian palæozoic strata, and also those of the European palæozoics among themselves, as expressed by the numerical proportions of their fossils, and also by the generic forms of their organic remains, and learned where the stream of life was most continuous, and where most interrupted, it remains to coordinate the deposits of the two basins with each other. Thus may we hope to learn what formations are synchronous, and what are without equivalents. In attempting this correlation, it should be remembered that Nature presents no true or literal equivalency of strata, nor anything closer than a mere approximate relationship where the deposits compared belong to independent basins, or even to the remote sides of the same great receptacle. The most we can hope to establish, is a general agreement in time with possibly a stricter synchronism of the few chief paroxysmal movements which agitated the bed of the ancient ocean. Partially *representative* formations are discoverable, but *equivalent* ones are not to be looked for upon any philosophical view, since the distribution of organic beings is essentially partial or geographical. The life horizons of the globe are no more universal than are its horizons of sedimentation. With these reservations, we turn to the degrees of affinity, linking the American and European palæozoic groups of fossils.

Relations of the Primal Series (*Potsdam sandstone*).—The Appalachian Primal strata characterized by a peculiar group of Trilobites, absent from the higher formations and by those earliest brachiopodous genera, *Obolus*, *Lingula* and *Orbicula*, are obviously nearly on the horizon of Barrande's Primordial zone, and of the lowest rocks of Russia and Scandinavia. Notwithstanding a general agreement of type, there is not a species common to the two continents.

Auroral Series (*Calciferous, Chazy and Black River Groups*).—The Appalachian Auroral strata, containing in New York alone more than 83 recognized forms, possess but a single species, the *Lituites convolvens*, in common with the strata which represent them in Europe. Hall thinks that the Auroral limestones are not represented by any British rocks, nor clearly by any European. Possibly they were approximately contemporaneous with the Swedish Orthoceratite limestone.

Matinal Series (*Trenton and Hudson River Groups*).—This group of formations, Matinal limestone (Trenton), Matinal black slate (Utica), and Matinal shale (Hudson River), would seem, from the testimony of the fossils, to be represented in Great Britain by the Llandeilo flags and Caradoc sandstone, or more generally by Sedgwick's Bala or Upper Cambrian group. It finds also a near equivalent in the Orthoceratite limestone of Sweden and Russia, and in the Graptolite shales. Mr. Hall, the best American authority, states that the Caradoc sandstone is zoologically an equivalent of the Hudson River group. While the Matinal series in New York has afforded more than 250 forms, and the Bala group 122, there are, according to the late Mr. Sharpe's comparison, only 12 in common. M. de Verneuil, contrasting the American and North Europe Matinal fossils, finds only 14 in common. Still the two faunas, though so poor in cosmopolite forms, have so many identical genera that there can be no hesitation in admitting them to be the products of the same age. Of the 20 species common to the American Matinal limestones and Matinal shales, 10, according to Mr. Sharpe, are also European species. This is one among many facts showing that the most widely distributed races were those which best withstood the revolutions between one formation and another. Adding together the British and the North European species, there are only 24 or $6\frac{1}{4}$ per cent. found also in the American basin.

Levant Series (*Medina Group*).—Passing the important horizon which divides the Matinal from the Levant strata, we find that the latter, produced in an age of much crust disturbance, contain a very limited fauna and flora, and seem not to be represented in Europe, but to have been formed in America just prior to the Wenlock period of Great Britain.

Surgent and Scalent Series (*or Clinton and Niagara*).—While the Surgent series contains more than 100 well-defined species, 12 of them are ascertained to be European, and are eminently distinctive of the British Wenlock strata. But this Wenlock formation is equally a representative of the Scalent or Niagara of the United States. The two together contain more than 326 species, the Surgent about 104; the Scalent some 222. Only 15, that is to say about 5 per cent., are common to both; but according to Hall, the Wenlock and its European continental equivalent has, at least, 35 Niagara species. Thus we perceive that the Surgent and Scalent groups are severally in closer affinity with the Wenlock of Europe than with each other. This instructive fact suggests, that, during the quiet deposition of the Wenlock beds, an important crust-movement may have occurred within the Appalachian basin, altering the conditions suitable to its marine inhabitants. The dissimilar areas which the Surgent and Scalent deposits occupy indicate such a shifting of the Appalachian sea-bed. These facts indicate that we cannot proceed securely in the classification of formations until we synchronize them widely.

Premeridian Series (*Lower Helderberg*).—In the region of New York, where this formation has been most closely examined, it has furnished Mr. Hall more than 200 species, only about 9 per cent. of which are also European, being fossils of the Wenlock and Dudley strata; but Mr. Hall thinks that this number of identical forms will be increased on a more critical comparison. Only two or three of the species, namely the *Calymene Blumenbachii, Atrypa reticularis*, &c., occur in any higher or lower stratum. Though thus insulated by its species, it is linked to the adjoining formations by possessing with them many common genera. While palæontologically it has so little in common with the strata above and beneath it, it curiously enough finds more than a tenth part of its organic remains in distant European formations, in the Wenlock especially. This anomaly disappears, however, when we reflect on the superior magnitude of the crust-movements or changes of physical geography which seem to have taken place in the Appalachian sea. Compared with those in the Silurian basin, Mr. Hall, agreeing with Mr. Sharpe, regards the lower Helderberg strata as representing the Wenlock formation of England, while M. De Verneuil considers them equivalent to the Ludlow. Hall admits the propriety of recognizing the Niagara on the one side, and the Lower Helderberg on the other, as of Wenlock age.

Meridian Series (*Oriskany*).—This formation is still more completely insulated from the formations above and beneath it, than any of the preceding. Its fossils, not numerous, are exclusively its own, though they possess features linking them somewhat with those of the next higher formations. Most American geologists, adopting the view of their synchronism, first proposed by M. De Verneuil, regard them as the base of the American Devonian deposits. We shall see, however, that, though nearly on this horizon, no precise coordination of any of the middle palæozoic strata of the two basins is practicable.

Pomeridian, Cadent, and Vergent Series (Upper Helderberg, Hamilton, and Chemung Groups).—These three natural, physical groups of strata, though characterized by many peculiar fossils, are much less completely insulated from each other by their species, than are the formations below them. It is remarkable that they are related almost as intimately to the Silurian-Ludlow formation of England, and to its continental equivalents, as to the European Devonian strata. Only two out of all the Pomeridian species seem to be European; but the general *facies* of the fauna is as much Silurian as Devonian. The number of species common to the Pomeridian and the Cadent rocks, is even less than the number which in England pass upward from the Ludlow into the Devonian. Guided by numerical proportion only, we might be justified in drawing the Silurian-Devonian line, — if the attempt at recognition of the Silurian and Devonian, as independent systems, is legitimate at all for the Appalachian basin, — at the boundary of the Pomeridian and the Cadent. Mr. Hall, who was the first to promulgate explicitly this view of the joint Silurian and Devonian affinities of the American Pomeridian and later strata, reminds us, that in England there is a fusion amounting to 25 per cent. of Silurian-Ludlow fossils with Devonian in the rocks of Devonshire, or 10 per cent. of all the Devonian species described by Professor Phillips. He justly says, "there is no such mingling of species in the American formations." The older members of the American Association of geologists will recollect, that, from an early day, the author, in fellowship with his brother W. B. Rogers, contended, that we should not look for a true equivalence between the formations of the American and European basins, nor hope to discover either the same physical or the same palæontological breaks on both sides of the Atlantic; and that therefore we were forbidden by the rules of a sound philosophy to apply a European nomenclature to the American formations.

Out of more than 220 or 230 species from the Cadent and Vergent (Hamilton and Chemung) strata, about 20 are recognizable as European, Silurian and Devonian forms, though Mr. Hall reduces the list to 12. He thinks that the organic remains of the Cadent series are more closely related to those of the Ludlow formation of England, than to the European Devonian. M. De Verneuil recognizes 39 species of the Pomeridian, Cadent, and Vergent series, as belonging to the Silurian and Devonian rocks of Continental Europe. Mr. Hall is unable to appreciate the evidence which would place all these deposits in parallelism with the Devonian.

From all the foregoing facts and statements, we arrive at this general inference, that upon both palæontological and physical evidence, there is no well-marked Silurian-Devonian break discernible in the North American basin, no proof of an epoch of general interruption in the life-stream, with wide crust-disturbance in the middle palæozoic ages, such as that which in earlier times, in the morning of the palæozoic day, at the Cambro-Silurian transition, revolutionized alike the entire extent of the American and European areas both in their inhabitants and in their physical geography.

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CONTENTS:—Rev. W. Whewell, Account of a Level Line, measured from the Bristol Channel to the English Channel, by Mr. Bunt;—Report on the Discussions of Tides, prepared under the direction of the Rev. W. Whewell;—W. S. Harris, Account of the Progress and State of the Meteorological Observations at Plymouth;—Major E. Sabine, on the Magnetic Isoclinal and Isodynamic Lines in the British Islands;—D. Lardner, LL.D., on the Determination of the Mean Numerical Values of Railway Constants;—R. Mallet, First Report upon Experiments upon the Action of Sea and River Water upon Cast and Wrought Iron;—R. Mallet, on the Action of a Heat of 212° Fahr., when long continued, on Inorganic and Organic Substances.

Together with the Transactions of the Sections, Mr. Murchison's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE NINTH MEETING, at Birmingham, 1839, *Published at* 13*s*. 6*d*.

CONTENTS:—Rev. B. Powell, Report on the Present State of our Knowledge of Refractive Indices, for the Standard Rays of the Solar Spectrum in different media;—Report on the Application of the Sum assigned for Tide Calculations to Rev. W. Whewell, in a Letter from T. G. Bunt, Esq.;—H. L. Pattinson, on some galvanic Experiments to determine the Existence or Non-Existence of Electrical Currents among Stratified Rocks, particularly those of the Mountain Limestone formation, constituting the Lead Measures of Alston Moor;—Sir D. Brewster, Reports respecting the two series of Hourly Meteorological Observations kept in Scotland;—Report on the subject of a series of Resolutions adopted by the British Association at their Meeting in August 1838, at Newcastle;—R. Owen, Report on British Fossil Reptiles;—E. Forbes, Report on the Distribution of pulmoniferous Mollusca in the British Isles;—W. S. Harris, Third Report on the Progress of the Hourly Meteorological Register at the Plymouth Dockyard.

Together with the Transactions of the Sections, Rev. W. Vernon Harcourt's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TENTH MEETING, at Glasgow, 1840, *Published at* 15*s*.

CONTENTS:—Rev. B. Powell, Report on the recent Progress of discovery relative to Radiant Heat, supplementary to a former Report on the same subject inserted in the first volume of the Reports of the British Association for the Advancement of Science;—J. D. Forbes, Supplementary Report on Meteorology;—W. S. Harris, Report on Prof. Whewell's Anemometer, now in operation at Plymouth;—Report on "The Motions and Sounds of the Heart," by the London Committee of the British Association, for 1839-40;—Prof. Schönbein, an Account of Researches in Electro-Chemistry;—R. Mallet, Second Report upon the Action of Air and Water, whether fresh or salt, clear or foul, and at various temperatures, upon Cast Iron, Wrought Iron and Steel;—R. W. Fox, Report on some Observations on Subterranean Temperature;—A. F. Osler, Report on the Observations recorded during the years 1837, 1838, 1839 and 1840, by the Self-registering Anemometer erected at the Philosophical Institution, Birmingham;—Sir D. Brewster, Report respecting the two Series of Hourly Meteorological Observations kept at Inverness and Kingussie, from Nov. 1st, 1838 to Nov. 1st, 1839;—W. Thompson, Report on the Fauna of Ireland: Div. *Vertebrata*;—C. J. B. Williams, M.D., Report of Experiments on the Physiology of the Lungs and Air-Tubes;—Rev. J. S. Henslow, Report of the Committee on the Preservation of Animal and Vegetable Substances.

Together with the Transactions of the Sections, Mr. Murchison and Major E. Sabine's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE ELEVENTH MEETING, at Plymouth, 1841, *Published at* 13*s*. 6*d*.

CONTENTS:—Rev. P. Kelland, on the Present state of our Theoretical and Experimental Knowledge of the Laws of Conduction of Heat;—G. L. Roupell, M. D., Report on Poisons;—T. G. Bunt, Report on Discussions of Bristol Tides, under the direction of the Rev. W. Whewell;—D. Ross, Report on the Discussions of Leith Tide Observations, under the direction of the Rev. W. Whewell;—W. S. Harris, upon the working of Whewell's Anemometer at Plymouth during the past year;—Report of a Committee appointed for the purpose of superintending the scientific co-operation of the British Association in the System of Simultaneous Observations in Terrestrial Magnetism and Meteorology;—Reports of Committees appointed to provide Meteorological Instruments for the use of M. Agassiz and Mr. M'Cord;—Report of a Committee to superintend the reduction of Meteorological Observations;—Report of a Committee for revising the Nomenclature of the Stars;—Report of a Committee for obtaining Instruments and registers to record Shocks and Earthquakes in Scotland and Ireland;—Report of a Committee on the Preservation of Vegetative Powers in Seeds;—Dr. Hodgkin, on Inquiries into the Races of Man;—Report of the Committee appointed to report how far the Desiderata in our knowledge of the Condition of the Upper Strata of the Atmosphere may be supplied by means of Ascents in Balloons or otherwise, to ascertain the probable expense of such Experiments, and to draw up Directions for Observers in such circumstances;—R. Owen, Report on British Fossil Reptiles; Reports on the Determination of the Mean Value of Railway Constants:—D. Lardner, LL.D., Second and concluding Report on the Determination of the Mean Value of Railway Constants;—E. Woods, Report on Railway Constants;—Report of a Committee on the Construction of a Constant Indicator for Steam-Engines.

Together with the Transactions of the Sections, Prof. Whewell's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWELFTH MEETING, at Manchester, 1842, *Published at* 10*s.* 6*d.*

CONTENTS:—Report of the Committee appointed to conduct the co-operation of the British Association in the System of Simultaneous Magnetical and Meteorological Observations;—J. Richardson, M.D., Report on the present State of the Ichthyology of New Zealand;—W. S. Harris, Report on the Progress of Meteorological Observations at Plymouth;—Second Report of a Committee appointed to make Experiments on the Growth and Vitality of Seeds;—C. Vignoles, Report of the Committee on Railway Sections;—Report of the Committee for the Preservation of Animal and Vegetable Substances;—Lyon Playfair, M.D., Abstract of Prof. Liebig's Report on Organic Chemistry applied to Physiology and Pathology;—R. Owen, Report on the British Fossil Mammalia, Part I.;—R. Hunt, Researches on the Influence of Light on the Germination of Seeds and the Growth of Plants;—L. Agassiz, Report on the Fossil Fishes of the Devonian System or Old Red Sandstone;—W. Fairbairn, Appendix to a Report on the Strength and other Properties of Cast Iron obtained from the Hot and Cold Blast;—D. Milne, Report of the Committee for Registering Shocks of Earthquakes in Great Britain;—Report of a Committee on the construction of a Constant Indicator for Steam-Engines, and for the determination of the Velocity of the Piston of the Self-acting Engine at different periods of the Stroke;—J. S. Russell, Report of a Committee on the form of Ships;—Report of a Committee appointed "to consider of the Rules by which the Nomenclature of Zoology may be established on a uniform and permanent basis."—Report of a Committee on the Vital Statistics of large Towns in Scotland;—Provisional Reports, and Notices of Progress in special Researches entrusted to Committees and Individuals.

Together with the Transactions of the Sections, Lord Francis Egerton's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE THIRTEENTH MEETING, at Cork, 1843, *Published at* 12*s.*

CONTENTS:—Robert Mallet, Third Report upon the Action of Air and Water, whether fresh or salt, clear or foul, and of Various Temperatures, upon Cast Iron, Wrought Iron, and Steel;—Report of the Committee appointed to conduct the co-operation of the British Association in the System of Simultaneous Magnetical and Meteorological Observations;—Sir J. F. W. Herschel, Bart., Report of the Committee appointed for the Reduction of Meteorological Observations;—Report of the Committee appointed for Experiments on Steam-Engines;—Report of the Committee appointed to continue their Experiments on the Vitality of Seeds;—J. S. Russell, Report of a Series of Observations on the Tides of the Frith of Forth and the East Coast of Scotland;—J. S. Russell, Notice of a Report of the Committee on the Form of Ships;—J. Blake, Report on the Physiological Action of Medicines;—Report of the Committee on Zoological Nomenclature;—Report of the Committee for Registering the Shocks of Earthquakes, and making such Meteorological Observations as may appear to them desirable;—Report of the Committee for conducting Experiments with Captive Balloons;—Prof. Wheatstone, Appendix to the Report;—Report of the Committee for the Translation and Publication of Foreign Scientific Memoirs;—C. W. Peach on the Habits of the Marine Testacea;—E. Forbes, Report on the Mollusca and Radiata of the Ægean Sea, and on their distribution, considered as bearing on Geology;—L. Agassiz, Synoptical Table of British Fossil Fishes, arranged in the order of the Geological Formations;—R. Owen, Report on the British Fossil Mammalia, Part II.;—E. W. Binney, Report on the excavation made at the junction of the Lower New Red Sandstone with the Coal Measures at Collyhurst;—W. Thompson, Report on the Fauna of Ireland: Div. *Invertebrata*;—Provisional Reports, and Notices of Progress in Special Researches entrusted to Committees and Individuals.

Together with the Transactions of the Sections, Earl of Rosse's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE FOURTEENTH MEETING, at York, 1844, *Published at* £1.

CONTENTS:—W. B. Carpenter, on the Microscopic Structure of Shells;—J. Alder and A. Hancock, Report on the British Nudibranchiate Mollusca;—R. Hunt, Researches on the Influence of Light on the Germination of Seeds and the Growth of Plants;—Report of a Committee appointed by the British Association in 1840, for revising the Nomenclature of the Stars;—Lt.-Col. Sabine, on the Meteorology of Toronto in Canada;—J. Blackwall, Report on some recent researches into the Structure, Functions, and Œconomy of the *Araneidea* made in Great Britain;—Earl of Rosse, on the Construction of large Reflecting Telescopes; —Rev. W. V. Harcourt, Report on a Gas-furnace for Experiments on Vitrifaction and other Applications of High Heat in the Laboratory;—Report of the Committee for Registering Earthquake Shocks in Scotland;—Report of a Committee for Experiments on Steam-Engines; —Report of the Committee to investigate the Varieties of the Human Race;—Fourth Report of a Committee appointed to continue their Experiments on the Vitality of Seeds;—W. Fairbairn, on the Consumption of Fuel and the prevention of Smoke;—F. Ronalds, Report concerning the Observatory of the British Association at Kew;—Sixth Report of the Committee appointed to conduct the Co-operation of the British Association in the System of Simultaneous Magnetical and Meteorological Observations;—Prof. Forchhammer on the influence of Fucoidal Plants upon the Formations of the Earth, on Metamorphism in general, and particularly the Metamorphosis of the Scandinavian Alum Slate;—H. E. Strickland, Report on the recent Progress and Present State of Ornithology;—T. Oldham, Report of Committee appointed to conduct Observations on Subterranean Temperature in Ireland;—Prof. Owen, Report on the Extinct Mammals of Australia, with descriptions of certain Fossils indicative of the former existence in that continent of large Marsupial Representatives of the Order Pachydermata;—W. S. Harris, Report on the working of Whewell and Osler's Anemometers at Plymouth, for the years 1841, 1842, 1843;—W. R. Birt, Report on Atmospheric Waves; —L. Agassiz, Report sur les Poissons Fossiles de l'Agile de Londres, with translation;—J. S. Russell, Report on Waves;—Provisional Reports, and Notices of Progress in Special Researches entrusted to Committees and Individuals.

Together with the Transactions of the Sections, Dean of Ely's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE FIFTEENTH MEETING, at Cambridge, 1845, *Published at* 12*s*.

CONTENTS:—Seventh Report of a Committee appointed to conduct the Co-operation of the British Association in the System of Simultaneous Magnetical and Meteorological Observations;—Lt.-Col. Sabine, on some points in the Meteorology of Bombay;—J. Blake, Report on the Physiological Actions of Medicines;—Dr. Von Boguslawski, on the Comet of 1843; —R. Hunt, Report on the Actinograph;—Prof. Schönbein, on Ozone;—Prof. Erman, on the Influence of Friction upon Thermo-Electricity;—Baron Sentfenberg, on the Self-Registering Meteorological Instruments employed in the Observatory at Sentfenberg;—W. R. Birt, Second Report on Atmospheric Waves;—G. R. Porter, on the Progress and Present Extent of Savings' Banks in the United Kingdom;—Prof. Bunsen and Dr. Playfair, Report on the Gases evolved from Iron Furnaces, with reference to the Theory of Smelting of Iron;—Dr. Richardson, Report on the Ichthyology of the Seas of China and Japan;—Report of the Committee on the Registration of Periodical Phænomena of Animals and Vegetables;—Fifth Report of the Committee on the Vitality of Seeds;—Appendix, &c.

Together with the Transactions of the Sections, Sir J. F. W. Herschel's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE SIXTEENTH MEETING, at Southampton, 1846, *Published at* 15*s*.

CONTENTS:—G. G. Stokes, Report on Recent Researches in Hydrodynamics;—Sixth Report of the Committee on the Vitality of Seeds;—Dr. Schunck on the Colouring Matters of Madder;—J. Blake, on the Physiological Action of Medicines;—R. Hunt, Report on the Actinograph;—R. Hunt, Notices on the Influence of Light on the Growth of Plants;—R. L. Ellis, on the Recent Progress of Analysis;—Prof. Forchhammer, on Comparative Analytical Researches on Sea Water;—A. Erman, on the Calculation of the Gaussian Constants for 1829;—G. R. Porter, on the Progress, present Amount, and probable future Condition of the Iron Manufacture in Great Britain;—W. R. Birt, Third Report on Atmospheric Waves;—Prof. Owen, Report on the Archetype and Homologies of the Vertebrate Skeleton;—J. Phillips, on Anemometry;—J. Percy, M.D., Report on the Crystalline Flags;—Addenda to Mr. Birt's Report on Atmospheric Waves.

Together with the Transactions of the Sections, Sir R. I. Murchison's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE SEVENTEENTH MEETING, at Oxford, 1847, *Published at* 18*s*.

CONTENTS:—Prof. Langberg, on the Specific Gravity of Sulphuric Acid at different degrees of dilution, and on the relation which exists between the Development of Heat and the coincident contraction of Volume in Sulphuric Acid when mixed with Water;—R. Hunt, Researches on the Influence of the Solar Rays on the Growth of Plants;—R. Mallet, on the Facts of Earthquake Phænomena;—Prof. Nilsson, on the Primitive Inhabitants of Scandinavia;—W. Hopkins, Report on the Geological Theories of Elevation and Earthquakes; —Dr. W. B. Carpenter, Report on the Microscopic Structure of Shells;—Rev. W. Whewell and Sir James C. Ross, Report upon the Recommendation of an Expedition for the purpose of completing our knowledge of the Tides;—Dr. Schunck, on Colouring Matters;—Seventh Report of the Committee on the Vitality of Seeds;—J. Glynn, on the Turbine or Horizontal Water-Wheel of France and Germany;—Dr. R. G. Latham, on the present state and recent progress of Ethnographical Philology;—Dr. J. C. Prichard, on the various methods of Research which contribute to the Advancement of Ethnology, and of the relations of that Science to other branches of Knowledge;—Dr. C. C. J. Bunsen, on the results of the recent Egyptian researches in reference to Asiatic and African Ethnology, and the Classification of Languages; —Dr. C. Meyer, on the Importance of the Study of the Celtic Language as exhibited by the Modern Celtic Dialects still extant;—Dr. Max Müller, on the Relation of the Bengali to the Arian and Aboriginal Languages of India;—W. R. Birt, Fourth Report on Atmospheric Waves;—Prof. W. H. Dove, Temperature Tables; with Introductory Remarks by Lieut.-Col. E. Sabine;—A. Erman and H. Petersen, Third Report on the Calculation of the Gaussian Constants for 1829.

Together with the Transactions of the Sections, Sir Robert Harry Inglis's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE EIGHTEENTH MEETING, at Swansea, 1848, *Published at 9s.*

CONTENTS:—Rev. Prof. Powell, A Catalogue of Observations of Luminous Meteors;—J. Glynn, on Water-pressure Engines;—R. A. Smith, on the Air and Water of Towns;—Eighth Report of Committee on the Growth and Vitality of Seeds;—W. R. Birt, Fifth Report on Atmospheric Waves;—E. Schunck, on Colouring Matters;—J. P. Budd, on the advantageous use made of the gaseous escape from the Blast Furnaces at the Ystalyfera Iron Works;—R. Hunt, Report of progress in the investigation of the Action of Carbonic Acid on the Growth of Plants allied to those of the Coal Formations;—Prof. H. W. Dove, Supplement to the Temperature Tables printed in the Report of the British Association for 1847;—Remarks by Prof. Dove on his recently constructed Maps of the Monthly Isothermal Lines of the Globe, and on some of the principal Conclusions in regard to Climatology deducible from them; with an introductory Notice by Lt.-Col. E. Sabine;—Dr. Daubeny, on the progress of the investigation on the Influence of Carbonic Acid on the Growth of Ferns;—J. Phillips, Notice of further progress in Anemometrical Researches;—Mr. Mallet's Letter to the Assistant-General Secretary;—A. Erman, Second Report on the Gaussian Constants;—Report of a Committee relative to the expediency of recommending the continuance of the Toronto Magnetical and Meteorological Observatory until December 1850.

Together with the Transactions of the Sections, the Marquis of Northampton's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE NINETEENTH MEETING, at Birmingham, 1849, *Published at* 10*s*.

CONTENTS:—Rev. Prof. Powell, A Catalogue of Observations of Luminous Meteors;—Earl of Rosse, Notice of Nebulæ lately observed in the Six-feet Reflector;—Prof. Daubeny, on the Influence of Carbonic Acid Gas on the health of Plants, especially of those allied to the Fossil Remains found in the Coal Formation;—Dr. Andrews, Report on the Heat of Combination; —Report of the Committee on the Registration of the Periodic Phænomena of Plants and Animals;—Ninth Report of Committee on Experiments on the Growth and Vitality of Seeds; —F. Ronalds, Report concerning the Observatory of the British Association at Kew, from Aug. 9, 1848 to Sept. 12, 1849;—R. Mallet, Report on the Experimental Inquiry on Railway Bar Corrosion;—W. R. Birt, Report on the Discussion of the Electrical Observations at Kew.

Together with the Transactions of the Sections, the Rev. T. R. Robinson's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWENTIETH MEETING, at Edinburgh, 1850, *Published at* 15*s*.

CONTENTS:—R. Mallet, First Report on the Facts of Earthquake Phænomena;—Rev. Prof. Powell, on Observations of Luminous Meteors;—Dr. T. Williams, on the Structure and History of the British Annelida;—T. C. Hunt, Results of Meteorological Observations taken at St. Michael's from the 1st of January, 1840, to the 31st of December, 1849;—R. Hunt, on the present State of our Knowledge of the Chemical Action of the Solar Radiations;—Tenth Report of Committee on Experiments on the Growth and Vitality of Seeds;—Major-Gen. Briggs, Report on the Aboriginal Tribes of India;—F. Ronalds, Report concerning the Observatory of the British Association at Kew;—E. Forbes, Report on the Investigation of British Marine Zoology by means of the Dredge;—R. MacAndrew, Notes on the Distribution and Range in depth of Mollusca and other Marine Animals, observed on the coasts of Spain, Portugal, Barbary, Malta, and Southern Italy in 1849;—Prof. Allman, on the Present State of our Knowledge of the Freshwater Polyzoa;—Registration of the Periodical Phænomena of Plants and Animals;—Suggestions to Astronomers for the Observation of the Total Eclipse of the Sun on July 28, 1851.

Together with the Transactions of the Sections, Sir David Brewster's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWENTY-FIRST MEETING, at Ipswich, 1851, *Published at* 16*s*. 6*d*.

CONTENTS:—Rev. Prof. Powell, on Observations of Luminous Meteors;—Eleventh Report of Committee on Experiments on the Growth and Vitality of Seeds;—Dr. J. Drew, on the Climate of Southampton;—Dr. R. A. Smith, on the Air and Water of Towns: Action of Porous Strata, Water and Organic Matter;—Report of the Committee appointed to consider the probable Effects in an Œconomical and Physical Point of View of the Destruction of Tropical Forests;—A. Henfrey, on the Reproduction and supposed Existence of Sexual Organs in the Higher Cryptogamous Plants;—Dr. Daubeny, on the Nomenclature of Organic Compounds;—Rev. Dr. Donaldson, on two unsolved Problems in Indo-German Philology;—Dr. T. Williams, Report on the British Annelida;—R. Mallet, Second Report on the Facts of Earthquake Phænomena;—Letter from Prof. Henry, to Col. Sabine, on the System of Meteorological Observations proposed to be established in the United States;—Col. Sabine, Report on the Kew Magnetographs;—J. Welsh, Report on the Performance of his three Magnetographs during the Experimental Trial at the Kew Observatory;—F. Ronalds, Report concerning the Observatory of the British Association at Kew, from September 12, 1850, to July 31, 1851;—Ordnance Survey of Scotland.

Together with the Transactions of the Sections, Prof. Airy's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWENTY-SECOND MEETING, at Belfast, 1852, *Published at* 15*s*.

CONTENTS:—R. Mallet, Third Report on the Facts of Earthquake Phænomena;—Twelfth Report of Committee on Experiments on the Growth and Vitality of Seeds;—Rev. Prof. Powell, Report on Observations of Luminous Meteors, 1851–52;—Dr. Gladstone, on the Influence of the Solar Radiations on the Vital Powers of Plants;—A Manual of Ethnological Inquiry;—Col. Sykes, Mean Temperature of the Day, and Monthly Fall of Rain at 127 Stations under the Bengal Presidency;—Prof. J. D. Forbes, on Experiments on the Laws of the Conduction of Heat;—R. Hunt, on the Chemical Action of the Solar Radiations;—Dr. Hodges, on the Composition and Œconomy of the Flax Plant;—W. Thompson, on the Freshwater Fishes of Ulster;—W. Thompson, Supplementary Report on the Fauna of Ireland;—W. Wills, on the Meteorology of Birmingham;—J. Thomson, on the Vortex-Water-Wheel;—J. B. Lawes and Dr. Gilbert, on the Composition of Foods in relation to Respiration and the Feeding of Animals.

Together with the Transactions of the Sections, Colonel Sabine's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWENTY-THIRD MEETING, at Hull, 1853, *Published at* 10*s*. 6*d*.

CONTENTS:—Rev. Prof. Powell, Report on Observations of Luminous Meteors, 1852–53;—James Oldham, on the Physical Features of the Humber;—James Oldham, on the Rise, Progress, and Present Position of Steam Navigation in Hull;—William Fairbairn, Experimental Researches to determine the Strength of Locomotive Boilers, and the causes which lead to Explosion;—J. J. Sylvester, Provisional Report on the Theory of Determinants;—Professor Hodges, M.D., Report on the Gases evolved in Steeping Flax, and on the Composition and Œconomy of the Flax Plant;—Thirteenth Report of Committee on Experiments on the Growth and Vitality of Seeds;—Robert Hunt, on the Chemical Action of the Solar Radiations;—John P. Bell, M.D., Observations on the Character and Measurements of Degradation of the Yorkshire Coast; First Report of Committee on the Physical Character of the Moon's Surface, as compared with that of the Earth;—R. Mallet, Provisional Report on Earthquake Wave-Transits; and on Seismometrical Instruments;—William Fairbairn, on the Mechanical Properties of Metals as derived from repeated Meltings, exhibiting the maximum point of strength and the causes of deterioration;—Robert Mallet, Third Report on the Facts of Earthquake Phænomena (continued).

Together with the Transactions of the Sections, Mr. Hopkins's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWENTY-FOURTH MEETING, at Liverpool, 1854, *Published at* 18*s*.

CONTENTS:—R. Mallet, Third Report on the Facts of Earthquake Phænomena (continued);—Major-General Chesney, on the Construction and General Use of Efficient Life-Boats;—Rev. Prof. Powell, Third Report on the present State of our Knowledge of Radiant Heat;—Colonel Sabine, on some of the results obtained at the British Colonial Magnetic Observatories;—Colonel Portlock, Report of the Committee on Earthquakes, with their proceedings respecting Seismometers;—Dr. Gladstone, on the influence of the Solar Radiations on the Vital Powers of Plants, Part 2;—Rev. Prof. Powell, Report on Observations of Luminous Meteors, 1853–54;—Second Report of the Committee on the Physical Character of the Moon's Surface;—W. G. Armstrong, on the Application of Water-Pressure Machinery;—J. B. Lawes and Dr. Gilbert, on the Equivalency of Starch and Sugar in Food;—Archibald Smith, on the Deviations of the Compass in Wooden and Iron Ships; Fourteenth Report of Committee on Experiments on the Growth and Vitality of Seeds.

Together with the Transactions of the Sections, the Earl of Harrowby's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWENTY-FIFTH MEETING, at Glasgow, 1855, *Published at* 15*s*.

CONTENTS:—T. Dobson, Report on the Relation between Explosions in Coal-Mines and Revolving Storms;—Dr. Gladstone, on the Influence of the Solar Radiations on the Vital Powers of Plants growing under different Atmospheric Conditions, Part 3;—C. Spence Bate, on the British Edriophthalma;—J. F. Bateman, on the present state of our knowledge on the Supply of Water to Towns;—Fifteenth Report of Committee on Experiments on the Growth and Vitality of Seeds;—Rev. Prof. Powell, Report on Observations of Luminous Meteors, 1854–55;—Report of Committee appointed to inquire into the best means of ascertaining those properties of Metals and effects of various modes of treating them which are of importance to the durability and efficiency of Artillery;—Rev. Prof. Henslow, Report on Typical Objects in Natural History;—A. Follett Osler, Account of the Self-Registering Anemometer and Rain-Gauge at the Liverpool Observatory;—Provisional Reports.

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PLATE VI.

Fig. 1. Three adult specimens of *Arca grandis,* Brod. & Sby., laid on the same hinge-line: *n,* normal state; *e,* elongated; *o,* obese.
Fig. 2. The same specimens in profile.
Fig. 3. Two young specimens, showing that the changes of form are not merely the result of circumstances of growth: *e,* elongated; *t,* transverse.
Fig. 4. The same specimens in profile. The *A. æquilatera,* Sby., is probably the young of this species. It has been selected from a group usually constant in its characters; the nestling Byssoarks being notoriously irregular.

PLATE VII.

Fig. 1 *a*. *Cyrena Mexicana*, Brod. & Sby. Two young specimens laid together at the left angle between the dorsal margin and the umbo: *n*, normal; *e*, elongated. In this state it forms part of *C. Floridana*, Desh. MS., non Conr.

Fig. 1 *b*. Four specimens, similarly placed, adult: *n*, the largest shell, normal shape; *e*, elongated; *r*, rounded; *a*, an extreme form, described by Dr. Gould as *C. altilis*. The *Cyrenæ* are generally very regular shells.

Fig. 2. Two specimens of *Avicula sterna*, Gould: the black line, normal; the dotted line, with the characteristic tail almost evanescent, while the upper ears are enormously developed.

Fig. 3. *Gadinia pentegoniostoma*, Sby.: *a*, normal state, round, margin deeply crenate, ribs deeply grooved internally; these characters pass away more or less in the other specimens; *b*, with one corner; *c*, with two corners; *d*, with three corners; *e*, with four corners; *f*, with five corners; *g*, with six corners obscurely marked.

Fig. 4. *Glyphis inæqualis*, Sby., including *Fissurella pica*, Sby., and *F. mus*, Rve.: *a*, extreme form, type of *F. inæqualis*, oblong, with faint sculpture, shown at *a′*, and trilobed hole; *b*, lobes of hole evanescent; *c*, form *F. mus*; *d*, type of *F. pica*, oval, with rounded hole and strong sculpture shown at *d′*; *e, f, g, h, i, k, l, m, n*, internal views of the hole and callosity, magnified, showing the great changes of form, and the development or absence of the posterior truncation and pit. This, with an oval hole, are considered generic characters by Messrs. H. & A. Adams: *vide* Gen. vol. i. p. 447 (as *Lucapina*, but not of Gray, except *L. crenulata*).

Fig. 5. *Fissurella rugosa*, Sby., including *F. chlorotrema*, Mke., *F. humilis*, Mke., and *F. viminea*, Mke. non Rve.: *a*, finely grown, with faint, flattened, smooth ribs, and trilobed hole; *b*, normal state, ribs faint, hole suboval; *c*, specimen of irregular growth, normal outline when young, ribs stronger; *d*, specimen with ribs on the upper portion strongly developed; *e*, specimen of coarse growth, ribs nodulous; *f*, extreme form, from which the species was described, ribs very strong and irregular. The colour varies from uniform green to nearly uniform red; the young shells being generally green with a red patch. *g, h, i, k*, interior sketches of hole and callosity. The shape of the hole is generally a very constant character in *Fissurellidæ*.

PLATE VIII.

Fig. 1. Development and varieties of *Crepidula nivea*, C. B. Ad., including *Calyptræa squama*, Brod., *Calyptræa Lessonii*, Brod., and *Crepidula striolata*, Mke. (=*Crypta nivea*, *Ianacus squama*, and *Ianacus Lessonii*, H. & A. Ad.): *a*, inside view of very young specimen, deck just forming; *b*, ditto, a stage older; *c*, ditto, older, less magnified, anterior sinus not developed (*Crypta*, H. & A. Ad.); *d*, external view, showing prominent, ribbed apex; *e*, another specimen, rayed (*squama*, Brod.); *f*, group of deck-margins, the horizontal line representing the medial point; the two to the right are young, magnified; the rounding of the outline and development of the anterior sinus, made of subgeneric importance by Messrs. Adams, here appear extremely variable; *g*, a normal specimen, margin sharp; *h*, the same indented by attachment to a *Strombus granulatus*; *i*, margin in layers, flattened, abnormally thickened near the umbo; *j*, outside view, form *striolata*, the layers beginning to appear separate outside; *k*, layers here and there prominent, form *Lessonii*, shell concentrically striated, and with colour rays as in *e*; *l*, an abnormally bilobed specimen, form *Lessonii*; *m*, a specimen abnormally costated, by attachment to a ribbed shell; *n*, inside view of two specimens, laid with the deck-margin to correspond, to show the great length of deck in the lined specimen, and its shortness in the dotted one; *o*, two specimens similarly laid, one long and straight, the other rounded and semispiral, like *Crepipatella*, H. &

A. Ad.; the long specimen has grown in the burrow of a *Lithophagus*, and displays margin-layers at the umbonal region, and one Lessonioid lamina in front; *p*, profile of the last-named specimen, with deck prominent, and back somewhat indented, as in *C. explanata*, Gld.

Fig. 2. Young state of *Crepidula unguiformis*, Lam. (*Ianacus*, H. & A. Ad.), to compare with the last species, which it closely resembles when adolescent: *a*, inside view, showing large imbedded spiral portion; *b*, outside, showing flattened, smooth spire.

Fig. 3. *Crepidula aculeata*, Gmel., including *Calyptræa echinus*, Brod., *Calyptræa hystrix*, Brod., *Crepidula Californica*, Nutt., and probably *Crepidula costata*, Mke. (not Sby.), subgenus *Crepipatella*, H. & A. Ad.: *a*, young state, like *Neritina*, deck just commencing; *b*, ditto, a stage older; *c*, the same in profile; *d*, ditto, somewhat older; *e*, ditto, a little older; *f*, outside view, older, showing spiral growth, margin not produced, spines just appearing; *g*, a group of deck-margins, arranged as in fig. 1 *f*, the three to the right being magnified; the second from the left is the normal state; in the first, not only the characteristic medial angle is rounded off, but an abnormal angle appears, turned the wrong way; *h*, two specimens, outside view, to show straight and spiral growth, as in fig. 1 *o*; *i*, two specimens, laid with the upper margins corresponding, to show disproportionate length of deck; the short deck belongs to the dotted margin; *j*, two specimens in profile; one arched, with deck internal; the other (dotted) flat, with deck prominent.

Fig. 4. *Lophyrus articulatus*, Sby.: *a*, front profile of a specimen abnormally trilobed; the dotted line shows the same profile of an elevated specimen; *b*, terminal valves of two specimens, one with inner margin incurved, the other excurved; *c*, medial valves of two specimens, one much waved, the other nearly straight. These characters are much dwelt on by Middendorff in the discrimination of species.

Fig. 5. A monstrosity of *Fissurella virescens*, Sby., inside view, with a circular hole in addition to the normal one.

PLATE IX.

Fig. 1. *Crucibulum imbricatum*, Sby., Brod., Desh. = *Patella scutellata*, Wood, = *Calypeopsis rugosa*, Less. non Desh.: including the non-pitted form, *Dyspotæa dentata*, Mke. = *Calyptræa ? extinctorium*, Sby. non Lam. = *Calyptræa rugosa*, Val., Rve., non Desh.: showing development. *a*, fry, magnified, outside view; *b*, ditto, inside, shell like *Narica*, with umbilical chink, slight columellar lip, and a thin film of patelliform margin surrounding the whole; *c*, young state, slightly magnified, cup much expanded; in this state it appears to belong to the subgenus *Dispotæa* (Say) of H. & A. Ad.; *d*, ditto, outside view, ribs scarcely indicated; *e*, adolescent, ribs strongly developed, cup-angle narrower; *f*, a stage nearer maturity, cup-margins nearly closed; *g*, adult state.

Fig. 2. *Crepidula ?dorsata*, Brod., var. *bilobata*, nearly adult (*Crepipatella dorsata*, H. & A. Ad.), to compare with *fig.* 1 *c* and 3 *a*.

Fig. 3. *Crucibulum spinosum*, Sby., = *Patella Peziza*, Wood, = *Calyptræa tubifera*, Less., = *Calypeopsis auriculata*, D'Orb. non Chemn.; including *Calypeopsis tenuis*, *C. hispida*, and *C. maculata*, Brod. The *C. quiriquina*, Less. = *C. Byronensis*, Gray, MS. = *C. rugosa*, D'Orb. (pars), is probably a coarse variety of the same species; and the *C. rugosa*, Desh., non Less. nec Val. = *C. lignaria*, Brod., may be a distorted growth of the same variety. *a*, young state, magnified; *b*, the same, a stage older, wrinkles developed crenating the margin, shape abnormal; *c*, inside of smooth form, adult; *d*, a specimen with the cup diseased, probably owing to the decay of half the outside, where the commencement of the cup may be seen exposed; margin of the undecayed part thick and in layers, as in *C. quiriquina*; *e*, outside view of specimen without spines, wrinkles very faint; *f*, specimen with a very few rudimentary spines in the form of tubercles, and faint, curved, radiating lines indicating the direction in which the spines would normally appear; *g*, another specimen, smooth over most of the surface, but with spines fully developed at the top; *h*, a specimen with wrinkles almost evanescent, yet with a few well-developed spines, in straight radiating lines; *i*, a specimen of normal development, with irregular wrinkles crossed by curved rows of spines; *j*, portion of internal margin of specimen *h*; *k*, margin of specimen with spines partly formed, open; *l*, ditto fully developed, hollow throughout; *m*, profile of specimen beginning with regular margin, smooth, afterwards with irregular margin and a few long spines at one corner; *n*, profile of smooth specimen beginning regularly, then with different amounts of irregularity, ending with a regular margin; *o*, three specimens in profile, laid for the vertex to coincide; the first is flattened throughout, forming a regular, obtuse-angled triangle; the second (shaded) begins very conical, spinous, then with two stages, flattened, smooth; the third begins like the first, then spreads somewhat, but ends much compressed; *p*, an abnormal specimen found by Mr. Cuming in a hole, from deep water, and figured in Trans. Zool. Soc. vol. i. pl. 28. f. 8; the long spines are curved backwards over the flat shell, and the cup is extremely prominent; the dotted line represents the outline of a shell at the opposite extreme, var. *compresso-conicum*, Proc. Zool. Soc. 1856, p. 167.

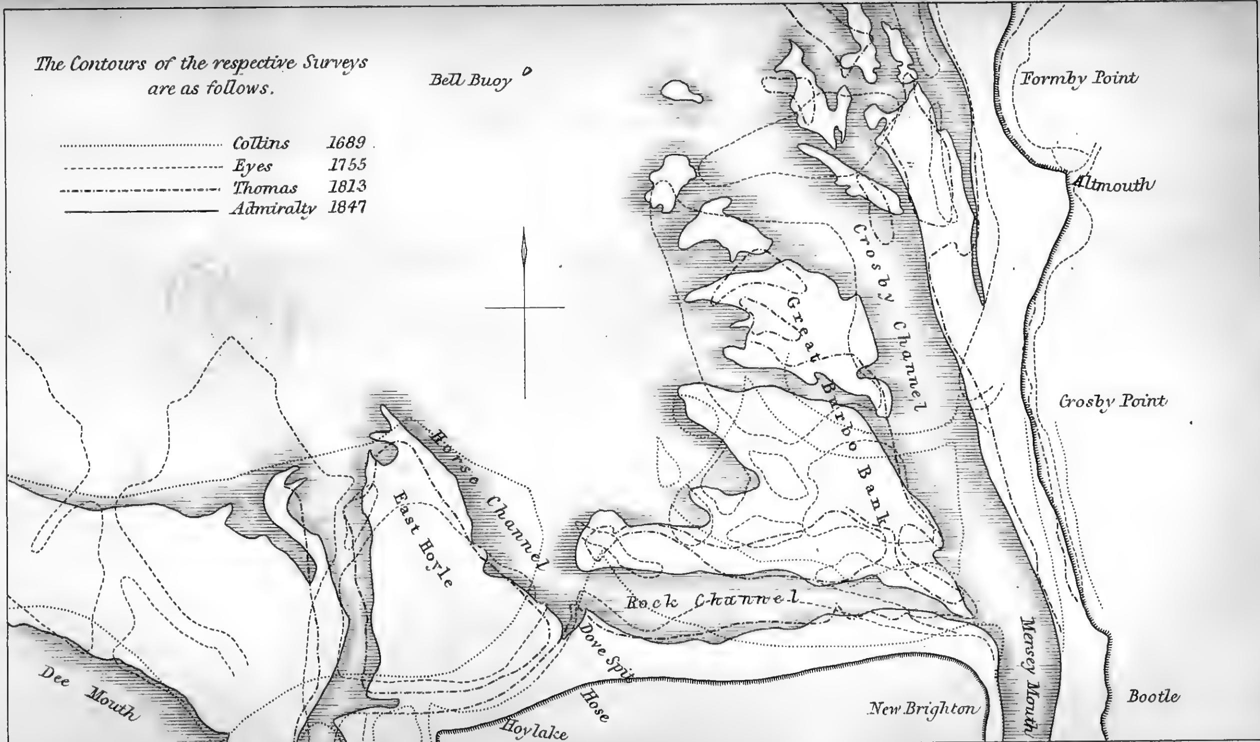
Fig. 4. *Cæcum undatum*, magnified, exhibiting development and variations in shape, sculpture, form of mouth, prominence of plug, &c., observed among about 340 specimens. Similar changes in the common Panama species form the *Cæcum diminutum*, *C. pygmæum*, *C. monstrosum*, *C. eburneum* and *C. firmatum* of Prof. C. B. Adams: (*a*, young *Cæcum*, with spiral part attached, species not known;) *b*, tube smooth and short; *c*, ditto, long; *d*, with faint indications of rings near the margin; *e*, shell more curved; marginal rings stronger; *f*, shell passing at once from smooth to fully ringed state; *g*, the same, more bent, rings irregular; *h*, ditto, curvature irregular; *i*, with more rings, outline very irregular; *j*, stumpy form, rings close, mouth immature; *k*, adult, front view, with multispiral operculum *in situ*, apical portion smooth; *l*, another specimen, mouth contracted, apical portion ringed; *m*, normal state, profile; *n*, specimen with rings almost evanescent; *o*, deformed specimen, broken, and mended without rings. All the irregularities in these figures are intended.

Fig. 5. *Neritina cassiculum*, Sby.: *a*, elevated state, corresponding with subgenus *Vitta* (Klein) of Messrs. Adams; *b*, normal state, subgenus *Neritina* (Swains.) of Messrs. Adams; *c*, depressed state, answering to restricted genus *Neritella* (Humph.) of Messrs. Adams. The same changes of form are observable in the very closely related *Neritina picta*, Sby. = *Vitta picta* of Messrs. Adams.

P. P. Carpenter.

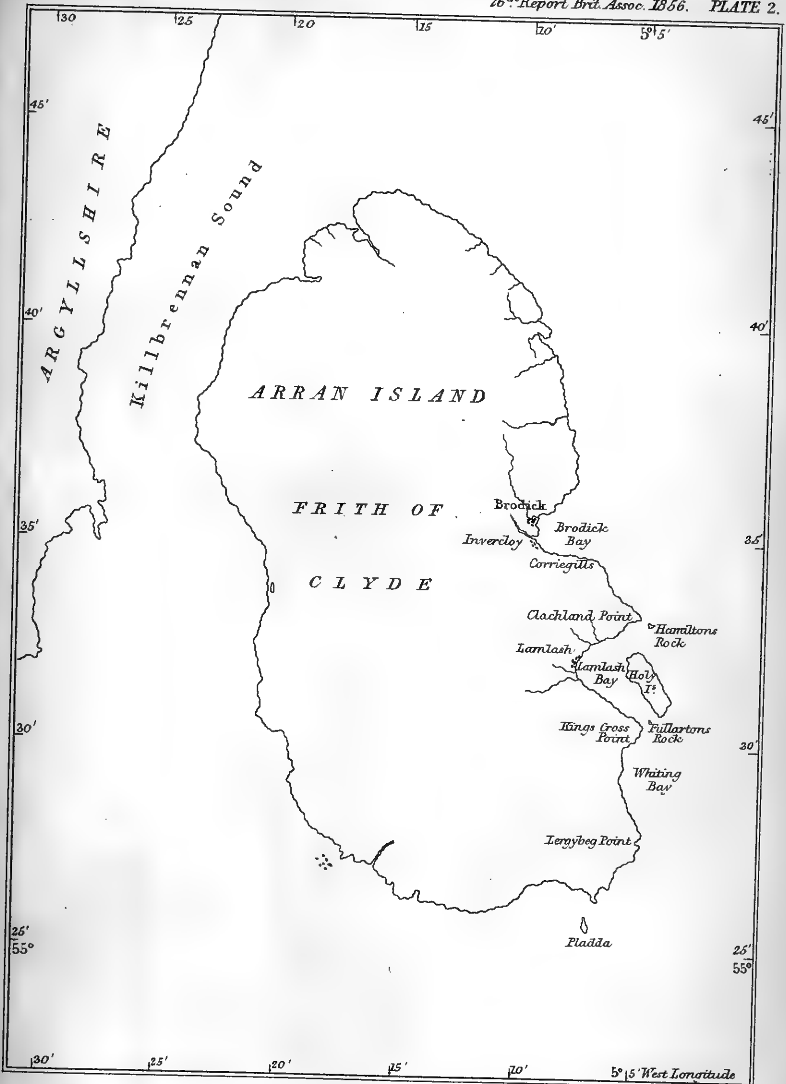
Chart A

Plate 1.



J.B. DELT.

J.W. LOWRY SC.



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Invercloy
Corriegills
Clachland Point
Hamiltons Rock
Lamlash
Lamlash Bay
Holy Is
Kings Cross Point
Fullartons Rock
Whiting Bay
Lergybeg Point
Pladda
5° 5' West Longitude

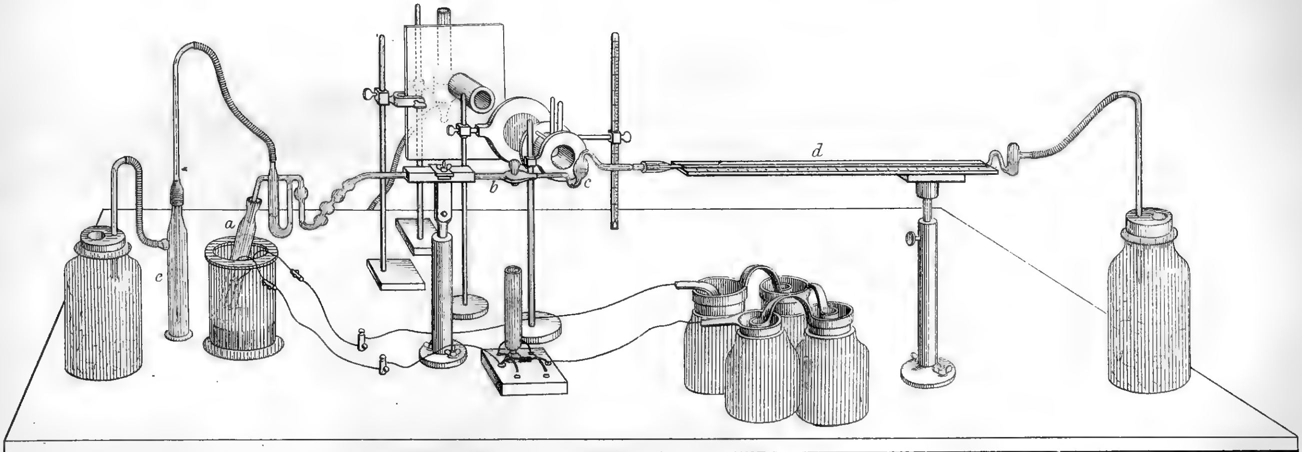

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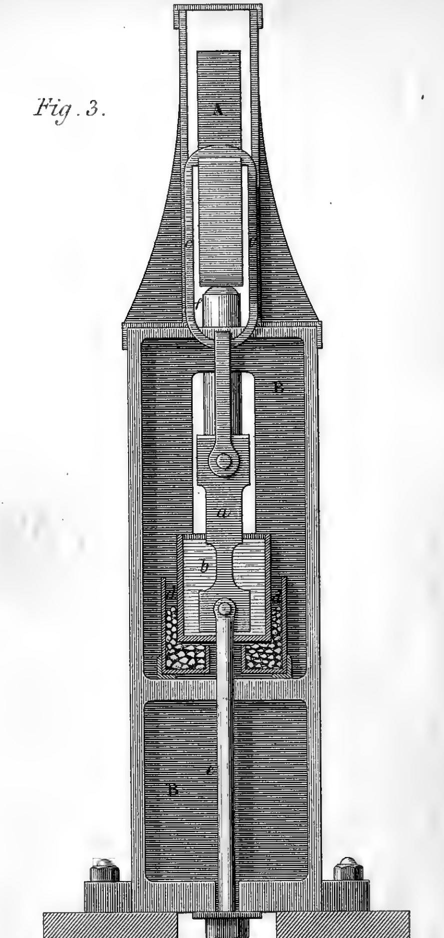
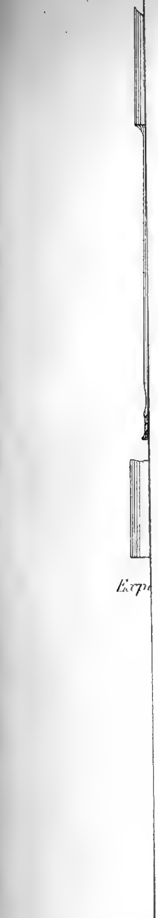
Fig. 3.





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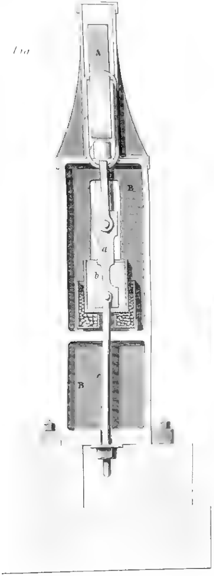
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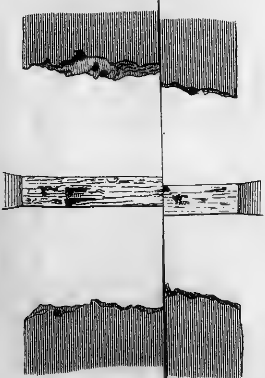

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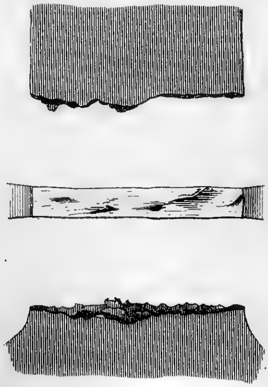

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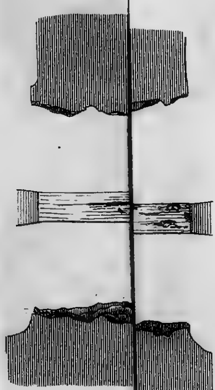

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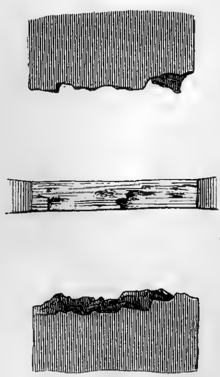

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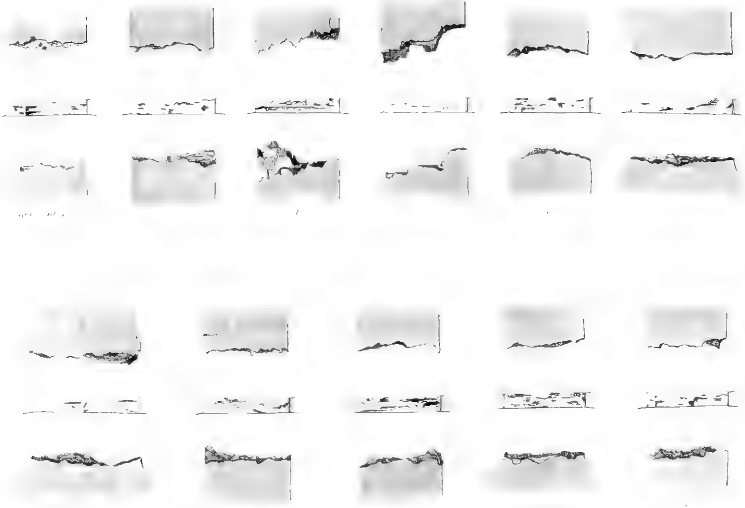

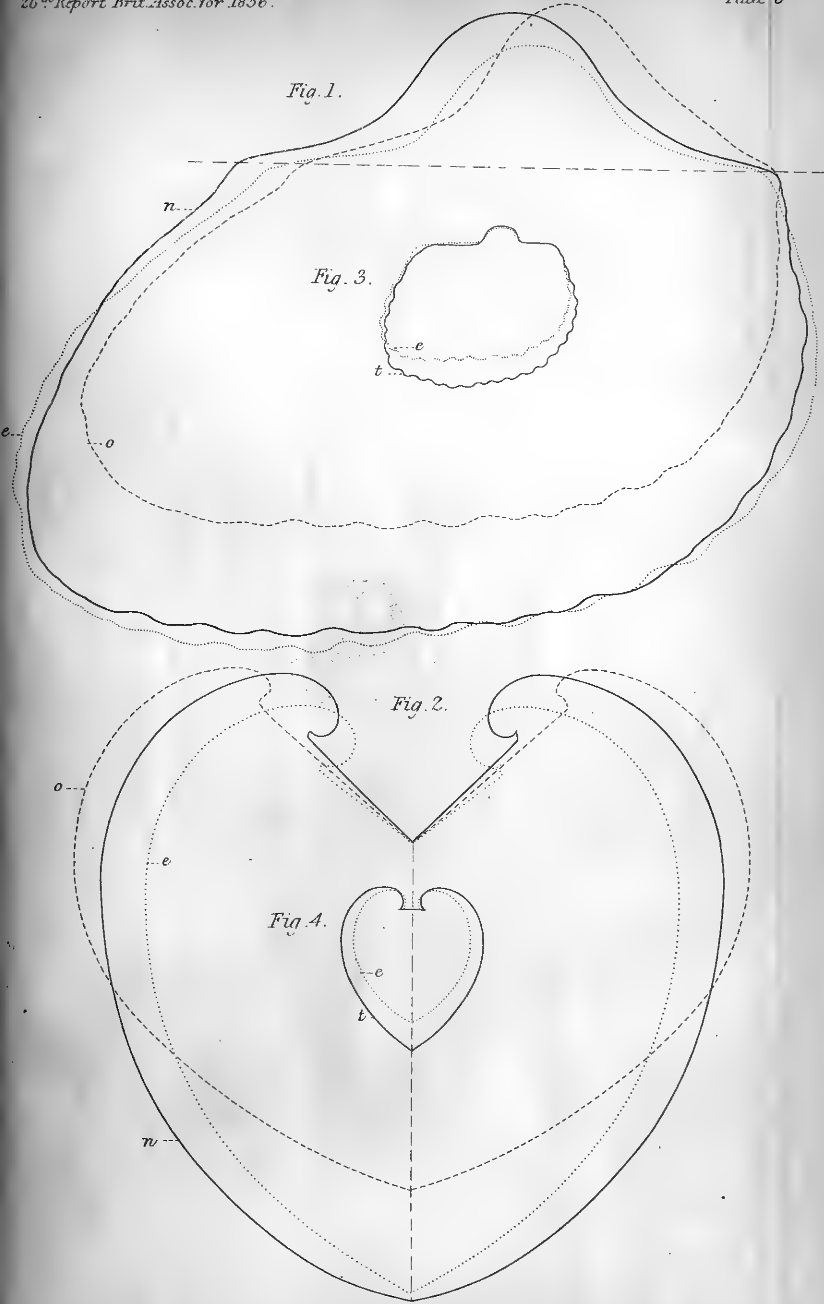

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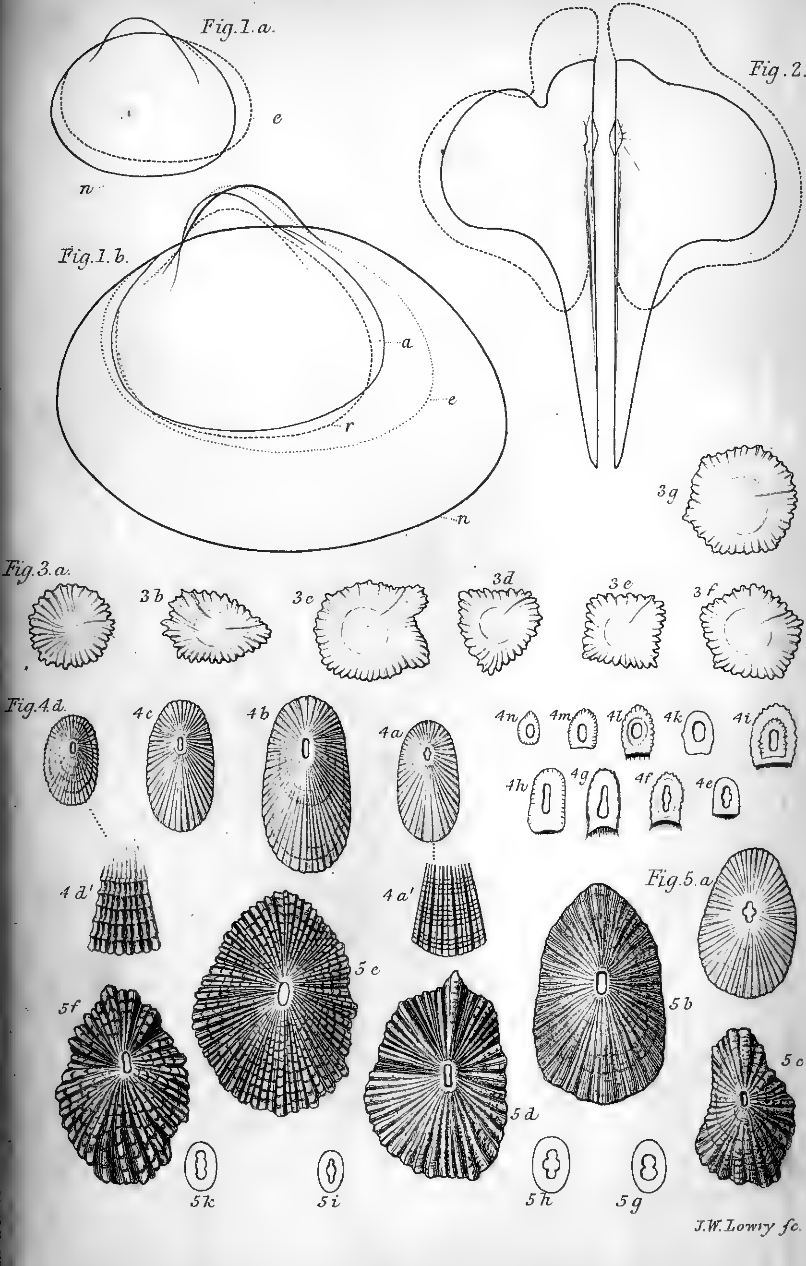
Fig. 1. a.
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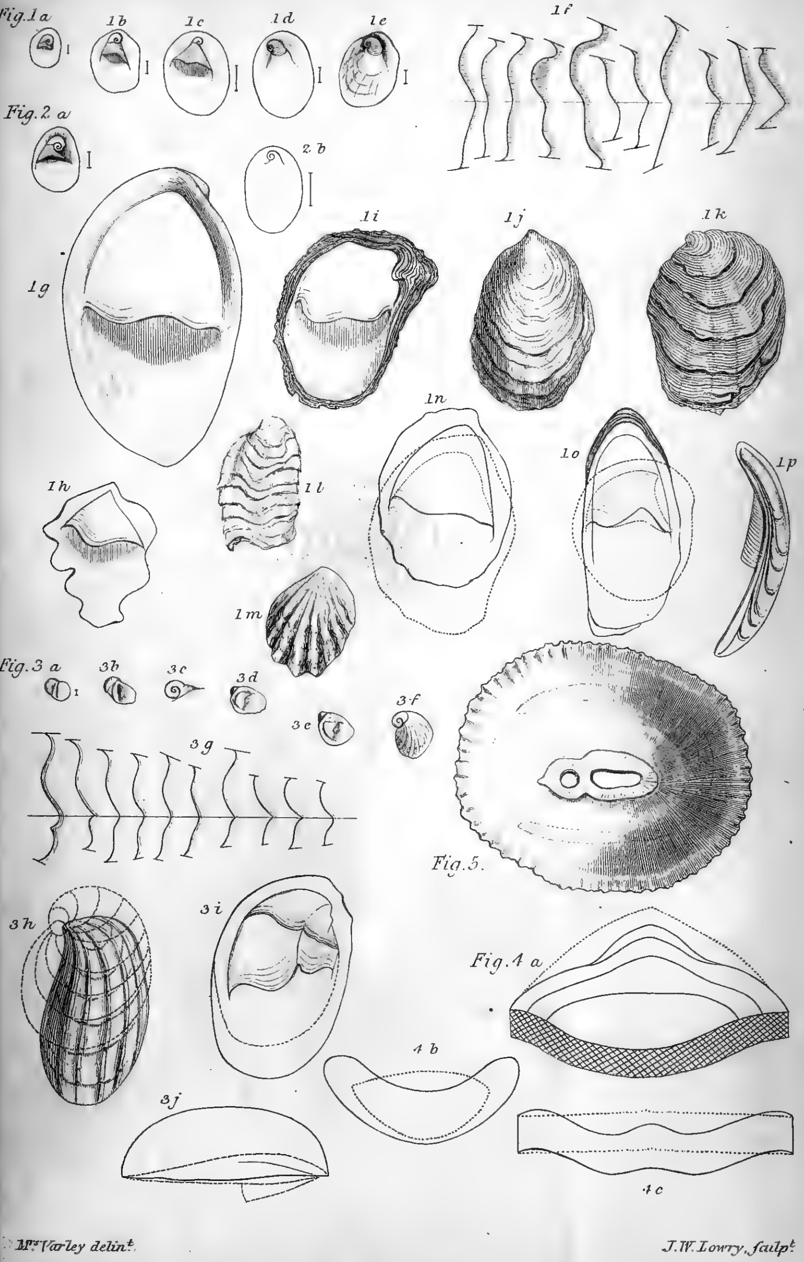

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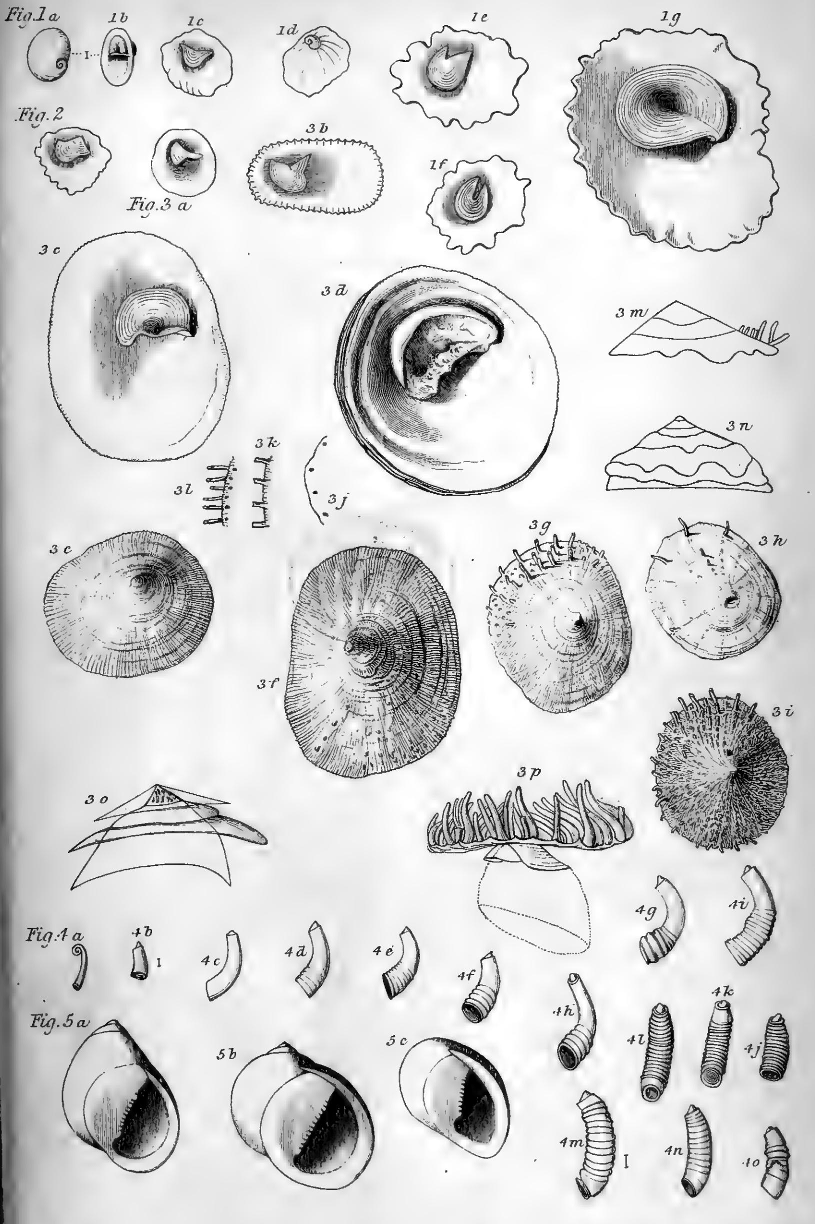

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